
Montessori Teaching Approach and Primary School Pupils Achievement and Knowledge Retention in Mathematics

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Abstract

The study investigated Montessori approach of teaching with respect to primary school pupils' achievement in mathematics. The study was carried out in Ngor Okpala Local Government Area of Imo State using quasi-experimental research design adopting the pre-test post-test non-equivalent control type. A sample of 190 primary school pupils was selected for the study. Data required for the study was collected through researcher made objective test titled "Pupils Achievement in Mathematics (PAM)". It had reliability coefficient of 0.79 determined using Pearson's product moment correlation coefficient. The experiment group was taught mathematics using the Montessori approach while the control group was taught traditionally. The result of the study showed that Montessori approach improved primary school pupils' achievement in mathematics. Based on the result it was recommended that primary school teachers should apply the Montessori approach in teaching mathematics in primary schools to enhance pupils' achievement.

Keywords: Montessori approach, Pupils, Achievement, Mathematics, Nigeria.

INTRODUCTION

Mathematics is very vital and essential in science, technology and in everyday living. Hardly will a day pass without one encountering mathematical calculation in one way or the other e.g. in the markets, school, meeting, on the road and in the household activities (Azuka, 2003, as cited in Kurumeh & Mohammed, 2012). Butler, Charles and Lynwood (1970) in Komolafe, Yara and Omitogu (2015) defined mathematics as a very important tool that could be used for the understanding of science and technology and its application cuts across all areas of human endeavour. Mathematics is important for the understanding of basic science that is necessary for the understanding of most other school subjects (Fehr, 1996). Mathematics is the most versatile of all the science subjects, it is uniquely well placed to respond to the demands of a rapidly changing landscape. Mathematics has the opportunity more than ever before to under-pin quantitative understanding of industrial strategy and processes across all sectors of business. Mathematics builds the intellectual ability, thinking ability, problem solving ability and logical thought of an individual. When students are well placed in mathematics understanding, it improves their learning of other science subjects. Mathematics provides a powerful universal language and intellectual toolkit for abstraction,

generalization and synthesis. It is the language of science and technology. It enables us to probe the natural universe and to develop new technologies that have helped us control and master our environment, and change societal expectations and standards of living. Mathematics skills are highly valued and sought after, mathematics training disciplines the mind, develops logical and article reasoning and develops analytical problem solving skills to a high degree (Smith 2004).

The primary school is often considered most important period of a child's academic career. At this level of education, the child develops the right mathematics background required for further education. The pupils develop the positive attitude towards mathematics which enhances their understanding and appreciation of mathematics for proper functionality.

ACME (2008) suggested some aims for mathematics education in the primary years, these include:

- To develop children's mathematical attitude skills and understanding so that they can recognize and use mathematics in their own lives inside and outside school, for a variety of purpose;
- To enable children to gain enjoyment and doing mathematics and pleasure from their ability to use it to solve problems;
- To develop children's appreciation of the nature of mathematics, how it developed as part of society and how it used today in different ways in our culture and economy;
- To develop as far as possible children's mathematical skills and understandings and their positive attitude to mathematics, so that they can build on these functions in their learning of mathematics and subjects dependent on it at secondary level and throughout their lives.

The required mathematics background derivable from primary school education to sustain the student understanding of the subject has continued to be a mirage as a result of inappropriate instructional approaches employed in teaching mathematics by the teachers. Harbor-Peter (2001) in Kurumeh and Mohammed (2012) indicated that the use of inappropriate teaching method and lack of interest are among the factors responsible for incessant failure in mathematics. Mathematics knowledge is fundamental, but alas, it is poorly taught in elementary schools and ultimately mathematical performance remain down to mark leading towards lower ability of individuals in accordance with their actual abilities (Aikins, Duel & Hutter, 2005). According to Aikin (1998) in Komolafe et al. (2015) mathematics teaching can only be result oriented when students are willing and the teachers are favourably disposed, using the appropriate methods and resources in teaching the students. Interest in the subject of Mathematics serves as a significant factor that enhances the learning of mathematics which ultimately improves students' achievement in the subject (Udegbe, 2009).

