Effects of School Type Based on Gender on Problem-Solving Abilities in Algebra Among Senior Secondary School Students in Rivers State

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ABSTRACT

The study examined the effects of school type based on gender on problem solving abilities in algebra among senior secondary school students, in Rivers State, Nigeria. The design of this study was Ex-post facto. The population was all senior secondary school students in Rivers State. Convenience and purposive sampling technique was employed in this study. 390 senior secondary school students participated in the study. Nine senior secondary schools were selected by purposive sampling for the study in two local government areas of Rivers State. Algebraic Problem Solving Test questions collated by the researcher from different past West African School Certificate Examinations was used as the instrument. The reliability of the instrument was determined to be 0.72 using Pearson product moment correlation formula. Two research questions were answered using statistical mean. Two hypotheses were raised to guide the study, at 0.05 significant level using t-test. The results of the analyses showed that: there is a significant difference in the problem solving abilities between males in single-sex and co-educational schools in favor of the males in co-educational schools, also there is a significant difference in problem solving abilities between females in single-sex and co-educational schools in favor of the females in co-educational schools. Based on the results, recommendations were made.

Keywords: School Type, Algebra, Problem-solving Ability, Single-sex Schools, Co-educational schools.

Introduction

Problem solving is an essential aspect of human activity, thus the major part of human thinking is consciously aimed at problem-solving, (Alacaci & Dogruel, 2012). Generally, problem means a situation that is harmful and not welcome, that needs to be addressed and resolved. However, one of the ways humans provide solution to problems in life is through the application of mathematical procedures.

According to Napaphun (2012) one of the purposes of studying mathematics is to solve problems, thus it involves the ability to understand problems, prepares mathematical models, completing models, interpreting the models and to prepare students to solve problems regularly. Pant and Luitel (2016), reported that mathematics is a problem-solving game in which there are several procedural mathematical problems focusing on algorithmic process, seeking for correct answer in mathematics text. Those who consider it as a game enjoy the challenges of developing new mathematics and solving previously unsolved problems in the various branches of mathematics including algebra. According to Julius, Abdullah and Suhairom (2018), problem solving is said to be one of the primary causes of poor academic performance in mathematics and science related disciplines. This occur as a result of students' inability and unwillingness to acquire the basic knowledge involved in solving problems, they rather prefer memorizing solutions given by teachers in line with outdated methods of teaching in spite of the fact that problem solving spans across all spheres of life. As noted by Kaya, Izgiol and Kesan (2014) problem solving ability is a basic skill needed by individuals and is virtually applied in all areas of human endeavor. Specifically, mathematics is regarded as a universal branch of science that is highly important in the society, as its requirement is seen as a prerequisite to the study of many science oriented courses, notably, in engineering, science, business management, medicine, agriculture, computer sciences among others. Various techniques have been adopted in finding solutions to problems through mathematical operation. The twentieth centuries and beyond have witnessed increasing difficulties and complexities that required high problem-solving skills at the workplace as well as society and as such, makes mathematical literacy becomes one of the components required to develop the 21st century skills (Julie, Sanjaya & Anggoro, 2017). According to Nazariah and Abidin (2017) states that mathematics helps to provide students the ability to work harmoniously and as well, prepares them to think creatively, analytically, logically and critically. As noted by Jayanthi (2019), mathematics is the pillar of national development, as the level of expertise acquired in mathematics, to an extent determines the level of scientific and technological aspects of nations, which acts as a pre-requisite for national development. Mathematics is applied in every occupation and activity in human lives. It is crucial in today's business management, as organizations use it to complete business operations efficiently in areas such as accounting, marketing, sales forecast, inventory management among others. Mathematical knowledge is also applied in Arts, as Pythagoras the most notable mathematician acknowledged, numerical reasoning in harmonizing music (Jayanthi, 2016).

Statement of the Problem

Many students perceive mathematics as a difficult subject because of algebraic contents, especially word problems, and subsequently score low grades in external examinations, (Zalmon & Wonu, 2017, Jega, Muhammad & Gwandu, 2018) and West African Examinations Council (WAEC) Chief Examiners' report from 2011 to 2019.

