Gender and School Location as Factors of Students' Difficulty in Geometry: Implication for Girl-Child Education

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ABSTRACT

The study explored gender and school location-related differences with respect to difficulties in geometry among students. The study is an analytic survey research design, because, it attempted to compare the statuses of two groups of subjects in a given tribute. The effect or observation investigated in this study was students' areas of difficulties in geometry. Three research questions and two hypotheses guided the study. The population of the study was 9,200 senior secondary school three students from Obollo and Nsukka Education zones of Enugu state, Nigeria. The sample of the study, using cluster proportionate random sampling technique was 1,000 students made up of 492 boys and 508 girls, clustered as 515 urban and 485 rural students from the two education zones. The instrument for data collection was Test on Secondary School Geometry (TOSSG) developed by the researchers, using Test Blue Print to ensure content validity. The 30-multiple choice test instrument was validated by two experts from the department of Science Education, University of Nigeria, Nsukka and trial tested on 20 students from a co-educational school in Enugu education zone of the state. The reliability coefficient of the instrument was 0.91, Using Kuder-Richardson 20 (KR-20). Data were analyzed using mean and standard deviation to answer research questions, while the null hypotheses were tested at 0.05 level of significance, using the Z-test statistic. The result of the study indicated differences in achievement with respect to gender and school location. Boys experienced less difficulty than girls, while urban students experienced less difficulty than their rural counterparts. It was recommended that teachers should adopt a variety of pedagogical strategies that are gender and culture-sensitive, capable of securing girl-child education and addressing different learning styles within instructional environments.

Keywords: Achievement, Difficulty, Gender, Geometry, School location,

INTRODUCTION

Mathematics is one of the school subjects that constitute a vital tool for science, commerce and technology. It is a valuable and general purpose subject for satisfying other needs and for entry into many professions. In other words, it is a pivot on which other subjects revolve and can therefore be likened to the central processing unit of a computer. Its general objectives appear to centre on explaining the physical world, showing the extensive application of mathematics in other concerns, emphasizing transfer value and appreciation of elegance of nature. (Odo, 2017). Mathematics is a basic factor for all scientific and technological research. It plays an important role in the economic development of any nation. Among other physical sciences, mathematics seems to be the backbone in the national capacity building in science and technology. A successful implementation of mathematics curriculum in the school could be a spring board

on a nation's march into the advancement of science and technology, while any shortcoming could create a gap to the attainment of science and technology objectives. Mathematics helps to enumerate, calculate, measure, collate, group, analyze and relate. When properly conceived, mathematics is a model for thinking, for developing scientific structures and solving problems as well as for drawing conclusions. Mathematics is comprised of such themes like, Number and Numeration, Algebraic processes, Geometry / mensuration, Trigonometry and statistics and probability (Odo, 2021).

Geometry is one of the broad themes in the mathematics curriculum. It is one of the basic concepts and most widely applied aspect of mathematics. It is started in grade two in the primary school and runs through the entire secondary school mathematics curriculum. It relates to the three domains (cognitive, psychomotor and affective) of human behavior. It is a study of spatial relationship (position, size and shape). Its study is carried out through observations, construction and description of shapes and location in one-, two-, or three-dimensional space (Agashi, 2014); (Obi, 2014). Its focus on the study of points, lines, angles and figures in space, does not only make it an important and versatile branch of mathematics but also enhances understanding of many phenomenon in several other areas of knowledge especially within the sciences and even mathematics. For instance, the geometric interpretation given to the topics of algebra and calculation have made their understanding easier and enhanced their utilitarian values. In addition, the knowledge of geometry is basic to understanding the environment in which we live.

Inspite of the importance of geometry in everyday life, students achievement in this area of mathematics is poor, according to West African Examination Council (WAEC) (2015, 2016, 2017, 2018). WAEC report fingered poor achievement of students' in geometry as being partly responsible for the general poor achievement of students in mathematics within the period under review. WAEC report went further to state that many students avoided questions from geometry and those who attempted them failed woefully. According to WAEC, some of the candidates (students) did nothing beyond reproducing questions from geometry on their answer papers, showing the level of difficulties they experience in geometry. Such difficulties include deficiencies in verbal skills and lack of intuitive basis of geometric concepts. Literature revealed that some of the causes of poor achievement of students in geometry are mathematics phobia, lack of interest on the part of the students, abstract nature of the concepts, poor teaching methods and strategies as well as use of inadequate instructional materials, (Agashi, 2014, Obi, 2014). None of the studies investigated students' areas of difficulty in geometry with respect to gender and school location. This has created the need for this study, which ascertained the content areas of geometry which students find difficult to understand with respect to gender and school location.