Stephen (1999) in Bamidele (2009) averred that the teacher is the major cause of pupils poor performance in mathematics it was further stated that teacher's bad method of teaching mathematics can make or cause the pupils to perform woefully and this can make them lack interest in mathematics. The need for improved mathematics achievement at the primary school level calls for application of activity oriented approach of teaching such as the Montessori teaching approach.

Montessori approach is a teaching approach introduced by Mari Montessori of Italy in 1907. Ryniker and Shoho (2001) stated that the Montessori approach in based on the tenet that children learn most effectively when information is developmentally appropriate. Kendal (1993) in Lopata, Wallace and Finn (2005) stated that in Montessori approach, children learn at their own pace through manipulation of objects. As such, personal independence, self-discipline, and initiative are essential for learning and motivation, with motivation

purportedly fostered through interactions in the environment. Montessori teaching approach allows pupils to learn through hand-on activities, pupils move through stages of the learning process at their own pace using concrete materials. NAMTA (2003) indicated that central to this approach is the notion that children's natural tendencies "unfold" in specially designed multi-age environments that contain manipulative self-correcting materials. Grain (1992) in Lopata et al. (2005) noted that in Montessori approach teachers do not "direct learning" but respect the children's efforts towards independent mastery. This implies that the approach allows the pupil to control the learning process.

In Montessori classroom, learning equipment is specially prepared to suit the environments and learning environment stimulates and encourages the child to learn (Kurumeh et al., 2013). In Montessori classroom, children of different age's share the same classes learn together share ideas, encourage and collaborate with each other to foster learning. Popoola (2014) opined that to sustain children's interest in mathematics, the environment and activities provided for the children have influence on behaviour and suggested that teachers should understand child development and provide most learning situations and materials in playful manners. According to Kurumeh et al. (2012), the materials are designed to foster self-independent, interest, develop a healthy self-concept, encourage reflective thinking provide an appreciation of nature and the world. The purpose of the didactic materials is first to stimulate the students natural desire to learn through action which will give them better control of their body and will power, Third to lead them naturally from a simple task to a more difficult one they must spontaneously take interest in materials before learning can occur.

Statement of the Problem

The mathematics background within the primary school aids students understanding of mathematics at the secondary school level. This implies that if the background in weak, students understanding and interest will also be weak at the secondary level leading to poor outcome in the subject. It is pertinent therefore to sustain student's interest in mathematics at both primary and secondary levels through approaches that are activity oriented and students centred.

This study was therefore carried out to determine the impact of Montessori teaching approach on primary school pupils' achievement and knowledge retention in mathematics.

Purpose of the Study

The main purpose of the study was to determine the impact of Montessori approach on primary school pupils' achievement and knowledge retention in mathematics. Specifically, the study will determine whether.

- Primary school pupils' taught mathematics using Montessori teaching approach will differ in achievement with those taught traditionally;
- Male and female primary school pupils taught mathematics using Montessori teaching approach will differ in achievement; and
- Primary school pupils taught mathematics using Montessori approach will retain knowledge gained.

Research Questions

The following research questions guided the study:

- What is the difference between the mean achievement scores of primary school pupils taught mathematics using Montessori teaching approach and those taught using traditional approach?
- What is the difference between the mean achievement scores of male and female primary school pupils taught mathematics using Montessori teaching approach?
- What is the difference between the post-test and delayed post-test mean achievement scores of primary school pupils taught mathematics using Montessori teaching approach?

Hypotheses

The following hypotheses were formulated for the study:

- H_{01} : There is no significant difference between the mean achievement scores of primary school pupils taught mathematics using Montessori teaching approach and those taught using traditional approach.
- H_{02} : There is no significant different between the mean achievement scores of male and female primary school pupils taught mathematics using Montessori teaching approach.
- H_{03} : There is no significant different between the post-test and delayed post-test mean achievement scores of primary school pupils mathematics using Montessori teaching approach.

