

Differentiated Instruction in Senior Secondary School: Effect on Students' Academic Achievement in Geometry

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ABSTRACT

This study examined the effect of differentiated instruction strategies on the academic achievement of senior secondary school students in Geometry. The study employed quasi experimental design of pretest, post -test non-randomized and non-equivalent control group. Two research questions and two hypotheses were used in the study. The population of the study consisted of all 24 public senior secondary schools in Bauchi metropolis with a total of 33,880 students. A simple random sampling technique was used to select two schools (80 control, 86 experimental). The experimental group was taught geometry using differentiated instruction, while the control group was taught using conventional method. The instrument used for data collection was Geometry Achievement Test (GAT). The validity of the instrument was obtained by given to experts from mathematics education and measurements and evaluation and their observations were effected accordingly. The reliability of the instrument was determined by pilot testing the instrument on selected sample of schools that were not located within the area of the study on two different occasions, 0.72 reliability coefficient was obtained. Descriptive statistics and inferential statistics were used for data analysis at 0.05 level of significant. The results showed that teaching using differentiated instructional improved students' achievement in geometry. It was recommended that teachers should use differentiated instructional strategies to enhance teaching and learning of mathematics in schools.

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INTRODUCTION

Mathematics is the scientific study of quantities, including their relationship, operations and measurements expressed by numbers and symbols. Hytho (2015) view mathematics as the science of logical study of numbers, shape, arrangement, quantity, measure and many related concepts. Mathematics remains very

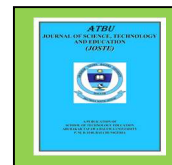
important discipline of science and is a basis for understanding other subject that is why is compulsory at senior secondary education for all students (FRN 2013). Geometry is one of the concepts of mathematics that are taught in Nigerian secondary education. According to Paulina (2007). Geometry is a branch of mathematics that deals with the measurement, properties and

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relationships of points, lines, angles, surfaces and solids. Geometry plays a significant role in primary and secondary schools mathematics curricula in Nigeria and other countries (Julie, 2015). It provides a rich source of visualization for understanding arithmetical, algebraic, and statistical concepts (Chukuemeka, Nwaneri & Nsigbe 2017). Geometry has many practical uses in everyday life, such as measuring circumference, area and volume of an object (Tanton, 2016). It develops students' spacial ability, logical reasoning skills and the ability to solve real world problems (Bot, 2017).

In spite of these important, the reports of the West African Examination Council (WAEC May June 2015) identified geometry as one of the branches of mathematics in which students have not been performing satisfactorily. Similarly the WAEC (2015) Chief Examiner's reports on the question "the ratio of the interior angle to the exterior angle of a regular polygon is 5:2" The Chief Examiner report that students had poor knowledge of geometry and the candidates were unable to recall the formula for the sum of the interior angles and exterior angles of a polygon. The report also indicated that majority of the students were unable to apply circle theorems correctly. Ubi, Odiong, & Igiri, (2018) revealed that difficulty in the learning of geometry concepts could be attributed to; methods of teaching, unavailability of instructional materials, insufficient time allocation, students gender, complexity and misconceptions of concepts, many students fails to understand the basic concepts in geometry and work out the class without learning the necessary basic

terminology (Telima, 2012). Isa, Mammam, Badar and Bala (2020) opined that improvement in the academic achievement of students is dependent on method of teaching. That is why the poor academic achievement of students in mathematics has been partly attributed to lecture method often used by some teachers. Hence, Obafemi (2022) recommended the use of differentiated instruction as a method of teaching to bring about improvement in the academic achievement of students.

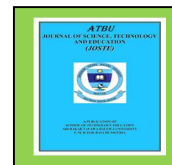
Differentiated instruction is a teaching approach based on the premise that instructional approaches should vary and be adapted in relation to individual and diverse students in classrooms (Tomlinson, 2003). Differentiated instruction is an approach that assumes there is a diversity of learners in every classroom and that all learners can be reached if a variety of methods and activities are used. According to Tomlinson (2009) differentiated instruction is a means of teaching all students to help them reach a common goal, regardless of the path they take to get there. All students are not alike, that is, students learn in different ways and at different rates. Based on this knowledge, differentiated instruction applies an approach to teaching and learning that gives students multiple options for taking in information and making sense of ideas. Butt & Kausar (2010) opine that "differentiated instruction is an approach to planning so that one lesson may be taught to the entire class while meeting the individual needs of each child". Moreover, Levy (2008) explained that the focus of differentiated instruction is to ensure that all learners reach the same goals. However, teachers

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use different strategies to differentiate content and ensure that student's characteristics or needs are achieved. Such strategies involve scaffolding, curriculum compacting, learning contracts, using varied texts and resource materials, and content. But such strategies should be implemented according to student's readiness, interest, and learning profile.

