COMPARATIVE EFFICACY OF 4-ORDERING QUADRATIC EQUATION SOLUTION METHODS ON SENIOR SECONDARY SCHOOL STUDENTS' RETENTION IN QUADRATIC EQUATION

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Abstract
The study investigated the effects of Ordering Quadratic Solution Methods (OQSM) on senior secondary school students' retention in quadratic equation. The design of this study was non-equivalent quasi-experimental research. The sample size of the study was two hundred and seventy senior secondary school two students who was drawn from two secondary schools in Enugu urban of Enugu State. The study was guided by two research questions and three hypotheses. Mathematics Retention Test (MRT) was the instrument that was used for data collection, which was subjected to face validation by experts and found to have a reliability index of 0.87. Mean and standard deviation were used in answering research questions. Analysis of covariance (ANCOVA) was used in testing the hypotheses at 0.05 alpha levels, and Sheffe (Post Hoc) Test was used to ascertain the location of significant difference. Results from the study indicated that there was a significant difference between the 4-methods in methodical ordering with regards to retention. Sheffe test also showed that the best order was the Formula-Completing Square-Factorization-Graph (FOCOFGRA)) method. Gender had no significant influence on the students' retention on quadratic equations. The study recommended that the proper ordering solution method be adopted by teachers for teaching mathematics in secondary schools and also, curriculum planners should review and reordering of the current mathematics curriculum to be in proper order.

Keynotes: *Ordering Quadratic, mathematics, Retention, Quadratic Equations.*

Introduction

Mathematics is one of the most important subject's taught in our school system, irrespective of country or level of education. It is the master and servant of most disciplines and source of enlightenment to human understanding. It deals with the study of relationships of shapes, objects and numbers. It is the foundation of hard core science and technology and it is liable index of the potential for development (Iyiiola, 2005). Usman (2011) in Afolabi (2017) stated that mathematics is the only subject that can be used in all culture of the world to produce the educated man. Usman added that mathematics is the touchstone of wit and whetstone of intelligence. It has been described as a model of thinking (Iji, 2008) which encourage learners to observe, reflect and reason logically about a problem and in communicating ideas, making it be central intellectual discipline and a vital tool in science, commerce, technology and nature building (Imoko & Agwagah, 2006). This means that anyone who wants to pursue other science subjects should have a clear retention mathematics principle.

Ndukwe (2018) opined that one of the factors that affect students' achievement in mathematics is retention. This is because retention is the ability of the students to keep in memory what has been taught and assimilated. Retention is the ability for someone to remember

what one was taught after an interval of time. Bichi (2009) as cited in Abdullahi (2017) defined retention as the ability to retain and consequently remember things experienced or learned by an individual at a later time. A student retrieves what he/she has retained in his/her memory while answering question in test or examination. Thus, degree of achievement has to do with degree of retention. In line with this view, Obodo (1995) as cited in Ugwuanyi (2016) affirmed that retention is measured in collaboration with achievement. This is so because the ability of the students to retain what they have been taught by their teachers depends mainly on the appropriateness of the method and mode of instruction. Ndukwe (2018) asserted that these challenges needs to be tackled by mathematics planners and researchers. Based on this, the researcher decided to embark on a study to determine the effect of ordering quadratic solution methods on students' retention irrespective of their gender.

Another issue of research is the influence of gender on students' achievement on quadratic equations. Gender is simply the characteristics of being male or female. Gender is a social construct; it is not biologically determined but a concept equivalent to race or class (Offorma 2004). Gender inequality still remains in Nigerian education systems in terms of subject teacher preferences and in qualitative aspects of the education and training experience. Arigbabu and Iji (2004) are of the opinion that in Nigeria, and perhaps the whole of Africa, gender bias is still very prevalent. Findings of some research studies on achievement have reported no statistical difference between boys and girls in mathematical tasks, while some reported differences in favour of female and vice-versa. For example, Abiam and Odok (2006), found that there is no significant difference in the performance of male and female students in mathematical tasks. Okam and Zakaria (2017), Dalu (2016), Imasuen and Omorogbe (2016), and Dangpe (2015) equally observed that gender plays no significant role in mathematics achievement and continue to conclude that male and female students have nearly equivalent mathematics achievement capacity and levels. This implies that a result on the superiority of boys over girls in mathematical potentials, especially in algebra is inconclusive.