The WAEC Chief Examiner's reports also revealed that the poor achievement of students in mathematics is traceable to their poor understanding of algebraic contents. The reports revealed students' weak areas as inability to form relevant equations from word problems,   simplification of algebraic equations, using the roots of quadratic equation to determine the quadratic equation and interpretation of quadratic graphs. Different researchers have studied gender and problem-solving; some reported that Mathematics achievement is gender related (Anjum, 2015, Marcus & Joakim, 2016), while others reported that it is not gender related (Archin & Offoe, 2015, Ajai & Imoko, 2015). Could the school type in terms of single-sex or co-educational affect students' problem-solving abilities in algebra? This study therefore aims at investigating the effects of school type based on gender on the problem-solving abilities in algebra among senior secondary school students in Rivers State.

1.3 Purpose of the Study

The purpose of this study was to:

1.   Determine the performance of senior students in single-sex and co-educational schools on algebraic problem solving ability.

2.   compare the problem solving abilities of senior secondary female students in single-sex and co-educational schools.

3.   Compare the problem solving abilities of senior secondary male students in single-sex and co-educational schools.

Research Questions

1.   What is the performance of senior students in single-sex and co-educational schools on problem-solving ability in algebra?

2.   How do senior secondary female students in single-sex and co-educational schools differ in their abilities to solve algebraic problems?

3.   How do senior secondary male students in single-sex and co-educational schools differ in their abilities to solve algebraic problems?

Hypotheses

1. There is no significant difference in the problem solving abilities of senior secondary school students in algebra between females in single-sex schools and females in co-educational schools.

2. There is no significant difference in the problem solving abilities of senior secondary school students in algebra between males in single-sex schools and males in co-educational schools.

Methodology

Ex-post facto design was adopted, for this study. The population of the study was all 145,894 senior secondary school students in Rivers State, Nigeria.

This study adopted convenience and purposive sampling techniques. The study was carried out in Port-Harcourt and Akuku-Toru Local Government Areas (L.G.A) in Rivers State, selected by convenience sampling. Nine senior secondary schools (six in Port-Harcourt L.G.A and three in Akuku-Toru L.G.A) were purposively selected to participate in this study. The study involved three private and six public schools from both local government areas. Intact class method was employed to administer the questions in the different schools. A sample of 390 senior secondary school students participated in this study. Senior secondary school III class was purposively selected for the study, this is because the researcher considered that at this level, the students would have been taught sufficient algebraic contents. The researcher also confirmed this status from the curriculum and the mathematics teachers in the schools that participated. The instrument used in this study was five algebraic word problems collated by the researcher from past West African School Certificate Examination questions. The instrument was validated using the blue print table of specification. The researcher administered the instrument personally with the support of some teachers in the schools that participated in the study. The algebraic questions used as the instrument, have the components of Polya's suggested four stages of problem solving model. The answers were graded accordingly. Questions 1 and 5 correctly answered were graded 15marks each, questions 2, 3 and 4 correctly answered were graded 10 marks each so the maximum score for the five questions was 60 marks, which was converted to percentage. The same questions were pre-tested, using test-retest method which involved 20 students from one senior secondary school in Obio-Akpor local government area of Rivers State, which is outside the study area. The questions were administered to the students twice in two weeks interval. The two sets of scores were collated to obtain reliability co-efficient of 0.72 with the use of Pearson's Product Moment Co-relation formula. Test scores of 50% and above in this study were considered as good performance and classified as high problem-solving ability, while scores of 49% and below were considered as poor performance and classified as low problem solving ability. The research questions were answered by statistical mean while the null hypotheses were analyzed at 0.05 level of significance using t-test. The decision rule was to accept the null hypothesis if p-value is greater than the significant level of 0.05 and to reject the null hypothesis if p-value is less than 0.05, level of significance.

Results

Research Question 1

What is the performance of senior students in single-sex and co-educational schools on problem-solving ability in algebra?

