THE EFFECTIVENESS OF DIFFERENTIATED INSTRUCTION ON STUDENTS' GEOMETRIC ACHIEVEMENT IN KEBBI STATE SENIOR SECONDARY SCHOOLS, NIGERIA

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ABSTRACT

This study investigated the effectiveness of differentiated instruction on students' geometric achievement in Kebbi state senior secondary schools. The study adopted pretest-posttest control group design. The population consists of 69,573 students. A random sampling technique was used in selecting the schools and the level of the students. A sample size of 96 participants was selected for the study which is in accordance with Central Limit Theorem that regarded a minimum of 30 sample size viable for experimental research; the sample is made up of 55 male students and 41 female students. Geometric achievement test (GAT) was the instrument used in collecting data for the study. A Spearman-Brown equal length reliability coefficient of 0.76 was achieved using split-half method. The data were analyzed using mean, standard deviation and t-test all at 5% level of significance. The result showed that differentiated instruction is more effective in facilitating students' achievement in geometry than the lecture method. Also, there exists a significant difference in the achievement of male and female students in geometry when taught with differentiated instruction. It's recommended among others that mathematics teachers should endeavour to use differentiated instruction in order to engage students in solving geometric problems rather than the rote learning and memorization.

***Keywords**: Effectiveness, differentiated instruction, lecture method, geometric achievement and senior secondary school students.*

1   INTRODUCTION

Education at secondary school level is the bedrock and the foundation towards higher knowledge in tertiary institutions. It is an investment as well as an instrument that can be used to achieve a more rapid economic, social, political, technological, scientific and cultural development in the country. The National Policy on Education [1] stipulated that secondary education is an instrument for national development that fosters the worth and development of the individual for further education and development, general development of the society and equality of educational opportunities to all Nigerian children, irrespective of any real or marginal disabilities.

More than any time in the past, the future of every country depends on the quality and type of education received by its citizens. The countries that benefit the most are those that have a well educated population. Not only most of the countries need to be well educated in such traditional fields as languages, history, religions, but also in the scientific and technical disciplines that characterize the 21st century. Science and technology has become an integral part of the blood stream of modern civilization and is the major driving force for economic growth and development [2]. Mathematics serves in many of the branches of science. This relationship is explained by [3] who views mathematics as the 'Queen and Servant" of the sciences. The importance of mathematical knowledge in understanding engineering

and technical education studies cannot be over emphasized. It is common knowledge that mathematics and science is one of the major requirements for admission into engineering and technical education programmes in Nigeria and elsewhere. The classroom practitioners, notably the professional teachers of science and even non-science teachers believe that no student can make a head way in science and technology without a basic knowledge of mathematics and according to [4] fewer people seem to be aware that mathematics carries the main burden in all of scientific reasoning and is the core of the major theories of physical science. In recent years all fields of science have become more and more quantitative.

Differentiated instruction has been a buzz phrase in Nigerian education for many years. Much of what has been written in support of the practice was created in the 1990s. [5] defines differentiated instruction as an approach to teaching in which teachers proactively modify curricula, teaching methods, resources, learning activities and student products to address the diverse needs of individual students and small groups of students to maximize the learning opportunity for each student in a classroom. Differentiated instruction is a modification of teaching and learning routines and can address a broad range of learners' readiness levels, interests and modes of learning [6]. It stems from a teacher's solid and growing understanding of how teaching/learning occur and it responds to varied learners' needs for more

structure or independence, more practice or greater challenge and more active or less active approaches to learning. [7] reported that differentiated instruction has a great importance for students who struggle in the mastery of the grade level curriculum. As a result of differentiated instruction, two goals are achieved. First, a high level of achieving the grade level standards for all students is paramount. It is important for teachers to scaffold the instruction as necessary for struggling learners. The second goal is to make curricular adaptations for those students who need it. [8] indicated that students in a differentiated classroom setting can become more engaged, motivated and excited about learning if the curriculum is authentic and meaningful and if appropriate learning goals are provided. Because students' received the necessary modifications to meet their specific learning needs, either more challenging or layered in order to achieve mastery.

