International Journal on Teaching and Learning Mathematics
2022, Vol. 5, No. 1, pp. 1-14
P-ISSN: 2621-2188, E-ISSN: 2621-2196

Utilizing microsoft excel spreadsheet technology to improve senior secondary school students' achievement and retention in quadratic function in Nigeria education

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A R T I C L E I N F O
Original Article
doi: 10.18860/ijtlm.v5i1.18292

Keywords:
Microsoft Excel Spreadsheet, Achievement, Retention, Quadratic function Graphs, Gender

A B S T R A C T
This study examined effect of Ms-Excel spreadsheet technology on senior secondary two students' achievement and retention in quadratic function graphs in Education Zone C Benue State, Nigeria. The study employed a quasi-experimental, non-randomized pre-test post-test control group design. A sample of 302 SS 2 students from two schools in Benue education zone C were selected from a population of 10,918 SS 2 students for the study using purposive sampling technique. Data were collected using Quadratic Function Achievement Test (QFAT) and Quadratic Function Retention Test (QFRT) instruments. The instruments were validated by five experts, two in Mathematics Education, one in Measurement and Evaluation and two Mathematics teachers. The reliability of QFAT was 0.82. Research questions were answered using mean, standard deviations and percentages (scatter gram) while hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The results of the study showed among others, that SS2 students taught quadratic function graphs using Ms-Excel spreadsheet technology improved more on their achievement and retention with no gender difference. Among suggestions made were, the need to create awareness among Mathematics teachers, Mathematics educators and curriculum planners to integrate Ms-Excel spreadsheet in particular and ICT in general as a teaching strategy in Mathematics teaching and learning process.

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How to cite: Iji, C. O., Abakpa, B. O., Agbo-Egwu, A. O., & Takor, D. I. (2022). Utilizing microsoft excel spreadsheet technology to improve senior secondary school students' achievement and retention in quadratic function in Nigeria education. *International Journal on Teaching and Learning Mathematics*, *5*(1), 1-14.

1. INTRODUCTION

The study of Mathematics as an educational subject is often not an end in itself but rather a vehicle employed in the service of other goals (Cheung & Kwan, 2021; Karsenty et al., 2021; Segarra & Julià, 2022). This means Mathematics is not just a system of numbers and calculations; it provides a framework for simple to complex reasoning. Thus, it is a means to so many ends; it is not just aimed at academic achievement. This was the thinking of Aghadiuno in Iji (2019) who posits that,

for ideas and theories to be meaningful and understandable by the mind they must be presented in a mathematically understandable form. This implies that Mathematics do evokes human affective responsiveness. In line with this thought, Takor (2020) defines Mathematics as a science of symbolic transformation and representation of human thoughts and ideas into functional relations that serves as a framework for simple to complex reasoning. This is to say that, beside a system of numbers and calculations, Mathematics is also concerned with the affective and cognitive basis of human thinking, feeling and behavoiur. These may be the reasons why the Nigerian Government made Mathematics compulsory at the Basic (Basic 1 – 9) and Secondary School (SS1 -3) levels and as well, a prerequisite for admission into most tertiary institutions for all Mathematics related courses.

Mathematics as a secondary school subject is a conglomeration of number and numeration, algebraic processes, trigonometry, plane geometry, mensuration and statistics (Nigeria Educational Research and Development Council, NERDC, 2012). Quadratic functions are a core element introduced in algebra and built upon for the rest of a student's mathematical career (McGowen, & Davis, 2019; Hu, Son, & Hodge, 2022). Quadratic function is one of the areas at the secondary level Mathematics that examination bodies usually test students' affective, cognitive and psychomotor domains using the graphical solutions method. Using graphical method, a student can easily observe and clearly see the quadratic key components which include; **X**-intercepts or the roots of the equation which are the x-values where the parabola/quadratic function/quadratic graphs intersect the x-axis.

Y-intercept is the y-value where the quadratic function intersects the y-axis.

Vertex of a quadratic function/quadratic graph is the highest or the lowest point on the graph.

Axis of symmetry is the vertical line that passes through the vertex and divides the graph into two mirror images.

Intercept form of a quadratic function is $y = a(x - p)(x - q)$; where p and q are the x-intercepts.

