

Mastery-Based Learning Approach and Junior Secondary Students' Performance and Retention in Change of Subject Formula

GEORGE, Nchelem Rosemary (Ph.D)

*Department of Mathematics/Statistics
Ignatius Ajuru University of Education Port Harcourt
Rivers State. Nigeria.*

Abstract

This study investigated the effect of mastery-based learning approach on the performance and retention of junior secondary students in change of subject formula. Three objectives guided the investigation. The quasi experimental research design which presented one experimental and one control group was employed. A sample of 108 was randomly selected from a population 7,428 junior secondary three students in Port Harcourt Local Government Area of Rivers State Nigeria. An instrument titled "Change of Subject Formula Mathematics Achievement Test" (CSFMAT) was used to collect pretest, posttest and post posttest data from the sample. The reliability of the validated CSFMAT was established to be 0.83 using the test retest reliability method. The mean, standard deviation and Analysis of Covariance statistical tool were used for analysis at .05 probability level. The result showed that the students in the experimental group who were taught with the Mastery-based Learning Approach (MLA) had a higher achievement and retention than the students in the control group who were taught using the non mastery-based approach. Subjecting the hypotheses to statistical test revealed that there was a significant difference in both group with respect to achievement and retention. The finding also revealed that the male students achieved higher than their female counterpart in the experimental group with no significance. It was recommended that Mathematics teachers should identify the mathematics concepts that are bulky so as to break them down into smaller manageable teaching units in order to teach for mastery.

Keywords: *Mathematics, performance, , retention, change of subject formula, mastery-based learning.*

Date of Submission: 16-08-2020

Date of Acceptance: 02-09-2020

I. Introduction

Hierarchy of concepts is one feature of Mathematics. Mathematical concepts are numerous and are not isolated in any way. Concepts and ideas in Mathematics are built upon each other. The complex concepts are developed by using elementary ideas as foundations. This may suggest why one of the principles of teaching and learning Mathematics is to always assess what students already know since what they already know enhances the understanding of higher order Mathematics concepts (Sullivan, 2014; Hufford, 2017; Tang, Tsai & Huang, 2020). For instance, the knowledge of change of subject formula forms the foundation for manipulating with mathematical formulae, the knowledge of solving linear equations forms the foundation for solving simultaneous and quadratic equations. The knowledge of properties of geometrical shape forms the foundation for solving problems related to perimeter, areas and volumes. The knowledge of cartesian coordinate forms the foundation for plotting graphs.

The hierarchical nature of Mathematics implies a sequential order of concepts from lower to higher. Therefore, to understand a particular concept in Mathematics, students have to understand and master the lower or prerequisite concepts. Lower order concepts must be understood before higher order concepts are communicated to the students. The order of hierarchy is more in Mathematics than any other subject. One cannot apply change of subject formula without really mastering the rudiments of the concepts such as inverse operation, balancing of equations and directed numbers. Ukpo (2016) posited that there should be a clear explanation on the difference between basic and secondary mathematical concepts. The concept of prerequisite skills or knowledge for any topic is also very important in Mathematics because it enhances concept formation.

The mastery of all the sub topics in change of subject formula that prepare them for the application in other areas of Mathematics and other school subjects is very crucial. This is because the concept mastery of change of subject formula has to be formed to a higher understanding before its application can be achieved. The concept formation in change of subject formula is a predictor of its application. When students are taught mathematical concepts for mastery it boosts the development of the schema responsible for mathematical

concept formation and manipulation. It is therefore the responsibility of the Mathematics teachers in the midst of all odds to ensure that they employ appropriate teaching method to prepare students for mastery of mathematical concepts. Mathematics is regarded as a peculiar subject because it deals with mental activity which consists of carrying out, one after the other, those mental construction which are inductive and effective. To achieve this effective mental construction, every user of Mathematics has to use formula or equations. This may suggest why Kaucci (2019) stated that equations are the life line of Mathematics, be it pure Mathematics or applied Mathematics. Mathematics lends its use to the solving of real life problems. Solving real life problems mathematically requires the translation of such problems into mathematical models otherwise known as formula.