Quadratic equations as one of the topics in algebra, has a teaching methodical order. Quadratic equation is equation of the form: $ax^2 + bx + c = 0$ where, a, b, c are constants while x is unknown. In equations, the desired quantities usually the unknown, specially named (marked or titled) by use of literal symbols, usually letters of alphabet (*say a, b, …, x, y, z*) and signs of operation are used. The conditions of the problems are translated into mathematical language, that is expressing the relationship between the given quantities and the unknown. Then the given statement is called equation. Quadratic equation being one of the major topics taught in our schools and its teaching and learning with students' achievement and retention has posed some problems to both the teachers and the students as well. In the findings of Agashi (2006), who find that if the methods of solving quadratic equation are adequately emphasized and properly sequenced during instructions. Students' interest and retention would be aroused thereby giving rise to their achievement in the topic.

Teaching method and sequences have lots of influence on the student's achievement outcome in teaching and learning. There are four methods of teaching quadratic equations. Non-usage of uniform or generally acceptable ordering (method) in teaching and learning of mathematics in our schools have contributed a lot in diverting the learner's interest in mathematics and its allied subjects This was proved in an experiment carried out by Obodo (1995), on the effect of methodical ordering in learning simultaneous equations in Junior Secondary School class three mathematics. He discovered that in various combinations of the

three methods of learning simultaneous equation – substitution, elimination and graph, the students' achievement is highly determined by the teaching method/order used. Obodo, therefore, taught the student's using different orders and after a post – test result, he arrived at the conclusion that Graph – Elimination – Substitution methods has the highest number of well – performed students than those taught with Elimination – Substitution – Graph methods. This gave rise to the desire to find how to improve the student's performance outcome in other mathematical concepts with various methods as in quadratic equations which is the aim of this research topic. The four independent methods of teaching quadratic equations are: Factorization – Completing the square – Formular – Graph (FACOFGRM) as can be seen in available tests. These is need to examine how these four methods of solutions can be ordered (arranged) to increase students' retention in quadratic equation which is the purpose of this research topic.

Research Questions

The study was guided by the following research questions.

1. What are the mean achievement scores of students in each of the four methodical orders on quadratic equations with respect to retention test?
2. What are the mean retention scores of male and female students taught quadratic equations using the four methodical orders?

Hypotheses

The following null hypotheses was tested at 0.05 level of significance:

HO_1: There is no significant difference between the mean retention scores of students in the methodical orders on quadratic equations.

HO_2: There is no significant difference between the mean retention scores of the male and female students that are taught quadratic equations using methodical ordering.

HO_3: There is no interaction effect of students' sex and methodical ordering on their mean retention scores on quadratic equations.

Method

The study adopted a quasi – experimental research design with the non-equivalent control group. In order to minimize threats to internal validity, the researcher used random selection and random assignment. There are twenty-four (24) possible methods in teaching and learning of quadratic equations. But the researcher sampled four methods. They are:

1) Completing of Square – Formula – Graph – Factorization
2) Formula – Completing the Square – Factorization – Graph
3) Graph – Factorization – Completing the Square – Formula
4) Factorization – Completing the Square – Formula – Graph

Number 4 was used as the control method because practicing teachers are currently using it in teaching quadratic equations. The experimental group was taught quadratic equation using methods 1, 2 and 3 above. 20 questions were developed by the researcher for the post achievement test on quadratic equations. The sample size consists 134 males and 136 females, (270) Senior Secondary School Two (SS2) students in two secondary schools were used. Retention Test on Quadratic Equation (RTQE) constructed by the researcher was used to collect data. RTQE was validated by experts in mathematics and measurement and evaluation. The reliability of instrument was a Test – Retest form of reliability which allows the same test to the same group of tests on two different occasions separated by some time interval. The post-

retention test on quadratic equation was administered in the experimental as well as the control groups immediately after the experimental treatment. Both the trained assistants and researcher allowed two hours for the exercise after which the scripts were gathered. Two weeks after, retention test was administered. A period of two hours was allowed for the test. Mean and standard deviation were used to answer the research questions while analysis of covariance (ANCOVA) using SPSS was used to test hypotheses at 0.05% level of significance.

