IAA Journal of Education 6(1):46-53, 2020. ISSN: 2636-7270

Effect of Scale Drawing on the Secondary School Students Achievements in Circle Geometry

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ABSTRACT

This study was an investigation into the effect of scale drawing on the achievement of secondary school students in circle geometry in Orumba south local government Area of Anambra state. The population of the study is 523 students from 13 publicSecondary schools in the geographical area of study.Two secondary schools were randomly selected from 13 schools in the local government area. The two schools were randomly assigned to experimental and control groups in their intact forms. The sample size which consists of 65 students is made up of 35 and 30 for experimental and control groups respectively. All the schools were familiar with the formal method of proof of teaching geometry theorems in their lower basic education. For the purpose of this study, the experimental group was taught geometric proofs using scale drawing strategy. The instruments for data collection were lesson plan and Geometric Theorem Achievement Test (GAT) developed by the researchers. The instrument was validated by two experts in Mathematics education and an expert in test construction and evaluation. The pre- test was administered on the students to establish their level of experience in the study of circle geometry. After the instructional stage, the posttest was also administered on the same groups of students. Both groups of students were taught by their regular class teachers to make sure that the subjects do not fake any response due to teacher effect. However, the researchers trained the class teachers for the period of one week with the use of scale drawing strategy for proving the selected theorems with specially written lesson notes for the experimental and control groups respectively. Three research questions and one hypothesis guided the study. The mean and standard deviation were used to provide answers to the research questions and the t- test was used to find out if there was any significant. Difference in the mean achievement scores of students taught geometric. Proof with scale drawing strategy and those taught with the conventional method. The findings of the study showed that scale drawing teaching strategy increased the mean achievement score more than that of the control group who were taught the same topic using the formal method of geometric proof. The researchers recommended that scale drawing as an alternative strategy should be used with other methods in the teaching and learning of geometric proofs. This will help to reduce fear and abstraction associated with proofs in Mathematics in general.
Keywords:Drawing, Scale, School, Circle and Achievements.

INTRODUCTION

The subject Mathematics means different things to a number of people, authorities, even nations . The Oxford English dictionary defined it as the abstract science which investigates deductively the conclusions implicit in the elementary conceptions of spatial and numerical relations, and which includes as its main divisions geometry, arithmetic and algebra. Also [1] defined it as the science of structure, order and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects. [2] defined Mathematics as the study of numbers, and computation, sizes, shapes and spaces and the science of generalization and measurement. From the formalism point of view, Mathematics is the manipulation of the meaningless symbols of a first

order language according to explicit, syntactical rules. The formalists tend to study the symbols and rules that govern them. (en.m.wikipedia.org). Further it observed that there is no generally accepted definition of Mathematics [3].

Mathematics has a number of branches and one of such branches is geometry. This concept has also been defined in different ways by a number of authors. The Webster Dictionary defined it as a branch of Mathematics which investigates the relations, properties, and measurement of solids, surfaces, lines, and angles; the science which treats the properties and relations of magnitudes, the relation of space. The Future school, [4] specifically defined geometry as a branch of Mathematics that deals with space, the shapes that inhabit space, and a range of properties that apply to these shapes. Similarly [5], said that geometry is a branch of Mathematics that studies the size, shape, and position of 2-dimensional shapes and 3- dimensional figures. A number of authors have observed the importance of the study of geometry in particular and Mathematics in general [6].

One of such observations is, if we enhance students' geometry skills, we enhance their spatial intelligence and overall mathematical intellect. Spatial ability or visualization is essential in engineering and scientific fields. It is a skill that is required for the effective generating and transforming of visual images [7].This author argued further, if geometry is neglected and therefore spatial ability in the curriculum, as well as in standard assessments, the students with spatial strengths will be in the minority – and it is this group who are required to push the boundaries of the Technical and Scientific professions. There is no doubt that geometry skills are essential for a student to make progress in other branches of Mathematics, such as trigonometry and topology. Topology studies various different spaces and trigonometry.

