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IMPACT OF FINLEY-JENSEN PROBLEM SOLVING MODEL ON PERFORMANCE AND RETENTION IN 3-D GEOMETRY AMONG SSII STUDENTS IN ZARIA METROPOLIS KADUNA STATE, NIGERIA

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Abstract

The study investigated the Impact of Finley-Jensen Problem-Solving Model on Performance and Retention in 3-D Geometry among SSII Students in Zaria Metropolis, Kaduna State, Nigeria. Two research Questions and two null hypotheses were formulated to guide the study. Fifteen Public Senior Secondary Schools in Zaria educational zone made up of the population of this study. Two schools were randomly selected using simple random sampling techniques as the samples. The study adopted pretest, posttest and post posttest quasi experimental nonequivalent control design. The pretest and posttest were to find out the students' performance equivalent while post posttest is to find the Retention ability. The reliability coefficient was found to be 0.74 using (SPSS) at α=0.05 level of significance. Both descriptive and inferential statistics were used. The findings shows that Finley-Jensen Problem-Solving Model enhances the Performance and Retention of Secondary School Students on 3-D Geometry concepts. Finley-Jensen Problem-Solving Model should therefore, be incorporated into the main stream of pedagogy in the teaching of Mathematics and other science subjects at senior secondary schools in Zaria Local Government, Kaduna, Nigeria.

Introduction

Mathematics is the Quantity, Structure, Space and Change. Mathematics Education is the practice of teaching and learning Mathematics along with the associated scholarly research. The teaching of Mathematics started with Arithmetic in the Southern part of Nigeria brought by the missionaries. Mathematics is a compulsory subject for both primary and secondary school students and even to some courses at tertiary levels. The concept of mathematics as a school subject had developed in Christian mission schools in the south but the subject was done in three different sections as Arithmetic, Algebra and Geometry, though at that time syllabus was planned by Cambridge syndicate WAEC. By 1956, Mathematics became one single subject in the West Africa School Certificate Examinations, but Arithmetic remained as a separate subject to Mathematics in Teacher Training College (Hassan, 2007). Mathematics has very wide application in the field of science and engineering technology and even in social sciences. Despite its importance, performance in mathematics is generally poor especially in the finishing examinations of WAEC or SSCE and NECO. Many variables had been identified as responsible for poor performance in mathematics. Such variables include Curriculum, Examination Bodies, Teachers, Students, Environment and Textbooks. Lack of interest by students toward mathematics also contributes a lot in poor performance.

Geometry from the Ancient Greek; geo "earth", -metro "measurement" arose as the field of knowledge dealing with 2-D and 3-D relationships. Geometry was one of the two fields of pre-modern mathematics, the other being the study of numbers. Numerous studies have shown that geometry is of great important than most areas of Mathematics and also, helps students to understand and love Mathematics (Julie, 2015). Geometry is highly important so much so that, engineers apply its knowledge in construction of houses, cars, chairs and almost all equipment we use in our day-to-day activities, as such there is a need of good academic performance in the subject area.

Academic performance is the extent to which a student, teacher or institution has achieved their short or long-term educational goals. Completion of educational degrees such as higher diploma and bachelor's degrees represent academic achievement (Friedman and Mandela 2011). Academic performance is commonly measured through examinations and continuous assessments, but there is no general agreement on how it is best evaluated or which aspects are most important procedural knowledge such as skills or declarative knowledge such as facts. Furthermore, there are inconclusive results over which individual factors successfully predict academic performance, elements such as test anxiety, environment, motivation, and emotions require consideration when developing models of school achievement (Hannon & Ann 2014).

Retention is the act of keeping something in one's memory and can be seen as the ability to learn, to recall, remember and recollect a body of knowledge after passing through instruction (Yero, 2011). Retention is a Latin world. (Re, means hold and tenere means back, re-tenere meaning, back to hold), teaching for conceptual understanding can leads to longer retention of mathematical knowledge. Retention in mathematics is the power to recall, remember, and retain the mathematical concepts taught or learning in the classes.

The Finley-Jensen problem solving model (1996) is based on Dewey (1933) and Bruner (1973) theories of learning. These scholars have agreed that meaningful learning can only be achieved through active participation of learners. Problem Solving is among the methods that support constructivism theory of learning, since it allows students to be actively participating in the classroom activities, develop creativity and problem-solving skills, promotes autonomy, responsibility and independence (Bruner, 1961). In this case learners are free to select and transform information, construct hypotheses, and make decision, relying on a cognitive structure (schema and mental models) to do so, people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experience. In constructivism classroom, the focus tends to shift from the expert (teacher) to the students that, the expert cannot be pouring knowledge into passive learners, who wait like empty vessels to be filled (Driscoll, 2005). In general, according to constructivism theory of learning, learners should learn through active participation and teaching method should be learners-centered. The active participation of learners in learning made learning to be real, create effective retention and also, motivate learners to discover things by themselves, while teachers remain as facilitators by guiding the learners to grasp things (Obioma, 2005). Students need regular chances to engage in problem solving so that they can become mathematically proficient.

