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Effects Of Lattice Model On Performance And Retention In Long Multiplication Solution Process Among Pupils In Dutsin-Ma Local Education Authority, Katsina State, Nigeria

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Abstract

This study was carried out to determine the effect of lattice model on performance and retention in long multiplication solution process among pupils in Dutsin-Ma Local Education Authority (LEA), Katsina state, Nigeria. The design of the study was quasi-experimental employing pretest, posttest, post-posttest design. The population of the study comprises all primary five (5) pupils in eighty seven (87) schools of the LEA whose number is eight thousand and eighty two (8,082) made up of four thousand and fifty two (4,052) males and four thousand and thirty (4,030) females. Six intact classes from four out of seven Area Offices of the LGEA were selected for treatment which lasted for six weeks. Two instruments were used to generate data. Long Multiplication Performance Test (LMPT) and the Teaching Package Model. The LMPT was validated by a panel of experts; two from Federal University Dutsin-Ma and a primary school teacher with BSc (Ed) Mathematics qualification and 15 years teaching experience. The test was pilot tested and reliability established through test retest method with two weeks interval. Reliability coefficient (r) was calculated using Pearson Product Moment Correlation Coefficient formula with r = 0.77. The experimental group was taught using lattice model while the control group was taught using conventional method. Data collected were analysed using t-test statistic. The result revealed; (a) significant difference in the mean performance score between pupils taught with lattice model and those taught with conventional method, (b) no significant difference between mean academic performance scores of male and female pupils taught long multiplication solution process using lattice model, (c) significant difference between mean retention score of pupils taught long multiplication solution process using lattice model and those taught the same concept using conventional method and (d) no significant difference between mean retention score of male and female pupils taught long multiplication using lattice model. Sequel to these findings, it is recommended that, teachers in experimental schools share the idea of the use of lattice model in long multiplication solution process among their colleagues.

Introduction

The future of the citizens of any country in today's global, competitive, and knowledge driven societies depend upon the educational system that builds knowledge, skills, competencies and desired behaviours required for optimizing the quality of human capital and increasing economic growth. It is through education that scientific literacy is acquired which is essential for stimulating amiable environment for creating new knowledge, discovery and innovation. In all human societies, particularly the modern ones, education remains one of the most powerful instruments for both the development of man and transformation of the human society (Hyatt actions, 2017). All over the world, primary education has been regarded as the most important as well as the most patronized by people. This perhaps may be due to the fact that it is the foundation of the whole educational pursuit, which is expected to provide literacy and enlightenment to citizens.

A careful perusal of the goals of primary education reveals that mathematics is essential for the achievement of most of them. The importance attached to mathematics in school curriculum at all levels of our education system accurately reflects the role of the subject in society as asserted by Thomas (2018) that mathematics is so important to the extent that without its knowledge there may be no development in Nigeria. However, in spite of the importance of primary education, its quality in general and that of mathematics at primary level in particular falls short of being satisfactory regarding pupils' performance and retention. While performance is seen by Williams (2018) more as an aggregate of several factors that indicate a student's success, retention as defined by Frost (2019) is the persistence to perform a learned behavior (facts or experiences) after an interval has elapsed in which there has been no performance or practice of the behavior. Researchers like Kajuru and Kauru (2014) found that activity based learner-centred approaches yields statistically significant differences in achievement and retention over conventional method. Pupils' fortunes in respect of performance and retention in mathematics

fall short often. Not much of a surprise that pupils' performance in mathematics at the unity school exams for the years 2010-2016 has not been heartwarming as the percentage of pupils who scored between 51% and 100% in mathematics were respectively 23.67, 24.47, 24.39, 39.06, 34.15 and 49.14 (Ayinde & Folorunso, 2018). Similarly, Ugwanyi (2016) reported that extent of achievement has to do with degree of retention and retention is measured in collaboration with achievement.