Table 1.1 Mean Scores of Students by School Type Based on Gender

	single-sex		co-educational
	Boys (N=134)	Girls (N=108)	(N=148)
Mean score	4.60	6.10	12.70
Std. Error	0.60	0.90	1.50

Table 1.1 reveals that the students in all boys schools are 134 with a mean score of 4.60, students in all girls' schools are 108 with a mean score of 6.10 while the students in the coeducational schools are 148 with a mean score of 12.70. This table above also reveals that: students in the co-educational schools performed better than students in single-sex schools with a mean score of 12.70, students in all girls schools outperformed their counterparts in all boys schools with a mean score of 6.10 as against 4.60. From the result, it was revealed that students in the coeducational schools have higher problem solving abilities in algebra than those in single sex schools.

Research Question 2

How do senior secondary female students in single-sex and co-educational schools differ in their abilities to solve algebraic problems?

Table 1.2 Mean Scores of Female students in single-sex and co-educational schools

School Type	N	$\bar{x}$	Std. Deviation	Std. Error Mean
single-sex	108	6.10	11.528	0.80
Co-educational	84	10.30	10.884	0.50

Table 1.2, shows 108 students from 'all girls' schools with a mean score of 6.10 and 84 students from co-educational schools with a mean score of 10.30, revealing a mean difference of 4.20 in favour of the female students in co-educational schools. The figures on table 1.2 show that female students from co-educational schools have higher problem solving abilities in algebra than their counterparts in 'all girls' schools.

Research Question 3.

How do senior secondary male students in single-sex and co-educational schools differ in their abilities to solve algebraic problems?

Table 1.3 Mean Scores of Male students in single-sex and co-educational schools

School Type	N	$\bar{x}$	Std. Deviation	Std. Error Mean
single-sex	134	4.70	9.18	0.90
Co-educational	64	15.80	15.84	0.60

Table 1.3 shows 134 male students from 'all boys' schools with a mean score of 4.70 and 64 male students from co-educational schools with a mean score of 15.84, showing a mean difference of 11.10 in favour of the male students in co-educational schools. It can be deduced from the information on table 1.3 that the male students in the co-educational schools have higher problem solving abilities in algebra than those in 'all boys' schools.

Null Hypotheses 1

There is no significant difference in the problem solving abilities of senior secondary school students in algebra between girls in single-sex schools and girls in co-educational schools.

Table 2.1: t-test analysis of Mean Scores of Females by School Gender

School Type	N	$\bar{x}$	Std. Deviation	Std. Error Mean	df	t-cal	p-value	Decision
single-sex	108	6.10	11.528	0.80	190	0.45	0.0001	rejected
Co-educational	84	10.30	10.884	0.50				

t(190) =0.45, P< 0.05 therefore the null hypothesis is rejected.

Table 2.1 shows p-value to be 0.0001which is less than the significant level of 0.05. Therefore, there is a statistically significant difference between the mean scores of female students in 'all girls' schools and that of the female students in the co-educational schools in favour of the females in the co-educational schools. Hence, the null hypothesis is rejected

Null Hypothesis 2.

There is no significant difference in the problem solving abilities of senior secondary school students in algebra between boys in single-sex schools and boys in co-educational schools.

Table 2.2: t-test analysis of Mean Scores of Males by School Gender

School Type	N	$\bar{x}$	Std. Deviation	Std. Error Mean	df	t-cal	p-value	Decision
single-sex	134	4.70	9.18	0.90	196	11.50	0.0002	Rejected
Co-educational	64	15.80	15.84	0.60				

t(196) =11.50, P< 0.05 therefore the null hypothesis is rejected.

Table 2.2 shows p-value to be 0.0002 which is less than the significant level of 0.05. Therefore, there is a statistically significant difference between the mean scores of male students in the co-educational schools and the male students in all-boys schools in favour of the male students in the co-educational schools. Hence, the null hypothesis is rejected

Discussion of Findings

The study was carried out to investigate the effect of school type based on gender on problem-solving abilities of senior secondary school students in Rivers State, Nigeria.

