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SENIOR SECONDARY SCHOOL STUDENTS CONCEPTION OF ALGEBRA IN KWARA STATE, NIGERIA

BY

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Abstract
The application of mathematical knowledge is important to the economic development of any nation. Therefore there is the need to have proper understanding of mathematical concepts. Literature is a washed with evidences that students perform poorly in mathematics and some of the reasons adduced for this include students' lack of understanding and inadequate interpretation of word problems. This study, investigated the conceptions of quadratic graph held by Senior School students in Kwara State. The study adopted a descriptive research of the survey type and the population for the study was all Senior School students offering mathematics in Kwara State. A sample of 1,200 SSII students were randomly selected and data for the study were gathered using the Algebra Conceptions Test developed by the researchers. Findings from the study revealed that the students held various degrees of correct conceptions, alternative conceptions and misconceptions. It was also revealed that there was a significant difference in the conceptions of quadratic graph held by male and female students in favor of the male students. The study thereby concluded that very few (25.7%) of the students held correct conceptions and that students; gender influences their conception of algebra. It was therefore recommended that mathematics teachers should incorporate innovative teaching strategies that would facilitate students' conception of algebra.

Keywords: Algebra, conception, senior, school, students

Introduction

Mathematics can be described as the backbone of other branches of Science, such as Pure, Applied and Social Sciences, Engineering, Agriculture, Medicine, and others. Mathematics is the study of topics such as quantities (numbers), structure, space, and change in quantities. Azuka (2013) viewed mathematics as not only the language of science but an essential nutrient for thought and logical reasoning. It is

the spine for all scientific and technological investigations and all activities of human development (Olaleye & Aliyu, 2013). Adeleke (2013) opined that mathematics is an instrument for problem-solving which plays a major role in understanding and applying concepts in science and technology useful to mankind. Mathematical knowledge and skills are the bedrock of all societal transformation and transfer of ideas into reality (Abubakar, Wokoma & Afebwame, 2012). Mathematics is a subject required in all fields of human endeavour. Animashaun (2002) reported that the effective and meaningful teaching of the content of Mathematics would provide students with the right mathematical knowledge necessary for successful schooling and its knowledge is also inevitable for human daily activities. The study of Mathematics occupies a unique position in Nigeria education system. According to Bassey, Ndiyo and Joshua (2010), Mathematics is central to the national curriculum and its roles toward technological and industrial development made it one of the core subjects at the primary as well as secondary school levels in Nigeria. The Federal Government of Nigeria (FRN, 2013) in stating the objective of mathematics education stated that mathematics education should equip students with the skills and knowledge that would make them functional members of the society.

Despite the importance of Mathematics in the technological advancement of any nation, the persistent high rate of students' poor performance in public Mathematics examinations in Nigeria is of great concern to education stakeholders. As Nigeria desires scientific and technological advancement, there is the need for good achievement in Mathematics by students at all levels of education, with specific focus on secondary school from where future leaders are prepared for tertiary education (Aliyu, Lawal & Garba, 2013). Literature have shown that students' performance in Mathematics at both internal and external examinations are poor (Agwagah, 2001; Amazigo, 2008). Salman, Mohammed, Ogunlade and Ayinla (2012) in a separate research on causes of mass failure in senior school certificate Mathematics examinations, identified teachers', students' and parents' factors as major causes of students' poor performance in Mathematics. The research findings indicated that 98% of teachers and 76% of students identified laziness on the part of students as a factor responsible for mass failure in senior school certificate mathematics examinations while 97% of teachers and 79% of students indicated students' lack of frequent practice of mathematics questions as another factor responsible for mass failure in Mathematics problems, among others.

Amazigo (2008) and Ige (2001) observed that teachers' failure in engaging learners to develop conceptual understanding of the subject matter content and enhancing problem-solving ability may lead to the continual problem of students' poor performance. In addition, the inappropriate method of teaching by teachers,

unavailability of teaching equipment and materials, lack of interest, readiness and problem solving abilities, self-concept and achievement motivation on the part of the learners also lead to poor performance in the subject (Yilgi & Tongjura, 2000; Salman, 2003). Furthermore, West African Examinations Council, Chief Examiners' Reports (WAEC, CER 2013, 2014 & 2015) identified students' weaknesses in algebra as a contributing factor to poor performance of students in mathematics. Algebra is a generalised arithmetic that involves the use of letters and symbols to represent quantities. Barton (2003) explained algebra as the use of method of calculation according to a set of established rules to simplify expressions and find solutions to equations. The algebraic process as one of the themes of senior secondary education curriculum in Nigeria is identified with the theory of equations. Algebra is the study of mathematical symbols and the rates for manipulating these symbols. It is the unifying trait of almost all forms of mathematics (Kieran, 2007). Algebra and its expression are considered as mathematical language; and are used to describe the relationship between people, thought, elements and structures. Algebra expressions play an important role in mathematics curriculum and mathematics in general; it serves as a way of understanding and making deduction about facts. It helps in the calculation of incomes, loans and bank interest. Also, companies use it for their annual budget calculation including their expenditures. Algebra can also be used to predict the demand of a product and then place order (Barton, 2003).