Vertex form of a quadratic function is $y = a(x - h)^2 + k$; where (h, k) is the vertex of the parabola. These are not easily identified all at a time when solving quadratic functions using factorization, completing the square or formula methods.

Despite the importance of Mathematics for sound foundation in scientific study and human daily services, studies have shown that students have learning difficulties when it comes to teaching and learning of functions particularly quadratic functions (Akanmu & Fajemidagba, 2013). This is likely to contribute to the overall low achievement in Mathematics as evident by West African Examination Council (WAEC, 2016, 2018). According to Mathematics Chief Examiner's reports (WAEC, 2016 and 2018), quadratic equation is among the areas students avoid attempting questions, while those who dare to, perform poorly. Mathematics being a prerequisite subject for all human endeavors, this low achievement has denied many students admission to read courses of their choice in tertiary institutions for not meeting admission requirements which include a credit pass in Mathematics.

This poor achievement in Mathematics, especially in algebra, WAEC (2016) attributed to teaching approaches and strategies used in the classroom by the teachers. Literature has specifically identified inappropriate teaching methods and lack of manipulative materials or technological innovative pedagogies in the classroom as major factors responsible for poor achievement in Mathematics especially algebra (Eze, 2011). On this note Oteze (2011) opined

that Mathematics teaching should be structured in a manner that knowledge is built on a foundation already laid; encourage students to learn by doing, ensuring that learning grows out of useful experiences and experimentations. Among the different methods and strategies of teaching Mathematics for student's comprehension, Sunday, Akanmu, Salman and Fajemidagba (2016) suggested that, to sustain students' high achievement in Mathematics, the teaching of the subject most particularly the concept of functions should be practical, exploratory and experimental. This is because teaching Mathematics using verbal and mechanical methods some of the higher level objectives of school Mathematics like critical thinking, analytical thinking, logical reasoning, decision-making and problem-solving are difficult to be achieved. Such teacher-centered instructional methods have been criticized for failing to prepare students to attain high achievement levels in Mathematics (Anyagh & O'kwu, 2010). Among the different methods and strategies of teaching Mathematics for student's comprehension, Sunday, Akanmu, Salman and Fajemidagba (2016) opine that, to sustain students' achievement and retention in Mathematics, the teaching of the subject most particularly the concept of functions should be practical, exploratory and experimental.

In the present day techno-cultural global society, technology has provided us with a mediating tool which is information and communication technology (ICT) in addition to use of language. Therefore in this study the researchers sought to explore the use of Ms-Excel spreadsheet technology in learning quadratic function with the SS2 students. Research into the use of spreadsheets and their benefits in teaching and learning Mathematics had shown that with Ms-Excel spreadsheet, students can manipulate numbers by using stored formulas and calculate different outcomes. The stored formulas are built using mostly computer BASIC programming language. Hence such BASIC character set of alphabets, digits and special characters like ?, (), +, =, *, &, ", %, $, ^, !, >, <, f, \, ;, :, @, ', are commonly used. Specifically, one unique use of Ms-Excel is its ability to interactively model and simulate mathematical situations which will enable students in their conceptualization of relationships among numerical, graphical and algebraic representations (Sudgen & Miller, 2010). The choice of Ms-Excel as a prime example among all other spreadsheets programs is as follows:

1. Utility. The spreadsheet is a general-purpose tool with which we may reasonably expect that almost all upper secondary and tertiary students are nowadays at least somewhat familiar.
2. Ubiquity. Excel, or perhaps its open source or other equivalent, may be expected to be found on essentially every desktop, laptop, note book and teaching laboratory machine.
3. User-friendliness. Spreadsheets are quite forgiving when an error is made. They don't just fall in a heap and die, but usually give an (admittedly terse) indication of the error.
4. Updated values are (usually) instantly displayed when a quantity in a model is changed. Such rapid feedback (describes it as immediate feedback) allows for very efficient testing of hypotheses in many instances.
5. Useful, transferable skills are acquired by modelers–Excel is now a standard business and scientific tool. Although spreadsheets were created to fulfill a need in accounting and related applications, they now find much broader application. In particular, their application nowadays to assist in the teaching of algebra is beyond any reasonable doubt.

