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THE IMPACT OF INSTRUCTIONAL PROGRAMME ON STUDENTS PERFORMANCE IN MATHEMATICS

Omotosho, Gabriel Akinlolu
Department of Math/ Stat
Isah Mustapha Agwai I Polytechnic, Lafia
Email: jogbodoakinlolu@gmail.com

ABSTRACT: The study investigated the impact of instructional programme on students' performance in mathematics in Nasarawa State. The study was designed to find out whether students taught geometry using instructional programme would perform better in mathematics than those taught using the conventional method. Two hypotheses were formulated and tested at 0.05 level of significance. The design of the study was quasi-experimental, non-equivalent pre-test, post- test control group type. Purposive sampling technique was employed in the selection of the schools for the study. Mathematics Performance Test (MPT) with reliability coefficient of 0.84 was used for data collection. Analysis of Covariance (ANCOVA) was used for testing the hypotheses at 0.05 level of significance. The results showed that there is significant difference in mean performance scores between the students taught mathematics using instructional programme and those taught using the conventional method. The results showed that there is no significant difference in the performance of male and female students taught mathematics with instructional programme.

Keywords: Teacher-Centered Method, Performance in Mathematics, Discovery Learning, Conventional Method

Introduction

Mathematics can be understood by the definition given by Galileo who defines Mathematics as a language in which God has written the world. According to Ibironke (2011), the fact that the average Nigerian student seems to under-perform in Mathematics is a source of serious concern to educationists, parents and the general public. Learning outcomes in Mathematics education have become a phenomenon of interest to all. According to the National Examinations Council (NECO) annual reports (2018), Mathematics education is currently in a crisis state as evidenced in the low performance of students in both internal and external examinations. It attributed students' poor performance in Mathematics to poor teaching that results in weak preparation for candidates for the examination. It further asserts that the issue of poor performance in Mathematics examination was due to problem of teaching methods used. Okafor (2019) recommends good teaching methods and good preparation of the candidates as the only remedy to students' poor performance in Mathematics.

Mathematics teaching is effective if it assists pupils to satisfactorily achieve its objective as stated in the national core curriculum for secondary school science in the National Policy on Education (2014). Effective teaching of Mathematics needs to emphasize active participation by learners. Children learn best when they are active rather than passive learners. Purser and Renner (2010) states that people generally remember 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they hear and see and 70% of what they see as they do a thing. Instructional programme is a blueprint for teaching. However, just as blueprints do not dictate all actions of engineers, instructional programmes are not intended to dictate actions of teachers. Teachers must select the appropriate model in order to achieve a specified goal just as engineers select appropriate designs or methods based on desired outcomes. Models differ from general teaching strategies because they are designed to accomplish specific goals. In fact, instructional models generally include a variety of instructional strategies that can enhance students' performances in Mathematics (Eggen & Kauchak, 2010). Instructional programme provides a range of tools for constructing geometric objects from a range of 'primitive' objects such as points, segments, lines and circles. They enable users to define objects such as points, straight objects (segments, lines, rays and vectors) and circles (or arcs). With the introduction of instructional programme into the education system, Mathematics teaching could be changed dramatically and Mathematics learning would return to science laboratory based-approval. This dynamic functionality has given opportunity for students to work on a more abstract structures rather than work on a widely used traditional paper-and-pencil studies.

Statement of the Problem

Research evidences showed that the teaching strategies employed by teachers in teaching Mathematics are not different from the conventional methods. These methods do not enable students to acquire practical skills. Rather, teachers employ more of the information aspects of the subject. This makes the subject boring to the students and accounts for the low performance in the subject. . So far, the conventional pattern of teaching Mathematics does not seem to be effective in helping students perform better, neither does it help in improving students' performance in the subject. Therefore there is the need for the exploration of other teaching techniques that could improve students' performance in Mathematics. The purpose of this study was to investigate the impact of instructional programme on students' performance in Mathematics.

Hypotheses

1. There is no significant difference in the mean performance scores of SS1 students taught mathematics using the instructional programme and those taught using conventional method.
2. There is no significant difference in the mean performance scores of male and female SS1 students taught mathematics using instructional programme.

Theoretical Framework

The theory on which this study is anchored is van Hieles's learning theory. It assumes that students pass through five hierarchical levels of thinking, namely: recognition, analysis, ordering, deduction and rigor.

Level 1 (Recognition): The student operates on geometric figures such as triangles and parallel lines by identifying, naming and comparing them according to their appearance. Perception is only visual. A student who is reasoning at level 1 recognizes certain shapes holistically without paying attention to their component parts. For example, a rectangle may be recognized because it looks "like a door" and not because it has four straight sides and four right angles as there is no appreciation of these properties. Shape is important and figures can be identified by name.