Despite the important place of algebra in mathematics and human daily activities, the reports of WAEC Chief Examiners Reports between 2005 and 2016 indicated that weaknesses of candidates were noticed in algebra due to their inability to understand the instructions needed to solve and interpret algebraic word problems and their inability to analyze the rule of BODMAS and its application (WAEC, 2014). Candidates' weaknesses were also traced to lack of or shallow knowledge of the basic concept, principles and appropriate application of laws, theories and formulae in solving mathematical problem (Galadima & Yusha'u, 2007). In the year 2010, the Chief Examiners' report indicated that majority of the candidates that sat for the WAEC examination attempted the quadratic graph question and were reported to have completed the table of values and drew the graph correctly. However, reading and drawing inferences from the graph posed some problems to candidates. While only a few candidates were reported not to have plotted the points correctly, majority of them were reported not to have determined the required range of values correctly. In 2011, the WAEC Chief Examiners' report indicated that majority of the candidates who attempted the quadratic question were able to find the missing values in the given table and correctly plot the graph, but some of them did not draw the tangent of the curve as required by the question. Hence, they were unable to determine the gradient of the curve. In the year 2012, the Chief Examiners

reported that the quadratic graph question was reported to be quite popular among the candidates because those who attempted it completed the table of values and drew the required graph. However, reading and answering questions from the graph were poorly handled by majority of the candidates. In year 2013, The Chief Examiners stated that this question on quadratic graph was also very popular among the candidates. According to the report, majority of the candidates completed the given table and correctly drew the graph, but they found it difficult to read from the graph, as most of the candidates could not calculate the required gradient by drawing the appropriate tangent to the curve. In 20l5, The Chief Examiners reported that this question on quadratic graph was popular among the candidates and they performed very well in it. Majority of them were reported to have completed the table of values and plotted the points correctly. However, some of them did not apply the correct scale and some others could not read from the graph correctly.
The weaknesses observed by the Chief Examiners' Reports may be due to students' misconception of the wording of the questions. Balogun (2010); Abdulraheem (2012); Charles-organ (2014) emphasised the importance of conducting studies on the conception of students in mathematics and science. Mangwabnan (2013) assessed the translation of misconceptions inside the classroom, while Idehen and Omoifo (2016) examined students' misconceptions in algebra. These researches and others were geared towards knowing if students understand the mathematical concept, they will be able to solve the problem themselves. According to Hornby (20l0) conception is the process of forming an idea or a plan. Balogun (20l0) defined conceptions as the viewpoint of an individual in explaining certain events. Conceptions generally refer to individual views or idea about a particular phenomenon in a subject matter. Thus, Novak (2003) and Hewson (2007) opined that the previous idea which students held before attending the classroom could be a factor responsible for their various conceptions.

Ideas could be classified as correct conceptions, misconceptions, and alternative conceptions. Correct conception is an idea held by an individual that agree with acceptable scientific ideas or knowledge. Misconceptions are ideas held by an individual that disagrees with acceptable scientific ideas or knowledge. An alternative conception is a term used for describing the idiosyncratic knowledge of the learners. It is not necessarily in conflict with accepted scientific knowledge but has its value, and is therefore not necessarily wrong (Hewson, 2007). According to Abimbola (2015), an alternative conception can be used to explain learner's autonomous conceptions of natural phenomena, while misconception refers to erroneous understanding which occurs with relatively high frequency. Misconception could arise from other factors such as the failure to realize the importance of examining the subject prior concept and the resistance to such conception to be modified by conventional teaching. Also, misconception occurs

when input is filler through schemas that are oversimplified, distorted or incorrect. Its effect on students learning showed that misconceived prior knowledge can lead to misconception. Therefore, in view of the above reasons; the researcher is interested in the conceptions held by students in algebra. Several researchers had investigated students' conception in mathematics over the years. For instance, Idehen and Omoifo (20l6) carried out a research study on students' misconceptions in algebra in Edo State, Nigeria. The study was designed to identify students' correct conception and misconceptions of six basic Algebraic concepts in Mathematics. The survey design was used to select 4332 students from 114 senior secondary school s in Edo State. Frequency counts and simple percentages were used to analyze data and answer the three research Questions raised. Results showed that students had high correct conception in the concepts of addition, subtraction and division of whole numbers. Sam-Kayode (2015) carried out a study on the conception of geometry held by senior secondary school students in Ogun State, Nigeria. The study revealed that correct conceptions, misconceptions, and alternative conceptions exist among students and gender influenced students' conceptions. Also, the study showed that there was a significant difference in the number of students who held correct conceptions, misconceptions, and alternative conceptions in geometry based on students' scoring levels and subject combination.