A mathematical formula is a group of mathematical symbols that expresses the relationship which exist between the various variables in the formula. This implies that a formula is used to solve problems mathematically. A formula according to Garuba (2010) is an equation that links sets of physical quantities. In all real life situations, formula forms the basis for calculations. Formulae are used in sciences (physics, chemistry, biology, engineering), traffic control, government and taxes, business, internet searching, finance, marketing, agricultural, music, religious sector et cetera. In solving problems with formulae, there arises a situation when the problem solver has to make some rearrangement of the terms in the formula to reduce complexity. This venture is called change of subject of the formula. This implies every formula possess the facility of been rearranged by obeying the principles of balancing equation. Nwachukwu (2006) posited that once students have a strong understanding of the fundamental properties of mathematical formulae, they can begin to confidently apply this knowledge to more complex problems related to equations.

Change of subject formula is used by everyone who uses mathematical formula to solve problems. This is because formula and change of subject formula are intertwined. Hence the inclusion of the topic "change of subject formula" in the Mathematics curriculum. The rules of inverses are the tips that govern how to change the subject of a formula. The rules of inverses are very important when changing the subject of a formula. This may suggest why Rulu (2013) emphasized that these rules of inverses are pre requisite to students understanding of change of subject formula. Mathematics is a compulsory subject in secondary schools and students are expected to learn how to change subject of a formula in the Mathematics class. This topic is very central to all problem solvers within and outside the realm of Mathematics. Given that formulae are used in all branches of pure and applied Mathematics, it therefore becomes imperative that change of subject formula be taught in schools with a level of mastery. The nature of Mathematics includes abstraction, estimation, approximation, calculation, visualization, hierarchy of concepts, deduction, induction and symbolism. Teaching for mastery of mathematical concepts involves the breaking down of the bulky Mathematics units into smaller topics that can be taught and managed by the teacher.

Collins (2014) defined mastery-based learning as an instructional strategy which is based on the premise that students achieve a high level of understanding in a given domain before moving to the next level. Mathematics comprise of so many concepts which are interrelated in a hierarchical manner. Concept mastery in Mathematics despite its pros and cons has helped to improve students' understanding of higher order concepts in Mathematics (Nwachukwu, 2018). Mastery of mathematical concepts such as change of subject formula places students in a position to solve problems that are connected with formulae and equations successfully. Mastery of concepts in Mathematics has to do with the breakdown of a bulky curriculum unit in simple manageable units.

The research finding of Tukur (2018), Batta and Mumuni (2017), Adebiji, Ameen, Dambatta and Orilonise (2018) revealed that students who were taught Mathematics concepts using MLA had a higher performance mean score that those taught using the traditional teaching approach. The result also showed that there was a significant difference between the Mathematics performance of students in the experimental and control groups. Giricho (2018) investigated the retention of students when taught mathematics with mastery-based instructional strategy and found that the male students who were taught Mathematics using mastery-based instructional approach performed academically higher than their female counterparts in the same group and there was no significant difference in the performance of the male and female students taught with MLA. However, the finding of Lawal (2011) revealed that the female students out performed their male counter part and that there was a significant difference between the male and the female students in the experimental group. The research findings of Toheed, Ali and Jabeen (2017); Adebiji, Ameen, Dambatta and Orilonise (2018); Giricho (2018) revealed that students' retention was enhanced better amongst the group that was taught using mastery-based instructional strategy than those taught using the traditional approach.

Mathematics teachers who are the classroom implementers of the Mathematics curricula tend to shallowly teach change of subject formula in a hurry and move into other aspects without actually breaking down this topic into sub-units to pave way for mastery of the concept. Teaching change of subject formula has sub topics such as formulae with integers, brackets, powers, roots and fractions. Handling all these in just one instructional session may not yield mastery of the concept of change of subject for application in other areas of Mathematics or Mathematics related disciplines. It is based on this backdrop that this study sought to investigate

the effect of mastery-based learning on the performance of junior secondary students in the change of subject formulae.

