

## DIAGNOSIS OF STUDENTS' MISCONCEPTIONS ON CONSTRUCTION OF GRAPHICAL QUADRATIC EQUATIONS (GQE)

By

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### **Abstract**

*This study diagnosed students' misconceptions on construction of graphical quadratic equations. The population of the study comprised of the Senior Secondary School two (SS2) and three (SS3) students of grammar school, Ozuoba, Rivers state. 40 students were selected using purposive sampling technique. The instrument used in the study was Diagnostic Test on Graphical Quadratic Equation "DTGQE". DTGQE comprised 10 objective questions with 4 options A-D and 2 essay questions of WAEC standard. The validation of the instrument was done by two experts in the Department of Curriculum Studies and Educational Technology, University of Port-Harcourt. The reliability of DTGQE was determined by test-retest using pearson product moment correlation in order to determine the stability of the instrument. Reliability index of 0.76 was obtained for DTGQE. Frequency counts and percentages were used to answer the research questions, while Chi-square was used in testing the hypothesis formulated for the study at 0.05 level of significance. The result revealed that there are 92 misconceptions observed out of the 160 possibilities from the 40 students. Day students had 64 and boarding students 28 out of the 92 misconceptions. It implies that there is 57.5% misconceptions observed with a setback of those who did not answer the questions. Based on the findings of the study, students and teachers should be familiar with the key concepts of construction of GQE for effective performance. Also, Mathematics teachers should see the need to diagnose their students' misconceptions and lay more emphasis on those areas when they are teaching to avoid errors.*

**Key words:** *Diagnosis, Misconception, Graph and Quadratic equations.*

### **Introduction**

Mathematics is an important subject for everyone. Okigbo and Ejikeme (2017) expressed that the modern world will come to a standstill if Mathematics is neglected. Mathematics comprised topics from simple (topic that are easy to solve) to complex (topics that are technical/difficult to handle). Ekwueme, Popoola and Orim (2012) stated that Mathematics at the junior class has often been taught as a series of steps to follow in order to get the right answer. Ekwueme et al (2012) also opined that for students to possess conceptual understanding in different ways, they should know how and when these different representations can be used for different purposes. So, why then do students find it difficult to understand some complex (difficult) concepts? Okigbo and Ejikeme (2017) surveyed some difficult Mathematics topics in the Senior Secondary School Mathematics curriculum as perceived by student-teachers from University of Lagos, using 60 Sandwich Degree programme students. They opined that student teachers perceived eight topics; trigonometry, probability, arithmetic, latitude, graphs, bearing and distances, construction, and inequalities as difficult to teach. So, if student- teachers find it difficult to teach these difficult concepts like graphs, what becomes of the students learning process and performance? Muhammad (2017) carried out an analysis which suggested that many upper-secondary Mathematics students did not even acquire instrumental competency with respect to quadratic equations (A quadratic equation is any equation having the form  $ax^2+bx+c=0$ , where x represents an

unknown, and  $a$ ,  $b$ , and  $c$  represent known numbers such that “ $a$ ” is not equal to 0. If  $a = 0$ , then the equation is linear, not quadratic. The numbers  $a$ ,  $b$ , and  $c$  are the coefficients of the equation, namely the quadratic coefficient, the linear coefficient and the constant or free term respectively. The study was prompted to diagnose the misconceptions of students in graphical quadratic equations.

Diagnosis is to recognize something by signs and symptoms. It is to analyze or find the cause or nature of something. Beresibo (2016) opined that diagnosis is the process of identifying the nature and cause of students’ learning inability in a concept. It is to identify the nature of an illness or other problem by examination of the symptoms. It is synonymous to identify, determine, distinguish, recognize, discover, spot, detect, pinpoint, and more. When it is related to Mathematics, diagnosis is identifying problems encountered by students in learning Mathematics (James, Taiwo & Ahmed, 2015). Also, it is to detect and name the exact character of a problem, by looking at the students, boarders/day.

A student is someone who is studying and is either coming from her place of residence (day student) or stays within the school premises (boarder). Boarding school is a College preparatory institution where students and teachers live and study together in a safe and secure campus environment. Boarding school is different from day school in the following ways: boarding school provides teacher accessibility due to the fact that who stay on campus longer than a normal school; it allows for easier bonding between peers; it focuses on co-curricular activities; it encourages proactivity and self discipline, like boarding students spend more than twice as many hours a week (17 to 18) on homework than their peers who are day students; and it places emphasis on family bonds. This implies that boarding students should have fewer misconceptions of concepts due to their exceptional time/ inputs than day students.