Results

Research Question 1. What are the mean achievement scores of students in each of the four methodical orders on quadratic equation with respect to retention test?

Table 1: Mean and standard deviation of mean scores of students with respect to retention test

Group	Methodical Order	Number of Students	Post – test		Retention	
			Mean	SD	Mean	SD
GP A	A	65	67.48	12.38	70.42	8.02
GP B	B	69	61.97	10.07	64.94	9.55
GP C	C	71	61.62	8.11	67.75	18.17
GP D	D	65	64.09	9.07	65.11	12.72
		270				

From the table above, the groups A, B, C and D had a post-test mean score and the standard deviation of 67.48, 61.97, 61.62, 64.09 and 12.38, 10.07, 8.11, 9.07 respectively, while the retention test mean scores and standard deviation were 70.42, 64.94, 67.75, 65.11 and 8.02, 9.55, 18.17 and 12.72 respectively. This suggests that methodical order A had the highest mean scores.

Research Question 2

What are the mean retention scores of male and female students taught quadratic equation using four methodical orders?

Table 4: Mean retention scores of male and female students taught quadratic equations using four methodical orders

Group	Methodical Order	N	Male			Female		
			Mean	SD	N_2	Mean	SD	N_3
GP A	A	65	70.74	9.24	31	66.12	8.22	34
GP B	B	69	65.14	7.92	35	64.74	9.99	34
GP C	C	71	66.43	7.92	37	64.82	20.55	34
GP D	D	65	60.22	10.13	31	61.94	12.73	34
					134			136

Table 4 shows that the male students had mean retention scores of 70.74, 65.14, 66.43, 60.22 and standard deviation of 9.24, 7.92, 7.92, 10.13 respectively. The female had the mean retention scores of 66.12, 64.74, 64.82, 61.94 and standard deviation of 8.22, 9.99 and 20.55 and 12.73

respectively. From the table above, the researcher discovered that the male students had higher retention mean scores than their female counterparts but their female counterparts had higher standard deviation in retention test. Also, the table further, revealed that the student taught quadratic equation with order (method) A had the highest mean scores.

Test of Hypotheses 1, 2 and 3

HO_1: There is no significant difference between the mean retention scores of students in the methodical orders on quadratic equations.

HO_2: There is no significant difference between the mean retention scores of the male and female students that are taught quadratic equations using methodical ordering.

HO_3: There is no interaction effect of students' sex and methodical ordering on their mean retention scores on quadratic equations.

Table 3: SPSS Result for Hypotheses 1, 2 and 3 on the mean scores of students

Source	Type III Sum Squares	DF	Mean Square	F	Sig
Corrected Model	12834.420[a]	8	1604.303	1788.011	.000
Intercept	27611.600	1	27611.600	262.864	.000
Post-achievement	2928.167	1	2928.167	29.147	.000
Method 2	11424.292	3	3808.097	38.088	.000
Gender	43.258	1	43.258	.434	.526
Method 2 * Gender	599.701	3	199.900	2.148	.118
Error	24224.672	261	92.815		
Total	1294423.000	270			
Corrected Total	28982.41	256			

aR Squared = .330 (Adjusted R Squared = .310)

HO_1: There is no significance difference between the mean retention scores of students in the methodical orders on quadratic equation.

From the result of ANCOVA in table 3, it was observed that the F-Calculated value of 38.008 was found significant at 0.000 level, which is less than 0.05 for the study. Therefore, hypothesis 1 was rejected. Hence, the study concluded that there is a significant difference between the groups.

HO_2: There is no significant difference between the mean retention scores of male and female students that are taught quadratic using methodical ordering.

From the result of ANCOVA in table 3, it was found that Gender which was the main effect gave an f-value of 0.434 and was significant at 0.526. since 0.526 was greater than 0.05, this meant that at 0.05 level, the f – value was not significant. Hence, hypothesis 2 was accepted. Therefore, the study concluded that there was no significant different between the mean retention scores of male and female students that are taught quadratic using methodical ordering.

HO_3: There is no interaction effect of students' sex and methodical ordering on quadratic equations.

From the table of ANCOVA in Table 3, it was observed that Method * Gender which was the main effect gave an f – value of 2.148 and was significant at 0.118. since 0.118 was greater than 0.05, this meant that at 0.05 level, the f – value was not significant. Therefore, the study concluded that there was no interaction effect of students' sex and methodical ordering on quadratic equation.