In another situation, the author above stressed that there is a widening gap between the effective teaching of geometry in elementary schools and the geometry skills students need in high school. Often, geometry tasks at the younger grades are limited to identifying shapes or labeling properties; in high school, students are expected to use abstract reasoning to prove a complex relationship. [8], observed that the foundation for learning geometry does not start in high school; it starts in elementary and middle school. Students need to learn how to start proving and explain why things occur before they hit high school. If students were introduced to simple informal proofs and required to reasonably justify statements, they would be far more prepared for the formal proofs to come. The authors above pointed out that geometry is one of the primary courses which are difficult to learn and comprehend for students. This situation results in low level success and hence makes geometry and Mathematics a nightmare for most of the students. [9], observed that results from Mathematics teaching and learning have not yielded encouraging results. In the same way, [10] argued that the teaching of Mathematics has not been effective due to the impact of Mathematics anxiety on working memory.

The situation above is made clear in the chief examiners annual report by the West African Examination Council (WAEC). Between 2006 and 2016 candidates' achievement in Mathematics is poor. Within this period out of 16, 142, 529 who sat for the examination at ordinary level, 33.74% obtained credits and above (A1 – C6) while 66.26% scored (D7 – F9).

This implies that majority of the students who took the examination would not obtain a pass grade in the examination.

One may begin to ask, what is responsible for such poor achievements? A number of researchers and Mathematics educators have drawn attention to some factors that may have contributed to this. [11], is of the view that students do not pay attention during lessons and that both students and teachers lack motivation. The situation has been a source of worry to many stakeholders especially the parents. Many students have also been denied opportunities to read courses of their choice [12].

The poor performances of the students in this aspect of Mathematics can be due to poor foundation occasioned by poor knowledge of the concept by some of the teachers [13]. The situation can be improved through laboratory method of teaching and learning [14]. This method which involves a lot of mathematical activities can be employed using the scale drawing as innovative strategy in proving the theorems that the students find difficult to comprehend using the formal proof method. This study therefore set out to investigate into the effect of using scale drawing in teaching and learning some circle theorems in geometry.

Statement of the problem

The WAEC chief examiners report (2006-2016) which has been documented observed that geometry is one of the areas in Mathematics that students have not shown good performance and this has largely contributed to the general poor results for the periods. Geometry ought to be an interesting area in mathematics as it involves a number of Psychomotor activities that appear concrete and practical. But, this has not been the situation. Most of the reviewed works observed that the senior secondary school students lack the elementary skills and knowledge that should form a necessary base for learning formal proof in geometry. The knowledge of geometry is needed greatly in engineering, building, construction industries etc. The absence or lack of this conceptual understanding of formal geometric proofs in Mathematics can be improved if practical approach is used before the formal method. This will help to reduce the mental stress students usually pass through memorizing the various theorems and their proofs. This observed knowledge gap negates the two closely related objectives of Blooms taxonomy; understanding and applying. The method used by most teachers to introduce and teach formal proofs in geometry will continue to create more problems in the understanding of the basics of geometric proofs not to talk of higher order application of the acquired knowledge that has remained elusive. The practical approach will also help the students identify mistakes as they learn independently and with peers.

In the light of this, the researchers wandered if the methods the teachers have continued to employ is a contributory factor or that the students are just not able to conceptualize the topic. The problem of this study is to investigate into effect of scale drawing as an alternative strategy for teaching and learning of some circle theorems. This observed gap in knowledge acquisition between understanding and applying, due to poor method used by most teachers to introduce and teach formal geometric proofs especially circle theorems; is what this study has set out to address.

Purpose of the study

The main purpose of study is to find out the effect of scale drawing teaching strategy on the mean achievement score of senior secondary school students in circle geometry in Orumba South L.G.A. of Anambra State. Other objectives include;

1. Find out through the use of mean achievements score of the students effectiveness of scale drawing as an alternative teaching strategy for the formal proofs of circle theorems.
2. Find out if there will be difference in mean achievement scores between students taught circle theorem using scale drawing and the conventional formal method.