Macson and Chigozirim (2015) researched into students' conceptions and misconceptions in chemical kinetics in Port Harcourt metropolis of Nigeria. The study sample was made up of 107 SS 3 students. Two main instruments were used to collect data for the study; they are the chemical kinetic calculation problem and alternative conceptions test in chemical kinetics. Overall results of the study showed that students' performance in basic chemical kinetics calculation was generally poor with the mean scores less than one point. Item-by-item analyses on the conception test revealed that about 10% of the students identified the correct answers while about 90% could not identify the correct answers. In another study, Dejene (2014) examined students' misconceptions of the limit concept in a first calculus course. Misconceptions of the limit concept were examined in 130 pre-engineering students in Dilla Universities. Questionnaire and interview were designed to explore students understanding of the idea of a limit of a function and to explore the cognitive schemes for the limit concept. The study employed a quantitative-descriptive or survey design. The empirical investigation was done in two phases. A questionnaire on the idea of a limit was given to 130 students during the first phase. During the second phase 14 interviews were conducted. Results from the study revealed that students in the study saw a limit as unreachable, an approximation, a boundary, a dynamic process and not as a static object, and are under the impression that a function will always have a limit at a point. Abdulwali and Fahad (2012) carried out research on the secondary school students' alternative

conceptions about genetics. The aim of the study was to explore secondary school students' alternative conceptions of concepts related to genetics and heredity. The results indicated that students hold many alternative conceptions about concepts related to genetics and heredity, which are; direct and indirect cell division, reduction division, sexual and asexual reproduction, and the process of genetic information transfer. The results indicated also that there is an overlap in students' understanding of the mechanisms of transferring genetics and heredity characteristics in reproduction and cell division. These types of alternative conceptions have weakened students' ability to express themselves; as a result, such misconception may hinder students' understanding of most biological concepts.

Gunawardena (2011) conducted a research work on the secondary school students' misconceptions in Algebra in United States of America. The study investigated secondary school students' errors and misconceptions in Algebra with a view to exposing the nature and origin of those errors and to make suggestions for classroom teaching. The study used a mixed method research design. An algebra test which was pilot-tested for its validity and reliability was given to a sample of Grade 11 students in an urban secondary school in Ontario Canada. The test contained questions from four main areas of Algebra: variables, algebraic expressions, equations, and word problems. A rubric containing the observed errors was prepared for each conceptual area. Result from the study showed that some errors emanated from misconceptions. Some of the reasons that led to misconceptions as revealed in the study were; lack of understanding of the basic concept of the variable in different contexts, the abstract structure of algebraic expressions and inadequate understanding of the use of the equal sign and its properties when it is used in an equation. Egodawatte (2011) conducted a research on the errors committed and students' misconceptions in algebra. The study was conducted in Toronto and the findings showed that students committed a number of errors in algebra. Some of the errors committed emanated from the misconceptions students held. The main difficulty one was in the area of word problems which was due to lack of proper interpretation of natural language to algebraic language; this led the students to resolve to the use of guessing or trial and error method in solving word problems involving algebra.

However, none of the aforementioned studies was neither conducted on the conception of quadratic graph in Algebra nor carried out in Kwara State, Nigeria. Hence, this is the gap that this study attempted to fill by identifying senior secondary school students' conceptions of algebra with reference to quadratic graph in mathematics. In the same vein, this study explored the influence of gender on senior secondary school students' conceptions of Algebra in Kwara State.

Researchers are still investigating the relationship between gender and students' academic performance. Research has shown that there is a difference in the academic performance of male and female while other findings showed that sex as a factor had no impact on students' achievement. Salman (2005), Adeniyi (2012) and Akanmu (2013) asserted that gender did not have any significant influence on students' achievement. In separate independent researches, Halpern (2000) and Keller (2002) reported that male students achieved significantly better than their female counterparts in mathematics.

Research Questions

Answers were sought to the following research questions

1. What are the conceptions of senior secondary school students on quadratic graph in algebra?
2. What proportion of senior school students hold correct conceptions, alternative conceptions and misconceptions of quadratic graph in algebra?
3. Is there any difference between male and female senior secondary school students' conceptions of quadratic graph in algebra?

Research Hypotheses

The following research hypotheses were formulated and tested at 0.05 level of Significance

H0: There is no significant difference between male and female senior secondary school students' conceptions of quadratic graph in algebra.

Methodology

This study was a descriptive research of the survey type and the population for the study was all senior secondary school students in Kwara State, Nigeria offering mathematics. The target population was all students in Senior Secondary School II in Kwara State, Nigeria. The sampled schools were selected across the three senatorial districts of Kwara State (Kwara North, Central and South) using the multistage sampling technique. At the 1st stage, systematic sampling technique was used to select two (2) local government areas from each of the senatorial districts making a total number of six (6) local Government areas that constituted this study. At the 2nd stage, simple random sampling technique was used to pick five (5) public schools from each of the selected local government areas which made a total number of sixty (30) schools for this study while at the 3rd stage, purposive sampling technique was used to choose SSSII class of students. This category of students were chosen because they are at the stage not only where the major content of the Mathematics curriculum are taught and learnt alone, but also at the period where the students need to hold correct conceptions of quadratic graphs in algebra and other concepts of Mathematics. At the 4th stage, simple random sampling technique was used to select 40 students across all the three alms of the SSSII class from each of the selected schools to arrive at 1200 students as sample size for this study.

