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# **Effect of Algebrator Software Instructional Approach on Senior Secondary School Students' Achievement and Retention in Quadratic Equations in Otukpo Local Government Area, Benue State, Nigeria**

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### **Abstract**

This study investigated the Effect of Algebrator Software Instructional Approach on Senior Secondary School Students' Achievement and Retention in Quadratic Equations in Otukpo Local Government Area, Benue State. The study was carried out in Otukpo local government area, Benue State, Nigeria. The study adopted quasi-experimental of non-equivalent group research design, precisely non-randomized pre-test post-test control group design and multistage sampling techniques was used to select a sample of 90 senior secondary Two (SS11) students. Two schools were assigned to experimental and control group by the use of simple random sampling technique. The experimental group was taught quadratic equations using Algebrator instructional strategy while the control group was taught the same concept using conventional methods. The data required for the study

were collected using Quadratic Equation Achievement Test (QEAT) and Quadratic Equation Retention Test (QERT). The instrument had reliability coefficient of 0.89 determined using Kuder-Richardson formula 20 (KR-20). The study was guided by four research questions and four hypotheses. Answers to the research questions were given using mean and standard deviation while the hypotheses were tested at 0.05 significant level using analysis of covariance (ANCOVA). Results from the analysis revealed that students exposed to Algebrator software had higher achievement and retention than those taught with conventional teaching methods. Also, the achievement and retention scores of male and female students were not statistically significant. The study therefore recommended amongst others that training of Mathematics teachers on the use of Algebrator instructional strategy in their daily lessons especially in Quadratic equation with a view to making learning meaningful, relevant and interesting.

**Keywords:** Mathematics, Algebrator, Achievement, Retention, Quadratic Equations

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## Introduction

The poor achievement of students in public examinations most especially on the concept of quadratic equation has been blamed on the wrong choice of teaching methods by teachers. Teaching and learning activities have a lot to do with other variables such as instructional materials, teachers, qualifications, student factors variables and to mention but a few. Mathematics is an important subject because it is the basic for scientific, industrial and technological advancement of any country. It is associated with more academic and career opportunities (Iji, Omenka & Honmane, 2016). However, it seems to be an abstract subject when teaching it. Therefore, concrete objects should be used in impacting mathematical ideas. Symbols have been used to explain new concepts but often learners are not sufficiently familiarized with the language and concept that teachers are trying to explain.

Most of the teaching methods today have embraced modern technology and this has brought tremendous changes in the field of learning. Teaching methods can best be described as the types of principles and methods used for instruction (Andrella, 2018). One of the technology-based approaches to teaching mathematics is the use of mathematical software such as Algebrator.

Kalantarnia (2012) defines Algebrator as one of the computer algebra programs (CAS) that focuses on solving algebraic problems mainly in order to develop the educational process in all stages. It provides a descriptive solution step by step in problem solving. This comprehensive tool gives not only the answers needed but also all the steps needed to get to the solution as well as a full explanation of each of them. It covers problems from pre-algebra to College Algebra, Trigonometry and Statistics. It is not dependent on specific Mathematics book or books, as it is capable of solving “any” Mathematics problem you may come up with.

The first thing that grabs one’s attention when using Algebrator is its simple and clear interface. It does resemble one of those lined blank pages you already know from your exercise books, making you feel at home right from the start. Thus, Algebrator

includes- namely, the possibility of exporting any expression and its explanation into a more accessible document that can enhance students achievement in Mathematics. .

Achievement is the result of acquired knowledge or information, understanding, skills and techniques developed in Mathematics. It means a thing that somebody has done successfully especially using one's own effort and skill (Onah, 2015). Iyaoromi (2012) described achievement as an individual status in a specific content area or course of instruction after the individual or group has undergone tutoring in a programme. It refers to the students' present academic skills in Mathematics (Ogunyele & Babajide, 2011). In as much as efforts are being made to enhance students' achievement in mathematics, it is equally important to consider students' ability to retain what they have learnt.

Retention means recalling pieces of knowledge, processes and skills that were learned earlier in time. It is the ability of the working memory of an individual to retrieve stored information from long- term memory for processing (Zakariyya, 2014).