Hence, a significant difference exists between experimental and control groups in the methodical order 1, 2, 3 and 4. This shows that hypothesis 1 is rejected. But there are four methodical orders. Where does the significant difference lie among the four orders? Scheffe (post – hoc) test were used to ascertain the location of this significant difference.

Table 4: Post Hoc Test to locate the difference between methodical order

4	**(J)**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**
METHOD2	METHOD2			
CLASS B	CLASS A	CLASS C	**12.8418***	**1.75382**	**.000**
		CLASS D	17.8454*	1.74187	.000
		CLASS A	15.3834*	1.78765	.000
CLASS B		CLASS C	-12.8418*	1.75382	.000
		CLASS D	6.1136*	1.71648	.048
		CLASS A	3.6717	1.75382	.553
CLASS C		CLASS B	-17.8454*	1.74187	.000
	CLASS D		-6.1136*	1.71648	.048
		CLASS A	-3.5518	1.74187	.586
CLASS D		CLASS B	15.3834*	1.78765	.000
		CLASS C	-3.6717	1.75382	.553
			3.5518	1.74187	.586

The Table 4 shows that there is a slight different between the methodical orders in the retention test on quadratic equations. There is significant difference between methodical orders B, C and D. Only methodical orders A of the significance shown in the table are statistically significant. Hence, the table reveals that the slight difference is located with order A(FOCOFGRA) which has a mean of 70.42. This shows that the students who were taught quadratic equations with methodical order (FOCOFGA) achieved higher marks than those taught with the other three orders.

Discussion of the Findings

The study investigated the comparative efficacy of 4-ordering quadratic equation solution methods on senior secondary school students retention in quadratic equation. The study revealed among the four ordering equation methods solution methods that were used in this study, only the students that taught quadratic equation using the order: FOCOFGRA have the highest mean score of 70.42 in the post achievement test, followed by those students that were taught quadratic equation using order B, D and C. The results indicate that most of the students used the FOCOFGRA technique to solve quadratic equations. The result of the findings in Table 3 shows that there is a significant difference between methodical order A, B, C and D at 0.05 level. The reason could be that when the ordering is in line with cognitive ability of the students,

assimilation of learning materials would become easier. The location of this difference using Sheffe test, indicates that there is a significant difference which is located with order A, that is Formula – Completing the square – Factorization – Graph method (FOCOFGRA). In the table, this order produced the highest means score of 70.42 in the retention achievement test. The findings of this study confirmed the assertion of Agashi (2006) that proper sequence in teaching mathematics have significant effect on students' achievement thus, supporting the finding of researches, that ordering of methods enhances student's achievement.

Secondly, the study discovered that there is no significant difference between male and female students that are taught quadratic equation in the post-test and retention as shown in table 3. The reason for the no significant difference in the mean mathematics retention male and female students could be that both groups of the students have realized the importance of mathematics and are using similar learning strategies to improve in their mathematical knowledge. The finding opposes the findings of Ezema and Ikeazota in Ugwoka (2008) who revealed that there is significance difference in achievement between male and female. The result agrees with the finding of Okoye and Okechukwu (2006) who found out that there was no significant difference between the scores of male and female teachers' vis-a-vis is the student poor achievement in science.

Conclusion

Based on the findings and discussions of this study, the following conclusions were made:

5.0 Students exposed to Formula – Completing the squares – Factorization – Graph (FOCOFGRA) method achieved higher in quadratic equations than the other three orders used for the study.

6.0 Gender has no significant influence on students' achievement in quadratic equations based on the ordering method.

Recommendations

Considering the findings in this study, the following recommendations are made:

5 Mathematics teachers should use Formula – Completing the Square – Factorization – Graph (FOCOFGRA) methodical order since it enhances students' achievement in quadratic equations in algebra.

6 Teacher training institutions should include FOCOFGRA ordering in the mathematics method course content.

7 Federal and state ministries of educational, professional bodies such as Mathematical Association of Nigeria (MAN), Science Teachers Association of Nigeria (STAN) etc. should organize seminars, workshops on the use of mathematical ordering so as to sensitize the mathematics teachers on the benefit derivation from using method.

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