Contemporary Journal of Education and Social Sciences,
Volume 1, Issue 1, June 2026
ISSN: 2806-4968

GENDER DISPARITIES AND SCORING LEVELS: EFFECTS OF MATHEMATICS LABORATORY ON SENIOR SECONDARY SCHOOL STUDENTS' PERFORMANCE IN GEOMETRY IN KOGI STATE, NIGERIA

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Abstract
Geometry is an important topic of Mathematics that many students often fear and perform poorly in internal and external examinations. This is traceable to non-pragmatic method of teaching the topic employed by Mathematics teachers. There is a need for a pragmatic students-centered method of learning such as the Mathematics laboratory to improve students' understanding of the topic. Also, there is a dearth of studies on students' performance in geometry using Mathematics laboratory.. A quasi-experimental design was employed for the study. Purposive sampling technique was used to select four senior secondary schools in Abuja. The sample consisted of 195 students. The instruments used for data collection was plane geometry performance test (PGPT) which was validated by two experienced Mathematics Education lecturers and three experienced senior secondary school Mathematics teachers. The PGPT had a reliability co-efficient of 0.79, using Pearson's Product-Moment Correlation. Mean, standard deviation and Analysis of Covariance were used to analyze the data at 0.05 level of significance. The findings of the study were that: there was a significant difference in the performance of students taught geometry using Mathematics laboratory and their counterparts taught using the conventional method in favor of those taught using Mathematics laboratory, there was no significant difference in the performance of students taught geometry using Mathematics laboratory on the basis of gender, there was a significant difference in the performance of students taught geometry Mathematics laboratory on the basis of scoring levels in favor of the low scoring students, This study recommended that Mathematics teachers should use Mathematics laboratory in teaching geometry.
Keywords: Gender, Disparities, Scoring levels, Mathematics laboratory and Geometry

Introduction

Mathematics is one of the field of study that is universally used for the advancement of technology and human development, which knowledge is necessary for the study of everything in life (Samuel & Sunday, 2024). Mathematics is the science of patterns and relationships which explores the possible relationships among abstractions without concern for whether those abstractions have counterpart in the real world (Sunday, etal, 2024). The belief of the nature of mathematics held by the teachers, students, parents and all stakeholders in the community influences to a great extent the development of school mathematics curriculum, instruction and

implementation. According to Dossey (2013), the understanding of the conceptions of the nature of mathematics is as important to the development and successful implementation of programs in school mathematics as it is to the conduct and interpretation of research studies in mathematics. Furthermore, the unprecedented increase in mathematics knowledge and its applications have led to several articles on the nature of mathematics some of which include (Stewart, 1987; Hilton, 1987; Davis & Hersh, 1980; Steen, 1988). These articles range from axiomatic structures to generalized heuristics for solving problems which have a great influence on the perceptions and reactions on the daily use of mathematics in our lives (Dossey, 2013).

Geometry is one of the longest-established branches of mathematics and its origins can be traced back through a wide range of cultures and civilizations. During the nineteenth and twentieth centuries, geometry, like most areas of mathematics, went through a period of growth that was near cataclysmic in proportion. As a consequence, the content of geometry and its internal diversity increased almost beyond recognition. The geometry of the ancient world, codified in the books of Euclid, rapidly becomes no more than a subspecies of the vast family of mathematical theories of space (Fajemidagba, 2009).The contemporary classification of more than 50 geometries illustrates the richness of modern geometrical theory (Malkevitch, l998). Malkevitch(1998) proposed that geometry be viewed as the study of the properties of a space that are invariant under a given group of transformations. This synthesis and definition of geometry made it possible to classify the various geometries into related families, ranging from topology as the most general, through projective and affine geometries, to Euclidean geometry which has the most restricted congruence because more properties are invariant. This way of viewing geometry, and subsequent developments, spurred the delineation of many more geometries. Geometry, in all its variety, is also rich in application. Here, briefly, are a few illustrative examples of current applications as suggested by Whitely (1999): Computer aided design (CAD) and geometric modeling (including designing, modifying, and manufacturing cars, planes, buildings, manufactured components, among many others). Medical imaging which has led to some substantial new results in fields like geometric tomography