Students may pass an examination following an ardent study session but fail to retain much of these materials in long-term memory. This may be the experience of the Nigerian students who become qualified for SSCE at the end of Senior Secondary Schools programme. Students' low retention in Mathematic may be due to non-utilization of interactive materials in the classroom (Ifamuyiwa & Ajilogba, 2012). Thus, there is need to explore instructional strategies such as computer – based instruction that will enhance retention of knowledge among students.

The fact that computer based instruction enables students to learn better; it is pertinent therefore, to put gender difference into consideration as one of the factors that affect students' academic achievement. Gender issues are of global contemporary concern and gender disparities have been found in students' achievement in Mathematics examinations. It is responsible for the inequality in opportunity, access, enrollment, curriculum, subject disciplines and several others (Gibb, Fergusson & Horwood, 2012). Review of studies showed inconsistency on results of male and female students' achievement in Mathematics public examination and in Mathematics achievement tests. Reports from studies of Anyamene, Nwokolo, Anyachebelu and Anemelu (2012), Gambari, Falode and Adegbenro (2014), Malik and Salman (2016), all show no significant differences among male and female students in Mathematics achievement tests. However, Akpan (2017) indicate that there is significant difference among male and female students in Mathematics achievement tests. Specifically, most of the studies did not examine the achievement of male and female students in quadratic equation achievement tests but rather, Mathematics in general.

It is based on this background that this study seeks to find out the effect of Algebrator software instructional approach on senior secondary school students' achievement and retention in quadratic equations in Otukpo Local Government Area of Benue State, Nigeria, in order to alleviate the poor achievement of students in Mathematics.

## Research Questions

The following research questions were asked to guide the study:

- i. What are the mean achievement scores of students taught quadratic equation using Algebrator approach and those taught using conventional method?
- ii. What is the difference in mean achievement scores of male and female students taught quadratic equation using Algebrator approach?
- iii. What are the mean retention scores of students taught quadratic equation using Algebrator approach and those taught using conventional method?
- iv. What is the difference in mean retention scores of male and female students taught quadratic equation using Algebrator approach?

## Hypotheses

The following research hypotheses formulated were tested at 0.05 level of significance.

- i. There is no significant difference in the mean achievement scores of students taught Quadratic Equation using Algebrator Approach and those taught using Conventional Method.
- ii. There is no significant difference in mean achievement scores of male and female students taught quadratic equation using Algebrator approach.
- iii. There is no significant difference in mean retention scores of students taught quadratic equation using Algebrator approach and those taught using conventional method.
- iv. There is no significant difference in mean retention scores of male and female students taught quadratic equation using Algebrator approach.

## Methodology

The design for this study is quasi-experimental of non-equivalent group design. Specifically, a non-randomized pre-test post-test control group design was used.

The study was carried out in Otukpo Local Government Area, Benue State, Nigeria. Otukpo is a town in Benue State which is located in the Middle Belt Region of Nigeria. Otukpo is the oldest and the most developed Local Government Area in Idoma land. In the March 2006 population census, Otukpo Local Government Area had a population of 266,411 and was projected to be 359,600 in 2016.

The population of this study was 2,663 Senior Secondary two (SS2) students which comprised 1,326 male and 1,335 female students from all the 75 government approved secondary schools in Otukpo Local Government Area. (Source: Area Education Office, 2021).

The sample size for this study was 90 senior secondary two students selected using multistage sampling techniques. The instruments used for data collection were Quadratic Equation Achievement Test (QEAT) and Quadratic Equation Retention Test (QERT). The instrument was validated and the reliability was determined using the Kuder-

Richardson (KR-20) formula and the value of 0.89 was obtained indicating that the instrument is reliable.

The descriptive statistics of mean and standard deviation was used to answer the research questions while the analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

## Results

### Research Question One

What are the mean achievement scores of students taught quadratic equation using Algebrator approach and those taught using conventional method?

Answer to this research question is presented in Table 1.