Considering the use of information and communication technology integration in Mathematics classroom for practical and experimental teaching and learning, Aderonke (2014) conducted a study on impact of technology interventions on students' achievement in rural Nigerian schools. The results revealed significant differences in students' achievement between technology and

nontechnology schools. This difference was in favour of technology used schools. The result of level of technology implementation (LoTi) framework indicated a low level of technology implementation in classroom instruction and no significant relationship between teachers' technology integration and student performance.

Also, Farayola (2014) conducted a study on teaching of Mathematics at tertiary level through effective use of Information and Communication Technology and Mathematics Laboratory in Emmanuel Alayande College of Education, Oyo State. The result revealed generally that, there was improvement in students' Mathematics achievement, and enhanced students' performance in Mathematics. The result however, shows no statistically significant difference in the achievement of male and female pre-service NCE Mathematics teachers in Mathematics when taught using ICT and Mathematics laboratory.

Övez-Dikkartın (2018) conducted a study on the impact of instructing quadratic functions with the use of Geogebra software and guided discovery worksheets on students' achievement and level of reaching acquisitions in Turkey. The findings of the study revealed that the experimental group instructed with the use of GeoGebra software and guided discovery worksheets were more effective in increasing achievement and their level of capability to reach acquisitions compared to the control group; thus, the findings indicated that the instruction created a significant difference. The study also revealed that the students in the control focused on algebraic operations and formulas, mainly memorized the formulas, and were unable to build the relation between graphics and the algebraic expression of functions. On the other hand, the students in the experimental group were better in building the relation between algebraic expressions and graphics, and more successful in interpreting graphics.

Ayuba (2017) conducted a study on Effects of Computer – Based Instruction (CBI) on Retention and Performance in Algebraic Word Problems among Junior Secondary School Students in Kaduna State, Nigeria. The results obtained revealed a significant difference in performance in favour of student exposed to the Computer Based Instruction (CBI). On the other hand the results revealed no significant difference in performance of male and female students exposed to CBI. Again, the result revealed that, the students exposed to CBI had better retention compared to their counterparts who were taught with lecture method. However, the difference in retention of male and female students exposed to CBI was not significant.

This study is anchored on socio-cultural theory by Vygotsky (1987), Diffusion of Innovation Theory by Rogers (1962) and Decay Theory of Forgetting by Thorndike (1914). Vygotsky's socio-cultural theory provides a radical reorientation of learning from an individualistic to a socio-cultural perspective. The relevance of Rogers' theory to the study lies in the fact that Mathematics teachers are seen as early adopters of change; their attitudes toward new innovations are more important. The subjective evaluations about any instructional innovation reach students through the teachers who put their stamp of approval on a new idea by adopting such an idea and having a positive attitude towards its use. The relevance of Thorndike decay theory in the use of Ms-Excel spreadsheet technology (MSS) in teaching and learning quadratic function is that MSS encourage intensive and extensive practices hence, promoting efficient encoding of information for maximal long-term retention. Again, extensive and intensive practice during learning promotes automaticity of information retrieval.

2. METHOD

This study adopted quasi-experimental, non-randomized pre-test pos-test control group design. Intact classes were sampled for both experimental and control groups to avoid

disrupting school activities, hence the subjects involved were not randomly selected into the said study groups.

A sample of 302 students from two schools out of a total of 10,918 senior secondary two students from 206 secondary schools in the study Area was used. This was arrived at by purposive selection of two co-educational schools with enough computers to accommodate a class of forty (40) students at a time. The sample comprised all streams (with a total of 153) students from Federal Government College (FGC), Otobi, and all streams (with a total of 149) students from Federal Science and Technical College (FSTC), Otukpo. One of the two colleges was assigned control group and the other was assigned experimental group by balloting.

The instruments for the study were Quadratic Function Achievement Test (QFAT) and Quadratic Function Retention Test (QFRT). The QFAT items were developed by the researchers based on the revised Bloom's Taxonomy of higher and lower order thinking processes. The Quadratic Function Achievement Test (QFAT) comprised 40 multiple choice objective test items covering all the aspects of quadratic functions as contained in senior secondary two Mathematics curriculum. The QFRT items are the same in content with the QFAT items. However, the morphology (stems and branches) was reshuffled. The instrument QFAT was validated by five experts, two Mathematics educators, one expert in measurement and evaluation and two Mathematics teachers. The coefficient of the internal consistency measure of reliability of the test instrument for QFAT was 0.82 using Kuder-Richardson formula K-R_{20}. This was informed by the right/wrong (binary data) scoring nature of the multiple choice objectives test instrument used.