Researches concerning gender continued to attract attention as it has remained inconclusive. In the light of the importance of gender, elimination of gender inequality at all levels of education by 2015 is part of the agenda in the Millennium Development Goals (MDGs) proposed by the United Nations in September, 2000. Gender has continued to be a topic of interest in educational research for long and in mathematics it has become a subject of conflicting findings. Alio and Okafor (2018) in their study on 'Effects of Some Mathematical Games on Primary School Pupils' Achievement and Interest in Mathematics in Anambra State' carried out in Otuocha and Onitsha education zonesinvolving one hundred and sixty-two (162) primary five pupils found that there was no significant difference between the mean achievement and interest scores of pupils taught with the mathematical games based on sex and location. However, typical with back and forth nature of research findings regarding gender however, Obasi, Ogbonna and Ezekwe (2018) in their investigation on 'Observations on Growth Rates of Male and Female Students' Susceptibility to Harmful Einstellung Effect in Mathematics Instruction' involving a cross-section of secondary school students in Owerri Metropolis numbering 640 (283 females and 357males) who were continuously observed within the space of 31 days. 81 students were found to have developed Einstellung phenomenon (54 female and 27 male). The study found increasing susceptibility to harmful Einstellung effect in mathematics instruction for female students to be 83.9% while that of males is 67.4% showing that female students are experiencing harmful Einstellung effect more than their male counterparts.

Long multiplication (or column multiplication) is a written method of multiplying numbers (usually a two- or three-digit number by another large number). The lattice method according to Goodman (2018) is an alternative to long multiplication for numbers. In this approach, a lattice is first constructed, sized to fit the numbers being multiplied. If we are multiplying an m-digit number by an n-digit number, the size of the lattice is $m \times n$. The multiplicand is placed along the top of the lattice so that each digit is the header for one column of cells (the most significant digit is put at the left). The multiplier is placed along the right side of the lattice so that each digit is a (trailing) header for one row of cells (the most significant digit is put at the top). Lattice provides a refreshing break from the conventional method use. Most teachers utilized the paper-and-pencil strategy combined with the concepts-operations-example-drilling approach which is a too mechanistic way of teaching. There are occasions when children struggle when they have to do a transition from subtraction and addition to multiplication and division.

Statement of the Problem

There is widespread dissatisfaction over primary and secondary school leavers' level of development of literacy, numeracy and mental computational skills nowadays. The trend questions in serious terms whether the goals of primary education are being achieved. This development spells danger of immense proportion as primary education is the foundation upon which other subsequent levels of education can effectively be built. In addition**,** as numbers and basic operations are cells of the organism of mathematics and most teachers utilized the paper-and-pencil strategy combined with drilling approach which is referred to as mechanistic way of teaching, in many occasions pupils struggle when they have to do a transition from the subtraction and addition to multiplication and division. Similarly, Seah (2004) found that many school students demonstrated limited understanding of multiplication concepts, restricted to procedural [i.e. solely rule-based] rather than conceptual understanding. The researchers chose to focus on it in a way novel to popular classroom practice approach as a preparation for conquering the difficulty associated with learning long multiplication.

Objectives of the Study

The objectives of the study include:

1. To find out if Lattice model has effect on academic performance of pupils in long multiplication concept.
2. To examine the gender friendliness of Lattice model on academic performance among pupils in long multiplication concept.
3. Determining the effect of Lattice model on retention of pupils in long multiplication concept.

4. To examine the gender friendliness of Lattice model on retention among pupils in long multiplication concept.

Research Questions

The study answered the following questions:

1. What is the difference in the mean academic performance scores of pupils taught long multiplication using lattice model and those taught the same concept using conventional method?
2. What is the difference in the mean academic performance scores of male and female pupils taught long multiplication using lattice model?
3. What is the difference in the mean retention scores of pupils taught long multiplication using lattice model and those taught the same concept using conventional method?
4. What is the difference in the mean retention scores of male and female pupils taught long multiplication using lattice model?

Null Hypotheses

The following null hypotheses were formulated and tested at $p \leq 0.05$.

Ho_1: There is no significant difference in the mean academic performance scores of pupils taught long multiplication using lattice model and those taught the same concept using conventional method.

Ho_2: There is no significant difference in the mean academic performance scores of male and female pupils taught long multiplication using lattice model.

Ho_3: There is no significant difference in the mean retention scores of pupils taught long multiplication using lattice model and those taught the same concept using conventional method.

Ho_4: There is no significant difference in the mean retention scores of male and female pupils taught long multiplication using lattice model.

Significance of the Study

The findings of this study were envisaged to be useful as pupils may benefit when they discover a new and interesting model of handling long multiplication aside the age long column multiplication method. Again, primary school teachers will hopefully benefit and have variety in presenting long multiplication to their pupils and variety is said to be the spice of life. Also, Head teachers, being pedagogical leaders in their schools, would have an opportunity to learn and consider the feasibility of adopting the new model in their schools. Moreover, Staff of Quality Assurance unit of the Local Education Authority (LEA) would be availed the opportunity to assess the effectiveness of the new model and possibly consider popularizing it among schools.