Further areas where geometric problems arise are in chemistry (computational chemistry and the shapes of molecules), material physics (modeling various forms of glass and aggregate materials), biology (modeling of proteins, ‘docking’ of drugs on other molecules), Geographic Information Systems (GIS), and most fields of engineering. In recent times, the nature of geometry has continued to expand. A number of contemporary developments in mathematics are predominantly geometrical. These developments include work on ‘dynamical systems a major mathematical discipline closely intertwined with all main areas of mathematics. Mathematical visualization which is the art of transforming the symbolic into the geometric and geometric algebra a representational and computational system for geometry that is entirely distinct from algebraic geometry. Some implications of these developments in geometry for the teaching of algebra are given in Jones (2001). Thus geometry has continued to evolve and now encompasses the understanding of diverse visual phenomena. A useful contemporary definition of geometry is that attributed to the highly-respected British mathematician, Sir Christopher Zeeman: “geometry comprises those branches of mathematics that exploit visual intuition (the most dominant of our senses) to remember theorems, understand proof, inspire conjecture, perceive reality, and give global insight” (Royal Society, 2001). The Royal Society (2001) report on the teaching and learning of geometry suggests that the contemporary aims of teaching geometry can be summarized as follows:

Mathematics laboratory means different things to different people, however there are two generally accepted meaning of mathematics laboratory. Firstly, mathematics laboratory as a physical structure of a classroom where there are so many hardware for teaching and learning of mathematics. Secondly, mathematics laboratory as an instructional strategy of re-focusing the role of the students and teachers in the classroom (Akanmu, Sunday & Ayinla, 2016).The mathematics laboratory could be an intelligent synergy of the physical structure of a classroom equipped with different mathematics manipulative and an instructional strategy of refocusing the role of the teacher and the students such that the students take the dominant role in a lesson while the teachers’ role is drastically reduced to a facilitator. The students are the focal point of learning in the mathematics laboratory not

the teacher. The students use manipulative, construct model, design all forms of mathematics activities that suit their interest either as individual or in a group of four or five students or as a whole class.

Adenegan (2011) while applying the macro-instructional versus a micro-instructional role of activity learning which takes place in the mathematics laboratory was of the opinion that the macro-instructional use of mathematics laboratory could mean its application to many content and objectives of a given class. While the micro-instructional use of mathematics laboratory is application to teaching a single concept. For example, the Macro-use of mathematics laboratory could mean using a mathematics laboratory to teach either all of the SS1 or SS2 or SS3 mathematics content. And the micro-use could be for teaching a concept such as geometry. The micro-use could be very expensive if a mathematics laboratory could be developed only for teaching and learning of a single concept. However, the focus of this study will be for micro-use of teaching geometry. The mathematics laboratory is mathematics and its consequent connectivity to the real World. It is learning by doing instead of been told. It could be a highly structured learning strategy involving planned experiences with concrete embodiments of certain mathematical concepts which could be seen as totally unstructured open-ended involvement in well or loosely defined real world situation (Maschietto, 2012). The relevance of gender as one of the difference in students' variable that influence students' performance in mathematics is often reported. Researchers argue severally that the high or otherwise achievement of students is closely linked to the students' gender. Hence the need to investigate the potency of gender as a determining factor influencing the achievement of students in mathematics.