Specification of the Problem

The subject matter of Mathematics deals with a lot of mathematical concepts. These mathematical concepts are built in hierarchical order. This implies that the teaching of mathematical concepts should be carried out in such a way that students reach a mastery level of the concepts before moving to the next level. Change of subject formulae is a topic in Mathematics that is very crucial to the understanding of many other concepts in Mathematics and other Mathematics related disciplines. It is a topic that boosts students understanding of any problem that involves equation. Change of subject formulae lesson unit in Mathematics which has so many sub-units to delve into for students to really come to terms with the intricacies of the topic. Changing subject of a formula show cases in a variety of forms. It may come in form of rearranging formula with brackets, powers, roots, fractions or harder questions which are multifaceted. Most times students are presented with formulae in different areas of Mathematics. They are therefore required to solve the various mathematical problems related to the formulae. Thus, change of subject formulae as a topic forms a unit in Mathematics. It has been observed by the researcher that many students do not completely succeed in Mathematics problem solving due to lack of knowledge on how to make a given term of an equation its subject. The researcher begins to wonder if this lack of knowledge to change the subject of a formula by students could be due to non mastery of the concept. This study therefore, was set out to investigate the effect of Mastery-based Learning Approach (MLA) on the performance of junior secondary students in the change of subject formulae.

Objectives of the Study

1. Determine whether any difference exist in the academic performance mean scores of students taught change of subject formulae using the mastery-based learning approach and those taught using the non mastery-based learning approach.
2. Ascertain if any difference exist in the academic performance mean scores of the male and the female students taught change of subject formulae using the mastery-based learning approach.
3. Find out whether there is any difference in the retention mean scores of students taught change of subject formulae using the mastery-based learning approach and those taught using non mastery-based learning approach.

Research Questions

The three research questions posed below were answered.

Research Question 1: What is the difference in the academic performance mean scores of students taught change of subject formulae using the mastery-based learning approach and those taught using non mastery-based learning approach?

Research Question 2: What difference exist in the academic performance mean scores of the male and the female students taught change of subject formulae using the mastery-based learning approach?

Research Question 3: What is the difference in the retention mean scores of students taught change of subject formulae using the mastery-based learning approach and those taught using non mastery-based learning approach.

Hypotheses

Hypotheses were tested at .05 alpha level.

H₀₁: There is no significant difference between the academic performance mean scores of students taught change of subject formulae using the mastery-based learning approach and those taught using non mastery-based learning approach.

H₀₂: There is no significant difference between the academic performance mean scores of the male and the female students taught change of subject formulae using the mastery-based learning approach.

H₀₃: There is no significant difference between the retention mean scores of the students taught change of subject formulae using the mastery-based learning approach and those taught using non mastery-based learning approach.

II. Materials and Method

Research Design

This study employed the pretest-posttest intact class quasi-experimental research design. Fig 1 shows the experimental outline that was used to conduct the experiment.

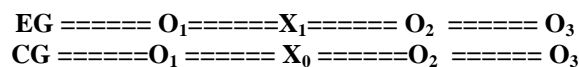


Fig 1 Experimental Outline

Where:

- EG = Experimental Group (Use of Mastery-Based Approach)
- CG = Control Group (Use of Non Mastery-Based Approach)
- O₁ = Pre test (Test given before the treatment)
- X₁ = EG Treatment (Taught with Mastery-Based Approach)
- X₀ = CG Treatment (Taught with Non Mastery-Based Approach)
- O₂ = Post test (Test given after treatment)
- O₃ = Post posttest (Test given after posttest)

Population of the Study

A total of 7,428 government owned junior secondary school three (JSS3) students in Port Harcourt Local Government Area of Rivers State made up the study.

Sample and Sampling Technique

The sample for this study consisted of all the one hundred and eight (108) students in the two sampled intact classes. Two schools were drawn using the simple random sampling technique. Two schools were first drawn, followed by the assignment of experimental group and control group to each of the school. The third random selection was done by drawing from each school an intact class of JSS 3.

Instrument for Data Collection

The instrument used to collect data was titled “Change of Subject Formula Mathematics Achievement Test” (CSFMAT). This instrument was developed by the researcher with test items emanating from the recommended reference material, New General Mathematics for JSS 3 and Mathematical Association of Nigeria (MAN) Mathematics for JSS 3. CSFMAT was made up of sections A and B. Section A contained the bio-data of the sample students while section B was made up of twenty five (25) multiple choice test items on change of subject formula. Each multiple test item in CSFMAT had four options labelled A to D of which there were three incorrect answers and only one correct answer. Each correct answer in the multiple choice test part was awarded 4 marks and each wrong answer was awarded zero mark. The total score for CSFMAT was 100%. A table of specification was prepared using Bloom’s revised version of the educational cognitive taxonomy. A marking guide/scheme was also prepared for the marking of CSFMAT.