Misconception is a view or opinion that is incorrect because it is based on faulty thinking or comprehension. It is gotten from wrong concepts based on inadequate teaching, poor remembrance, or thinking out of the box. Inoyapeh (2014) stated that the suggestive of a faulty line of thinking is referred to as a misconception. Misconceptions can give rise to wrong answers due to ones point of view which can be explained, thereby leads to repeated errors. In other words, misconceptions are incorrect understandings of the Mathematics. According to Charles-Ogan (2014), misconceptions are systematic errors which produce wrong answers, but the arguments that lead to the answers can be explained. Howbeit, the same error will be made time and time again. In other words, in Mathematics, misconceptions are incorrect understanding of Mathematics. Misconception is an erroneous interpretation or difference of opinion that students make based on the teaching methods used which do not follow up the developmental stages of the concept, thereby having a faulty knowledge of the concept like key concepts of graphical quadratic equations.

Graph is a pictorial way of representing relationships between various quantities, parameters, or measurable variables in nature. It summarizes how one quantity changes if another quantity that is related to it also changes. Graphing is using data to plot (mark data on a chart) it as points on a set of axes (that is, one variable on the X-axis and the other variable on the Y-axis). These axes are basically two lines (one vertical and the other horizontal) that are perpendicular to each other. Graphing gives the plotting of  $x$  and  $y$ .

Stretching is a graph that can make one to often learn much as regards to its functions. It gives an intuitive picture of a process and one can generate a new data from graphs. It can predict the physical ways/ behaviours of functions. Graphs can be written

numerically, visually and symbolically. There are 4 **key concepts** when constructing graphical quadratic equations which are: table of values (substitution, rules of signs etc), choosing scales/graduating the axes, plotting of graphs/joining of points, and readings graphs/solving related problems using the graphs. When students do not fully comprehend the above concepts, it leads to misconceptions which result to poor performance. However, knowing the benefits of graphs and diagnosing misconceptions of graphical quadratic equations is not enough, but it should be implemented for effective performance.

### **Statement of the Problem**

Graphical representations play an important role in modeling and understanding of complex natural systems like quadratic equations. Students are not meeting up to expectations due to lack of understanding of concepts (misconceptions) including graphical quadratic equations. It is the preconceived ideas held by students which are wrong and likely the procedural steps of teaching them that resulted to the misunderstanding of concepts. Diagnosing these misconceptions and implementing them can increase the academic performance of students. Hence to overcome these misconceptions, the study deemed it necessary to diagnose students' misconceptions on constructions of graphical quadratic equations.

### **Aim and Objectives of the Study**

The aim of the study is to diagnose students' misconceptions on construction of graphical quadratic equations in Ozuoba, Rivers State. Specifically, the objectives of the study are to:

1. determine the frequency of different types of misconceptions made by day and boarding students when solving related graphical quadratic equations and when constructing the graphs.
2. find out the frequency of different types of misconceptions made by SS2 day and boarding students when solving related graphical quadratic equations and when constructing the graphs.
3. ascertain the frequency of different types of misconceptions made by SS3 day and boarding students when solving related graphical quadratic equations and when constructing the graphs.

### **Research Questions**

The following research questions were raised in the study.

1. What is the frequency of different types of misconceptions made by day and boarding students when solving related graphical quadratic equations and when constructing the graphs?
2. How frequent are the different types of misconceptions made by SS2 day and boarding students when solving related graphical quadratic equations and when constructing the graphs?
3. What is the frequency of different types of misconceptions made by SS3 day and boarding students when solving related graphical quadratic equations and when constructing the graphs?

### **Hypothesis**

One null hypothesis was formulated to guide the study:

1. There is no significant difference between the frequency of day and boarding students holding misconceptions of construction of graphical quadratic equations.

### Methodology

Quasi experimental research design was adopted. The population of the study comprised of Senior Secondary School two (SS2) and three (SS3) students of grammar school, Ozuoba. Purposive sampling technique was used to select forty (40) students as the sample of the study. Instrument used in the study is “Diagnostic Test on Graphical Quadratic Equations (DTGQE). DTGQE comprise of ten (10) objective questions with four options A-D and two (2) essay questions of WAEC standard. Each objective question is 5marks with total of 50marks and each essay question is 25marks with total of 50marks. The total marks for DTGQE is 100%. Validation of the instrument was done by two experts in the Department of Curriculum Studies and Educational Technology, University of Port Harcourt. The reliability of DTGQE was determined by test- retest method using pearson product moment Correlations with index of 0.76. Frequency counts and percentages were used to answer the research questions, while Chi-square was used in testing the hypothesis formulated for the study at 0.05 level of significance.

### Results

The results of data analyzed were presented according to the serial order of stated research questions and hypothesis. The data is presented in a tabular form and responses of the students were analyzed.