The scoring levels (entry behavior) of students into any mathematics lesson is of great importance and studies have shown that it influences students' performance in probability. In a study conducted by Sam-Kayode and Salman (2015) on effect of ludo game on senior school students' performance in mathematics. Using a pre-test, post-test group design and a sample of 100 SS2 students in two coeducational schools in Oyo State, Nigeria. The mathematics performance test was used to collect data which were analysed using t-test and Analysis of Covariate. The findings of the study reveals among others that there was a significant difference in the mean scores of high, medium and low scoring students exposed to Ludo game instructional strategy, with the low scorers benefitting most, followed by the high and medium scorers. Furthermore, on the effects of trajectories in mathematics on secondary school students' understanding of algebraic equations in Rivers state Nigeria. Amadi and Charles-Ogan (2015) in a study discovered that there is significant difference in the achievement of high and low scoring students. Although the treatment benefitted both groups, but the low scorers achieved significantly better than the high scorers, hence this study. Obi, Agwagah and Agah (2014) carried out a study on the effect of Origami on student's retention in geometry. The study which was a quasi-experimental design was carried out on 101 Junior Secondary school students in Nsukka local government Area of Enugu State, Nigeria. Two research questions and three hypotheses were raised for the study. Geometry Retention Test was used to collect data which was analysed using mean, standard deviation and analysis of covariance. The findings of the study reveals that students taught geometry using Origami performed significantly better than those not taught with the approach. There is no significant difference in the performance of students using the approach on the basis of gender. The study recommended the organization of workshops for the training of mathematics teachers to improve their knowledge on how to use the approach to enhance students' performance in geometry.

Sunday, Akanmu and Fajemidagba (2014) investigated the effects of Target-task mode of teaching on students' performance in geometrical construction in Abuja, Nigeria. The study was a quasi-experimental study which involved 138 SS II students in senior secondary schools. Three research questions and hypotheses were raised as a guide to the study. Mathematics Performance Test (MPT) was used to collect data which were analysed using t-test, Analysis of Covariance and Duncan Post-hoc Test. The findings of the study revealed that students taught geometrical construction using Target-task mode of instruction performed significantly better than those taught using the conventional mode. There was no significant difference in the students' performance on the basis of gender when taught geometrical construction using target-task mode of instruction. And students' scoring levels

have significant effects on their performance when taught geometrical construction using target-task in favor of the medium and low scoring students. The impact of cooperative learning strategy was investigated to be positive in the teaching and learning of geometry in a study by Kajuru and Isah (2014). The researchers used ten co-educational junior secondary schools. A total of 266 students participated in the study which has one research question and hypothesis in quasi-experimental design. Data was collected using Construction Geometry Performance test. t-testwas used to analysed the data which findings indicated that students taught geometry using cooperative learning strategy performed significantly better than those taught with lecture method. Gambari, Ezenwa and Anyanwu, (2014) investigated the effects of two modes of Computer-Assisted instructional package on solid geometry on senior school student's achievement in Minna, Niger State, Nigeria. The study adopted a pre-test, post-test control experimental group design. A total of 120 students in SS II participated in the study. The findings of the study reveals that there are no significant differences in the learning achievements in favor of the group taught solid geometry concepts with animation and narration and that there is no significant difference in the performance of students base on gender. The above literatures show the various strategies for teaching and learning of geometry but none of these studies have directly organize intensive workshops for mathematics teachers on the use of any of their recommended strategy for teaching geometry. The authors also did not report to have used their innovative teaching strategies.

Okigbo and Osufor (2008) investigated the effect of using mathematics laboratory on students' performance in Enugu, Nigeria. The researchers adopted a quasi-experimental design using 100 students in the junior secondary school as respondents. The researchers used Mathematics Achievement Test and Designed Mathematics Laboratory as instrument for collecting data. Mean, standard deviation and Analysis of covariance were used to analysed the collected data.The findings of the study revealed that mathematics laboratory increased students' performance in plane geometry and algebraic expression and there is no significant difference in the performance of male and female students when taught plane geometry using the mathematics laboratory. Olatunde (2010) conducted a study on adequacy of resources materials and students' mathematics achievement of senior secondary schools in southwestern Nigeria. Four research questions were raised for the study two of which include: what is the perception of mathematics teachers towards Mathematics laboratory programme in the school? Will the mathematics laboratory programme improve students' achievement in mathematics and attitude towards mathematics? The researcher used three instruments in collecting data: Questionnaire for Mathematics Teachers (QMT), Students Mathematics Attitudinal Scale (SMAS) and Mathematics Achievement Test (MAT), the findings of the study reveals that mathematics teachers perceived the need to have a well-equipped mathematics laboratory and that students taught geometry in the mathematics laboratory performed significantly better than those taught using the traditional methods. Muhammad and Ibrahim (2015) investigated the influence of laboratory activities and peer tutoring on slow-learners' achievement and retention in senior school trigonometry in Kebbi State, Nigeria and discovered that slow-learners taught using laboratory activities achieved better than those taught using traditional method. Hence this study investigated gender disparities and scoring levels: effects of mathematics laboratory on senior secondary school students' performance in geometry in Kogi state, Nigeria