Table 1: Table of Specification for Change of Subject Formula Mathematics Achievement Test (CSFMAT).

| S/N | Topic | Remembering (16%) | Understanding (28%) | Applying (20%) | Analysing (20%) | Evaluating (16%) | Total (100%) |
|-----|---------------------------------------|-------------------|---------------------|----------------|-----------------|------------------|--------------|
| 1. | Change of subject with integers (20%) | 1 | 2 | - | 1 | 1 | 5 |
| 2. | Change of subject with brackets (20%) | 1 | 2 | - | 1 | - | 5 |
| 3. | Change of subject with powers(20%) | - | - | 2 | 2 | 1 | 5 |
| 4. | Change of subject with roots(20%) | 2 | 2 | 2 | - | - | 5 |

| | | | | | | | |
|----|---------------------------------------|---|---|---|---|---|----|
| 5. | Change of subject with fractions(20%) | - | 1 | 1 | 1 | 2 | 5 |
| | Total (100%) | 4 | 7 | 5 | 5 | 4 | 25 |

Validation of the Instrument

The instrument CSFMAT was subjected to both face and content validation by two experts in Mathematics education. The review made by the experts was employed to modify the instrument before administering to the sample.

Reliability of the Instrument

Kuder Richardson Formula 20 (KR-20) was used to establish a reliability index of 0.83 for CFSMAT.

Method of Data Collection

Three lesson plans on the subtopics on change of subject formula were prepared for the experimental group while one lesson plan on the topic change of subject formula was prepared for the control group. The lessons prepared for the experimental group was taught using mastery-based instructional approach while lesson prepared for the control group was taught using the non mastery-based teaching approach.

The regular intact class Mathematics teachers carried out the teaching. These regular Mathematics teachers of the sample students were briefed by the researcher for two (2) consecutive days on how to conduct the teaching using the researcher constructed lesson plans. The teachers were also monitored during the teaching session to make sure the teaching session was in accordance with the expected procedure.

A pre CSFMAT was given to students before the commencement of teaching. The difference in the two groups was the breakdown of the topic into manageable subtopics for the experimental group and the bulky teaching of the topic change of subject formula without breakdown for the control group. After the experiment, a post CSFMA which was re-shuffled were given to the two groups. The students' scripts for both pretest and posttest were marked, scored in percentages. To ascertain the effect of use of mastery-based approach on retention, the same CSFMAT was administered to the sample as post posttest after a period of four (4) weeks. This was also marked and scored in percentages.

Method of Statistical Analysis

Mean, standard deviation and Analysis of Covariance (ANCOVA). were used for statistical analysis respectively at a probability level of.05.

III. Results

Table 2: Mean and standard deviation on the difference in the performance of students taught change of subject formulae using the mastery-based learning approach and those taught using non mastery-based learning approach

| Pre-test Group | N | Post-test | | Gain | | | |
|----------------|----|-----------|-------|-------|-------|-------|-------|
| | | Mean | SD | Mean | SD | Mean | SD |
| EG | 56 | 32.41 | 14.27 | 62.95 | 16.06 | 30.54 | 16.67 |
| CG | 43 | 32.21 | 12.50 | 42.44 | 14.65 | 10.23 | 8.23 |

Table 2 presents the mean and standard deviation on the difference in the performance of students that were taught change of subject formula with mastery-based learning approach and those that were taught without mastery-based learning approach. The table showed that the students taught change of subject formulae using mastery-based learning approach had a mean gain performance of 30.54, SD = 16.67 whereas those taught using the non mastery-based learning approach had a mean gain performance of 10.23, SD=8.23.

Table 3: Mean and standard deviation on the difference between the performance of the male and the female students taught change of subject formula using mastery-based learning approach.

| Pre-test Sex | N | Post-test | | Gain | | | |
|--------------|----|-----------|-------|-------|-------|-------|-------|
| | | Mean | SD | Mean | SD | Mean | SD |
| Male | 25 | 35.00 | 13.99 | 66.80 | 13.22 | 31.80 | 16.70 |
| Female | 31 | 30.60 | 14.37 | 59.84 | 17.63 | 29.52 | 16.85 |