Level 2 (Analysis): The student discovers properties/rules of a class of shapes empirically such as folding, measuring, analyzing figures in terms of their components and relationships among components. At this level, component parts and their attributes are used to describe and characterize figures. For example, a student who is reasoning analytically would say that a square has four equal sides and four corners. The same student, however, might not believe that a figure can belong to several general classes and has several names. The student may not accept that a rectangle is a parallelogram. A figure at this level presents as a totality of its properties. A student may be able to state a definition but will not have understanding.

Level 3 (Ordering): By following or giving informal arguments, the student logically inter-relates previously discovered properties or rules. He operates with these relationships both within a figure and between related figures. There are two general types of thinking at this level. Firstly a student understands abstract relationships among figures, for example, the relationship between a rectangle and parallelogram. Secondly, a student can use deduction to justify observations made at level 2. The role of the definition and the ability to construct formal proofs are not understood at this level though there is comprehension of the essence of geometry.

Level 4 (Deduction): The student proves theorems deductively and establishes interrelationships among networks of theorems. The student can manipulate the relationships developed at level 3. The need to justify relationships is understood, and sufficient definitions can be developed. Reasoning at this level includes the study of geometry as a formal mathematical system rather than a collection of shapes.

Level 5 (Rigor): The student establishes theorems in difficult postulation systems and analyzes and compares these systems. The study of geometry at level 5 is highly abstract and does not necessarily involve concrete or pictorial models. At this level, the postulates or axioms themselves become the object of intense rigorous scrutiny.

Conceptual Framework

Concept of Instructional Programme

Instructional programme is software that provides a range of tools for constructing geometric objects such as points, segments, lines and circles. It is one of the most innovative, open-code Mathematics programmes that can be freely downloaded. It works on a wide spectrum of operating system platform which have Java virtual machine installed on. Markus Hohenwarter created free, open-source Mathematics software, which is used for both teaching and learning Mathematics from middle school through college to the university level (Hohenwarter & Preiner, 2018). This tool extends the concepts of dynamic geometry to the fields of algebra and mathematical analysis. Designed specifically for educational purposes, instructional programme can help students to understand, grasp experimental, problem-oriented and research-oriented learning of Mathematics both in the classroom and at home. Students can simultaneously use computer algebra and an interactive geometry system. By doing this, they may increase their cognitive abilities and retention in the best way.

Instructional programme offers students' tools that enable them to create drawings, make measurements and drag elements of a drawing while those elements maintain the dependency relations that exist based on the initial construction in the environment. Although the tools available to students are designed for specific purposes, the ways in which students use these tools when learning a new mathematical concept vary (Virillon & Rabardel, 2015). This study shall investigate the strategies that students employ for using Instructional programme when they were engaged in a unit of instruction focused on Mathematics transformation.

The Instructional programme enable users to define objects such as points, straight objects (segments, lines, rays and vectors) and circles (or arcs). From these, you can construct further geometric objects (which are dependent on them) by classical constructions of the "straight edge and compass" type (midpoints, bisectors, parallels and perpendicular), and/or linear "affine" transformations (translation, rotation, dilation, reflection) and/or algebraic relationships using coordinates (Cartesian and polar). An ordered set of points can be designated to define a polygon. Measurements may be made of objects such as the length of a segment, the size of an angle, the area of a polygon, the circumference of a circle or the coordinates of a point. As a "free" object such as a point is dragged around the screen, all objects and measurements which depend on it change dynamically. According to Wilberford (2012), instructional programme can be a beneficial tool for using geometric transformations in the study of geometry. An important consideration is to use technology to develop background knowledge and ways of thinking as well as help students move further in their understanding of core geometry concepts. To maximize the potential of dynamic geometry instructional programme, teachers need to understand the how, what and why of teaching with technology. They need experience in considering when instructional programme can most effectively be used. It was also observed that computations can be performed using any measurements, and these results need to define other objects. As an object is dragged, such as a point P on a given segment AB, the path taken by a dependent object, such as point P′, can be traced. The path can itself become an object: the locus of P′ with P. Similarly, the envelopes of moving lines can be defined and drawn. Such curves change shape instantly as adjustments are made to their defining objects (parameters).