**TABLE 1: The Mean Achievement Scores and Standard Deviation of Students taught quadratic equations using Algebrator Approach and those taught with Conventional methods.**

Group	N	Pretest		Posttest		Mean gain
		Mean	SD	Mean	SD	
Experimental	45	23.62	3.24	24.56	2.64	0.94
Control	45	21.51	4.06	22.11	3.16	0.60
Mean Diff.		2.11		2.45		0.34

In Table 1, the mean score for pre-test is 21.51 and post-test is 22.11 for the control group with standard deviation 4.06 and 3.16. Also in table 1, the mean scores for pre-test is 23.62 and post-test is 24.56 for the experimental group with standard deviation 3.24 and 2.64. The mean difference for the control group is 0.60 and experimental group is 0.94. This indicates those students who were taught using Algebrator approach achieved higher than students taught using conventional method.

### Research Question Two

What is the difference in mean achievement scores of male and female students taught quadratic equation using Algebrator approach?

Answer to this research question is presented in Table 2.

**TABLE 2: The Mean Achievement Scores and Standard Deviation of Male and Female Students taught Quadratic Equations using Algebrator Approach.**

Gender	N	Pretest		Posttest		Mean gain
		Mean	SD	Mean	SD	
Male	31	23.35	3.18	24.97	2.68	1.62
Female	14	24.21	3.42	23.64	2.41	- 0.57
Mean Diff.		- 0.86		1.33		2.19

In Table 2, the mean scores of male students' pre-test is 23.35 and post-test is 24.97 for the experimental group with standard deviation 3.18 and 2.68. Also in table 2, the mean scores of female students' pre-test is 24.21 and post-test is 23.64 for the experimental group with standard deviation 3.42 and 2.41. The mean differences between the male and female students in the experimental group are 1.62 and - 0.57 in favour of the male students and the mean gain is 0.55.

### Research Question Three

What are the mean retention scores of students taught quadratic equation using Algebrator approach and those taught using conventional method?

Answer to this research question is presented in Table 3.

**TABLE 3: The Mean retention scores and standard deviation of students taught using Algebrator approach and those taught with conventional method.**

Group	N	Posttest		Retention test		Mean gain
		Mean	SD	Mean	SD	
Experimental	45	24.56	2.64	26.89	1.84	2.33
Control	45	22.11	3.16	23.89	2.90	1.78
Mean Diff.		2.45		3.00		0.55

In Table 3, the mean scores for the post-test are 22.11 and 24.56 for the control group and experimental group with standard deviation 3.16 and 2.64 respectively. Also in table 3, the mean retention scores are 23.89 for the control group and 26.89 for the experimental group with standard deviation 2.90 for the control group and 1.84 for the experimental group. The mean difference for the control group is 1.78 and experimental group is 2.33. This implies that the students taught quadratic equations using Algebrator approach has a higher retention scores than those taught using conventional method.

**Research Question Four**

What is the difference in mean retention scores of male and female students taught quadratic equation using Algebrator approach?.

Answer to this research question is presented in Table 4.

**TABLE 4: The Mean Retention scores and Standard Deviation of Male and Female Students taught using Algebrator approach.**

Gender	N	Posttest		Retention test		Mean gain
		Mean	SD	Mean	SD	
Male	31	24.97	2.68	26.74	2.00	1.77
Female	14	23.64	2.41	27.21	1.42	3.57
Mean Diff.		1.33		- 0.47		1.80

In Table 4, the mean scores of male and female students' post-test are 24.97 and 23.64 with standard deviation of 2.68 and 2.41 respectively. Also in table 4, the mean scores of male and female students' retention scores are 26.74 and 27.21 with standard deviations 2.00 and 1.42 for the retention test. The mean difference is 1.77 and 3.57 in favour of female students.

**Research Hypothesis One**

There is no significant difference in the mean achievement scores of students taught Quadratic Equation using Algebrator Approach and those taught using Conventional Method.

To test the hypothesis, the ANCOVA result of students taught quadratic equation using Algebrator approach and those taught with conventional methods are computed and presented in Table 5.