Table 3 presents the mean and standard deviation on the difference between the performance of the male and the female students taught change of subject formula in the experimental group using the mastery-based learning approach. The presentation in table 3 revealed that the male students who were taught change of subject formulae had a mean gain performance of 31.80, SD = 16.70 while their female counterpart had a mean gain performance of 29.52, SD=16.85

Table 4: Mean and standard deviation on the difference in the retention of students taught change of subject formulae using the mastery-based learning approach and those taught using non mastery-based learning approach

| Group | Post-test | | Retention | | Gain | | | |
|-------|-----------|-------|-----------|-------|-------|-------|-------|--|
| | N | Mean | SD | Mean | SD | Mean | SD | |
| EG | 56 | 62.95 | 16.06 | 81.38 | 15.28 | 18.43 | 17.24 | |
| CG | 43 | 42.44 | 14.65 | 50.42 | 13.70 | 7.98 | 10.81 | |

Table 4 presents the mean and standard deviation on the difference in the retention of students that were taught change of subject formula with mastery-based learning approach in the experimental group and those that were taught without mastery-based learning approach in the control group. The table showed that the students taught change of subject formulae using mastery-based learning approach had a retention of 18.43, SD = 17.24 whereas those taught using the non mastery-based learning approach had a retention of 7.98, SD=10.81.

Table 5: Summary of ANCOVA on the difference between performance of students taught change of subject formula using the mastery-based learning approach and those taught using non mastery-based learning approach.

Dependent Variable: POSTTEST

| Source value | Type III Sum of Squares | df | Mean Square | F | p- |
|-----------------|-------------------------|----|-------------|-------|-----|
| Corrected Model | 17568.06 ^a | 2 | 8784.03 | 53.15 | .00 |
| Intercept | 14760.25 | 1 | 14760.25 | 89.31 | .00 |
| PRETEST | 7341.66 | 1 | 7341.66 | 44.42 | .00 |
| GROUP | 10097.08 | 1 | 10097.08 | 61.09 | .00 |
| Error | 15865.78 | 96 | 165.26 | | |
| Total | 322550.00 | 99 | | | |
| Corrected Total | 33433.83 | 98 | | | |

a. R Squared = .525 (Adjusted R Squared = .516)

Table 5 presents the summary of ANCOVA on the difference between the performance of students taught change of subject formulae using the mastery-based learning approach in the experimental group and those taught using non mastery-based learning approach in the control group. The result showed that there was a significant difference between the performance of students taught change of subject formulae using the mastery-based learning approach in the experimental group and those taught using non mastery-based learning approach in the control group (F1, 96=61.09, p = 0.00<.05). Since the p-value was less than .05 probability level, H₀₁ was therefore rejected.

Table 6: Summary of ANCOVA on the difference between the performance of the male and the female students taught change of subject formulae using the mastery-based learning approach.

Dependent Variable: POSTTEST

| Source value | Type III Sum of Squares | df | Mean Square | F | p- |
|-----------------|-------------------------|----|-------------|-------|-----|
| Corrected Model | 2613.87 ^a | 2 | 1306.93 | 5.98 | .01 |
| Intercept | 21152.75 | 1 | 21152.75 | 96.85 | .00 |
| PRETEST | 1943.22 | 1 | 1943.22 | 8.89 | .00 |
| SEX | 334.75 | 1 | 334.75 | 1.53 | .22 |
| Error | 11574.97 | 53 | 218.39 | | |
| Total | 236075.00 | 56 | | | |

Corrected Total 14188.84 55
 a. R Squared = .184 (Adjusted R Squared = .153)

Table 6 presents the summary of ANCOVA on the difference between the performance of the male and the female students taught change of subject formulae using the mastery-based learning approach in the experimental group. The result showed that there was no significant difference between the performance of the male and the female students taught change of subject formulae using the mastery-based learning approach in the experimental group ($F_{1, 53}=1.53, p = .22>.05$). Since p-value was greater than .05 probability level, H_{02} was therefore retained.