METHODOLOGY

The quasi experimental research design was applied in carrying out the study adopting the pre-test post-test non-equivalent control type. This was adopted in order to determine the impact of Montessori teaching approach on primary school pupils' achievement in mathematics. The population of the study consists of primary three pupils in all the primary schools in Ngor-Okpala Local Government Area of Imo State. A sample of one hundred and ninety (190) pupils from four purposively selected primary schools was used for the study. This consists of eighty five (85) males and one hundred and five (105) females. In each of the selected schools, two intact classes were randomly selected and assigned to control and experiment groups giving a total of eight (8) classes used for the study. The control groups were made up of eighty eight (88) pupils while the experiment groups made up of one hundred and two (102) pupils.

The instrument used for the study was a 15-item objective test question titled "Pupils Achievement in Mathematics (PAM)" constructed by the researcher. The construction of the test was guided by a table of specification based on the topic taught the pupils. The face and content validity was determined by two mathematics teachers in primary school and a measurement and evaluation expert. Their inputs were given consideration during restructuring of the instrument. To determine the reliability of the instrument, it was administered to a group of 20 pupils of the same characteristics with the study sample, but not part of the study. This was done through test-retest method within two weeks, their outcome was analysed using Pearson's product moment correlation coefficient (PPMCC) formula which gave a reliability coefficient (r) of 0.79 which was acceptable for the study.

To carry out the study proper, both groups were pre-tested to determine their readiness for the study. After that, the experiment groups were taught number and numeration by research assistants who were trained on Montessori approach for 2hrs daily for one week.

The Montessori class was provided with concrete materials of different colours, sizes, shapes and type which they were allowed to manipulate after teachers had introduced the topic through the lesson plan structured in line with the Montessori teaching approach. The teachers and researcher monitored the progress of the lesson in different groups as they manipulated the materials to solve problems related to the concept taught. The pupils were allowed to collaborate with each other, work in groups and ask questions for teachers' clarifications. The control groups were taught the same topic by their regular mathematics teacher using the traditional approach which deprived them of activities. The lessons lasted for two weeks using 40 minutes four times in a week. After that, a rearranged model of "PAM" was administered on both groups as post-test. After one week of post-test, a delayed post test was administered to the experiment group to test their knowledge retention.

The data generated was collated and analysed using mean and standard deviation to answer research questions while the hypotheses were analysed using ANCOVA and t-test statistical tools and tested at 0.05 level of significance.

RESULT

RQ₁: What is the difference between the mean achievement scores of primary school pupils taught mathematics using Montessori teaching approach and those taught using traditional approach?

Table 1: summary of pupils' achievement

Group	Test	N	Mean	SD	Diff. in mean	Diff. in achievement
Expt.	Pre-test	102	32.33	8.27	18.18	17.91
	Post-test		50.51	9.94		
Control	Pre-test	88	30.54	8.25	0.27	
	Post-test		30.81	8.26		

Table 1 shows that the experiment group had a mean gain of 18.18 while the control group had 0.27 this gave a difference in mean achievement of 17.91 in favour of the experiment group.

RQ₂ What is the difference between the mean achievement scores male and female primary school pupils taught mathematics using Montessori teaching approach?

Table 2: Summary of Achievement between males and female students

Group	N	Mean	SD	Diff. in mean
Male	49	51.76	9.04	2.40
Female	53	49.36	10.66	

Table 2 shows that male pupils had a mean gain of 51.76 while the females 49.36 this gave a difference in mean gain of 2.40 between them in the experiment group.

RQ₃ What is the difference between the post-test and delayed post-test mean achievement scores of primary school pupils taught mathematics using Montessori teaching approach?

Table 3: Summary of post-test and delayed post-test Achievement

Experiment	N	Mean	SD	Diff. in mean
Post-test	102	50.51	9.94	
D/post-test	102	49.25	10.02	1.26

Table 3 shows that the experiment group had mean achievement of 50.51 in the post-test and 49.25 in delayed post-test which gave a difference in mean of 1.26 between the tests.