The research instrument for this study was a researcher-designed test titled: Algebra Conception Test (ACT). The choice of using the ACT was to allow students display their misconceptions in Algebra without allowing them to make a guess. The ACT consisted of two parts: Part 1 contained the demographic data of the respondents which included: name of the school, student's gender, subject combination (Arts, Commercial or Science). Part 2 contained 4 essay tests on quadratic graph algebra. In order to ensure the face and content validity of the instrument, the research instrument was given to three Mathematics educators in the Department of Science Education, University of Ilorin and two Mathematics teachers to ascertain its validity.

The reliability of the instrument was carried out through a trial testing by involving 20 Senior School Two students (SS2) drawn from Ilorin East Local Government Area of Kwara State who did not participate in the main study. Test-retest method was used to administer the instrument to the selected students within two weeks interval. The instruments yielded a reliability value of 0.76 using Pearson Product Moment Correlation Coefficient the consent and co-operation of the parents of the students that were involved in the study were also sought. The researcher with the help of two research assistants visited the selected secondary schools to administer the instrument personally to enhance their prompt responses. All ethical issues governing the use of human as object of research such as; voluntary participation, anonymity, non-exposure to risks, confidentiality were strictly adhere to. The data collected were subjected to descriptive and inferential statistical analyses using Statistical Package for Social Sciences (SPSS) version 22.0 to obtain the results. Percentages were used to answer the research questions while chi-square was used to test the hypothesis formulated for the study. The hypothesis was tested at 0.05 level of significance using chi-square analysis.

Results

Research Question One: What are the conceptions of senior secondary school students on Quadratic graphs in algebra?

Participants' conceptions of quadratic graph in algebra were subjected to item by item analysis. Thus, item which the majority of students got correctly, alternatively and wrongly were marked as correct conceptions, alternative conceptions and misconceptions, respectively. The statistics of the students' conceptions of each item of quadratic graph in algebra were presented in Table 1.

As revealed in Table 1, out of the 1200 (100.0%) students that took part in this study, 606 (50.5%) of the students held correct conceptions, 392 (32.7%) held alternative conceptions while l45 (12.1%) of the students held misconceptions, 57 (4.8%) of the students provided no response to item la at all. Similarly, 340 (28.3%) of the students held correct conceptions, 287 (23.9%) held alternative conceptions,

468 (39.0%) of the students held misconceptions, while 105 (8.8%) of students gave no response to item lb. Also, 310 (25.8%) of the students held correct conceptions, 599 (49.9%) of the students held alternative conceptions,207 (17.3%) of the students held misconceptions while 84 (7.0%) of the students offered no response to item 1c.Futhermore, 448 (37.3%) of the students held correct conceptions,6l4 (51.2%) held misconceptions, 6l4 (51.2%) of the students held misconceptions while there was no response to item 1d from l38 (11.5%) student respondents. Thus, majority of the sampled students held correct conceptions to item la; alternative conceptions to item 1c and 1d and misconceptions to item lb.
Also, 308 (25.7%) and 582 (48.5%) of the students held correct and alternative conceptions to item 2ai, respectively; 227 (18.9%) held misconceptions, while 83 (6.9%) of the students provided no response to item 2ai.In addition 349 (29.1%) of the students held correct conceptions,6l3 (51.1%) held alternative conceptions, l33 (11.1%) of the students held misconceptions while l05 (8.7%) of the students gave no response to item 2aii.Futhermore, 462 (38.5%) of the students held correct conceptions, 322 (26.8%) held alternative conceptions, 254 (21.2%) of the students held misconceptions, while 162 (13.5%) provided no response to item 2aiii. Moreover 304 (25.3%) of the students held correct conceptions, 262 (21.8%) held alternative conceptions, 495 (41.3%) of the students held misconceptions, while 139 (11.6%) of the students gave no response item 2b.Similarly, 511 (42.6%) of the students held correct conceptions, 229 (19.1%) held alternative conceptions, and 317 (26.4%) of the students held misconceptions, while 143 (11.9%) of the students gave no response to item 2c. Therefore, majority of the sampled students held correct conception to item 2c alternative conceptions to item 2ai and 2aii, but misconceptions to item 2b respectively.