Eight lesson plans were prepared by the researchers for teaching the control group using conventional method, and another eight lesson plans were prepared for teaching the experimental group using Microsoft Excel spreadsheet. Before commencement of treatment, pre-QFAT achievement test was administered to both groups with the help of research assistants. The researchers marked the pre- QFAT scripts and kept for further analysis. The treatment of the subjects lasted for a period of two weeks. This is because each lesson lasted for more than an hour. The treatment was carried out by the researcher. At the end of the treatment period, Post-QFAT achievement test was administered to the subjects with the help of research assistants. The researchers marked the scripts of post-QFAT for both the experimental and control groups. Two weeks (Tahmina, 2015) after the administration of post-QFAT, QFRT was administered to both groups. According to Tahmina (2015), long term memory retention intervals ranged from two weeks to many years. Pre-QFAT, post-QFAT and QFRT data were collected and collated and analyzed using descriptive statistic of mean, standard deviation and percentages (scatter gram) in answering research questions, while Analysis of Covariance (ANCOVA) was used in testing the hypotheses at 0.05 level of significance.

3. RESULTS AND DISCUSSION

Results are presented according to research questions asked and hypotheses formulated.

3.1. Research Question 1

What are the mean achievement scores of SS2 students taught quadratic function graphs using Ms-Excel spreadsheet technology and those taught using conventional method?

Table 1 shows that in pre-QFAT, both the experimental and control groups had a mean achievement score of 12.54 each with a standard deviation of 4.24 and 3.41 respectively. Also, the results in Table 1 show the mean achievement score of the experimental group in the post-QFAT as 26.75 with a standard deviation of 5.63, while the mean achievement score of the control group is 22.42 with a standard deviation of 4.20. The mean difference in post-QFAT score of the

experimental and control groups is 4.33. This difference is in favour of the experimental group.

Table 1. Mean achievement scores and standard deviations of experimental and Control Groups in Quadratic Function Achievement Test (QFAT)

Groups		Pre-QFAT		Post-QFAT	
	N	Mean	S. D	Mean($\bar{X}$)	S. D
Experimental	153	12.54	4.24	26.75	5.63
Control	149	12.54	3.41	22.42	4.20
Mean Diff		0.00		4.33	
Total	302				

3.2. Research Hypothesis 1

There is no significant difference between the mean achievement scores of SS2 students taught quadratic function graphs in the experimental and control groups.

Table 2. Summary of analysis of covariance of experimental and control groups' mean achievement scores in Quadratic Function Achievement Test (QFAT)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5044.391[a]	2	2522.195	372.101	.000
Intercept	6545.446	1	6545.446	965.653	.000
Pre-QFAT	1976.810	1	1976.810	291.640	.000
Group	2799.561	1	2799.561	413.021	.000
Error	2026.699	299	6.778		
Total	205697.000	302			
Corrected Total	7071.089	301			

Table 2 shows that, the mean achievement scores of control and experimental groups is $F(1, 299) = 413.02, P = 0.00 < .05$ level of significance. This confirms the result of Table 1 which gave us mean achievement score difference of 4.33 in favour of the experimental group. Hence, we reject the null hypothesis and state that, there is statistically significant difference between mean achievement scores of SS2 students taught quadratic function graphs using Ms-Excel (experimental group) and those taught using conventional method. The difference is in favour of the experimental group.

3.3. Research Question 2

What are the mean achievements scores of male and female SS2 students taught quadratic function graphs using Ms-Excel spreadsheet technology?