Remillard, and Smith, (2007), opined that, mathematically proficient students exhibit problem solving behaviors such as reading problems carefully and understanding them, creating models, and making speculations about strategies and solutions. (Kilpatrick et al, 2001), stated that, children lacking mathematical proficiency demonstrate ineffective mathematical behaviors such as attempting to solve problems without making sense of the problem's context. Moreover, they are less likely to use their knowledge of mathematics content while problem solving. (Eccles, 2002), Stated that, Problem solving goes beyond the typical thinking and reasoning students employ while solving exercises. It means thinking deeply about concepts, their associated representations, possible solution procedures, related context or cultural knowledge, and creating problem models (Mayer & Wittrock, 2006).

According to the National Council of Teachers of Mathematics (2010), problem solving facilitates the extension of students' learning and nurtures the development of students' conceptual understanding, communication, and reasoning skills. Problem solving must remain part of day-to-day teaching because, solving problems is essential to doing and learning mathematics (Schoenfield, 1985). Mathematical Problem Solving is a complex and integrative task. This task requires a learner to understand the information that is presented in the problem. Furthermore, mathematical problem solving requires a person to select and use cognitive strategies and processes that are necessary for task completion. Cognitive strategies and processes for mathematical problem solving are technical methods or tools that help individuals plan and solve a problem. Possible cognitive strategies and processes can include finding the algorithm, estimating the problem, or drawing a diagram (Montague *et al*, 2011). Many problem-solving models have been developed over the years to determine the components required for successful problem solving. For example, Polya's (1945) model outlines four problem stages:

i. Understand the problem;
ii. Devise a plan;
iii. Carry out the plan;
iv. Check the solution.

This model also addresses various heuristic strategies. Heuristic strategies are techniques that help problem solver think through the problem when he encounters difficulties. Heuristic strategies are generally posed as questions (Foong, 2007). For instance, possible heuristic strategies for the second problem stage (i.e., devise a plan) can include asking oneself the following questions:

Do I know a related problem?
Do I know a theorem that could be useful?
Can I restate the problem?
Mayer (1985) developed a related model for mathematical problem solving.

This model outlines four stages:

i. Problem translation;
ii. Problem integration;
iii. Solution planning;
iv. Solution execution.

i. Problem translation refers to interpreting any grammatical and numerical information.
ii. Problem integration means understanding the relationship between the components of the problem to the mathematical structure.
iii. Solution planning: involves selecting appropriate operations,
iv. Solution execution means calculating the final solution to the problem.

Some strategies of problem solving were adopted by several researches and pose a problem for learners to solve was formulated by (Finely & Jensen, 1996). The teacher explained a concept for a short while and allowed learners to solve the problem individually and then later discuss the similarities and differences in group.

Step I: Problem was posed to the students similar to the concept to be taught. The purpose of this step is to make students become familiar with some concepts in 3-D geometry.

Step II: Student were allowed to think and solve a challenge presented to them individually on piece of paper or any rough page. This is to allow students to be expose to 3-D geometry.

Step III: Students were allowed to discuss in pairs the similarities and differences between their answers. This is to make all learners to fully involve in the study of 3-D geometry. Teacher allowed the students to accept the views of the others while working in group.

Step IV: Here, students were allowed to share their thoughts and findings. This enhances, students to assist themselves so as to validate others' views and make reliable conclusion. Teaching material both the improvised and classical will be used, this is to allow proper delivery of the lessons and will make students to learn faster. Upon this, the study investigated the Impact of Finely-Jensen Problem-Solving Model on Performance and Retention in 3-D Geometry among SSII Students in Zaria Metropolis, Kaduna State, Nigeria.

Objectives of the Study

The main objective of this study is to determine the Impact of Finely-Jensen Problem Solving model on Students' 3-D Geometry Performance among SSII in Zaria metropolis Kaduna State Nigeria.

Determine the impact of Finely-Jensen Problem Solving model on Students' Retention ability in 3-D Geometry among SSII Students in Zaria Education Zone.