Table 7: Summary of ANCOVA on the difference between the retention of students taught change of subject formulae using mastery-based learning approach and those taught using non mastery-based learning approach.

| Dependent Variable: POST- POSTTEST | | | | | | |
|------------------------------------|-------------------------|----|-------------|--------|-----|--|
| Source | Type III Sum of Squares | df | Mean Square | F | p- | |
| Corrected Model | 9386.62 ^a | 2 | 4693.31 | 236.01 | .00 | |
| Intercept | 999.89 | 1 | 999.89 | 50.28 | .00 | |
| Treatment | 574.81 | 1 | 574.81 | 28.91 | .00 | |
| Posttest | 8145.29 | 1 | 8145.29 | 409.59 | .00 | |
| Error | 2406.25 | 96 | 19.89 | | | |
| Total | 559620.00 | 99 | | | | |
| Corrected Total | 11792.87 | 98 | | | | |

a. R Squared = .796 (Adjusted R Squared = .793)

Table 7 presents the summary of ANCOVA on the difference between the retention of students taught change of subject formulae using the mastery-based learning approach in the experimental group and those taught using non mastery-based learning approach in the control group. The result showed that there was a significant difference between the retention of students taught change of subject formulae using the mastery-based learning approach in the experimental group and those taught using non mastery-based learning approach in the control group ($F_{1, 96}=28.91, p = .00<.05$). Since the p-value was less than .05 probability level, H_{03} was therefore rejected.

IV. Discussion of Findings

Performance of students taught change of subject formula using mastery-based learning approach and those taught using non mastery-based learning approach

The result showed that the students taught change of subject formula with mastery-based approach had a mean gain performance of 30.54, $SD=16.67$ while those taught with the non mastery-base approach had a mean gain performance of 10.23, $SD=8.23$. The students that were taught change of subject formula with mastery-base approach had a higher mean gain than those that were taught with the non mastery-base approach. When put to statistical test the result showed that there was a significant difference between the performance of students taught change of subject formulae using the mastery-based learning approach in the experimental group and those taught using non mastery-based learning approach in the control group ($F_{1, 96}=61.09, p = 0.00<.05$). This led to the rejection of H_{01} . This difference which was significant must have been as a result of the time the students in the experimental group embarked upon to master the various rudiments of change of subject formula. The mastering of the rudimentary aspect enhanced students' performance in their ability to successfully tackle both simple and harder or multi-faceted exercises on change of subject formula. This finding is in agreement with the findings of Tukur (2018) and Batta and Mumuni (2018) which revealed that students taught Mathematics concepts with mastery teaching approach performed better than their counterparts that were taught same Mathematics topics with the traditional teaching method and also there was a significant difference between the performance of students in the experimental and the control groups.

Performance mean scores of the male and the female students taught change of subject formula using mastery-based learning approach

The result showed that the male students taught change of subject formula with mastery-base approach had a mean gain performance of 31.80, $SD=16.70$ while the female students had a mean gain performance of 29.52, $SD=16.85$. The female students out performed their male counterpart in the experimental group. This is

in agreement with the finding of Giricho (2018) which showed that the female students that were taught Mathematics concepts with mastery learning approach out performed their male counterparts. When put to statistical test, the result showed that there was no significant difference between the performance of the male and the female students taught change of subject formulae using the mastery-based learning approach in the experimental group ($F_{1, 53}=1.53, p = .22 > .05$). HO₂ was therefore retained. This finding agrees with those of Nwokolo and Apaokwu (2016), Adebiji, Ameen, Dambatta and Orilonise (2018) and Giricho (2018) whose findings also showed that gender had no significant effect on the academic performance of students who were taught Mathematics for concept mastery.

Retention ability of students taught change of subject formula using mastery-based learning approach and those taught using non mastery-based learning approach

The finding with respect to retention for the students in the experimental and control groups showed that the students taught change of subject formula with mastery-based approach had a mean retention of 18.43, $SD=17.24$ while those taught with non mastery approach had a mean retention of 7.98, $SD=10.81$. When put to statistical test the result showed that there was a significant difference between the retention of students taught change of subject formulae using the mastery-based learning approach in the experimental group and those taught using non mastery-based learning approach in the control group ($F_{1, 96}=28.91, p = .00 < .05$). This is in agreement with Toheed, Ali and Jabeen (2017), Adebiji, Ameen, Dambatta and Orilonise (2018) and Giricho (2018) whose findings showed that there was a significant difference between the retention mean score of students taught Mathematics concept such as circle geometry with mastery-based learning approach and those taught with non mastery-base learning approach.