#### Research Question One (RQ1):

What is the frequency of different types of misconceptions made by day and boarding students when solving related graphical quadratic equations and when constructing the graphs?

**Table 1: Frequency Counts and Percentages of Day and Boarding Students Having Misconceptions on Construction of Graphical Quadratic Equations (GQE).**

Key concepts of GQE	Number of Students				Total
	With Misconceptions			Without Misconceptions	
	Day Students	Boarding Students	Total		
Table of values	19 (47.5%)	10 (25.0%)	29 (72.5%)	11 (27.5%)	40 (100%)
Choosing scales/graduating the axes	19 (47.5%)	6 (15.0%)	25 (62.5%)	15 (37.5%)	40 (100%)
Plotting of graphs/joining points	19 (47.5%)	9 (22.5%)	28 (70.0%)	12 (30.0%)	40 (100%)
Reading graph/solving related problems	7 (17.5%)	3 (7.5%)	10 (25.0%)	30 (75.0%)	40 (100%)

Table 1 revealed that 19 day students representing 47.5% have misconceptions in working of table of values out of the 40 students, 19 day students of 47.5% of choosing scales/graduating

the axes with the chosen scale out of 40 students, 19 day students of 47.5% in plotting graphs/joining points out of 40 students, and 7 day students of 17.5% to read graphs/solve related problems out of 40 students.

While, the boarding students have misconceptions of 25.0% of 10 students in working of table of values out of 40 students, 15.0% of 6 students of choosing of scales/graduating the axes with the chosen scale out of 40 students, 22.5% of 9 students in plotting graphs/joining points out of 40 students, and 7.5% of 3 students to read graphs/solve related problems out of 40 students. Therefore, total of 64 day students' misconceptions of the highest errors made out of the 92 misconceptions of key concepts of graphical quadratic equations as against 28 boarding students' misconceptions.

**Research Question Two (RQ2):**

How frequent are the different types of misconceptions made by SS2 Day and Boarding students when solving related graphical quadratic equations and when constructing the graphs?

**Table 2: Frequency Counts and Percentages of SS2 Day and Boarding Students Having Misconceptions of Construction of Graphical Quadratic Equations (GQE).**

Key concepts of GQE	Number of Students			Without Misconceptions	Total
	With Misconceptions				
	Day Students	Boarding Students	Total		
Table of values	10 (50.0%)	6 (30.0%)	16 (80.0%)	4 (20.0%)	20 (100%)
Choosing scales/graduating the axes	9 (45.0%)	4 (20.0%)	13 (65.0%)	7 (35.0%)	20 (100%)
Plotting of graphs/joining points	9 (45.0%)	5 (25.0%)	14 (70.0%)	6 (30.0%)	20 (100%)
Reading graph/solving related problems	4 (20.0%)	2 (10.0%)	6 (30.0%)	14 (70.0%)	20 (100%)

From table 2, it indicated that 10 day students representing 50.0% have misconceptions in working of table of values out of the 20 students, 9 day students of 45.0% of choosing scales/graduating the axes with the chosen scale out of 20 students, 9 day students of 45.0% in plotting graphs/joining points out of 20 students, and 4 day students of 20.0% to read graphs/solve related problems out of 20 students.

While, the boarding students have misconceptions of 30.0% of 6 students in working of table of values out of 20 students, 20.0% of 4 students of choosing of scales/graduating the axes with the chosen scale out of 20 students, 25.0% of 5 students in plotting graphs/joining points out of 20 students, and 10.0% of 2 students to read graphs/solve related problems out of 20 students. Therefore, total of 64 day students' misconceptions of the highest errors made out of the 92 misconceptions of key concepts of graphical quadratic equations as against 28 boarding students' misconceptions. However, SS2 day students' misconceptions are 32 out of the 49 misconceptions which is more than the SS2 boarding students' misconceptions of 17.

**Research Question Three (RQ3):**

What is the frequency of different types of misconceptions made by SS3 day and boarding students when solving related graphical quadratic equations and when constructing the graphs?

**Table 3: Frequency Counts and Percentages of SS3 Day and Boarding Students Having Misconceptions of Construction of Graphical Quadratic Equations (GQE).**

Key concepts of GQE	Number of Students			Without Misconceptions	Total
	With Misconceptions				
	Day Students	Boarding Students	Total		
Table of values	9 (45.0%)	4 (20.0%)	13 (65.0%)	7 (35.0%)	20 (100%)
Choosing scales/graduating the axes	10 (50.0%)	2 (10.0%)	12 (60.0%)	8 (40.0%)	20 (100%)
Plotting of graphs/joining points	10 (50.0%)	4 (20.0%)	14 (70.0%)	6 (30.0%)	20 (100%)
Reading graph/solving related problems	3 (15.0%)	1 (5.0%)	4 (20.0%)	16 (80.0%)	20 (100%)

Table 3 showed 4 SS3 boarding students with misconceptions of 20.0% and 9 SS3 day students with misconceptions of 45.0% in working of table of values which is more of the SS3 day students. 2 SS3 boarding students had misconceptions of 10.0% out of 12 students with misconceptions as regards choosing scales/graduating the axes with the chosen scale, while 10 SS3 day students with misconceptions of 50.0% were noticed.