Gender is male characteristics or female characteristics which highlight the unique attribute of any sex (Nwaodo, 2016). In this context, gender refers to the distinct role expected of male and female by the society. Gender is also the difference in the treatment of male and female by the society. Unequal treatment of either gender is as old as humanity, right from birth to the last days of life, usually pre-determined by the society. Gender inequality exists in various forms; in children upbringing, in natural life, in social life, in cultural life, in family life, in education, in marital status and even access to public opportunities, all geared towards subjugating the girl-child. These institutional inequalities pose serious challenges to the promotion of gender equality in academic achievement. These indirectly promote male dominance in the academic world and other human endeavours, including mathematics.

In mathematics, gender refers to the general notion that both sexes achieve differently in mathematics education (Alio, Iyoke and Kevin, 2019). Some studies have shown that boys, are not only superior to girls in academic achievement (Usman and Musa, 2015, Ajai and Imoko, 2015, Atovigbas Okwu amd Ijenkeli, 2012), but also more assertive in behaviour. Others show that females achieve higher than males (Awang and Ismail 2007, Rabah, Veloo and Perumal, 2014) while others also show that both sexes achieve equally (Obi, 2014, Agashi, 2014, Odo, 2017, Mutai, 2016, Saidu and Bunyamin, 2016). This trend in achievements

shows that in science and mathematics, boys and girls show different learning styles and respond differently to various teaching strategies and types of teacher behavior. In specific terms, this study sought to ascertain the content areas of geometry that boys and girls find difficult to understand with respect to school location.

School location is a particular place in relation to other areas (Quirk, 2008). It is a place where a school is located and where teaching and learning take place, either urban or rural area. Urban environment is a place that has high population density with a variety of social amenities unlike what obtains in the rural setting. While Obe (2004) found that students from urban schools achieved higher than their rural counterparts, Bowers (2002) found that students from rural school achieved higher than their urban counterparts. These inconsistent differences in achievement between urban and rural schools indicate a need for further research in terms of whether school location could be a factor in students' difficulty in geometry. Hence, while Louvinson (1978) observed that a child is a product of his total environment, Onyike (1993) held that urbanization has positive impact on students achievement, whether a boy or girl.

A girl-child is a biological female offspring from birth to eighteen years of age. This is the age before one becomes young adult. This period covers nursery or early childhood (0-5years), Primary school (6-12years) and Secondary school (12-18years). During this period the young child is totally under the care of her parents or guardians. An adage says, "educates a man, you educate an individual, but educate a woman, you educate a nation". Hence, education of the girl-child is important for national development. Girls' education is therefore crucial to meeting the broader goals of gender equality (Offorma, 2010). It may be interesting to observe that a girl-child is capable of doing well in school when given equal opportunity like her boy-child counterpart. Students' perceived difficulty in geometry was investigated to ascertain if gender and school location could be culprit. Hence, the need for this study which explored gender and school location as factors of students difficulty in secondary school geometry.

STATEMENT OF THE PROBLEM

Reports of poor achievement of students in geometry have continued to attract the attention of researchers in mathematics education and other stakeholders in the education industry. These reports neither made reference to possible factors responsible for the poor achievement, nor differentiated achievement with respect to gender and school location. In another development, several studies have investigated the influence of gender and school location on students achievement in geometry but none was on the content areas that present difficulties to the students which perhaps, might have been responsible for their poor achievement.

Hence, over the years, attempts to explicate poor achievement of students in geometry, among others, have been in terms of students' negative attitude towards geometry, geometry being weak area of students, poor teaching strategies and non-use of instructional materials. Based on the materials available to the researchers, it would appear that students' areas of difficulties in geometry with respect to gender and school location have not been identified. This was with a view to determining which of the two genders, boys and girls would experience fewer difficulties in relation to school location. There was therefore, the need to identify those areas responsible for the poor achievement of students' in geometry. Hence, the problem of this study was to ascertain whether gender and school location could be factors of students' difficulty in secondary school geometry.

Research Questions

The following research questions were addressed in this study.

1. What content areas of geometry do students find difficult to understand?
2. What content areas of geometry do students find difficult to understand with respect to gender?

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3. What influence does school location have on students' difficulty in geometry?

Hypothesis

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

HO_1: There is no significant difference between male and female students in the difficulties experienced in geometry as measured by their mean achievement scores in geometry tasks.

HO_2: There is no significant difference between urban and rural students in the difficulties experienced in geometry as measured by their mean achievement scores in geometric tasks.