Research questions

Three research questions were used in the study

1. Is there any difference in the mean achievement scores of the students taught geometric proofs (circle theorems) using scale drawing teaching strategy and those taught with the conventional method?
2. What percent gain in mean achievements score of students taught geometric proofs can be said to have occurred due to the use of scale drawing teaching strategy?
3. What is the percentage difference in the mean gain between the experimental and control groups taught circle theorems using scale drawing strategy and those taught with the conventional method?

Hypothesis

One null hypothesis was formulated for the study and tested at 0.05 level of significance.

Ho: There is no significant difference in the mean achievement scores of the students taught circle theorems using scale drawing strategy and those taught with conventional formal proof method.

Significance of the study

The findings of the study are considered significant to the teachers, researchers and students in the following ways: the teachers will be exposed to the knowledge of using alternative strategies and methods such as the scale drawing in enhancing student's achievements and conceptual knowledge in circle geometry. The students will be exposed to another non formal but innovative and activity based strategy of learning the circle theorems. It will reduce the mental stress associated with memorizing the proofs most of the times without basic understanding of the underlying concepts.

Scope of the study

The study is limited to the circle theorem. The investigation covered the following areas in this study.

1. The angle the arc of a circle subtended at the centre is twice the angle which it subtends at any point on the remaining part of the circumference
2. Angles in the same segments are equal
3. The sum of the opposite angles of a cycle quadrilateral is 180^{o}
4. The exterior angle of a cycle quadrilateral is equal to the opposite interior angles

5. The angle in the semi – circle is a right angle

Literature review

A number of concepts were briefly reviewed here. Godfried (2008) observed that circles can accurately be drawn with the compass from two given points, the centre and a point on the circle. It is also used to draw line segments and other arcs. Math is fun. [5], observed that scale drawing is a drawing representing an actual object where the size determined by the scale given in the scale statement. [7], argued that constructive proof is a method that demonstrates the existence of a Mathematical object by creating or providing a method for creating the object.

Scale drawing can affectively take place in mathematical laboratory. [8], observed that it is a place where things can be counted, ordered, recorded, joined, partitioned, grouped, arranged, rearranged, constructed, experimented in among other activities. This method is based on the principle of learning by doing, observing, trial and error, discussing with others, moving from concrete to abstraction. Mathematics Laboratory, which is associated with a number of mathematical activities is rewarding. The learning of circle theorems using scale drawing as a laboratory activity will also be rewarding.

Theoretical framework

The study is anchored on the constructivist theory. The theories view learning as building knowledge by active involvement through things that are tangible and sharable. It is a mathematical philosophy that advocates for learner-centered, discovery learning where learners use past information to acquire more knowledge [9],. The scale drawing strategy provides opportunity for the students to use previous ideas and experiences in learning new concepts. The modification of behavior and activities associated with behaviorism impacts the use of scale drawing. In this case, the reflexes involved in constructions, drawings, are gradually and steadily modified through close supervisions and regular exercises and activities. These are motivating with immediate feedbacks that follow under the supervision of the class teacher.

RESEARCH METHOD

The study is a quasi – experimental and involved two senior secondary school class two students randomly assigned in their intact forms to experimental and control treatment groups. The study was carried out among senior secondary school students in Orumba South L.G.A. of Anambra State. The population of the study is 523 and the sample is 65 students from two intact school classes randomly selected from 13 schools in the area of study. The two classes were assigned in their intact forms randomly to experimental and control treatment groups. The experimental group is made up of 35students while the control group is 30.

The Geometric Achievement Test (GAT) that was designed by the researchers was used for data collection for both the pre – test and post – test. The test items were selected from WAEC past questions June, 1990, 1993, 1996, 2008 and 2010 that were relevant to the area of study. They were only face validated as the items had already been standardized by the examination body (WAEC).

Before the teaching stage, the researcher administered a pre – test on the students and result showed that the students in both groups are homogeneous in

mathematics ability as there was no significant difference in their mean pre – test scores. The instructional period lasted two weeks. The students of each of the schools selected were taught in their intact classes. The normal class teachers who were trained as research assistants were used to prevent fake responses and disruption of class activities. The topics of choice were also as they appeared in the scheme of work for the period and class.