Students learn in many ways by seeing and hearing; reflecting and acting; reasoning logically and intuitively; memorizing and visualizing and drawing analogies and building mathematical models; steadily and in fits and starts. Teaching methods also vary. Some instructors lecture, others demonstrate or discuss; some focus on principles and others on applications; some emphasize memory and others understanding. How much a given student learns in a class is governed in part by that student's native ability and prior preparation but also by the compatibility of his or her learning style and the instructor's teaching style. A

teacher can also differentiate instruction in many ways in various subjects. Instruction can be differentiated based on a student's readiness, learning profile or interest by varying the content, process or product [9]. The main strategies utilized are compacting, independent projects, interest centers or interest groups, tiered assignments, flexible grouping, learning centers, varying questions, mentorships, anchoring activities, and learning contracts.

1.1   Statement of the Problem

The differential scholastic achievement of students in Nigeria has been and is still a source of concern and research interest to educators, government and parents. This is so because of the great importance that education has on the national development of the country. All over the country, there is a consensus of opinion about the fallen standard of education in Nigeria [10]. Parents and government are in total agreement that their huge investment on education is not yielding the desired dividend. Teachers also complain that students' low performance at both internal and external examination. The annual releases of Senior Secondary Certificate Examination results (SSCE) conducted by West African Examination Council (WAEC) justified the problematic nature and generalization of poor secondary school students' performance in different school subjects. For instance, the percentage of students scores in mathematics from 2009-2012 is shown below.

Table 1: **Mathematics West African Examinations Council (WAEC) result for students' achievement in May/June, 2009-2012**

YEAR	TOTAL NO OF CANDIDATE	CREDIT A1-C6 (%)	PASS P7-P8 (%)	FAIL F9 (%)
2009	1,019,524	33.97	28.16	34.47
2010	1,054,853	38.20	25.36	34.41
2011	1,149,277	41.12	31.09	24.95
2012	1,249,028	46.75	26.72	24.24

Source: [WAEC statistics office, Lagos Nigeria, 2013]

Differentiated instruction is viewed in schools as a positive approach to meeting the needs of the wide range of abilities in the classroom, but most of the research supporting it is of a qualitative nature, especially in a heterogeneously mixed classroom. This study seeks to answer the question of the effectiveness of differentiated instruction on students' mathematics achievement in Kebbi state senior secondary schools.

1.2 Objectives of the Study

The objectives of this study are to:

1. Determine the effect of differentiated instruction on students' academic achievement in geometry at senior secondary school level.

2. Investigate the effect of differentiated instruction on gender in geometry at senior secondary school level.

1.3   Research Questions

Based on the above objectives, the following questions are formulated for answering:

1.   Does differentiated instruction affect students' academic achievement in geometry at senior secondary school level?

2.   How does differentiated instruction affect the growth of student learning of a particular gender in geometry at senior secondary school level?

1.4   Research Hypotheses

From the research questions, the following null hypotheses were formulated and tested at 5% level of significance.

Ho_1: There is no significant difference between the performances of students taught geometry using differentiated instructional technique against those taught with lecture method.

Ho_2: There is no significant difference between the mean scores of male and female students in geometric concept using differentiated instructional techniques.

2   METHODOLOGY

2.1   Research Design

A quasi experimental design was considered to be the appropriate research design for this study adopting pretest and posttest control group which involves two groups for comparison, one experimental and the other one control. The research design illustration is presented in the figure below.

$$EG \longrightarrow 0_1 \longrightarrow X_1 \longrightarrow 0_2$$
$$CG \longrightarrow 0_1 \longrightarrow X_2 \longrightarrow 0_2$$
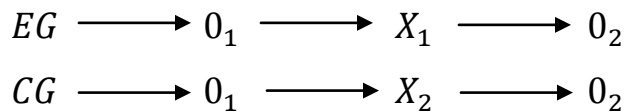
EG   =   Experimental group
CG   =   Control group
O_1 =   Pretest
X_I =   Treatment using differentiated instruction
X_2 =   Treatment using lecture method
O_2 =   Posttest

2.2   Population of the Study

The target population of this study comprises all the senior secondary school students in Kebbi state. There are two hundred and twenty eight (228) public and private senior secondary schools with the sum total of sixty nine thousand five hundred and seventy three (69,573) students in which 48,958 are male and 20,615 are female students. The state has seven educational zones, namely: Birnin Kebbi, Yauri, Argungu, Zuru, Bagudo, Gwandu and Bunza. The statistics were supplied by the State Secondary Education Management Board (SSEMB).