More so, 502 (41.8%) and 312 (26.0%) of the students held correct conceptions and alternative conceptions respectively to item 3a; 242 (20.2%) held misconceptions, while 144 (12.0%) of the students offered no response to item 3a. Item 3bi was held correctly by 304 (25.3%) of the students; held alternatively by 256 (21.3%) and 472 (39.3%) students held misconceptions, while 168 (14.0%) of the students provided no response to item 3bi. Item 3bii was held correctly by 609 (50.8%) of the students, held alternatively by 201 (16.8%) and 272 (22.7%) students held misconceptions while 118 (14.0%) of the students provided no response to item 3bii. Item 3ci was held correctly by 362 (30.2%) of the students; held alternatively by 511 (42.6%) and 221 (18.4%) held misconceptions with l06 (8.8%) of the students providing no response to item 3ci. Item 3cii was held correctly by 289 (24.1%) of the students; held alternatively by 314 (26.2%) and 498 (41.5%) held misconceptions, while 99 (8.3%) of the students provided no response to item 3cii. Thus, majority of the sampled students held correct conceptions of items 3a and 3bii; alternative conceptions of item 3ci and misconceptions of items 3bi and 3cii respectively.

Furthermore, 3l6 (26.3%) and 241 (20.1%) of the students held correct conceptions and alternative conceptions respectively of item 4ai and 499 (36.7%) held misconceptions while 144 (12.0%) gave no response to item 4ai. Item 4aii was held correctly by 343 (28.6%) of the students; held alternatively by 513 (42.8%) and 229 (19.1%) held misconceptions, while 115 (9.6%) of the students provided no response to item 4aii. Item 4b was held correctly by 391 (32.6%) of the students; held alternatively by 202 (16.8%) and 49l (40.9%) held misconceptions while 116 (9.7%) of the students offered no response to item 4b. Item 4ci was held correctly by 383 (31.9%) of the students, held alternatively by 264 (22.0%) and 422 (35.2%) held misconceptions, while 131 (10.9%) of the students provided no response to item 4ci. In the same vein, Item 4cii was held correctly by 348 (29.0%) of the students; held alternatively by 224 (18.7%) and 487 (40.6%) held misconceptions, while 141 (11.8%) of the students provided no response to item 4cii. Therefore, majority of the sampled students held alternative conception of item 4aii and misconceptions of items 4ai, 4b, 4ci and 4cii, respectively.

Table 1

Conceptions of Senior Secondary School Students of Quadratic Graph in Algebra

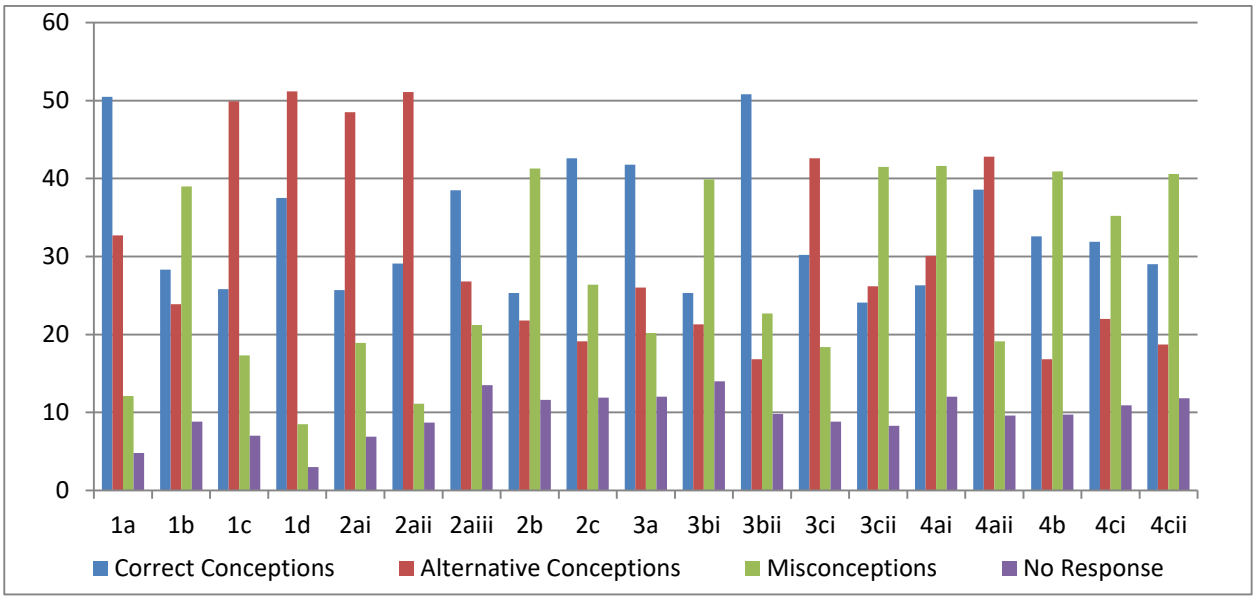
Quadratic Graph in Algebra	Conceptions			No Response		
	Correct Conception	Alternative Conception	Misconception		Total	Remark
Item la	06 (50.5%)	392 (32.7%)	145 (12.1%)	57 (4.8%)	1200 (100.0%)	Correct Conception
Item lb	340 (28.3%)	287 (23.9%)	468 (39.0%)	10 (8.8% 5)	l200 (100.0%)	Misconceptio n
Item lc	310 (25.8%)	599 (49.9%)	207 (17.3%)	(7.0% 84)	1200 (100.0%)	Alternative Conception
Item ld	448 (37.3%)	614 (51.2%)	102 (8.5%)	(3.0% 36)	l200(100.0 %)	Alternative Conception
Item 2ai	308 (25.7%)	582 (48.5%)	227 (l8.9%)	(6.9% 83)	l200 (100.0%)	Alternative Conception
Item 2aii	349 (29.1%)	613 (51.1%)	l33 (11.1%)	10 (8.7% 5)	1200 (100.0%)	Alternative Conception
Item 2aiii	462 (38.5%)	322 (26.8%)	254 (21.2%)	162 (13.5%)	1200 (100.0%)	Correct Conception
Item 2b	304	262	495	139 (11.6%)	l200	Misconceptio n