Similarly, concerned members of School Based Management Committees (SBMCs) may benefit as they care for the education of their children and likely support, encourage and counsel them about the new model in the course of assignments and home work. In addition, education and curriculum planners may benefit from the study consider the new model and make advocacy for its use in schools. Finally, professional bodies like Mathematical Association of Nigeria (MAN) and Mathematics Panel of Science Teachers Association of Nigeria (STAN) will hopefully benefit from the study and in their annual conferences and workshops may consider show casing lattice model if its effect is spectacular.

Methodology

This study adopted quasi-experimental design employing pretest, posttest and post posttest control group design. The study used two groups of primary five pupils (drawn randomly initially from six schools located in four out of seven Area Offices of the LEA using intact classes) - experimental and control groups. Both groups were pretested (O_1) on their knowledge of multiplication to establish similarity in ability before the administration of treatment. Sequel to the pretest two schools were excluded from the study on the account of statistically significant higher academic performance. The remaining four equivalent schools were randomly assigned in to experimental and control groups. The two groups were taught long multiplication for a period of six weeks. The experimental group was taught using lattice model (X_1) while the control group was taught using the conventional vertical arrangement place value method (X_0). Posttest (O_2) was administered after treatment to determine the effect of lattice model on academic performance of pupils. Again, post posttest (O_3) was re-administered after two weeks interval to ascertain the effect of lattice method on retention among pupils.

The research design is illustrated in figure 1 below:

$$\begin{array}{lllllll} EG & \longrightarrow & O_1 & \longrightarrow & X_1 & \longrightarrow O_2 & \longrightarrow O_3 \\ CG & \longrightarrow & O_1 & \longrightarrow & X_0 & \longrightarrow O_2 & \longrightarrow O_3 \end{array}$$

Source: Adapted from Kerlinger (1973)

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Key: EG ≡ Experimental group, CG ≡ Control group,
O_1 ≡ Pretest on academic performance, O_2 ≡ Posttest on academic performance,
O_3 ≡ Post posttest on retention, X_1 ≡ Treatment (lattice model), and
X_0 ≡ Conventional method

Population of the Study

The population of the study comprised all public primary five (5) pupils in Dutsin-Ma LEA. The population of pupils is made up of four thousand and fifty two (4,052) males and four thousand and thirty (4,030) females summing up to eight thousand and eighty two (8,082). A summary of the population Area Offices is presented in table 2.

Table 2: Population of the Study by Area Offices

S/No	Area Office	Male	Female	Total
1	Bagaggadi	347	312	659
2	Dabawa	331	321	652
3	Dutsin-Ma	1,424	1,391	2,815
4	Karofi	565	669	1,234
5	Kuki	343	356	699
6	Kutawa	423	519	942
7	Makera	619	462	1,081
Total		**4,052**	**4.030**	**8,082**

Source: (Dutsin-Ma L.E.A, 2019)

Sample and Sampling Procedure

The sample size of this study consisted of one hundred and ninety eight (198) pupils (comprising 102 males and 96 females with 106 and 92 pupils in experimental and control groups respectively) from six coeducational primary schools in four Educational Areas of Dutsin-Ma LEA. Singh (2006) indicated that for experimental and quasi-experimental researches, a sample that will permit at least thirty subjects in each group is required.. Multi grade simple random technique through balloting was used to select the four Educational Areas. The results of the pretest were subjected to Analysis of Variance (ANOVA) test statistic. Result of the statistic indicated significant difference; as such Scheffe's post hoc test was used to exclude two schools.Two schools each were randomly assigned to experimental and control groups. Summary of sample is given by table 3.

Table 3: Sample of the Study

S/No	School	Type	Male	Female	Total	Group
1	School A	Co-educational	26	26	52	Experimental
2	School B	Co-educational	29	25	54	Experimental
3	School C	Co-educational	27	15	42	Control
4	School D	Co-educational	20	30	50	Control
Total			102	96	198	

Instrumentation

Two instruments were used to obtain the data of the study, they include:

1. Long Multiplication Performance Test (LMPT)
2. The Teaching Package Model

The researcher developed 4 items test on long multiplication selected from the standard test developed by National Examination Council (NECO) for National Common Entrance Examination (NCEE). The test items are not multiple choice objective type as pupils are expected to show the workings to enable the researcher ascertain the particular model or method used (lattice or conventional). The test consists a problem each on multiplication of: 2 digit numbers, 3 by 2 digit numbers, 3 by 3 digit numbers and a word problem on 3 by 2 digit numbers. In each of the above cases, the multiplicand and the multiplier exceed 12. A marking guide was developed for scoring the test along the steps of the solution process. 4, 5, 8 and 8 marks totaling 25 were distributed in the solution process of questions 1, 2, 3 and 4 respectively.