Research Questions

To guide the study, a research question was formulated:

i. Is there any significant difference in the mean performance scores of students in SSII taught 3-D Geometry concept using Finely - Jensen problem-solving model and those taught with lecture method?
ii. Is there any significant difference in the Retention ability of students taught 3-D Geometry concept using Finely - Jensen problem-solving model and those taught with lecture method?

Hypotheses:

The hypotheses are going to be tested at alpha (α)$= 0.05$ level of significance.

Ho_1: There is no significant difference between the mean performance scores of Students taught 3-D Geometry concept with Finely-Jensen problem solving model and those taught with lecture method.

$Ho_{2:}$ There is no significant difference between in the Retention ability of Students taught 3-D Geometry concept with Finely - Jensen problem solving model and those taught with lecture method.

Methodology

The research design for this study is pretest-post-test and post posttest non-equivalent control design. The essence of pre-test was to determine the academic equivalence of the two groups before the treatment while post posttest was to determine the performance and retention ability of the student after the treatment. The students in the experimental group were exposed to 3-D geometry concept through problem solving model for a period of four (4) weeks and the control group were taught the same concepts using conventional lecture method. After which post and post posttest was administered to both groups.

The population of this study comprised of public Senior Secondary Schools Students in SSII within Zaria educational zone of Kaduna State, Nigeria. There are Fifteen Public Senior Secondary Schools in Zaria Local Government with the total number, of 4,021 Students out of which 2,427 are males and 1,594 are females as at the time the data were collected.

For the purpose of this study, a simple random sampling technique was used to select from the sample schools. The instrument for this study is 3-D Geometry performance test (3-D GAT), developed for the research. For the purpose of generating and analyzing data 3-D GAT comprises ten (10) items of essay test questions was developed, this is because: Essay test allow students to express their ideas with relatively few restraints. Essay involves recall and write, there are no options to select from, and therefore guessing is eliminated. The students must supply answer rather than selecting the good response, thus, it involved descriptive knowledge of students. The posttest in this study is to check the academic performance of the students on 3- D geometry Concept in Zaria local government.

Results

The result was analyzed using descriptive statistics answer the research question while inferential Statistics was used to test the null hypotheses at alpha equals 0.05.

Research Question

Research Question: Is there any significant difference in the mean performance scores of students in SSII taught 3-D geometry concept using Finely-Jensen problem-solving model and those taught with conventional method? To answer question, the mean score between the two groups was determined using descriptive statistics and the result is presented in the table below.

Table 1: Mean and Standard deviation for performance

Group	N	Min.	Max.	Mean	SD
Experimental	93	10	43	22.26	9.99
Control	91	11	25	14.86	6.20

Table 1 shows that after exposure to Finely-Jensen problem solving model and Conventional Lecture Method. The experimental group had a mean performance score of 22.26, while the control group had a mean performance of 14.86. This shows that the students in the experimental group had some level of improvement as a result of exposure to Finely & Jensen problem solving model. The standard deviation is an indicative value of wide variability between the scores of the group.

Table 2: Mean and Standard deviation of students' retention ability of Experimental and control groups

Group	N	Min	Max	Mean	SD
Experimental	93	17	46	32.35	7.21
Control	91	2	29	14.90	6.57

The results in table 2 shows that the students in the experimental group had a mean score of 32.35 retained higher than their counterparts in the control group with a mean score of 14.90. This shows that Finley – Jensen enhances students' retention ability.

Hypotheses Testing: In this section all the null hypotheses were tested using student's t-test at $\propto = 0.05$ significant level.

Ho_1: There is no significant difference between the mean performance scores of Students taught 3-Dgeometryconcept with Finely-Jensen problem solving model and those taught with lecture method;

Table 3: test on students' performance of Experimental and Control Groups;

Group	N	Mean	SD	t_{cal}	t_{crit}	df	Remark
Experimental	93	22.26	9.99				
				10.95	1.98	182	S
Control	91	14.86	6.20				

S = significant $(p < 0.05)$

Table 3 shows that the experimental group's performance has the mean of 22.26 while for the control group the mean is 14.86. Hence, the null hypothesis one which states that 'there is no significant difference in the mean performance scores of students taught 3-D geometry concept using Finely-Jensen problem solving model and those taught using the Conventional Method of Teaching' is hereby rejected. This is therefore, means that there is a significant difference in the performance scores of students taught 3-D geometry concept using Finely-Jensen problem solving model. But from the table above we $t_{critical\ (1.98)} < t_{calculated\ (10.95)}$ at α=0.05 significant level. Thus, H_{02} is rejected and the alternative hypothesis is accepted.