Data collected after the students were post tested was analyzed for both groups using the t – test as homogeneity was earlier established during the pre – test.

RESULTS

The results of the data analysis are presented and discussed below.

Research question one

1. Is there any difference in the mean achievement scores of the students taught geometric proofs (circle theorems) using scale drawing teaching strategy and those taught with the conventional method?

Table 1:Summary of the mean and standard deviation scores of the students in the posttest (GAT)

		Pre – GAT		Post GAT			
Group	N	$\overline{X}$	SD	$\overline{X}$	SD	mean gain	% gain
Experimental group	35	9.8	9.32	19.07	14.01	9.27	94.6
Control group	30	9.17	6.41	12.17	8.43	3.0	30.9
	65						

From table 1, the pre – test mean scores for the experimental and control groups are 9.8 and 9.17 respectively with standard deviation scores of 9.32 and 6.41 respectively. The table also shows the posttest mean scores of experimental and control groups to be 19.07 and 12.17 respectively. The experimental group experienced a higher within group variation of 14.01 while the control group had a lower variance of 8.43. However, the experimental group had a higher gain in mean achievement of 9.27.This finding has implications for the teaching and learning of geometry in general and circle theorems in particular. Students will continue to experience difficulty in understanding geometric proofs if they lack conceptual understanding of the basics of geometric proofs that are practically demonstrated using scale drawing strategy in the Mathematics laboratory.

Hypothesis (Ho). There is no significant difference in the mean achievement scores of students taught geometric proof (circle theorem) using scale drawing strategy and those taught with conventional method.

Table 2:Summary of t-test for post mean achievement scores of the students.

Group	N	Mean	Sd	df	t-cal	t-crit.	Decision
Experimental	35	19.07	14.01				Reject Ho
Control	30	12.17	8.43	63	3.83	2.00	
Total	65						

From table 2, the t – calculated value of 3.83 is greater than the t – tabulated value of 2.00 at 0.05 level of significance and degree of freedom 63, the null hypothesis of no significant difference was therefore rejected. Hence, there was significant difference in the mean achievement scores of the experimental and control groups. The scale drawing teaching strategy employed in teaching the experimental group had effective impact on the students' achievement scores.

Hence, scale drawing instructional strategy was more effective than the conventional method in proving geometric proofs. This result agrees with the findings of Keramati (2005) in a study on collaborative learning using construction method. The study revealed that the method was more effective than the conventional method.

Also from table 1, the experimental group experienced 94.6% in mean gain as against the control group that had 30.9% gain in mean experience in geometric proofs. The observed percentage difference of 63.7% in mean can be attributed to the method of teaching used for the two groups of students.

From table 1, the gain in the mean achievement scores for the experimental and control groups are 9.27 and 3.0 respectively. Though both groups experienced gain in mean achievement scores relative to the pre – test mean scores, the experimental group had a higher gain in mean achievement attributed to the strategy of instruction.

Similarly, from table 3, the difference in mean achievement scores between the two groups in the post test was significant at 0.05 significant level and degree of freedom 63; hence scale drawing teaching method was more effective in teaching geometric proof than the conventional method.

RECOMMENDATIONS

1. Students at times need to be in charge of their learning by being very active through effective participation. Teachers are encouraged to apply other teaching strategies that are very innovative such as the scale drawing before moving into formal proofs that involve abstraction.
2. The classroom is usually made up of diverse individual learners. Hence, there is need for diversification of teaching methods and strategies to give every individual opportunity to learn. This will help to reduce failure and anxiety in learning mathematics.

CONCLUSION

This study investigated the effect of scale drawing in teaching and learning of geometric proofs (Circle theorems) among senior secondary school students. The findings showed that scale drawing can be very effective in learning circle theorems and other geometric proofs as the learners are actively engaged with the three levels of educational objectives being realized. Completion of any mathematics tasks successfully by the learners provided immediate motivation.

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