Table 2: Population of the Study

S/N	Educational Zone	Number of schools	Males	Females	Total
1	Birnin Kebbi	44	9,177	4,116	13,293
2	Yauri	28	6,415	3,343	9,758
3	Argungu	30	6,603	2,711	9,314
4	Zuru	33	6,577	3,260	9,837
5	Bagudo	39	8,297	3,055	11,352
6	Gwandu	25	5,038	1,832	6,870
7	Bunza	29	6,851	2,298	9,149
	Total	**228**	**48,958**	**20,615**	**69,573**

Source: [Kebbi State Secondary Education Management Board, 2014]

2.3   Samples for the Study

From the population of this study, a sample size of 96 participants was selected for the study; this is in accordance with Central Limit Theorem that regarded a minimum of 30 sample size viable for experimental research [11], [12], [13] & [14]. Random sampling technique was used to select two senior secondary schools from seven educational zones of the state. The schools are: Abdullahi Fodiyo Day Secondary School Birnin Kebbi as the experimental group and Sama Secondary School Argungu as control group. Also a simple random sampling technique without replacement was adopted to select one SS2 class in each school with more than two arms. Out of the 96 respondents 55 are males and 41 are females. The table below shows the samples that are selected for the study.

Table 3:   Sample Selected for the Study

S/N	Name of School	Group	Males	Females	Total
1	A. F. D. S. S. B/Kebbi	Experimental	28	22	**50**
2	S. S. S. Argungu	Control	27	19	**46**
	Total		**55**	**41**	**96**

2.4   Treatment

During the treatment process, the experimental group participated in the differentiated instructional technique and the control group participated in lecture method class. To maintain the authenticity, two mathematics teachers of equal qualification and experience instructed both the groups. The two groups were taught separately for at least forty five minutes twice a week for a period of five weeks from May to June, 2014. At the end of the treatment, the same post-test was administered to the two classes to compare their geometric achievement in mathematics and to ensure the effect of intervention. The following topics were taught during the treatment.

- Angles on parallel lines

- Concept of similarity and congruency of triangles

- Properties of polygon, interior and exterior angles of a polygon

- Quadrilaterals

- Tangents to a circle

2.5 Instrumentation

This is an instrument developed by the researcher to examine students' knowledge on geometrical concepts before the treatment (pretest) and after the treatment (posttest). The research instrument that was adopted for the purpose of this study is a geometric achievement test (GAT). The test consists of 50 multiple choice objectives questions with options A-D, one correct answer and three distracters which were all drawn from 2000-2010 WASSCE past question papers because of the standardization of the questions. The first 25 questions from the test serve as the pretest, while the remaining 25 questions serve as the posttest. The answer scripts were collected and are marked fairly and honestly by the researcher. The response of the respondents on the tests was scored according to the key. The respondent that gives correct response to an item, he/she earned one score (i.e. 1 mark) for that item while zero score earned by a blank or an incorrect response.

2.6 Validity and Reliability of the Research Instrument

The GAT was distributed to experts with a rank of senior lecturers and with a qualification of PhD in mathematics education in the department of science education, Ahmadu Bello University Zaria, Kaduna state. After the validation exercise, the researcher makes some adjustments to the test as suggested by the experts. A trial testing of the instrument was carried out on a sample of 20 students which were not part of the targeted sample but part of the population. The

reliability of the research instrument was determined by test-retest method. Using split-half method, a Spearman Brown equal length value reliability coefficient of 0.76 was achieved. Thus, by the obtained coefficient, the instrument was found reliable for the study.

2.7 Administration of the Research Instrument

Two groups were involved in this study, which are from different schools in order to control interaction. Before the treatment, a pretest was administered to both groups to measure their level of homogeneity. Treatment session for both groups was conducted by trained research assistants with the aid of lesson notes prepared by the researcher; the lesson notes for the two methods were prepared based on the geometric contents to be covered. Then post-test was administered to the respondents after the treatment process. Both tests were conducted during the school hours.