	(25.3%)	(21.8%)	(41.3%)		(100.0%)	
Item 2c	511 (42.6%)	229 (19.1%)	317 (26.4%)	l43 (11.9%)	l200 (100.0%)	Correct Conception
Item 3a	502 (41.8%)	312 (26.0%)	242 (20.2%)	144 (12.0%)	l200 (100.0%)	Correct Conception
Item 3bi	304 (25.3%)	256 (21.3%)	472 (39.3%)	168 (14.0%)	1200 (100.0%)	Misconception
Item 3bii	609 (50.8%)	201 (16.8%)	272 (22.7%)	11 (9.8% 8)	l200 (100.0%)	Correct Conception
Item 3ci	362 (30.2%)	511 (42.6%)	221 (l8.4%)	10 (8.8% 6)	1200 (100.0%)	Alternative Conception
Item 3cii	289 (24.1%)	314 (26.2%)	498 (41.5%)	(8.3% 99)	1200 (100.0%)	Misconception
Item 4ai	316 (26.3%)	241 (20.1%)	499 (41.6%)	144 (l2.0%)	l200 (100.0%)	Misconception
Item 4aii	343 (28.6%)	513 (42.8%)	229 (l9.1%)	11 5 (9.6%)	1200 (l00.0%)	Alternative Conception
Item 4b	391 (32.6%)	202 (16.8%)	491 (40.9%)	11 6 (9.7%)	l200 (100.0%)	Misconception
Item 4ci	383 (3l.9%)	264 (22.0%)	422 (35.2%)	l31(l0.9%)	l200 (100.0%)	Misconception
Item 4cii	348 (29.0%)	224 (l8.7%)	487 (40.6%)	l41 (11.8%)	1200 (100.0%)	Misconception

As shown in Figure 1, majority of senior secondary school students held correct conception of items 1a, 2aiii, 2c, 3a, and 3bii of the quadratic graph in algebra; items 1c, 1d, 2ai, 2aii, 3ci, and 4aii were held alternatively by the majority of the senior secondary school students, while majority of the students held misconceptions of 1b, 2b, 3bi, 3cii, 4ai, 4b, 4ci and 4cii, respectively.

Figure 1

Conception of Senior Secondary School Students on Quadratic Graph



Research Question Two: What proportion of senior secondary school students' hold correct conception, alternative conception and misconceptions of quadratic graph in algebra?

Students' scores on quadratic graph in algebra were subjected to percentage analysis, given that students held correct conceptions, alternative conceptions and misconceptions of some questions. Thus, the proportion of students' correct conception, alternative conception and misconceptions of quadratic graph in algebra is presented in Table 2. As revealed in Table 2, out of the1200 (100.0%) students sampled for this study, 309 (25.7%) held correct conception of quadratic graph in algebra; 363 (30.3%) held alternative conception, while 528 (44.0%) of the students held misconception of quadratic graph in algebra.

Table 2

Proportion of Senior Secondary School Students Holding Correct Conceptions, Alternative Conceptions and Misconceptions of Quadratic Graph in Algebra

Conceptions of Quadratic Graph in Algebra	Frequency	Percentage
Correct Conception	309	25.7%
Alternative Conception	363	30.3%
Misconception	528	44.0%
Total	1200	100.0%

As shown in Table 2, a large proportion (44%) of the senior secondary school students sampled held misconception of quadratic graph in algebra, 30% of the students held alternative conceptions of quadratic graph, 26% of the sampled students held correct conception of quadratic graph in algebra.