V. CONCLUSION

The use of the mastery-based teaching approach to teach change of subject formula was more effective at improving students' performance and retention than the non mastery-based teaching approach. However, it was found that there was no significant difference between the male and the female students' performance in the mastery-based approach group. This study concluded that the use of mastery-based approach to teach change of subject formula made students to master the fundamental mathematical concepts which paved way for the next level learning of use of solving harder exercises encountered in change of subject formula.

VI. RECOMMENDATIONS

Based on the findings of the study the following recommendations were made:

1. Mathematics teachers should endeavour to employ the mastery-based teaching approach to teach Mathematics concepts.
2. Mathematics teachers should also endeavour to identify the Mathematics concepts that are bulky so as to break them down into smaller manageable teaching units.
3. The in-service training of Mathematics teachers should be embarked upon to boost their innovative teaching strategies.

References

- [1]. Adebiji, S.M., Ameen, S.K., Dambatta, B. U. & Orilonise, R. (2018). Effect of mastery learning approach on senior school students' academic performance and retention in circle geometry. *International Journal of Instruction*, 11(4), 951-962.
- [2]. Batta and Mumuni (2017) investigated the effect of using mastery learning instructional strategy on junior secondary school students' performance in the learning of linear equations. *Journal of Education and Instruction*, 8(5), 247-255.
- [3]. Collins, Z. (2014). *Mathematics teaching and learning in colleges*. Hohoe: Havillah Printing Press.
- [4]. Garuba, B.B. (2010). Early mathematics education: Characteristics of conceptual understanding of equations. In: Prefacto, J. (Ed). *Conceptual teaching of mathematics in schools*. Uyo: Churchill Publications.
- [5]. Giricho, T. (2018). Effect of concept mastery on students' achievement in Mathematics. *Journal of Instructional Development*, 6(5), 78-90.
- [6]. Hufford, E. (2017). Hierarchy of skills for effective mathematics intervention. Retrieved online from prezi.com/mvnrcoolk.Swic/hierarchy-of-skills-for-effective-mathematics-intervention on 10/07/2020.
- [7]. Kaucci, L.A. (2019). *Activation of Indicial equations in mathematics teaching and learning*. Kaduna: Venzilla Press.
- [8]. Lawal, D. V. (2011). Effects of mastery learning instructional approach on students' computational skill in mathematics. *International Journal of Computational Innovation*, 1(8), 20-34.
- [9]. Nwachukwu, O. I. (2006). Impact of formulae re arrangement on students problem solving skills in mathematics. *International Journal of Science Development*, 2(2), 18-25.
- [10]. Nwachukwu, O.I. (2018). *Teaching mathematics professionally in the classroom*. Aba: EcoGoz Ventures.
- [11]. Nwokolo, J.N. & Apaokwu, C. (2016). Concept mastery and students' performance in mathematics and further mathematics. *Journal of Science Research Innovation*, 4(1), 76-81.
- [12]. Rulu, G.A. (2015). Adaptive metacognition of students' application of mathematical equation to solving real life problems in industries. *Teacher Education and Development Policy*, 26, 237-251.
- [13]. Sullivan, P. (2014). Six principles of effective teaching of mathematics. Retrieved online from www.slideshare.net/aamtinc/six-principles-of-effective-teaching-of-mathematics on 08/08/2020.

- [14]. Tang, W., Tsai, J. & Huang, C. (2020). Inheritance coding with Gagne-based learning hierarchy approach to developing mathematics skills assessment system. Retrieved online from <https://doi.org/10.3390/app10041465> on 25/04/2020.
- [15]. Toheed, L., Ali, A.R. & Jabeen, F. (2017). The effect of mastery learning strategy on learning retention of secondary school students in the subject of mathematics. Retrieved online from www.semantic.scholar.org/paper on 12/12/2019.
- [16]. Tukur, M.Y. (2018). Mastery learning approach: Its effects on the students' mathematics academic achievement. Retrieved online from <http://doi.org/10.5281/zenodo.1227280> on 17/09/2019.
- [17]. Ukpo, J. (2016). Understanding mathematical basic and secondary concepts. *Journal of Readings in Mathematics Education*, 2 (1), 52-71.

GEORGE, Nchelem Rosemary (Ph.D). "Mastery-Based Learning Approach and Junior Secondary Students' Performance and Retention in Change of Subject Formula." *IOSR Journal of Research & Method in Education (IOSR-JRME)*, 10(4), (2020): pp. 18-26.