**TABLE 5: Summary of Analysis of Covariance (ANCOVA) on pre-test and post-test Quadratic Equation Achievement Test of students taught using Algebrator approach and those taught with conventional method.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
<b>Corrected Model</b>	170.48 <sup>a</sup>	2	85.24	10.42	.00
<b>Intercept</b>	855.92	1	855.92	104.66	.00
<b>PRETEST</b>	36.04	1	36.04	4.41	.04
<b>GROUP</b>	89.49	1	89.49	10.94	.00
<b>Error</b>	711.52	87	8.18		
<b>Total</b>	49882.00	90			
<b>Corrected Total</b>	882.00	89			

a. R Squared = .19 (Adjusted R Squared = .18)

In Table 5,  $F_{(1,89)} = 10.94$  with p-value of 0.00 which is less than the  $\alpha$ -value of 0.05. This means that null hypothesis is rejected. This implies that there is a significant difference in mean achievement scores of students taught quadratic equation using Algebrator approach and those taught using conventional method. The students taught quadratic equation using Algebrator approach scored higher in achievement test than those taught with conventional method.

**Research Hypothesis Two**

There is no significant difference in mean achievement scores of male and female students taught quadratic equation using Algebrator approach.

To test the hypothesis, the ANCOVA result of male and female students taught quadratic equation using Algebrator approach are computed and presented in Table 6.

**TABLE 6: Summary of Analysis of Covariance (ANCOVA) of experimental group male and female students taught quadratic equation using Algebrator approach.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
<b>Corrected Model</b>	17.09 <sup>a</sup>	2	8.55	1.24	.30
<b>Intercept</b>	483.22	1	483.22	69.98	.00
<b>PRETEST</b>	.16	1	.16	.02	.88
<b>GENDER</b>	16.26	1	16.26	2.36	.13
<b>Error</b>	290.02	42	6.91		
<b>Total</b>	27441.00	45			
<b>Corrected Total</b>	307.11	44			

a. R Squared = .06 (Adjusted R Squared = .01)

In Table 6,  $F_{(1,44)} = 2.36$  with p-value of 0.13 which is greater than the  $\alpha$ -value of 0.05. This means that the null hypothesis is not rejected. This implies that there is no significant difference in the achievement scores of male and female students taught quadratic equation using Algebrator approach.

**Research Hypothesis Three**

There is no significant difference in mean retention scores of students taught quadratic equation using Algebrator approach and those taught using conventional method.

To test the hypothesis, the ANCOVA result of students taught quadratic equation using Algebrator approach and those taught with conventional method are computed and presented in Table 7.



**TABLE 7 : Summary of Analysis of Covariance (ANCOVA) of retention of students taught quadratic equation using Algebrator approach and those taught with conventional method.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
<b>Corrected Model</b>	268.63 <sup>a</sup>	2	134.31	25.81	.00
<b>Intercept</b>	460.33	1	460.33	88.45	.00
<b>POSTTEST</b>	66.13	1	66.13	12.71	.00
<b>GROUP</b>	98.53	1	98.53	18.93	.00
<b>Error</b>	452.76	87	5.20		
<b>Total</b>	58735.00	90			
<b>Corrected Total</b>	721.39	89			

a. R Squared = .37 (Adjusted R Squared = .35)

In Table 7,  $F_{(1,89)} = 18.93$  with p-value of 0.00 which is less than the  $\alpha$ -value of 0.05. This means that the null hypothesis is rejected. This implies that there is a significant difference in mean retention scores between the students taught quadratic equation using Algebrator approach and those taught using conventional method. The students taught quadratic equations using Algebrator approach retained higher scores than those taught using conventional teaching method.

**Research Hypothesis Four**

There is no significant difference in mean retention scores of male and female students taught quadratic equation using Algebrator approach.

To test the hypothesis, the ANCOVA results of male and female students taught quadratic equation using Algebrator approach are computed and presented in Table 8.

**TABLE 8: Summary of Analysis of Covariance (ANCOVA) results of quadratic equation retention test of male and female students taught using Algebrator approach.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
<b>Corrected Model</b>	6.82 <sup>a</sup>	2	3.41	1.01	.37
<b>Intercept</b>	276.93	1	276.93	82.13	.00
<b>POSTTEST</b>	4.67	1	4.67	1.39	.25
<b>GENDER</b>	3.74	1	3.74	1.11	.30
<b>Error</b>	141.62	42	3.37		
<b>Total</b>	32684.00	45			
<b>Corrected Total</b>	148.44	44			

a. R Squared = .05 (Adjusted R Squared = .00)

In Table 8,  $F_{(1,44)} = 1.11$  with p-value of 0.30 which is greater than the  $\alpha$ -value of 0.05. This means that the null hypothesis is not rejected. We therefore conclude that there is no

significant difference in retention scores between the male and the female students taught quadratic equation using Algebrator approach.