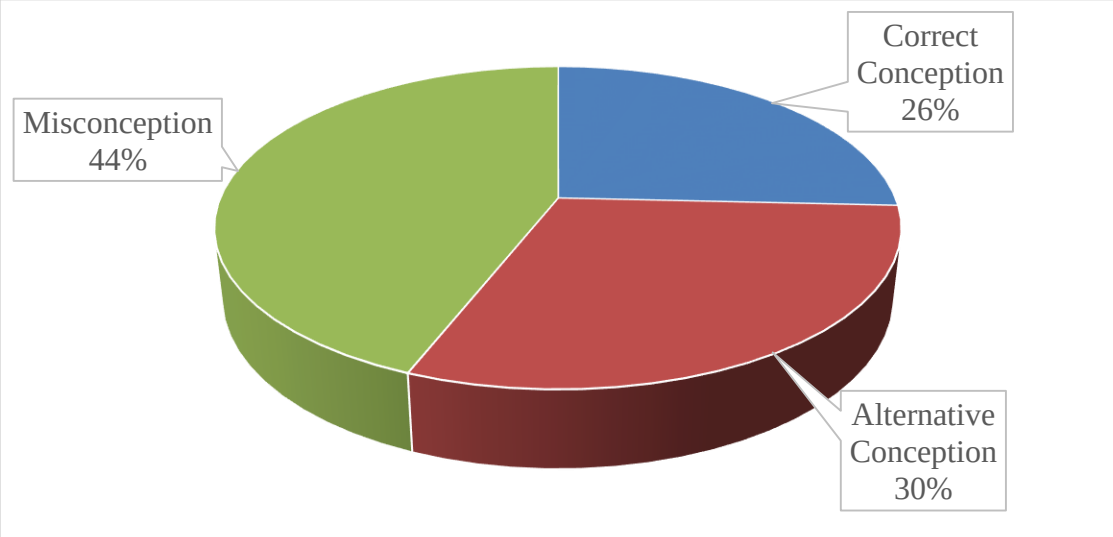


Figure 2: *Proportion of Students' Holding Correct Conception, Alternative Conception and Misconceptions of Quadratic Graph in Algebra*

Hypotheses Testing

The formulated hypothesis was tested using chi-square analysis at 0.05 level of significance

Ho_1: There is no significant difference between male and female senior secondary school students' conceptions of quadratic graph in algebra.

Table 3 shows that the -value 6.386 was obtained with a p-value 0.04l when obtained at 0.05 level of significance. Since the p-value 0.04l is less than 0.05 level of significance, the H_{01} was rejected. This implies that there is a statistically significant difference between male and female senior secondary school students' conceptions of quadratic graph in algebra $\chi(2) = 6.386; p<0.05$).

Table 3

Chi-Square Statistics Showing the Difference between Male and Female Senior Secondary School Students' Conceptions of Quadratic Graph in Algebra

Gender		Students' Conceptions of Quadratic Graph in Algebra							
		Misconception	Alternative Conception	Correct Conception	Total	df	χ^2–cal	Sig	Remark
Male	Count	253	l85	l76	6l4				
	Expected								

		270.2	l85.7	l58.l	6l4.0	2	6.386[a]	0.041	**Hol Rejected**
Female	Count	275	l78	l33	586				
	Expected	257.8	l77.3	l50.9	586.0				
Total		**528**	**363**	**309**	**l200**				

Figure 3 reveals that out of 614 male students sampled for this study, 253 (41.2%) held misconceptions, 185 (30.1%) held alternative conceptions, while 177 (28.7%) of the male students held correct conceptions of quadratic graph in algebra. Also, out of 586 female students sampled for this study, 275 (46.9%) of them held misconceptions of quadratic graph in algebra; 178 (30.4%) held alternative conceptions while l33 (22.7%) held correct conceptions of quadratic graph in algebra. Thus, more female senior secondary school students (46.9%) held misconceptions of quadratic graph in algebra than their male counterpart (41.2%) conversely, more male students held correct conceptions (28.7%) of quadratic graph in algebra than female students (22.7%). However, almost the same proportion of male students (30.1%) and female students (30.4%) held alternative conception of quadratic graph in algebra.

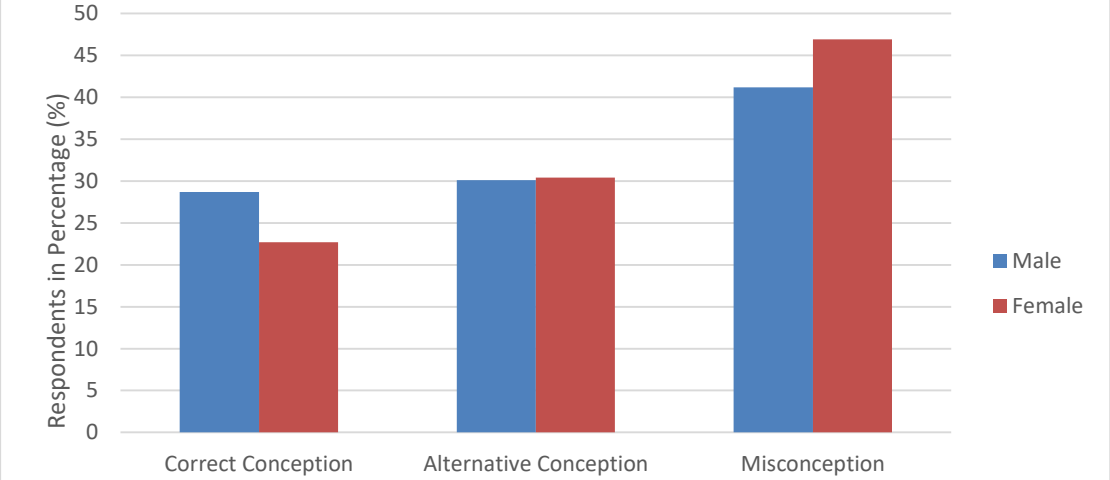


Figure 3: Male and Female Senior Secondary School Students' Conceptions of Quadratic Graph in Algebra