Research Questions

The following research questions were raised as a guide to the study:

1. Do students' performances differ when taught plane geometry using Mathematics laboratory and those taught using conventional method?
2. What is the difference in the students' performance when taught plane geometry using Mathematics laboratory on the basis of gender?
3. Do students' performance vary when taught plane geometry using Mathematics laboratory on the basis of their score levels?
4. What are the interaction effects of treatment and gender on senior school students' performance in plane geometry?

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ISSN: 2806-4968

5. What are the interaction effects of treatment and score levels on senior school students' performance in plane geometry?

Research Hypotheses

The following research hypotheses were formulated and tested in this study:

$H0_1$: There is no statistically significant difference in the students' performance when taught plane geometry using Mathematics laboratory and those taught using conventional method

$H0_2$: There is no statistically significant difference in students' performance when taught plane geometry using Mathematics laboratory on the basis of gender

$H0_3$: There is no statistically significant difference in students' performance when taught plane geometry using Mathematics laboratory only on the basis of score levels.

$H0_4$: There is no interaction effects of treatment and gender on senior school students' performance in plane geometry.

$H0_5$: There is no interaction effects of treatment and score levels on senior school students' performance in plane geometry.

$H0_5$: There is no interaction effects of gender and score levels on senior school students' performance in plane geometry.

Methodology

This design used for this study was a quasi-experimental design, the non-equivalent pre-test, post-test control group design. This design was adopted because experiment was carried out using intact classes of SS II of senior secondary school (Akanmu & Fajemidagba, 2013). The utilization of intact classes minimize to a large extent the disruptions of normal school classes. Hence, there was no randomization of students into treatment and control groups as its helped in not disrupting the school academic organization. The population for this includes all the senior secondary school students in the public senior secondary schools in Abuja. The target population was all SSII students in the Public senior secondary schools in Abuja. There were 57 public senior secondary schools in Abuja as at the time this study was conducted(FCT-Secondary Education Board, 2016). See appendix 12. The sample for this study consist of one hundred and ninety-five (195) SS II students who were drawn from four (4) schools which participated in the study. Experimental group I have 51 students, experimental group II have 56 students, there were 42 students in the experimental group III and 46 students in the control group. There are 57 public senior secondary schools in Abuja as at when this research was conducted. Since the schools that ought to participate should be operating co-educational system, 49 of these schools met the requirement of operating co-educational system. Secondly, the participating schools ought to have a mathematics laboratory, only five of these 49 schools have a mathematics laboratory. Four of these five schools' mathematics laboratory can accommodate at least 50 students while the fifth school's Mathematics laboratory cannot comfortably accommodate fifteen students. The four schools whose mathematics laboratory can accommodate minimum of 50 students were selected because each of the intact classes have minimum of 40 students. Hence, Purposive sampling technique was used to select the four schools which participated in the study.