More so, 4 SS3 boarding students with misconceptions of 20.0% in plotting graphs/joining points were observed and 50.0% of 10 SS3 day students with misconceptions out of the 14 students with misconceptions occurred. Also, in reading of graphs/solving related problems, 5.0% of 1 SS3 boarding student had misconceptions and 3 SS3 day students with misconceptions of 15.0% were made. Therefore, total of 32 SS3 day students' misconceptions of the highest errors made out of the 43 SS3 misconceptions of key concepts of graphical quadratic equations as against 11 SS3 boarding students' misconceptions.

**Hypothesis One (HO<sub>1</sub>):**

There is no significant difference between the frequency of day and boarding students holding misconceptions of construction of graphical quadratic equations.

**Table 4: Sample Distribution for Chi-square Calculations**

Students	Day	Boarding	Total
SS2	13	7	20
SS3	14	6	20
Total	27	13	40

**Table 5: Misconceptions (Observed/Expected Frequencies) of Day and Boarding Students of Key Concepts when Constructing/Solving of Graphical Quadratic Equations (GQE).**

Students	Number of Students
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	With Misconceptions	Without Misconceptions	Total
Day	19 (19.58)	8 (7.43)	27
Boarding	10 (9.43)	3 (3.58)	13
Total	29	11	40

\*Expected frequency ( $f_e$ ) is enclosed in bracket

**Table 6: Summary of Chi-square Analysis of Misconceptions of Day and Boarding Students of Key Concepts when Solving Graphical Quadratic Equations (GQE).**

Students	n	df	$\alpha$	$\chi^2$ calculated	$\chi^2$ critical	Decision
Day	27	1	0.05	0.19	3.84	Insignificant
Boarding	13					

\*Row = 2, \*Column = 2 df = (R-1)(C-1)

From Table 5, it reveals the numbers of misconceptions of day and boarding students with their observed and expected frequencies of key concepts when constructing/solving graphical quadratic equations.

Table 6,  $\chi^2$ calculated (0.19) <  $\chi^2$ critical (3.84) at 0.05 level of significance. It resulted that  $H_{O1}$  is accepted (retained) which means there is no significant difference between day and boarding students holding misconceptions of construction of graphical quadratic equations.

### Discussion of Findings

The findings indicated the related concepts when solving graphical quadratic equations which consists of table of values (substitution, rules of signs etc), choosing scales/graduating the axes, plotting graphs/joining points and reading graphs/solving related problems. It presents the frequencies of the misconceptions made by all the students with 92 out of 160, day (64) and boarding (28). It implies that there is 57.5% misconceptions observed with a setback of those who did not answer the questions (due to time factor/lack of concept).

Furthermore, it revealed from table 6 that there is no significant difference between day and boarding students holding misconceptions of construction of graphical quadratic equations.

The interpretation of the evidence of this hypothesis shows that no difference of the day and boarding students having misconceptions of graphical quadratic equations as regards to mode of operation (day/boarding) and class.

The work support Beresibo (2016) who opined that diagnosis is the process of identifying the nature and cause of student learning inability in a concept. It also provides views on misconceptions which include: Charles-Ogan (2014) opined that misconceptions are systematic errors. It produces wrong answers, but the arguments that lead to the answers which can be explained, and again the same error will be made time and time again. In other words, misconceptions are in correct understanding of Mathematics.

### Conclusion

Findings of the study confirmed that student misconceptions which hold when constructing graphical quadratic equations and solving related problems should be resolved by critically looking at the 4 key concepts of construction of graphical quadratic equations and be implemented promptly. The study also concluded that there is no significant

difference of day and boarding students holding misconceptions of construction of graphical quadratic equations.

### Recommendations

Based on the findings of the present study, the following recommendations are made:

1. Students and teachers should be familiar with the concepts of construction of graphical quadratic equations for effective performance.
2. Irrespective of mode of operation (day/boarding) and class, students should be encouraged to know the key concepts when solving/ constructing graphical quadratic equations.
3. Mathematics teachers should see the need to diagnose their students' misconceptions and lay more emphasis on those areas when they are teaching to avoid errors.

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