Table 3: Table of Specification of Long Multiplication Test Based on Bloom's Taxonomy

Topic	Weight (%)	Knowledge	Comprehension	Application
2 × 2 digit nos.	10	4	2	1

3 × 2 digit nos.	20	6	3	1
3 × 3 digit nos	30	9	4	1
Word problem	40	6	4	3

The instrument (Long Multiplication Performance Test) was pilot tested at Rawayau Model Primary School in an intact class of forty seven (41) pupils, a school in Kurfi Local Education Authority.

Validity: A panel of three experts went through to assess the face validity of the test whose items were selected from standard tests whose item difficulty and discrimination were certified to be appropriate for primary five; two from Faculty of Education, Federal University Dutsin-Ma and a primary school teacher with BSc (Ed) qualification and over 15 years teaching experience. Also, responses of pupils who participated in the pilot study were examined to determine the item difficulty and discrimination.

Reliability: test-retest method within two weeks interval was used to determine reliability. To obtain a reliability coefficient, scores from the two administrations were correlated using Pearson Product Moment Correlation Coefficient which yielded 0.77

The Teaching Package Model

For the purpose of this study, a teaching package was developed by the researcher. The package is a compilation of lesson plans on conventional place value partial algorithm and lattice method used by the researcher and two research assistants to ensure uniformity in lesson delivery. The content of the package covers numerous examples on long multiplication appropriate for primary 5 of the form; 2 digit numbers, 3 by 2 digit numbers, 3 by 3 digit numbers and a word problem on 3 by 2 digit numbers. In each of the above cases, the multiplicand and the multiplier are large numbers beyond multiplication table.

Data Analysis and Result Presentation

Academic performance and retention scores obtained after marking of posttest and post posttest were analyzed using Statistical Package for Social Sciences. The results are presented as follows:

Ho_1: There is no significant difference in the mean academic performance scores of pupils taughtlong multiplication using lattice model and those taught the same concept using conventional method

Table 4: t-test Analysis of Posttest Mean Academic Performance Scores of Experimental and Comparison Groups

Group	N	Mean	SD	t	DF	p
Experimental	106	15.42	2.398	9.288	196	.000
Comparison	92	12.34	2.240			
Total	198					

Significant at $P \leq 0.05$ significance level

Table 3 shows that, calculated p-value (.000) is less than the set p-value (.05), the null hypothesis is therefore rejected and it is concluded that, there is significant difference between mean academic performance scores of pupils taught long multiplication solution process using lattice model and those taught the same concept using conventional method.

Ho_2: There is no significant difference in the mean academic performance scores of male and female pupils taught long multiplication using lattice model.

Table 5: t-test Analysis of Posttest Mean Scores of Male and Female Pupils

Gender of the pupils	**N**	**Mean**	**SD**	**t**	**DF**	**p**
Male	102	13.94	3.061	-.226	196	.821
Female	96	14.03	2.464			
Total	**198**					

Not Significant at $P \leq 0.05$ significance level

Table 5 shows that, calculated p-value (.821) is greater than the set p-value (.05), the null hypothesis is therefore retained and it is concluded that, there is no significant difference between mean academic performance scores of male and female pupils taught long multiplication solution process using lattice model. It is noteworthy also; that the mean performance score of female pupils is slightly higher than that of male, though the difference is not significant.

Ho_3: There is no significant difference in the mean retention scores of pupils taught long multiplication using lattice model and those taught the same concept using conventional method

Table 6: t-test Analysis of Post Posttest Mean Retention Scores of Experimental and Comparison Groups

Group	N	Mean	SD	t	DF	p
Experimental	106	16.12	2.143	9.979	196	.002
Comparison	92	13.13	2.352			
Total	198					

Significant at $P \leq 0.05$ significance level

Table 6 shows that, calculated p-value (.002) is less than the set p-value (.05), the null hypothesis is therefore rejected and it is concluded that, there is significant difference between mean retention scores of pupils taught long multiplication solution process using lattice model and those taught the same concept using conventional method.

Ho_4: There is no significant difference in the mean retention scores of male and female pupils taught long multiplication using lattice model.