Several researches had been conducted on the effect of differentiated instructional strategy that revealed positive effects on student's achievement in mathematics for example; the work of Muthomi & Mbugha (2014) investigated the effect differentiated instruction on students' achievement in mathematics at senior secondary schools in Kenya. The study employed quasi experimental research design. A total of 374 students were use as sample of the study using simple random sampling technique. Mathematics achievement test was used as instrument for data collection. The result indicated that differentiated instruction significantly improved students' achievement. The study recommended that curriculum planners should include differentiated instruction in approaching to teaching mathematics.

Another similar study was conducted by Odicta (2017) who investigated the effect of differentiated instruction on the mathematics achievement and critical thinking skills in Roxas city. A total of 54 grade 10 high school students were used as sample of the study. The study employed pretest posttest quasi experiments as research design. Validated research made test in mathematics and critical thinking skills test, learning style and multiple intelligence inventories were used as

instruments for data collection. The result revealed that there was significance difference in the pretest and posttest mean gains of the two groups in mathematics achievement and critical thinking skills in favor of the differentiated group.

Ogunkunle & Henrietta (2014) examined the effect of differentiated instruction strategies on students' retention in Geometry in senior secondary school. The study employed experimental research design of pretest, posttest control group. The area of the study was Abuja municipal area council. The entire senior secondary school 2 was used as population of the study. Simple random sampling technique was used to select two secondary school and 100 subjects for the study. Geometry Achievement Test (GAT) was used as instrument for data collection with reliability coefficient of 0.90 was obtained. Descriptive and inferential statistic was used to analyze the research questions and hypothesis. The results revealed that differentiated instruction strategy was more effective in promoting students achievement and retention in geometry than conventional method.

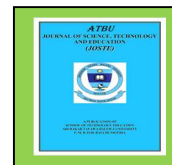
Onyishi & Sefotho (2021) explored the differential effect of Differentiated Instruction (DI) on the mathematics self efficacy (MSE) of learners with dyscalculia as well as high and low achieving learners. The study adopted a control group quasi experimental research design involving one experimental and one control group. A total of four mathematics teachers and (158) senior secondary learners in four regular classes participated in the study. Students Mathematics Self efficacy Scale (SMSES)

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was used as instrument for data collection. The quantitative data was analyzed using descriptive statistics and analysis of covariance (ANCOVA). The major findings indicated that using differentiated instruction led to significant improvement in learners MSE. Prior achievement (PA) had significant influence on MSE. However, differentiated instruction was effective in reducing the negative effect of poor PA on the self efficacy of low achieving learners and learners with dyscalculia. The study concludes that differentiated instruction offers teachers the impetus to help learners to improve their self efficacy in mathematics.

Obafemi (2022) examined the effect of differentiated instruction on the pupil academic achievement in mathematics in Ilorin Kwara State. The study adopted pretest posttest quasi experimental design. A total of 178 pupils was used in both experimental and control groups as sample of the study. Mathematics achievement test (BSTAT) was used as instrument for data collection with reliability coefficient of 0.79. Seven research hypothesis were formulated and tested at 0.05 level of significance. Inferential statistics of analysis of variance (ANCOVA) was used to analyze the data. The result indicated that treatment had significance effect on pupil's academic achievement in mathematics. Another finding of the study revealed that gender had no significant effect on the academic achievement of pupils in Mathematics in Ilorin West Local Government Area of Kwara State. The study recommended that differentiated instruction should be used in teaching mathematics and government should organized or sponsor teachers to attend

workshop and conferences on the use of differentiated instruction strategy.

Canque, Trinnidal & Cortes (2021) investigated the effect of differentiated instruction through tiered activities in teaching geometry. The study utilized quasi experimental design of pretest posttest control group. A total 48 junior secondary school 2 students were selected as respondents of the study which 38 belong to the control group and 38 belong to the experimental group. The findings revealed that the overall performance of the experimental group is above the 75% level of criterion. The result also showed that there is a significance increase in the performance of the experimental and control group from the pretest and posttest. The study conclude that traditional and differentiated instruction are both effective approaches in the teaching and learning process and teachers should use various teaching approaches to address today's' diverse learners.