Research question one as explained in table 1.1 revealed that female students in 'single-sex' schools have higher mean than male students in 'single-sex' schools. The findings of the present study also revealed that students in the co-educational schools had significantly higher mean score than their counterparts in the single-sex schools. Implication is that, from the result, students in co-educational schools had higher problem-solving abilities than those in the single-sex schools. In agreement with these findings is the finding of Craige (2011) in his study of comparison of students performance in single-sex and co-educational setting in urban middle schools on mathematics. The results revealed clearly that female students performed better than the male students on the Georgian Criterion Referenced Competency Test (GCRCT) in mathematics when both single sex schools were compared. Similarly, Adeneye and Awofala (2011) investigated the mathematics performance of graduating senior secondary school students over a period of 10 years for possible gender differences in relation to school types. Their finding agrees with this study that there were significant differences in the mathematics performance of male and female in single-sex schools. However their finding further revealed that male students in the single-sex schools outperformed the female students in the single-sex schools which is not in agreement with this study. In this study, the females in the single-sex schools outperformed the males in the single-sex schools this could probably be because of difference in sample size, sampling approach and other methodological reasons.

Research Question two as explained in table 1.2 revealed that female students in co-educational schools have higher mean score than their counterparts in 'single-sex' schools with a mean score difference of 4.20. Analysis of t-test also revealed that females in co-educational schools had higher problem-solving abilities than those in single-sex schools. In contrast to the findings of this study, Spencer and George (2016) in their study on Single sex versus co-educational high schools: Performance of Caribbean students across school types in mathematics on the Caribbeans Secondary Education Certificate (CSEC). Data for five years from, 2013 to 2017 showed that girls in single-sex schools in Jamaica, St. Lucia, St. Vincent, the Grenadines and Trinidad and Tobago had a higher pass rate consistently than girls in co-educational schools. In a study the Effects of Single-Sex Schooling on Achievement and Attitudes in Nigeria done by Lee and Lockheed (2016) for secondary school classes. The results revealed that single-sex schools evidently showed higher achievement and educational aspirations than their counterparts in co-educational schools. This is also in contrast with the findings of this study which revealed that females in co-educational schools had higher problem-solving abilities than their counterparts in single-sex schools. Narad and Abdullah (2016) also disagreed with the findings of this study. They investigated the relationship between academic performance of senior secondary school students and their school environment and their study revealed that there is no significant difference between senior secondary school girls studying in co-educational schools and girls' schools. The difference in the results could be as a result of environmental differences.

Research Question three as shown on table 1.3 revealed that male students in co-educational schools have a higher mean score than those in 'single-sex' schools, with a mean difference of 11.10. Analysis of t-test further revealed that males in the co-educational schools had higher problem-solving abilities than those in single-sex schools. In a study, The Effects of Single-Sex Schooling on Achievement and Attitudes in Nigeria done by Lee and Lockheed (2016) for secondary school classes. The results revealed that single-sex schools evidently showed higher achievement and educational aspirations than their counterparts in co-educational schools. Their finding is not in consonance with the findings of this study which revealed that students in co-educational schools have higher problem solving ability than those in single-sex schools, the difference in the results could probably be because of environmental differences and other methodological pitfalls.

Conclusion

From the results, it was concluded in this study that students in the co-educational schools have higher problem solving abilities than their counterparts in the single-sex schools. Also it was revealed that female students in 'single-sex' schools have a higher problem solving abilities than the male students

in 'single-sex' schools. This study further revealed that girls in co-educational schools have a higher problem solving abilities than those in 'single-sex' schools. Also, boys in co-educational schools have higher problem solving abilities than their counterparts in 'single-sex' schools.

Recommendations

The following recommendations were made based on the findings from the study:

Problem solving models like Polya's should be part of mathematics curriculum in our secondary schools and be adhered to since problem solving is the essence of mathematics. Stake holders in the educational system especially curriculum developers and mathematics teachers should focus more on the teaching of algebra with special attention to word problems in Nigerian secondary schools especially at the junior secondary level to lay a strong and good foundation. Developing students' ability to solve problems should be an integral part of mathematics learning at all levels and in all school types, therefore all students in both single-sex and co-educational schools, should be encouraged to take problem-solving seriously, in order to improve their abilities in solving problems as this is required in all spheres of life.

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