Table 7: t-test Analysis of Post Posttest Mean Retention Scores of Male and Female Pupils

Gender of the pupils	**N**	**Mean**	**SD**	**t**	**DF**	**p**
Male	102	15.94	2.231	-.316	196	.634
Female	96	15.18	2.411			
Total	**198**					

Not Significant at $P \leq 0.05$ significance level

Table 7 shows that, calculated p-value (.634) is greater than the set p-value (.05), the null hypothesis is therefore retained and it is concluded that, there is no significant difference between mean retention scores of male and female pupils taught long multiplication solution process using lattice model.

Summary of Findings

Following tests of hypotheses, the study found as follows:

1. There is significant difference between mean academic performance scores of pupils taught long multiplication solution process using lattice model and those taught the same concept using conventional method.
2. There is no significant difference between mean academic performance scores of male and female pupils taught long multiplication solution process using lattice model.
3. There is significant difference between mean retention scores of pupils taught long multiplication solution process using lattice model and those taught the same concept using conventional method.
4. There is no significant difference between mean retention scores of male and female pupils taught long multiplication solution process using lattice model.

Discussion of Results

The study investigated the effect of lattice model in the learning of long multiplication solution process on academic performance and retention among pupils in Dutsin-Ma L.E.A. Katsina state. Table 4 shows significant difference exists between mean academic performance scores of pupils taught long multiplication solution process with lattice model compared with those taught conventionally in favour of the former. This finding concur with National Assessment on Learning Achievement in Basic Education (NALABE) report 2013 that showed that; mathematics is one of the subject disliked in Primary schools for the reason that the subject is boring and teachers did not teach it well.

Table 5 shows that no significant difference between mean academic performance scores of male and female pupils taught long multiplication solution process using lattice model. The finding implies gender friendliness of the method at the same time countering finding of Samuelsson & Samuelsson (2016) research on performance in mathematics that highlighted a traditional gender gap in favour of boys. However, it concurs withLinn (2010) who reported that the gender gaps in mathematics are insignificant. It is noteworthy also; that the mean performance score of female pupils is slightly higher than that of male, though the difference is not significant. This finding agrees with Lubienski (2011) who reported that girls obtained slightly better grades in mathematics over the last four decades than boys. Again, Winthrop and King (2015) found that boys do better than girls in math and girls perform better in reading. Yet there is considerable variation in the size of these gender differences across countries.

Table 6 shows significant difference between mean retention scores of pupils taught long multiplication solution process using lattice model and those taught the same concept using conventional method. This finding seems to be in line with Enohuean (2015) who reported significant difference in the mean retention scores of students taught with instructional materials and those taught without instructional materials as lattice is a semi-concrete presentation. Also,Piaget (1968) pointed out that every normal student is capable of good mathematical reasoning if attention (and care) is directed to activities of his interest. Lattice model is capable of arousing learners' interest and is less rigorous than column multiplication method popular with teachers in the study area.
Table 7 shows no significant difference between mean retention scores of male and female pupils taught long multiplication solution process using lattice model. The finding agrees withEnohuean (2015) who reported that there is no significant difference in the retention ability of male and female students exposed to the use of instructional materials.

Conclusion

Based on the findings from this study, it is concluded that, use of lattice model in the solution process of long multiplication was found to have positive effect on pupils' academic performance, retention as well as gender friendliness. Hence, it is suggested that, its use be popularized in a bid to improve pupils' mastery of long multiplication in particular and their mathematics achievement in general.

Recommendations

In line with findings of this study and interactions with some stakeholders, the following recommendations are made.

1. Head and teachers I classroom teachers in the two schools where treatment was carried need to be in the vanguard of using and popularizing lattice method in contact sessions of Cluster Meetings they have at LEA headquarters fortnightly as the results of its impact on pupils' performance.
2. As pupils from experimental schools had been taking home work and assignment to their homes – requiring the use of a not so popular method, School Based Management Committee (SBMC) and Parent Teachers Association (PTA) members need to be informed about the method by the school.
3. Members of Quality Assurance Unit of the LEA need to be kept abreast by teachers and Head teacher of experimental schools about lattice method and its success in the study conducted for popularizing it in the LEA and beyond.
4. Nigeria Union of Teachers (NUT) chapter of the LEA need to be informed of the success of lattice method and its support solicited for popularizing it by LEA leadership.
5. Professional bodies be requested to conduct workshop on the method by NUT leaders.

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