One research instruments were used to collect data for this study which are Plane Geometry Performance Test (PGPT) The PGPT was researcher-designed test with two sections: A and B. Section A consist of the bio-data of the respondents such as sex and class. While, Section B consists of 12 open-ended questions on congruent and similar triangles. These questions were selected from past West African Examination Council's Mathematics examination, National Examinations Council' mathematics examination for senior secondary schools. The selected theory questions were reframed by the researcher to suit the purpose of this study. The instrument was administered on 600 SS II students of non-participating schools in Abuja in order to determine the difficulty index which was 0.51. This value indicates that the instrument (PGPT) was neither too difficult nor too simple The research instrument was given to 2 experienced lecturers and 3 experienced Mathematics teachers at the senior secondary schools. They were requested to validate the instrument based on clarity and appropriateness of the

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statement and for face and content validity of the instruments. After validation of PGPT, only twelve items remained out of the initial fifteen before validation and were used for the study. For the reliability of the instruments, the PGPT was administered twice on two non-participating schools in Abuja within an interval of two weeks using test re-test method and Pearson's Product-Moment Correlation was used to determine the reliability coefficient which was 0.79. All the fifteen research questions were answered using mean and standard deviation. All the fifteen hypotheses were tested using Analysis of Covariance (ANCOVA). The pre-test was used as covariates. Duncan's pos-hoc analysis was also employed to ascertain direction of difference. All the hypotheses were tested at 0.05 levels of significance.

Results

Research Question One: Will there be any difference in the students' performance when taught plane geometry using Piagetian-constructivism model and mathematics laboratory and those taught using conventional method?

In Table 1, the mean performance scores of the students taught plane geometry using Piagetian-constructivism model and mathematics laboratory was 13.35 and mean gain score of 9.98, while students taught with the conventional method had a mean performance score of 4.54 with a gain score of 1.17. This implies that the students taught plane geometry using the Piagetian-constructivism model and mathematics laboratory performed better than their counterparts that were taught with the conventional method.

Table 1: Mean performance scores and standard deviation of students' taught geometry using Mathematics Laboratory and those taught with conventional method

Variable		Pre-test		Post-test		
Method of Teaching	N	Mean	SD	Mean	SD	Mean gain
Maths Laboratory	51	3.37	1.98	13.35	3.42	9.98
Conventional Method	46	3.37	2.09	4.54	2.05	1.17

Hypothesis One: There is no statistically significant difference in the students' performance when taught plane geometry using mathematics laboratory and those taught using conventional method

The result in Table 2 showed that the mean performance score of students taught plane geometry using PCML differed significantly. This was indicated by the calculated *F*-value of 264.04 with p=.00 which is less than 0.05 set as level of significance. Therefore, the null hypothesis of no significant difference in the mean performance scores of students taught plane geometry using PCML and those taught with conventional method was rejected. This indicates that there is a statistically significant difference in the mean performance scores of both groups, as PCML increased students' performance in plane geometry than the conventional method. ($F_{(1,\ 94)}$= 264.04, p< .05).

Table 2: Analysis of Covariance of the mean performance score of students taught plane geometry using Mathematics Laboratory

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	1984.050[a]	2	992.025	139.603	.000	.748
Intercept	1315.263	1	1315.263	185.090	.000	.663
Pretest	107.090	1	107.090	15.070	.000	.138
Groups	1876.296	1	1876.296	264.041	.000	.737
Error	667.971	94	7.106			
Total	10818.000	97				
Corrected Total	2652.021	96				

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ISSN: 2806-4968

Research Question two: Will there be any difference in students' performance when taught plane geometry using mathematics laboratory on the basis of students' gender?

Results in Table 3 showed that the mean score for the male students taught plane geometry using Piagetian-constructivism model and mathematics laboratory was 13.22 and mean gain score of 9.48, while that of the female students was 13.50 with a gain score of 10.54. However for each of the group the post-test mean performance score was greater than the pretest mean performance score with female students having a slightly higher mean gain. This showed that both male and female students taught plane geometry using the Piagetian-constructivism model and mathematics laboratory seems to have similar performance in plane geometry.

Table 3: Mean performance scores and standard deviation of male and female students' taught plane geometry using ML.