Teaching with Instructional Programme

Computer-based learning environments continue to be a seductive notion in Mathematics education. The promise is that through using a particular software in carefully-designed ways, it is possible for learners simultaneously to use and come to understand important aspects of Mathematics, something that in other circumstances can be particularly elusive. One type of promising computer-based learning environment features is commonly referred to as the "direct manipulation" of mathematical objects and relations. In the domain of geometry, examples of such software include GeoGebra, Cabri-geometre, Sketchpad, Inventor, Thales, Cinderella, Dr. Geo, and others. Such software is often called dynamic geometry instructional programme. Instructional Programme has a strong claim as a tool to help learn, teach, explore and discover Mathematics, particularly in its classical, transformation and coordinate forms. It is also a very versatile and instructive tool for problem-solving and modeling. It can be used to produce a graph defined by a conventional algebraic function.

Modeling Activities Using Instructional Programme

The application of innovative trends in Mathematics teaching may also include modeling activities to stimulate active learning based on the investigation and discovery of mathematical relationships. There are some proposals of modeling activities from geometry areas of Mathematics that could be used in Mathematics teaching in secondary school. The main focus is on visualizing mathematical objects and relationships which could contribute significantly to the development of students' mathematical knowledge and improve understanding of geometrical concepts. The first activity can be used to investigate symmetry of geometric shapes. It enables students to explore the images of the right triangle in axial and central symmetry for different positions of an axis of symmetry or a centre of symmetry. Students should focus not only on observing relative positions of the right triangle and its image, but also on the possibility of creating a variety of specific types of quadrilaterals. The kite and parallelogram are formed in Figure 1.

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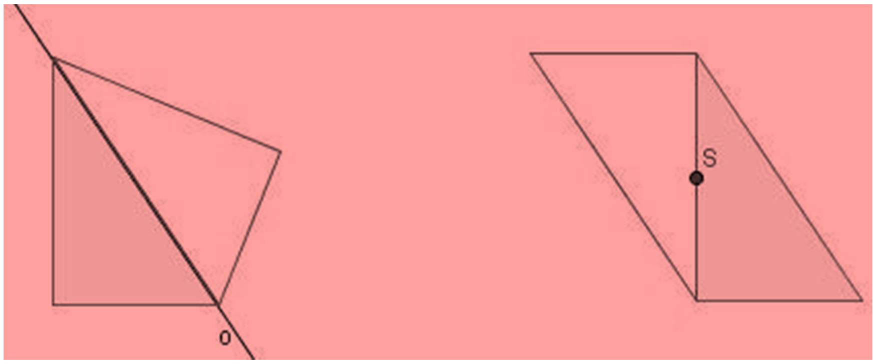

Fig. 1: Reflection of the right triangle in the axial and central symmetry.

The left side of Fig. 1 shows the position of the axis of symmetry determined by the hypotenuse of the right triangle in which the right triangle and its image form the kite. The right side of Fig. 1 shows the location of centre of symmetry in the middle of the leg. The right triangle and its image form a parallelogram. Changing the position of the line of symmetry and the centre of symmetry enables students also to get isosceles triangles and a rectangle. Students could write results of the investigation into a table with the position of the axis or centre of symmetry and the type of the quadrilateral. This activity could be the introduction into the investigation of specific types of symmetrical quadrilaterals (Laborde, 2012). Creation of multiple center-symmetrical geometric figures is the purpose of the activity which requires the composition of five identical squares to symmetrical figures. This is illustrated in figure 2 as follows:

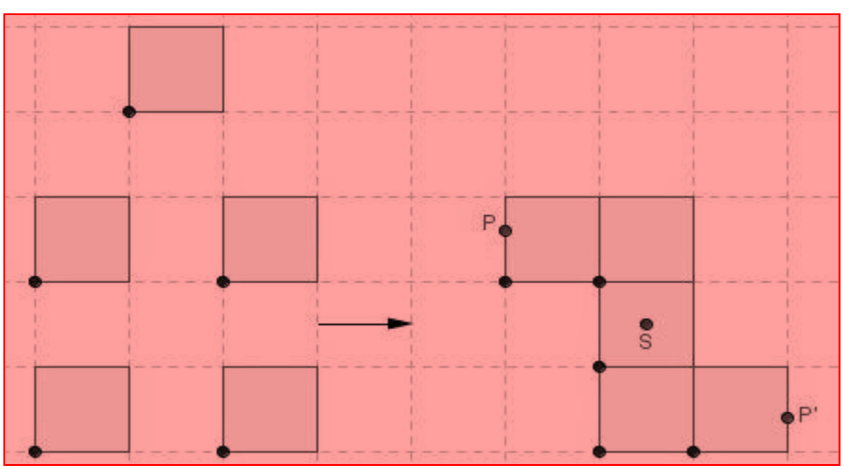

Fig. 2: Creating a centrally symmetrical image

On the left side of Fig. 2, there are five squares constructed with, which is easy to move using the highlighted vertices. The students' task is to use all the squares to set together centrally symmetrical shapes. On the right side of Fig. 2, one possibility to create a centrally symmetrical shape of those squares is displayed. Students can construct the expected center of symmetry in a figure. Using a selected point on the square and its image they can test the symmetry of the composed shape. In this activity, students have the opportunity to create several types of centrally symmetric figures.