Ho_2: There is no significant difference in the retention ability of Students taught 3-D geometry using Finely-Jensen Problem Solving model and that of those taught with conventional method;

Table 4: T-test on students' retention ability of Experimental and Control Groups

Group	N	Mean	SD	t_{cal}	t_{crit}	Df	Remark
Experimental	93	24.40	7.21				
				15.78	1.99	182	S
Control	91	14.86	6.57				

S=significant $(p < 0.05)$

Table 4: above shows that, the mean scores of post posttest of both the experimental and control groups with the mean of 24.40 and 14.86 respectively. The hypothesis two says "there is no significant difference between in the retention ability of students taught 3-D geometry using Finely-Jensen problem solving model and that of those taught using conventional method". But from the table above we $t_{critical\ (1.99)} < t_{calculated\ (15.78)}$ at α=0.05 significant level. Thus, Ho_2 is rejected and the alternative hypothesis is accepted.

Discussion of Findings

The results of the analysis related to the hypothesis one indicated that, a significant difference exists in the mean performance scores of SS II students taught 3-Dgeometry concepts with Finley-Jensen problem solving model and their counterparts taught with conventional teaching method (see table 3). This significant difference found in the performance of students taught 3-D geometry was in favour of the experimental group. The advantage of Finley-Jensen problem solving model stems from the fact that it was a task structured. Problem was posed to the students similar to the concept to be taught. The purpose of this step is to make students become familiar with some concepts in 3-D geometry. Students were allowed to think and solve a challenge presented to them individually on piece of paper or any rough page. This is to allow students to be exposed to 3-D geometry. Students were allowed to discuss in pairs the similarities and differences between their answers. This is to make all learners to fully involve in the study of 3-D geometry.

The Teacher allowed the students to accept the views of the others while working in group; students were allowed to share their thoughts and findings. This allowed the students to assist themselves so as to validate others view and make reliable conclusion. Teaching materials both the improvised and classical were used, this is to allow proper delivery of the lessons and make students to learn faster. This was why significance difference exists and a better performance was observed on students taught using 3-D geometry than those taught using chalk and talk method. As such they learn meaningfully, which in turns enhances their academic performance. This is in line with the findings of Julie (2015) and Fatoke et al (2013) who found that there is significant difference on academic performance on students that are exposed to problem solving on plane geometry and on learning numerical ability on chemistry. This is may be due to problem-Solving is "hand on approach" and it agrees with constructivism theory of learning.

Results of testing null hypothesis two shows that significant difference exist in the mean retention abilities of SS II mathematics, students taught 3-D geometry concepts with Finely-Jensen Problem Solving Model and those taught with Conventional Method of

Teaching. The analysis of the hypothesis two showed that the use of Finely-Jensen Problem Solving Model led to higher retention than the traditional method of teaching. The result of the mean scores of the student in the experimental group maintained a higher retention rates than their counterparts in the control group (see table 4).

The nature of Finley-Jensen Problem-Solving Model is learning by doing and elaborating. In Finely-Jensen Problem-Solving Model the students worked individually and later discuss their finding in pairs, where each student developed self confidence in the topic taught. The consistent elaboration of 3-D geometry concepts at Finely-Jensen Problem-Solving Model provides students who either received the explanation or those who gave the explanation with a deep understanding and a more complete retention of the concepts being learnt for a longer period of time. The post posttest was administered after two weeks and the result was showed in table 4.2. This finding agrees with the findings of Julie (2015) who found that students in the experimental group taught plane geometry concepts with Problem Solving Model had higher retention than those in control group, taught the concepts using traditional method. This is because problem-Solving in general and specifically Finely-Jensen Problem-Solving Model encourages verbalization and made Students communicate their ideas very well to classmates.

As a result of the findings in this study, it could be concluded that Finely-Jensen Problem Model enhances the Performance and Retention of 3-D Geometry concepts of secondary school students. This is because all SS II students exposed to 3-D Geometry concepts using Finley and Jensen problem solving model performed better than those exposed to conventional method.

Recommendations

On the basis of the findings and conclusion emanating from this study, the following recommendations were made;

1. The use of Finley-Jensen Problem Solving Model, seems to be appropriate in improving the performance and Retention of students in senior secondary schools Mathematics particularly in 3-D Geometry concept as investigated in this study. It should therefore, be incorporated into the main stream of pedagogy in the teaching of Mathematics and other science subjects at senior secondary schools in Zaria Local Government, Kaduna, Nigeria.
2. In-service training programmes for teachers of Mathematics in form of seminars, workshops and conferences should focus more on how to use Problem Solving Model Particularly Finely-Jensen Problem Solving Model in teaching of Mathematics concepts (3-D Geometry).

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