MATERIALS AND METHODS

The study adopted an analytic survey research design. This was because it attempted to compare the statuses of two groups in a given attribute. The effect or observation investigated in this study was students' area of difficulties in geometry, while the variables which serve as causative agents were gender and school location. Three research questions and two hypotheses guided the study. The population of the study was 9,200 senior secondary school three students in Obollo and Nsukka education zones of Enugu state, Nigeria. The sample of the study was 1,000 students' made up of 492 males and 508 females, using cluster proportionate random sampling technique. The two zones were further clustered into urban and rural schools with urban schools having 515students and rural school, 485 students. The instrument for data collection was Test on Secondary School Geometry (TOSSG) developed by the researchers based on the geometry content of mathematics curriculum using Test Blue Print to ensure content validity. The instruments was validated by two experts from the department of Science Education, University of Nigeria, Nsukka and trial tested on 20 students from a co-educational school in Enugu education zone. A reliability coefficient of 0.9 was obtained using Kurder-Richardson 20 (KR-20) formula. Data were collected through the research assistants, trained for that purpose. Research questions were descriptively answered using mean and standard deviation, while the hypotheses were tested at 0.05 level of significance using the Z-test statistic.

RESULTS AND DISCUSSION

The data for this study were the test scores. They were organized to reflect students' achievement in the entire test and in each aspect of geometry. The students mean scores and standard deviations on the entire test and in each aspect of geometry were computed and displayed in an

Research question 1: What content areas of geometry do students find difficult to understand?

Table 1: Students' Mean Scores and Standard Deviations in Different Aspects of Geometry

Aspect of Geometry	Mean	SD
Plane geometry	63.8	14.2
Construction and locus	30.9	19.3
Earth geometry (latitude and longitude)	56.1	17.1
Geometric proofs and applications	29.6	20.1
3-dimensional geometry/menstruation	38.4	17.3
General achievement on the entire test	43.9	13.9

From the results in table 1 above, it would appear that the students' achievement on the entire test was generally very low. The poor achievement was also common to three out of five aspects of geometry.

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Students achieved their best in plan geometry with a mean score of 63.8 and standard deviation of 14.2, followed by earth geometry with a mean score of 30.9 and standard deviation 19.3 and in 3-dimensional geometry/menstruation with a mean score of 38.4 and standard deviation of 17.3. This implies that students have greater difficulties in these three aspects of geometry.

Research Question 2: What content areas of geometry to students find difficult to understand with respect to gender?

Table 2: Mean scores and standard deviations in different aspects of geometry for Boys and Girls.

	Boys		**Girls**	
Aspect of geometry	**Mean**	**SD**	**Mean**	**SD**
Plane geometry	45.4	13.5	51.7	15.3
Construction and locus	38.6	14.6	32.4	12.7
Earth geometry (latitude longitude)	52.2	15.2	43.1	12.1
Geometric proofs and applications	36.7	19.2	24.5	11.8
3-dimensional geometry/menstruation	46.3	13.9	33.8	18.6
Grand mean	43.8	15.3	37.1	14.1
Number of students	$n_1 = 492$		$n_2 = 508$	

Results from table 2 above appear to indicate that students have difficulty with almost all the aspects of geometry. Although both boys and girls achieved averagely in plane geometry with boys having a mean score of 45.4 and standard deviation of 13.5, girls' achievement would appear to have outclassed those of boys since they had a mean of 51.7 and standard deviation of 15.3. However, girls had a wider range of variability among themselves than boys. Boys outclassed girls in earth geometry with a mean of 52.2 and standard deviation of 15.2 against a mean of 43.1 and standard deviation of 13.1 by girls. In any case boys had a wider variation among themselves than girls. The same feat was observed in 3-dimensional geometry/ menstruation where boys had a mean score of 46.3and standard deviation of 13.9 as against a mean of 33.8 and standard deviation of 18.6 by girls. In this case a wider variation among girls than boys was observed.

In constructions and locus, the achievement of both sexes was very poor with boys scoring a mean of 38.6 and standard deviation of 14.6, while girls obtained a mean of 32.4 and standard deviation of 13.1. The same poor achievement was observed in geometric proofs and applications where boys got a mean of 36.7 and standard deviation of 11.8. When these results are juxtaposed, it would appear that boys achieved better than girls and should therefore experience less difficulty in geometric tasks.

Hypothesis 1:

There is no significant difference between boys and girls in the difficulties experienced in geometry as measured by their mean achievement scores in geometric tasks.

Table 3: Z-test analysis for the difference in the mean scores of Boys and Girls at 0.05 level of significance

Gender	**Number**	**Mean**	**SD**	**Z-cal.**	**Z-value**	**Decision**
Male	492	43.8	15.3	7.20	1.96	Reject
Female	508	37.1	14.1			

At 0.05 level of significance, the Z-calculated = 7.20 as against the table value of 1.96. Since the calculated value is greater than the table value, we reject the null hypothesis and conclude that differences exist

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between boys and girls in the difficulties they experience in geometry. Therefore, boys experience less difficulties in geometry than girls.

Research question 3: What influence does school location (urban and rural) have on students' difficulty in geometry?