Research Design

The study employed quasi-experimental design of non-randomized pre-test post-test control group type. The design was chosen because it was not possible to have complete randomization of the subjects. Therefore, intact classes were randomly assigned to experimental and control groups using simple random sampling technique.

Area of Study

The study was carried out in Nasarawa State, Nigeria. Nasarawa State is made up of 13 local government areas namely: Akwanga, Awe, Doma, Keana, Keffi and Kokona. Others are: Lafia, Nasarawa, Nasarawa Eggon, Obi, Toto and Wamba. It is bounded in the north by Kaduna State, in the west by the Federal Capital Territory, Abuja, in the south by Kogi and Benue States, in the east by Taraba and Plateau States. Nasarawa State is situated on latitude 8.5705°N and longitude 8.308°E.

Sample and Sampling

The sample size for this study was 210 SSI students in six senior secondary schools. Purposive sampling technique was employed in the selection of the schools for the study. Two schools were selected from each of the three educational zones in Nasarawa State. In selecting the schools, the researcher made use of the following criteria: The school must be co-educational and schools where the authorities permitted that the research should be carried out. One intact class in each school was randomly assigned to either control or experimental group. This was to enable a generalized recommendation from the findings.

Instrumentation

Research instrument for this study was **Mathematics Performance Test (MPT).** This is a forty-item 4-option objective mathematics performance test constructed by the researcher based on Senior Secondary School 1 Mathematics syllabus. The test was objective form written to cover the area of knowledge, comprehensive and application levels. Out of the questions only forty passed the psychometric test. The same MPT was used for pre-test and post-test treatment test. However, the numbering was reshuffled so that both tests will still have the same weight.

Method of Data Analysis

Data were analyzed with respect to the research questions and hypotheses formulated for the study. Mean (x) and standard deviation (sd) were used to answer the research questions. Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

Analysis and Interpretation

HO1: There is no significant difference in the mean performance scores of SS1 students taught mathematics using the instructional programme and those taught using conventional method.

Table 1: One way ANCOVA on performance scores of SS1 mathematics students in experimental and control groups.

Source of variance	Sum of Squares	df	Mean square	F	P
Corrected model	29774.86	2	14887.43	264.82	0.00
Intercept	16569.48	1	16569.48	294.74	0.00
Pre-test	538.77	1	538.77	9.58	0.03
Method	20836.40	1	20836.40	370.65	0.00
Error	4722.00	207	56.22		
Total	196480.00	210			
Corrected total	34497.06	209			

Table 1 indicate that F (1,207) = 370.65 and P = 0.00 < 0.05. The null hypothesis is therefore rejected. This implies that there is a significant difference in the mean performance scores between those taught using instructional programme and those taught using the conventional method in favour of the experimental group exposed to instructional programme. The implication is that instructional programme is a programme that enhances students' academic performance in mathematics.

Ho2: There is no significant difference in the mean performance scores of male and female SS1 students taught mathematics using instructional programme.

Table 2: One-way ANCOVA on mean performance of male and female SS1 students exposed to instructional programme.

Source of variance	Sum of squares	df	Mean square	F	P
Corrected model	123.01	2	61.50	1.81	0.57
Intercept	13142.98	1	13142.98	387.01	0.00
Pre-test	33.71	1	33.71	0.99	0.58
Gender	6.96	1	6.96	0.002	0.80
Error	3634.18	107	33.96		
Total	157493.00	110			
Corrected total	3757.19	109			

Table 13 reveals that $F(1, 107) = 0.002$ and $P = 0.80 > 0.05$. Therefore the null hypothesis is not rejected. This means that there is no significant difference in the mean performance scores of male and female students in the experimental group taught with instructional programme. This implies that instructional programme is a strategy that helps both male and female students to perform well in mathematics.

CONCLUSION

The findings of this study showed that inclusion of instructional programme has a significant effect on students' performance in mathematics. This clearly indicates that the performance of students in mathematics is dependent on the strategy of instruction. The use of instructional programme gave the students the opportunity to interact freely among themselves and clarified doubts whenever the need arose. This showed a higher performance of students who were exposed to instructional programme above those that used conventional method. The study also proved that instructional programme was beneficial to both male and female students. There is significant interaction effect of methods and gender on mean performance scores of students in mathematics. The implication is that Mathematics teachers can adopt instructional programme to students irrespective of their gender.

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