3 PROCEDURE FOR DATA COLLECTION AND DATA ANALYSIS

Both tests were conducted during the school hours in order to avoid absentism and uncontrol of the respondents. The answer scripts were immediately collected and are marked fairly and honestly by the research assistants. The response of the respondents on pretest and posttest were scored according to the key. The list of the scores of students were prepared and submitted to the researcher. Scores obtained from the study were presented in tabulator form using SPSS for data

storage and for data calculation. Two null hypotheses were tested and answered at

$P \leq 0.05$ level of significance. The data obtained from the study were statistically

analyzed using mean, standard deviation and t-test all at 5% level of significance.

4   RESULT

Ho$_1$: There is no significant difference between the performances of students taught geometry using differentiated instructional technique against those taught with lecture method.

Table 4: Academic performance of students taught geometry using differentiated instructional technique against those taught with lecture method.

Group	N	Mean	S. D.	Std. Error	Df	t-cal.	t-crit.	p-value
Experimental	50	2.22	0.62	0.27	94	6.25	1.66	0.05
Control	46	1.47	0.65	0.92				

S* - Significant at 5% level, Df = 94

The result in table 4 shows that the performance of students   taught   geometry

using differentiated instructional technique against those taught   with   lecture

method. The table indicated that t-calculated is 6.25 while t-critical is 1.66 at 5%

level of significant. This shows that t-cal. is greater than t-crit., therefore the null

hypothesis which states that there is no significant difference between the

performance of students' taught   geometry   using   differentiated   instructional

technique against those taught with lecture method is rejected.

Ho₂: **There is no significant difference between the mean scores of male and female students' in geometric concept using differentiated instructional techniques**

Table 5: t-test showing the mean scores of male and female students in geometric concept taught using differentiated instructional techniques

Gender	N	Mean	S. D.	Std. Error	Df	t-cal.	t-crit.	p-value
Male	55	2.30	0.58	0.27	94	2.06	1.66	0.05
Female	41	1.93	0.59	0.92				

S* - Significant at 5% level, Df = 94

Table 5 shows the results of the analysis conducted on the mean scores of geometric concept taught using differentiated instructional techniques based on gender. The table clearly revealed that t-calculated is 2.02 while t-critical is 1.66 at 5% level of significant. This shows that t-cal. is greater than t-crit., therefore the null hypothesis which states that there is no significant difference between the mean scores of male and female students in geometric concept using differentiated instructional techniques is also rejected; this implies that males performed better than their female counterparts.

5   DISCUSSION

This study investigated the effectiveness of differentiated instruction on students' geometric achievement in Kebbi state senior secondary schools. The study resulted in a number of findings of practical significance. The most notable result is that the research group has been able to demonstrate differential effects on productive disposition, conceptual understanding, strategic competence and adaptive reasoning.

Result from table 4 shows a significant difference between the performances of students taught geometry using differentiated instructional technique against those taught with lecture method. This finding is in agreement with that of [15], [16] & [17] who asserted that new approach to mathematics teaching will provide opportunity for better achievement. From table 5, a significant difference between the mean scores of male and female students in geometric concept using differentiated instructional techniques was found; there for this implies that males performed better than their female counterparts. The finding of this study contradicts that of [18] who found no difference among gender using differential instruction.

6   CONCLUSION

The following conclusions were drawn on the basis of the findings of this study:

- Students taught geometry using differentiated instruction achieved better than those taught by lecture method.

- There exists a significant gender difference in geometric concept using differentiated instructional which shows that males performed better than their female counterparts.

- Difference between the achievements level is due to differentiated instruction strategy, otherwise both group have equal basic knowledge of geometry.

7   RECOMMENDATION

In view of the result of these findings, the following recommendations are made by the researchers:

- This study proved that differentiated instruction is more effective in teaching and learning geometric concepts when compared to lecture method. Therefore mathematics teachers should endeavour to use differentiated instruction in order to engage students in solving geometric problems rather than rote learning and memorization.

- Publishers should publish their books of mathematics in differentiated learning form. Because the traditional textbooks do not meet the criteria of differentiated instruction.

- Extensive training program, seminars and workshops should be organized for mathematics teachers in senior secondary schools on how to employ differentiated instruction.

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