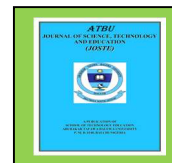
Yousef, Manar & Nasser (2020) investigated the degree to which teachers in Qatar implement differentiated instruction also the study explored the obstacles impending the application of differentiated instruction. A total of 1,836 early childhood teachers in 99 Qatar public schools were used as population of the study. A random of 236 teachers accounting for 12.9% participated in the study. The study employed mixed method design. Questionnaire and interview was used as instruments for data collection. The result showed no statistically significance among the respondents in the degree of application of differentiated instruction due to training and qualification. Statistical significance

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differences were detected in the relevance to years of experience, grade and the subject taught.

The present study investigated the effect of differentiated Instructional Strategies on Senior Secondary School Student's academic achievement in Geometry within Bauchi metropolis.

THEORETICAL FRAMEWORK

This study is based on theoretical perspective of Vygotsky Zone of Proximal Development. Vygotsky defined the ZPD as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peer" (p. 86). The idea is that individuals learn best when working together with others during joint collaboration, and it is through such collaborative endeavors with more skilled persons that learners learn and internalize new concepts, psychological tools, and skills. Roosevelt (2008) holds that the main goal of education from Vygotskian perspective is to keep learners in their own ZPDs as often as possible by giving them interesting and culturally meaningful learning and problem-solving tasks that are slightly more difficult than what they do alone, such that they will need to work together either with another, more competent peer or with a teacher or adult to finish the task. The idea is that after completing the task jointly, the learner will likely be able to complete the same task individually next time, and through that process, the learner's ZPD for that particular task will have been raised. This process is then

repeated at the higher level of task difficulty that the learner's new ZPD requires

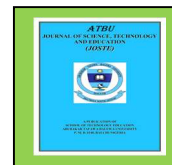
Theoretically, differentiated instruction is grounded under the socio cultural perspectives of learning as explained through Vygotsky's zone of proximal development (ZPD). Through differentiation, students are given slightly higher expectations, but appropriate to every individual student's ZPD. Thus, it is beneficial for mixed ability classroom as lessons are tailored to individual student's level of readiness, interests and learning profiles (Dodge, 2009). The goal of the instructor is to give instructions to learners on their level of understanding. Specifically, instruction should occur between the lower threshold of development and the upper threshold represented by the problems the child can complete with assistance (Vygotsky, 1934/1987). According to Tomlinson & Allan (2000) and Tomlinson (2010), ZPD supports Differentiated Instruction because it highlights the importance of the role of the teacher pushing the child into the ZPD, coaching for success so the learner can manage alone, and promoting independent thinking. The teacher is responsible for each student's ZPD (Tomlinson, 2006) by means of an instructional strategy called *scaffolding* in which the teacher develops tasks to build on prior knowledge. To differentiate instruction, the teacher flexibly adjusts the content, process, product and learning environment to suit individual learner's prior knowledge, interests, and learning styles (Tomlinson, 2001). In order to differentiate through content, teachers design activities for diverse groups of learners in a hierarchy of complexities

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(Algozzine & Anderson, 2007;) so that learners build on their different mastery/readiness levels. Through the differentiating process, the teacher offers diverse ways in which learners can access the curriculum (Walton, 2017). For instance, at the point of introducing a topic in a classroom, some learners may be unfamiliar with the concepts of the lesson, some may have partial mastery of the content or display mistaken ideas about the content, and others may show mastery of the content before the lesson. A teacher who differentiates instruction targets all learners in groups. To differentiate through the process, the teacher diversifies presentation of the content in a way that will appeal to diverse learners' learning styles.

Objectives of the Study

The main objective of this study is to investigate the effect of differentiated Instructional Strategies on Senior Secondary School Student's academic achievement in Geometry within Bauchi metropolis

The specific objectives of the study are to:

1. Investigate the effect of Differentiated Instructional Strategy on Senior Secondary School Students' academic achievement in Geometry
2. Investigate gender effect of Differentiated Instructional Strategy on Senior Secondary School Students' academic achievement in Geometry

Research Questions

The following research questions guided the study;

1. What is the mean difference between the academic achievement of students taught Geometry using differentiated instructional strategy and those taught using conventional method?
2. What is the mean difference between the academic achievement scores of male and female students taught Geometry in the experimental and control groups?