Variable	Pre-test			Post-test		
Gender	N	Mean	SD	Mean	SD	Mean gain
Male	27	3.74	2.28	13.22	3.45	9.48
Female	24	2.96	1.52	13.50	3.46	10.54

Hypothesis two: There is no statistically significant difference in the performance of students taught Plane geometry using ML on the basis of students' gender

The result in Table 4 showed that with respect students' performance, an *F*-value of 0.40 with p=0.53 which is greater than 0.05 level of significance. Therefore, the null hypothesis of no significant difference in the mean performance scores of students taught plane geometry using PCML on the basis of gender was not rejected. This indicates that there is no statistically significant difference in the mean performance scores of male and female students when taught plane geometry using ML. This suggest that gender has no influence on students' performance when taught plane geometry using PCML. ($F_{(1, 48)}$= 0.40,p> .05).

Table 4: Analysis of Covariance of the mean performance score of male and female students taught plane geometry using ML

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	35.901[a]	2	17.950	1.567	.219	.061
Intercept	1790.996	1	1790.996	156.377	.000	.765
Pretest	34.920	1	34.920	3.049	.087	.060
Gender	4.613	1	4.613	.403	.529	.008
Error	549.746	48	11.453			
Total	9679.000	51				
Corrected Total	585.647	50				

Research Question Three: What will be the difference in the students' performance when taught geometry mathematics laboratory on the basis students' score levels?

Table 5 shows the descriptive performance of the high, medium and low scoring students taught geometry using mathematics laboratory. The table indicated that the low scoring students benefitted most with a mean gain score of 11.23, followed by the high scorers with a mean gain score of 10.20 and the medium scorers with a mean gain score of 7.79.

Table 5: Mean Performance Score and Standard Deviation of the High, Medium and Low Scoring Students Taught Geometry Using Mathematics Laboratory

Levels	N	Pretest Mean	SD	Post-test Mean	SD	Mean Gain
High	15	4.20	2.54	14.40	3.18	10.2
Medium	14	3.50	1.61	11.29	3.31	7.79

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ISSN: 2806-4968

Low	22	2.72	1.57	13.95	3.21	11.23

Hypothesis Three: There is no statistically significant difference in students' performance when taught geometry using mathematics laboratory on the basis of score levels

Table 6 shows the ANCOVA analysis of the high, medium and low scoring students taught plane geometry using PCML. From the table, F-value of 4.25 was obtained with *p*-value of 0.02 was computed at 0.05 alpha level. Since the *p*-value (0.02) is less than the alpha-value (0.05), the null hypothesis of no significant difference was rejected. Hence, there is a statistical significant difference in the performance of students taught PG using PCML based on their score levels ($F_{(2, 47)} = 4.25$, $p < .05$). Duncan's Post-hoc analysis was used to determine the direction of difference in Table 7.

Table 6: ANCOVA of Mean Score of High, Medium and Low Scoring Students Taught Plane Geometry Using Mathematics Laboratory

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	109.345[a]	3	36.448	3.60	.02	.187
Intercept	1592.737	1	1592.737	157.17	.00	.770
Pretest	25.109	1	25.109	2.48	.12	.050
Score Levels	86.231	2	43.115	4.25	.02	.153
Error	476.302	47	10.134			
Total	9679.000	51				
Corrected Total	585.647	50				

Table 7 is the Duncan's analysis of mean score of students based on score levels. The table indicated that the low scorers benefitted most with a mean gain score of 11.09, followed by the high scorers with mean gain score of 10.27 and then the medium scorers with a mean gain score of 7.93.

Table 7: ***ANCOVA of the Interaction Effects of Treatment, Gender and Score Levels on Senior School Students' Performance in Plane Geometry***

Source	Type III Sum of Squares	*Df*	Mean Square	*F*	Sig.
Corrected Model	2062.961[a]	8	257.870	44.09	.00
Intercept	2750.336	1	2750.336	470.23	.00
Pretest	124.506	1	124.506	21.29	.00
Treatment	126.618	1	21.618	3.80	.05
Gender	9.044	1	9.044	1.55	.22
Score Level	209.350	2	104.675	17.90	.00
Treatment * Gender	29.494	1	29.494	1.94	.06
Treatment * Score Level	41.820	1	41.820	0.30	.26
Gender * Score Level	26.641	1	26.641	2.51	.20
Treatment * Gender * Score Level	34.945	1	34.945	1.99	.10
Error	1087.911	186	5.849		
Total	18856.000	195			
Corrected Total	3150.872	194			