Table 3. Means achievement scores and standard deviations of experimental group male and female students in Quadratic Function Achievement Test (QFAT)

Gender	N	Pre-QFAT		Post-QFAT	
		Mean	S. D	Mean	S. D
Male	101	13.20	4.44	26.76	5.52
Female	52	13.25	4.04	27.00	5.88
Mean Diff.		-0.05		-0.24	
Total	153				

Table 3 shows that in pre-QFAT, the male had a mean achievement score of 13.20 with a standard deviation of 4.44 while the female had a mean achievement score of 13.25 with a standard deviation of 4.04. Also, the mean achievement score of the male in the post-QFAT is 26.76 with a standard deviation of 5.52, while the mean achievement score of the female is 27.00 with a standard deviation of 5.88. It is observed that both male and female students improved

upon their quadratic function graphs achievement score. The implication is that, the use of Ms-Excel spread sheet technology may be a technological pedagogy that will bring improvement on all students' achievement and close any observed gender gap in Mathematics classroom.

3.4. Research Hypothesis 2

There is no significant difference between the mean achievements scores of male and female SS2 students taught quadratic function graphs using Ms-Excel spreadsheet technology.

Table 4. Summary of analysis of covariance of experimental group male and female students' mean Achievement scores in Quadratic Function Achievement Test (QFAT)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3687.555[a]	2	1843.777	244.602	.000
Intercept	1974.955	1	1974.955	262.004	.000
Pre-QFAT	3685.616	1	3685.616	488.947	.000
Gender	1.088	1	1.088	.144	.705
Error	1130.681	150	7.538		
Total	115063.000	153			
Corrected Total	4818.235	152			

Table 4 shows that, the mean achievement scores of male and female SS2 students taught quadratic function graphs in the experimental group is F (1, 150) = 0.14, P = .71 > .05 level of significance. That is, there is no statistically significant difference between mean achievement scores of male and female students taught quadratic function graphs using Ms-Excel spreadsheet technology as measured in QFAT. By this result, we do not reject the null hypothesis. Thus, the result is an indication that, learning quadratic function graphs using Ms-Excel spreadsheet technology improved both male and female students' achievement in quadratic function graphs taught during the period of this study.

3.5. Research Question 3

What is the interaction effect of Ms-Excel spreadsheet technology on male and female SS2 students' achievement in quadratic function graphs?

Linearity Scatter Gram for Male and Female students of Experimental Group in QFAT

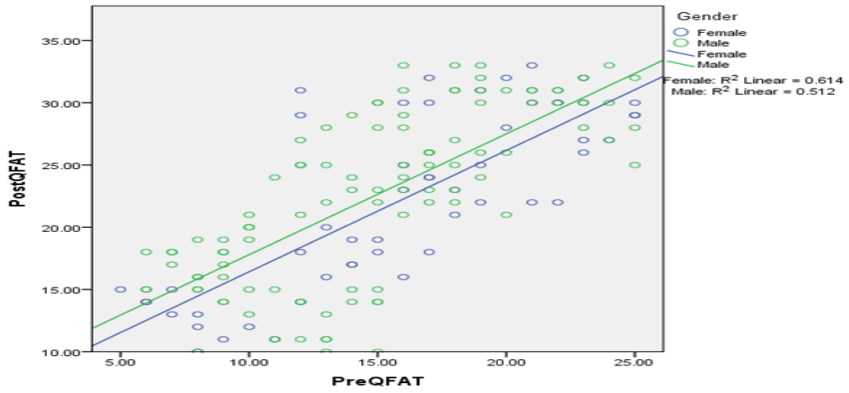

Figure 1. Interaction effect of Ms-Excel spreadsheet technology on male and female SS2 students' achievement in quadratic function test (QFAT)

The result in the scatter plot (Figure 1) shows that the two lines representing the male and female variables of gender are parallel. They both rise from y-axis to the top left of the x-axis. Their R-square or the coefficient of determination, variance explained, the squared correlation (as it is called) have such values as R^2 linear = 0.614 x 100 = 61% for female and R^2 linear = 0.512 x 100 = 51% for male. The parallel lines are indications that there is no interaction effect of

Microsoft Excel spreadsheet technology on male and female SS2 students' achievement in learning quadratic function graphs. In order words, it is an indication that SS2 students' achievement in quadratic function graphs using Microsoft Excel spreadsheet technology is not dependent on gender.

3.6. Research Hypothesis 3

There is no significant interaction effect of Microsoft Excel spreadsheet technology on male and female SS2 students' achievement in quadratic function graphs test.