Hypotheses

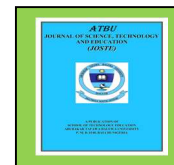
The following null hypotheses were formulated and tested at 0.05 level of significance.

H₀₁: There is no significant difference in the mean achievement scores of students taught geometry using differentiated instruction and those taught using the conventional method.

H₀₂: There is no significant difference in the mean achievement scores of male and female students taught geometry using differentiated instructional strategy.

METHODOLOGY

The study adopted the pretest-posttest non equivalents group Quasi-Experimental design. The study is made up two instructional groups; one experimental group and the other control group. The experimental group was exposed to treatment in differentiated Instructional Strategy while the control group was exposed to the conventional method of teaching Geometry. The population of the study comprised all public Senior Secondary Schools in Bauchi metropolis. There are total of thirty three thousand eight hundred and eighty students (33,880) in



which 18,940 are male and 14,940 are female students. A simple random sampling technique was used to select two co-educational senior secondary schools. A sample of 164 (80 control, 86 experimental) students were used for the study. Two groups were used, one experimental group and the other one is the control group. The experimental group was taught geometry for four weeks using differentiated instruction, while the control group was taught for four weeks as well using conventional method. The instrument used by the researchers was the Geometric Construction Achievement Test (GAT). Geometric Achievement Test (GAT) was a 40 items multiple choice objective test with four options (A, B, C & D). GAT was based on the senior secondary school mathematics curriculum content and the questions were of the Senior Secondary School Certificate Examination (SSSCE) standard. The

validity of the instrument was obtained by given to experts from mathematics education and measurements and evaluation and their observations were effected accordingly. The reliability of the instrument was determined by pilot testing the instrument on selected sample of schools that were not located within the area of the study on two different occasions, 0.72 reliability coefficient was obtained Data collected were analyzed using mean and standard deviation to answer the research questions. Analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significant.

RESULT

Research Question 1: What is the mean difference between the academic achievement of students taught Geometry using differentiated instructional strategy and those taught using conventional method?

Table 1: Pretest and post-test Mean and standard deviation of achievement scores of students taught geometry using differentiated instructional strategy and those taught using conventional method.

Group	N	PRE-TEST		POST-TEST		Mean Gain
		Mean	S.D	Mean	S.D	
Experimental	86	15.25	2.82	28.34	3.86	13.09
Control	80	12.16	2.14	16.52	3.29	4.36
Total	164					

Table 2 above showed that the mean gain in the experimental group was 13.09, while the mean gain for the control group was 4.36, with the difference of the mean gain 8.73 which indicate that the experimental group performed better than the control group.

Research Questions 2: What is the mean difference between the academic achievement scores of male and female students taught Geometry in the experimental and control groups?

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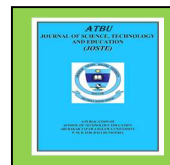


Table 2: Pretest and post-test Mean scores and standard deviation of male and female students taught geometry using differential instructional strategy

Group	PRE-TEST				POST-TEST			Mean Gain
	Gender	N	Mean	S.D	N	Mean	S.D	
Experimental	Male	41	13.43	2.34	41	25.83	3.21	12.40
	Female	45	12.02	2.06	29	21.12	3.26	9.10
Total		86			70			

Table 4 shows the mean scores and standard deviation of male and female pupils in the experimental and control groups. From table 4.3, it could be seen that the mean scores of the male students taught with differential instructional strategy were 13.43 and 25.83 in pretest and posttest respectively and standard deviation of 2.34 and 3.21 in the performance test. For the female students, it was observed that they had mean scores of 12.02 and 21.12 in pre-test and post-test respectively and standard deviation of 2.06 and 3.26 in

that order. It was further observed that the mean gain scores for male and female pupils stood at 12.40 and 9.10 respectively. This implies that the male students perform better than their female counter part when exposed to differential instruction.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught geometry using differentiated instruction and those taught using the conventional method.