Discussion

The findings of the study indicated that students held the correct conceptions, alternative conceptions and misconceptions of quadratic graph in algebra in Mathematics. The result revealed that majority of the senior school students held correct conceptions in items 1a, 2c, 3a, and 3bii of the quadratic graph in algebra; alternative conceptions of items 1c, 1d, 2ai, 2aii, 3ci, and 4aii and misconceptions in items 1b, 2b, 3bi, 3cii, 4ai, 4b, 4ci, and 4cii respectively. This implies that some students held correct conceptions about algebra while some of them held alternative conceptions and misconceptions about it which could be as a result of inadequate knowledge about quadratic graph in algebra. This finding corresponds with the findings of Ryan and Williams (2007), Egodawatte (2011), Sam-Kayode (2015), Idehen and Omoifo (2016) that researched on the conceptions of students in selected topics in mathematics and found out that student held correct conceptions, alternative conceptions and misconceptions of different topics in mathematics.

Findings from this study also revealed that majority of the students do not attempt some of the quadratic graph questions set. This implies that majority of the students' possessed poor existing knowledge which may be incomplete or misunderstood about quadratic graph in Algebra. This finding is in line with the submission of the WAEC Chief Examiners' Reports (WAEC, 2013, 2014 & 2015) which stated that students do not perform well in algebraic question especially quadratic graph. The reports further stated that students do not attempt the questions on quadratic graph while those who attempted the questions did not have correct interpretation of the graph; this factor contributed to students' poor performance in Mathematics. Also, findings from this study revealed that very low number of senior school students held correct conceptions of quadratic graph in algebra. This is in support of the findings of Egodawatte (2011), who stated in their various research reports that little percentage of the respondents held correct conceptions of algebra in Mathematics. The findings on students' conception indicated that majority of senior school students' held misconceptions about quadratic graph in algebra.

This is in line with the submissions of Egodawatte (2011); Dejene (2014); and Idehen and Omoifo (2016) who showed in their various findings that students held misconceptions of algebra and calculus in mathematics respectively. The result of the study revealed that male students held more correct and alternative conceptions of quadratic graph compared to their female counterpart. Out of the 614 male students sampled for this study, 176 (28.7%) of male students held correct conceptions while 185 (30.1%) held alternative conceptions. Also, out of the 586 female students sampled for this study, 133 (22.7%) of them held correct conceptions of quadratic graph in algebra while 178 (30.4%) held alternative conceptions. In a nutshell, female students held more misconceptions of quadratic graph compared to their male counterpart; 275(46.9%) of female students held

misconceptions of quadratic graph while 253(41.2%) of the male students held misconceptions of quadratic graph.

Thus, more female senior secondary school students held misconceptions and alternative conceptions of quadratic graph in algebra (46.9%, 30.4%) compared to their male counterpart (41.2%, 30.1%), while more male students held correct conceptions (28.7%) of quadratic graph in algebra compared to the female students (22.7). The findings were in agreement with the findings of Sam-Kayode (2015) who stated that gender had influence on senior school students' conceptions of geometry in Mathematics.

Conclusion

This study concluded that very low percentage of the students held correct conceptions of quadratic graph, while majority of the students held misconceptions of quadratic graph and some of the students sampled did not attempt the quadratic graph questions set for the study. It showed that majority of senior secondary school students do avoid questions on quadratic graph due to lack of understanding of the concept. The findings from this study revealed that gender affected the correct conceptions, alternative conceptions and misconceptions held by students on quadratic graph. Male and female students in the study displayed difference in depth knowledge of quadratic graph questions as there was significant difference in the conceptions of quadratic graph held by male and female students.

Recommendation

Based on the findings of this study, the following recommendations were considered appropriate:

1. Mathematics teachers must identify students' conceptions of quadratic graph in algebra in a similar way, employ appropriate teaching strategies that can facilitate correct conceptions and remediate their alternative conceptions and misconceptions.
2. Some of the senior school students do not attempt the quadratic graph; therefore the students should be committed to solve problems of quadratic graph in algebra through constant practice.
3. Mathematics teachers should make use of mathematical graph board in teaching quadratic graph in order to arouse interest and better understanding of the students.
4. Mathematics teachers' should consider gender difference and give recognition to both sexes in the classroom. This will geared both male and female students' better understanding of a quadratic graph in Algebra.

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