Table 4: Students' Mean scores and Standard Deviations for Urban and Rural Schools in percent

	Urban		**Rural**	
Aspect of geometry	**Mean**	**SD**	**Mean**	**SD**
Plane geometry	62.2	13.7	56.9	15.9
Construction and locus	42.2	12.6	38.3	15.7
Earth geometry (latitude longitude)	59.6	9.8	48.6	12.1
Geometric proofs and applications	39.2	14.2	32.9	13.1
3-dimensional geometry/menstruation	56.7	17.1	50.3	19.2
Grand mean	52.0	13.5	45.3	15.2
Number of students	$n_1 = 515$		$n_2 = 485$	

From the results in Table 4 above, it would appear that in plane geometry urban students with a mean of 62.2 and standard deviation of 13.7 achieved better than the rural students with a mean of 56.9 and standard deviation of 15.9. However, there is a wider range of variability among rural than urban students. In construction and locus, urban students with a mean of 42.2 and standard deviation of 12.6 achieved better than rural students with a mean of 38.3. and standard deviation of 15.7. Also urban students with a mean of 59.6 and standard deviation of 9.8 achieved better than rural students with a mean of 48.6 and standard deviation of 12.1 in earth geometry. In both geometric proofs and applications as well as in 3-dimensional geometry/ menstruation urban students outclassed their rural counterparts. When these results are put together, it would appear that urban students with a grand mean of 52.1 and standard deviation of 9.3 achieved better than rural students with a mean of 45.4 and standard deviation of 8.6 and should therefore experience less difficulties in geometric tasks.

Hypothesis 2:

There is no significant difference between urban and rural students in the difficulties experienced in geometry as measured by their mean achievement scores in geometric tasks

Table 5: Z-test analysis for the difference in the mean scores of urban and rural students at 0.05 level of significance.

Location	**Number**	**Mean**	**SD**	**Z-cal**	**Z-value**	**Decision**
Urban	515	52.0	13.5	7.3	1.96	Reject Ho
Rural	485	45.3	15.2			

At 0.05 level of significance, the Z-calculated = 7.3 as against the table value of Z = 1.96. Since the calculated Z-value is greater than the table Z-value, we reject the null hypothesis of no significant difference between urban and rural students. It therefore follows that urban students experienced less difficulties in geometry than their rural counterparts.

DISCUSSION OF THE FINDINGS

The findings of this study brought to the fore a number of revelations. For instance, one of the findings of this study showed that students achieved poorly in geometry, confirming WAEC (2015, 2016, 2017, 2018) chief examiners report that geometry is an area in mathematics where students do not do well. The reason for this could be due to poor instructional methods and strategies which have continued to dominate our instructional process.

Similarly, the findings of the study showed that boys achieved more than girls in plane geometry and this difference was statistically significant at $p<0.5$. The finding is in line with those of Usman and Musa (2015) and Ajai and Imoko (2015) who found that boys are superior to girls in academic achievement. But it disagrees with Odo (2017), Obi (2014) and Agashi (2014), who found that both genders achieve equally. It also disagrees with Raba'h, Veloo and Perumel (2014) whose study showed that girls outclassed their male counterparts in mathematics. The reason for this could be that in science and mathematics, boys and girls show different learning styles and respond differently to various teaching strategies and types of teacher behaviour.

In the same way, the finding of this study showed that urban students achieved more than their rural counterparts and this difference was statistically significant at $p<0.5$. The finding agrees with Obe (2004) who found that urban students achieved more than their rural counterparts. The reason for this could be due to the fact that urban students are more exposed to the modernizing effect of science and technology than rural students. This finding is in line with that of Onyike (1993) who opined that urbanization has positive impact on students' achievement.

CONCLUSION

Based on the findings of this study, it can then be concluded that the achievement of students in geometry is generally low. The findings revealed that boys achieved higher than girls and the difference was found to be statistically significant at $p<0.5$. It was also found that urban students outclassed their rural counterparts and this difference was statistically significant at $p<0.5$. Therefore, Gender and school location are factors of students' difficulty in secondary school geometry. However, girl-child education could be secured from the perspective of mathematics education.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made

1. Teachers should adopt a variety of pedagogical strategies that are gender and culture-sensitive, capable of addressing different learning styles within instructional environments. This approach, perhaps, could enhance female interest and achievement in geometry

2. Teachers should present geometry in a way that stimulates curiosity and encourages exploration among the students. This technique may enhance students' achievement and their attitudes towards geometry

3. There should be need to train the girl-child to be assertive in the form of being able to:

(a) say no to issues at variance with her desires or beliefs,
(b) stand up for her rights
(c) demand reasons for certain actions

(d) demand fair share of what she is involved

(e) express opinion in a non-aggressive manner

(f) unlearn some of the social-cultural beliefs and practices that impede on girl-child education.

These recommendations could help to enhance and secure girl-child education from a mathematical perspective.

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