Discussion of the Findings

Based on hypothesis one, the potency Mathematics laboratory of teaching was revealed. Students' performance in plane geometry was enhanced significantly better when taught using Mathematics laboratory. This could have been as a result of students having access to different manipulative in the Mathematics laboratory which increases their curiosity to learn geometry. And the construction of knowledge by the students in plane geometry which makes learning to be self-regulated and interesting. The findings of this study also revealed that students taught plane geometry using Mathematics laboratory performed significantly well. This might be due to the multiple instructional resources available in the Mathematics laboratory which could have aided students' discovery of proofs of theorems among others. This is supported by the findings of Farayola (2014), Shreedevi and Asha (2014), Muhammad and Ibrahim (2015) whose findings revealed that students taught algebra, geometry using Mathematics laboratory performed significantly better than their counterpart in the control group. However, the findings contradicted that of Grady, Watkins and Montalo (2012) whose findings revealed that the K-6 elementary Mathematics curriculum did not yield any higher Mathematics achievements when taught with the Piagetian-constructivism model than those taught using the conventional method. The finding of this study reveals that both male and female equally benefited when taught plane geometry using Piagetian-constructivism model and Mathematics laboratory. This could be as a result of the do it yourself manual which the strategy provides in an environment full of Mathematical resources.

The findings of this study is in agreement with the findings of Onwuka (2015) who found out that male and female students did performed significantly better when taught geometry at junior secondary school using Piagetian-constructivism model. Also the finding is also in line with findings of Musa and Bolaji (2015) whose findings revealed that mathematics laboratory approach enhances students' performances significantly irrespective of gender when taught geometry at the junior secondary school. However, this finding contradicts the findings of Kajuru and Kaura (2014) whose findings revealed that male students benefited most when taught trigonometry using the 7E's of Piagetian-constructivism model.

The findings of this study also reveals that there is significant difference in the performance of students taught plane geometry using Mathematics laboratory on the basis of score levels in favor of the low scorers and high scorers. The reason might be the student-centered activity of using Piagetian-constructivism model and Mathematics laboratory which the low learner took advantage of to show case their strength and ingenuity when Mathematics teaching is made of minds-on and hands-on activities. This finding is supported by the findings of Bhutto, Khalid, Muhammed and Najeeb (2013) whose findings revealed that both the high scorers and low scorers benefited most when taught algebra using the Piagetian-constructivism model. This finding is also corroborated by the findings of Sam-Kayode and Salman (2015) whose findings reveals that the low scorers benefited most followed by the high scorers and medium scorers respectively when taught Mathematics using ludo game.

The finding of this study also reveals that there are no interaction effects of treatment and gender, treatment and score levels, gender and score levels, treatment, gender and score levels on senior school students' performance in plane geometry. This finding is supported by the findings of Yunusa (2010) whose findings revealed no interaction effect of treatment and gender on the students' metacognitive skills on Mathematics self-efficacy belief, interest and achievement of low achievement in senior secondary schools.

Conclusion

This study concluded that mathematics laboratory improves students' performance in geometry without any bias in gender while low scorers can become high scorers if mathematics laboratory adopted as instructional strategy for teaching geometry in Abuja, Nigeria.

Recommendations

Based on the findings and conclusions drawn, this study suggests the following:

1. Mathematics teachers should utilize mathematics laboratory in the teaching of geometry as this might enhance their students' performance in the topic and Mathematics in general.
2. The Mathematics teachers should treat both the male and female students equally when using mathematics laboratory without any prejudice. This will give all the students equal chances of excelling in the learning of geometry.
3. Both the low, medium and high scorers should be given equal opportunity to excel when utilizing mathematics laboratory. The low scorers might become high scorers if given the adequate support and chances to do so.
4. Curriculum developers should design the curriculum in such a way that mathematics teachers should be seen utilizing Mathematics laboratory in teaching Mathematics specifically geometry.

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