Table 5. Summary of analysis of covariance of interaction of Ms-Excel spreadsheet technology on male and female SS2 students' Achievement in Quadratic Function Graph Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3939.384[a]	3	1313.128	60.279	.000	.548
Intercept	799.436	1	799.436	36.698	.000	.198
Method	3762.409	1	3762.409	172.713	.000	.537
Gender	7.396	1	7.396	.340	.561	.002
Gender * Method	.020	1	.020	.001	.976	.000
Error	3245.844	149	21.784			
Total	84080.000	153				
Corrected Total	7185.229	152				

In Table 5, it is observed that the gender variable has a significance value of (0.56) more than the threshold value (0.05) while Method has a significance value of (0.00) less than the threshold value (0.05). Again, the interaction between the two factors Method*Gender (0.98) is more than the threshold value (0.05). That is F(1, 149) = 0.00, P = 0.98 > 0.05, $\eta^2_{partial} = 0.00$. The $\eta^2_{partial} = 0.00$ means 0% variance explained, in other words it is a small ***d***- value (according to Cohen, 1988) or near absent interaction effect. Thus, we do not reject the null hypothesis and conclude that there is no statistically significant interaction effect of Microsoft Excel spreadsheet technology on male and female SS2 students' achievement in quadratic function graphs.

3.7. Research Question 4

What are the mean retention scores of SS2 students taught quadratic function graphs using Ms-Excel spreadsheet technology and those taught using conventional method?

Table 6. Mean retention scores and standard deviations of experimental and control group in Quadratic Function Retention Test (QFRT)

Groups		Post-QFAT		Retention	
	N	Mean	S. D	Mean($\overline{X}$)	S. D
Experimental	153	26.75	5.63	27.97	5.21
Control	149	22.42	4.20	22.49	4.31
Mean Diff		4.33		5.48	
Total	302				

The data in Table 6 shows the quadratic function retention score of the experimental group as 27.97 with a standard deviation of 5.21 while the control group had their quadratic function retention score as 22.49 with a standard deviation of 4.31. Their mean difference in the quadratic function retention score is 5.48. This is an indication that students in the experimental group who were taught quadratic function graph using Ms-Excel spread sheet technology retained more than students in the control group who were taught using conventional method.

3.8. Research Hypothesis 4

There is no significant difference between the mean retention scores of SS2 students taught quadratic function graphs in experimental and control groups.

Table 7. Summary of analysis of covariance of experimental and control groups' mean retention scores in Quadratic Function Retention Test (QFRT)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7529.988[a]	2	3764.994	939.769	.000
Intercept	246.599	1	246.599	61.553	.000
PostQFAT	5195.180	1	5195.180	1296.753	.000
Group	255.424	1	255.424	63.756	.000
Error	1197.883	299	4.006		
Total	202663.000	302			
Corrected Total	8727.871	301			

Table 7 shows that, the mean retention scores of SS2 students in the control and experimental groups in graphs of quadratic function retention test is F (1, 299) = 63.76, P = 0.00 < .05 level of significance. This confirms the result of Table 6 which shows 5.48 as the mean difference in the quadratic function retention score of the two groups. Thus, we see that there is significant difference between mean retention scores of students taught quadratic function graphs in the control and experimental groups as measured in QFRT. By this result, we reject the null hypothesis and state that, there is statistically significant difference between the mean retention scores of SS2 students taught quadratic function graphs in experimental and control groups. This difference is in favour of the experimental group. Thus, the result is an indication that, learning quadratic function graphs using Ms-Excel spreadsheet technology improved students' retention more than conventional method.

3.9. Research Question 5

What are the mean retention scores of male and female SS2 students taught quadratic function using graphs Ms-Excel spreadsheet technology?

Table 8. Mean retention scores and standard deviations of experimental group male and female in Quadratic Function Retention Test (QFRT)

Gender	N	Post-QFAT		Retention (QFRT)	
		Mean	S. D	Mean	S. D
Male	101	26.76	5.52	26.90	5.16
Female	52	26.88	5.89	26.90	3.71
Mean Diff.		-0.12		0.00	
Total	153				

Table 8 shows that in Post-QFAT, the male had a mean achievement score of 26.75 with a standard deviation of 5.89 while the female had a mean achievement score of 26.87 with a standard deviation of 4.43. Also, it shows the mean retention score of the male as 26.90 with a standard deviation of 5.16, while the mean retention score of the female is 26.90 with a standard deviation of 3.71. It is observed that both male and female students improved upon their quadratic function retention scores. The implication is that, the use of Ms-Excel spread sheet technology may be a technological pedagogy that will bring improved retention on all students in Mathematics classroom irrespective of gender.