Table 3: Analysis of Covariance (ANCOVA) on mean scores of students taught geometry using differentiated instructional strategy and those taught using conventional method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3426.125 ^a	2	2113.118	131.127	.000
Intercept	177.214	1	177.214	104.310	.000
Covariates	320.2	1	320.2	.000	.000
Group	3773.576	1	3773.576	104.03	.000
Gender	2.116	1	2.116	0.402	0.024
Error	1262.328	161	12.805		
Total	46805.101	164			
Corrected Total	5324.823	163			

a. R Squared = .601 (Adjusted R Squared = .601)

From the result of the ANCOVA above in table 3, it was observed that group which was the main effect gave an f-value of 104.03 and was significant at 0.000. Since 0.000

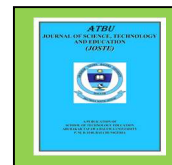
is less than 0.05, this means that at 0.05 level, the f-value is significant. Therefore, we reject hypothesis 1 and conclude that there is a significant difference in the students' achievement

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on geometry between the experimental-group applied the differential instruction strategies and the control group applied conventional teaching method.

Hypothesis 2 There is no significant difference in the achievement means scores between the male and female students taught geometry using Differentiated Instructional Strategy

The table 3 also presented the analysis of Covariance (ANCOVA) on the mean achievement scores of male and female students in the experimental group. From the table an F value of **0.402** were obtained. Since 0.024 was less than 0.05, this meant that at 0.05 level, the f- value was significant. Therefore the hypothesis 2 was rejected. Hence the study concluded there was significant difference between the mean achievement scores of male and female students in the experimental group. This gives an indication that male students achieved better than the female students in the treatment group

DISCUSSION OF FINDINGS

The study examined the effect of Differentiated Instructional strategy on the academic achievement of Senior Secondary school students in geometry in Bauchi metropolis, Bauchi State. The findings indicated that students in the experimental group had a higher post-test mean achievement score in geometry than their control group counterparts. This result is further confirmed by the results of Table 3 which indicates that method is a significant factor in the achievement of students in geometry. This is shown by rejection of the null hypothesis of no

significant difference in the achievement of students taught using differentiated instructional and those taught using conventional method.

The finding of the study supports the earlier findings of Yousef, Manar & Nasser (2020), Onyishi & Sefotho (2021) which all showed that students demonstrated greater understanding of mathematical concepts and improved performance when taught through strategies that are interactive and could improve their interest. The findings also agree with Muthomi & Mbugha (2014) and Obafemi (2022) who found that students taught via differentiated instruction perform better than those taught via conventional method. This implies that differentiated instruction can be adopted as a strategy for effective teaching of mathematical concepts.

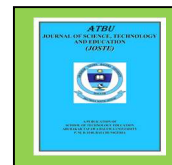
The findings in Table 2 showed that male students in the experimental group gained in achievement more than their female counterparts with a post-GAT mean of 25.83 for male and 21.12 for female. Results from Table 3 revealed that there is no significant difference in the mean achievement scores of male and female students exposed to differentiated instructional strategy. This finding corroborated the finding of Obafemi (2022) who discovered that there was no significant main effect of gender on the academic achievement of pupils in Mathematics in Ilorin Local Government Area of Kwara State. Similarly, the finding supported the finding of Canque, Trinnidal & Cortes (2021) which revealed that gender had no significant effect on the academic achievement of junior secondary school students in mathematics.

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CONCLUSION

The study has provided empirical basis for maximizing classroom teaching and learning of mathematics especially geometry. This is evident by the fact that the group taught with differentiated instruction performed significantly higher than the group that taught dominated by the teacher. The theoretical assumption that differentiated instruction enhances students' academic achievement has been tested and the findings have given empirical support to the earliest proposition.

RECOMMENDATIONS

Based on findings of this study, the researchers recommend that:

1. In view of the large students' population and inadequate number of qualified teaching staff, particularly in secondary schools, teachers should be encouraged to employ differentiated instruction strategy in their classroom teaching and learning.
2. Training and retraining programmes such as seminars and workshop should be organized by government for teachers of mathematics to learn more on differentiated Instructional Strategy so as to improve students' achievement in geometry.
3. Curriculum experts and textbook author should be encouraged by Federal and State Ministries of Education to incorporate differentiated instructional strategy as an innovative and efficacious

method in curriculum and in textbooks accordingly.

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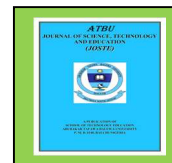
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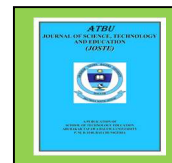
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