H₀₁: There is no significant difference between the mean achievement scores of primary school pupils taught mathematics using Montessori teaching approach and those taught using traditional approach.

Table 4: Summary ANCOVA analysis

Source	Type III sum of square	DF	Mean Square	F	Sig
Corrected model	19086.637	4	4771.659	58.197	.000
Intercept	15210.749	1	15210.749	185.518	.000
Pre-test	551.389	1	551.389	6.725	.010
Method	18705.429	1	18705.429	228.140	.000
Sex	236.243	1	236.243	2.881	.091
Method sex	9.817	1	9.817	.120	.730
Error	15168.315	185	81.991		
Total	359659.000	190			
Corrected total	34254.953	189			

Table 4 shows that of calculated (228.140) is greater than the table value (3.84) at 0.05 level of significance and $P < 0.05$. Based on the result, the null hypothesis is rejected and the alternative accepted at 0.05 level of significance. This implies that, there is a significant difference between the mean achievement scores of male and female primary school pupils taught mathematics using Montessori approach and those taught using traditional approach.

H₀₂: There is no significant different between the mean achievement scores of male and female primary school pupils taught mathematics using Montessori teaching approach.

Table 4 shows that f calculated (2.881) is less than F critical value (3.84) also, $P < 0.05$. Based on the result, the null hypothesis is upheld 0.05 level of significance.

H₀₃: There is no significant different between the post-test and delayed post-test mean achievement scores of primary school pupils mathematics using Montessori teaching approach

Table 5: Summary of t test analysis of post-test of delayed post-test

Test	N	Mean	SD	Df	t _{cal}	t _{0.05}
Post-test	102	50.51	9.94			
Delayed post-test	102	49.25	10.02	2.02	0.90	1.645

Table 5: shows that t-calculated value (0.90) to less than t-critical value (1.645) at degree of freedom 202 and 0.05 level of significance. Based on the result, the null hypothesis is upheld.

DISCUSSION OF FINDINGS

The result of the study revealed that Montessori approach of teaching mathematics enhanced pupils' achievement in mathematics. The statistical analysis showed a significant difference between the mean achievement scores of primary school pupils taught mathematics using Montessori approach and those taught traditionally. This is suspected to have resulted from the sustained interest, understanding and liberalization of the learning process that the approach stood for. It also allowed collaboration among pupils, enlivened the learning process through activities allowing classroom participation among pupils. This result is in agreement with Kurumeh et al. (2012) who in a similar study concluded that the use of Montessori method of teaching has proved more effective in promoting and stimulating students interest leading to better performance in mensuration.

The result also, dispelled the impression that mathematics is a male subject as no statistical significant difference existed between the mean achievement scores of male and female primary school pupils taught mathematics using Montessori approach. The result contradicts that of Kurumeh et al. (2012), Lopata et al. (2005) which variously revealed gender difference among male and female student's interest and achievement in mathematics. The study finally revealed that Montessori approach of teaching mathematics sustained pupil's mathematical knowledge. This was evident in the result which indicated no statistical difference between the post-test and delayed post-test mean scores of primary school pupils taught mathematics using Montessori approach. The practical nature of the approach enabled this result as pupils learn and understand more when they are involved in the teaching and learning process through classroom activities. This result is in tandem with Morrison (2010) who indicated that children learn best in a prepared environment, hence, a place in which they can do things for themselves; that prepared environment makes learning materials and experiences available to children in an orderly format, Montessori classroom is child centred and provides active learning.

CONCLUSION

The result of the study revealed that Montessori approach of teaching mathematics enhances primary school pupil's achievement and sustained knowledge in mathematics across gender.

Recommendation

Based on the result of the study the following recommendations are made:

- Primary school mathematics teachers should apply Montessori approach in teaching to improve pupil's interest, understanding and achievement in mathematics.
- The government should make available Montessori classroom with instructional materials to enable teachers use them in primary schools.
- The government and school managers should organize seminars, workshop and symposium to train teachers on how to apply the Montessori approach in teaching mathematics in primary schools.

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