3.10. Research Hypothesis 5

There is no significant difference between the mean retention scores of male and female SS2 students taught quadratic function graphs using Ms-Excel spreadsheet technology.

Table 9 shows that, the mean retention scores of male and female SS2 students taught quadratic function graphs in the experimental group is F (1, 150) = 0.61, P = .44 > .05 level of significance.

That is, there is no statistically significant difference between mean retention scores of male and female students taught quadratic function graphs using Ms-Excel spreadsheet technology as measured in QFRT. By this result, we do not reject the null hypothesis. Thus, the result is an indication that, learning quadratic function graphs using Ms-Excel spreadsheet technology improved both male and female students' retention in quadratic function graphs taught during the period of this study.

Table 9. Summary of analysis of covariance of experimental group male and female students' mean retention scores in Quadratic Function Retention Test (QFRT)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3390.757[a]	2	1695.378	347.376	.000
Intercept	168.948	1	168.948	34.617	.000
Post-QFAT	3236.790	1	3236.790	663.204	.000
Gender	2.953	1	2.953	.605	.438
Error	732.080	150	4.881		
Total	123795.000	153			
Corrected Total	4122.837	152			

3.11. Research Question 6

What is the interaction effect of Ms-Excel spreadsheet technology on male and female SS2 students' retention in quadratic function graphs?

Linearity Scatter Gram for Male and Female students of Experimental Group in QFRT

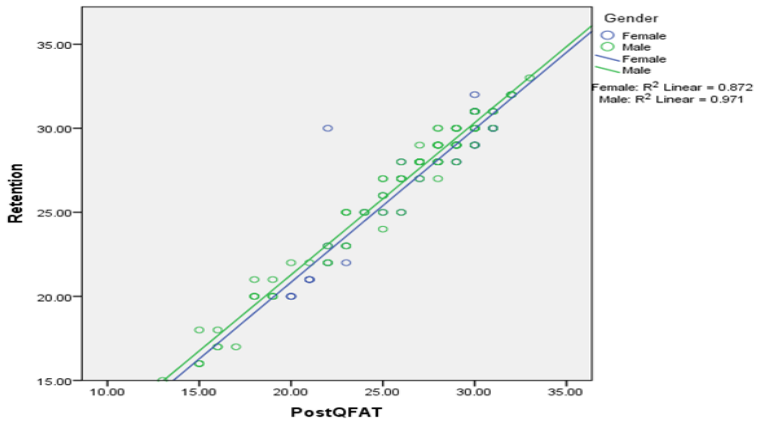

Figure 2. Interaction effect of Ms-Excel spreadsheet technology on male and female SS2 students' retention in quadratic function test (QFRT)

The result in the scatter plot (Figure 2) shows that the two lines representing the male and female variables of gender on quadratic function retention test are parallel. The line both rise above the origin on y-axis to the top left of x-axis, all incline at an angle of 45°. Their respective R-square values or the coefficient of determination, variance explained, the squared correlation (as it is called) are 0.745 x 100 = 75% for the male and 0.751 x100 = 75% for the female. This is an indication that there is no interaction effect of Microsoft Excel spreadsheet technology on male and female SS2 students' retention in quadratic function graphs. In order words, it is an indication that SS2 students' retention in quadratic function graphs using Microsoft Excel spreadsheet technology is not dependent on gender.

3.12. Research Hypothesis 6

There is no significant interaction effect of Microsoft Excel spreadsheet technology on male and female SS2 students' retention in quadratic function graphs test.