## Summary of Major Findings

The following findings emerged from this study:

- i. The students taught quadratic equations using Algebrator approach have higher achievement scores than the students taught using conventional teaching method and their mean difference was statistically significant.
- ii. The mean achievement scores of male and female students taught quadratic equations using Algebrator was not statistically significant even though the female students mean achievement score was higher than the male students.
- iii. The students taught quadratic equation using Algebrator approach have higher retention scores than the students taught using conventional teaching method in quadratic equation retention test, and their mean difference was statistically significant.
- iv. The mean retention score of male and female students taught quadratic equations using Algebrator approach was not statistically significant even though the female students mean retention score was higher than the male students.

## Discussion

The test of hypothesis results in Table1 reveals that there is significant difference in the mean achievement scores of students taught quadratic equations using Algebrator approach and those taught using conventional method. This result is supporting the finding by Kusamah (2014) that Algebrator approach gives students the opportunity to demonstrate their potentials. This study also supports the study of Riyadh (2021) that Algebrator approach helps in developing the skill of self-learning in students. Also this study is in line with Edwardo(2022) that the effect of using Algebrator as an aid in teaching and learning had a positive impact on the learning performance of the students.

The result in Table1 shows that students taught using Algebrator approach performed significantly better than those taught using conventional teaching method. The finding of this study is in agreement with Zahra (2021) that the students in the experimental group who were taught using Algebrator performed significantly better and achieved higher than their counterparts in the control group.

Table 2 centered on gender related difference on academic performance of male and female exposed to Algebrator approach, the post-test result of testing hypothesis two shows there is statistically no significant difference between the post-test means score of male and female student. This implies that the level of achievement in quadratic equation of male and female students exposed to Algebrator is relatively the same. This finding agrees with the finding of Yuliana (2016) who in his study found out that male and female students did not differ significantly in their performance when they are taught quadratic equation using Algebrator approach.

Table 3 implies that there was significant difference in the retention scores of students taught quadratic equations using Algebrator approach and those taught using conventional method. The results showed that experimental group taught quadratic equation using Algebrator approach retained better than their counterpart in control group. This finding agrees with that of Riyadh (2021) who investigated the effect of using the Algebrator program in Acquiring mathematical Concepts for Second – Grade intermediate students.

Table 4 focuses on retention ability between male and female student taught Algebrator approach. The result of hypothesis four shows that there is no significant difference between the post-test mean scores of male and female students. This implies that their retention ability is the same when exposed to Algebrator. This finding is in agreement with that of John and Benjamin (2015) who observed that if boys and girls are given the equal opportunities they will perform equally well.

## **Conclusion**

Based on the findings of this research, it was observed that Algebrator is a more effective instructional approach in teaching the concept of quadratic equations to senior secondary school students. The use of Algebrator approach in teaching quadratic equation leads to breaking the psychological barrier between the student and the topic and provides them with a degree of freedom to make mistakes without being ashamed or criticized. The nature of the Algebrator approach made it possible for the learners to explore and visualize relationships easily and the learning by doing that Algebrator provides enables students to master skills and connect them in a way that deepens their knowledge. It enhances students' achievement and retention in quadratic equation more than the conventional method and it is not gender bias.

## **Recommendations**

Based on the findings, the following recommendations were made:

- i. Workshops and seminars for mathematics teachers should be organized by the Ministry of Education on the use of Algebrator instructional approach.
- ii. The National Educational Research and Development Centre (NERDC) should encourage the use of Algebrator instructional approach as a method for teaching quadratic equations and other concepts in mathematics. This would make Algebrator instructional approach acceptable among teachers and students.
- iii. Teachers should employ Algebrator instructional approach in the teaching of quadratic equations in senior secondary schools to enhance students' achievement and retention.
- iv. Algebrator software and computer systems should be provided for secondary schools by school proprietors and government. This will enable Mathematics teachers to effectively and efficiently use them in the teaching of quadratic equation and other concepts in Mathematics.

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