Table 10. Summary of Analysis of covariance of interaction of Ms-Excel spreadsheet technology on male and female SS2 students' Quadratic Function Retention Test (QFRT)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
CorrectedModel	2507.846[a]	3	835.949	870.844	.000	.946
Intercept	25.020	1	25.020	26.065	.000	.149
Gender	.247	1	.247	.257	.613	.002
Post-QFAT	1818.732	1	1818.732	1894.653	.000	.927
Gender * Post-QFAT	.025	1	.025	.026	.873	.000
Error	143.029	149	.960			
Total	112681.000	153				
Corrected Total	2650.876	152				

In Table 10, it is observed that the gender variable had a significance value of (0.61) more than the threshold value (0.05) while Post-QFAT had a significance value of (0.00) less than the threshold value (0.05). Again, the interaction between the two factors Gender*Post-QFAT had a significance value of (0.87) more than the threshold value (0.05). That is F(1, 149) = 0.03, P = 0.87 > 0.05, $\eta^2_{partial}$ = 0.00. The $\eta^2_{partial}$ = 0.00 shows 0% variance explained, in other words, a small ***d***-value (according to Cohen, 1988) or near absent interaction effect. Thus, we do not reject the null hypothesis and conclude that, there is no statistically significant interaction effect of Microsoft Excel spreadsheet technology on male and female SS2 students' retention in quadratic function graphs.

The study found that the use of Ms-Excel spreadsheet in teaching quadratic function graphs improved students' achievement in Mathematics. This improvement was found to be statistically significant. This may be as a result of students' active involvement in the use of this software in learning during Mathematics classes. The finding of this study supports the earlier studies of Farayola (2014) who found students' improvement in Mathematics when taught using ICT and Mathematics laboratory. The finding is also in support of Aderonke (2014) who found significant difference in students' Mathematics achievement. The difference was favour of technology used schools as against non technology used schools. The findings of this study show that the use of Ms-Excel spreadsheet technology in teaching quadratic function graphs is more effective in improving students' achievement in Mathematics than conventional method.

Again, the study found that the use of Ms-Excel spreadsheet in teaching quadratic function graphs improved students' retention in Mathematics. This improved retention was found to be statistically significant. This may be as a result of students' active involvement in the use of this software which allows for extensive and intensive practices in learning during Mathematics classes. The result supports the earlier finding of Ovez-Dikkartan (2018) who found that, students in the experimental group who were instructed with the use of geogebra software and discovery work sheets were more effective in their level of capability to reach acquisition compare to control group, and that the students in the experimental group were better in building relation between algebraic expressions and graphics as well as more successful in interpreting graphics. The findings of this study show that the use of Ms-Excel spreadsheet technology in teaching quadratic function graphs is more effective in improving students' retention in Mathematics than conventional method.

In regard to gender, the study found that the use of Ms-Excel spreadsheet in teaching quadratic function graphs equally improved both male and female students' achievement and retention during the period of this study. This result agrees with the findings of Ayuba (2017) who found no significant gender difference in retention of male and female students taught Mathematics with CBI.

Also, the study found no statistically significant interaction in mean achievement scores of male and female SS2 students taught quadratic function graphs using Ms-Excel spreadsheet technology. That is, SS2 students' achievement in quadratic function graphs using Microsoft Excel spreadsheet strategy is not dependent on gender. Again, the study found no statistically significant interaction in retention scores of male and female SS2 students taught quadratic function graphs using Ms-Excel spreadsheet technology. This shows that, SS2 students' retention in quadratic function graphs using Microsoft Excel spreadsheet strategy is not dependent on gender. This support Vygotsky's socio-cultural theory (1987) which provides a radical reorientation of learning from an individualistic to a socio-cultural perspective, also, it support Thorndike Decay Theory of Forgetting (1914) that extensive and intensive practice during learning promotes automaticity of information retrieval.

4. CONCLUSION

It is evident that the use of Ms-Excel spreadsheet technology in Mathematics teaching and learning significantly improved students' achievement and retention with no gender difference. This implies that, the use of Ms-Excel spreadsheet technology is more effective in stimulating students' learning needs and closing gender gap in Mathematics than conventional method. It is recommended that national workshops and seminars should be organized to show Mathematics teachers how to use Ms-Excel spreadsheet in different Mathematics concepts. School authorities should encourage their Mathematics teachers by providing enabling and conducive environment for the use of Ms-Excel spreadsheet in particular and ICT in general in Mathematics teaching. Teacher trainers should encourage student teachers in the use of Ms-Excel spreadsheet technology in particular as one of the effective strategies of ICT integration in Mathematics teaching and learning processes.

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