

Mathematics Learning, Montessori Approach to Teaching/ Learning in Early Childhood Education: A Case Study of Ifo Local Government Area of Ogun State Nigeria

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Abstract

The study was aimed at appraising the way children learn mathematics and Montessori approach to teaching and learning in early childhood education in Ifo Local Government Area of Ogun State. The population of the study consists of 150 participants with 120 pupils and 30 teachers randomly selected from different socio-economic status and religious background within the local government area. Two instruments - Montessori Evaluation Questionnaire (MEQ) ($r = 0.67$) and Teacher Effectiveness Scale (TES) ($r = 0.75$) were constructed and used for data collection. Four hypotheses were constructed and tested at $p < 0.05$ level of significance. Descriptive survey research design was used. Data were analyzed using Pearson's Product Moment Correlation Coefficient statistic. The results showed that the way children learn mathematics at early years differ from age to age depending on how rich or poor their learning environment are; there is a significant relationship between Montessori-based curriculum and teaching and learning process of pre-school children($r = 0.21$; $p < 0.05$); there is a significant relationship between learning environment and teaching and learning process of pre-school children in Montessori schools ($r = 0.35$; $p < 0.05$); there is a significant relationship between assessment methods and teaching and learning process of pre-school children in Montessori schools($r = 0.27$; $p < 0.05$); and there is a significant relationship between teachers' qualifications and teaching and learning process of pre-school children in Montessori schools($r = 0.30$; $p < 0.05$). These results were discussed generally and recommendations were made based on the findings.

Keyword: Mathematics learning, Montessori, early childhood, early childhood education, Teachers' qualification.

Introduction

Mathematics as a subject is 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 (Butler, Charles and Lynwood, 1970).

Mathematics as a school subject has over the years attracted the interest of mathematics educators and researchers who are concerned about the teaching and learning of the subject especially at the early years of our pupils.

This concern might have been predicated on the fact that teaching mathematics as a subject is a very important tool that could be used for the understanding of other subjects especially science and technology (Johnson and Rising, 1972). Mathematics is the study of patterns and relations expressed in numbers or symbols. It is also the science of numbers, quantity and space (Kerlinger, 1985). It is fundamental to the understanding of basic science that is necessary for the understanding of most other school subjects (Fehr, 1996). The usefulness of mathematics in everyday life is obvious in areas like measuring, estimating the prices of goods when shopping, cooking, sewing, woodwork and other fields of life (Setidisho, 1996). The contributions that mathematical knowledge and skills have made to economic, industrial and technological growth of modern world are quite obvious to almost everyone. It enters into all areas of human activities.

The importance of mathematics does not only lie in its contributions to scientific and technological development but also in its utility in day-to-day interactions at the market places, transportations, business of all sorts by both literate and illiterate members of the society (Smith, 2004). Mathematics is needed in the world today much more than before since a lot of equipment based on digital development is going on and calculations are becoming much more complex (Keith, 2009). Hence we cannot escape mathematics because there is real value in and real-life applications for mathematics. Mathematics has beauty just as it has patterns and this has attracted most mathematicians to it (Thomaskutty and George, 2007). Mathematics is a tool and is a language even as it has many uses (Okebukola, 1992). For students to be effective in the present age there is need for them to be properly prepared and equipped to face the challenges ahead and this should start from the early years of our pupils. According to Toumasis (1993), mathematics knowledge is essential not only for living effectively in the society but also for making useful contributions towards the development of one's environment. 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 (Aiken, 1998). According to Udegbe (2009), 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.

Research studies have indicated that low interest of students in mathematics may be due to lack of understanding of the technical language associated with the subject (Nurudeen, 2007), teachers' strategies of teaching (Habor-Peters, 2001; Abakporo, 2005), inadequate instructional resources/materials (Ukpebor, 2006). Suggestions as to how to solve some of these problems have been given by researchers some of which are teachers' use of tangible/visual representation such as sketch/models to concretize ideas (Habor-Peters, 2002), mathematical recreation (Adetula, 2001), amusement and pleasure combined with instruction (Ukeje and Obioma, 2002), the use of games with materials that are readily available in the child's environment (Abubaka and Bawa, 2006). An atmosphere that is conducive to the learning process, which is more than just a physical space with good lighting, can help to solve some of the anxiety student experience in mathematics test (Xin, 1999). Learning is maximized when students and teachers have a good rapport, when students are safe, trusted and respected and when students believe in them (Aiken, 1998). The teacher should help students discover their potentials and thereby improve their self-confidence and hence test anxiety will become a thing of the past. Early Childhood Education is the bedrock upon which excellent basic and sound education is built.

The importance and value of education in the early years of life have been acknowledged for more than 2,000 years ago (Carter, 1987). According to Olaleye, Florence and Omotayo (2009), some recent factors have relatively brought early childhood education to the forefront of public awareness. These factors include the fundamental changes in the economy of the country and its impact on family life, rising cost of living, emergence of single-parent household, increased number of teenage parents, decrease in the impact of the extended family and the call by many professionals who advocated for the rights of children. These recent phenomena no doubt stressed the need for quality education of pre-school children. They asserted that education is an indisputable requisite for improving the social and economic conditions in a country and early childhood education plays a crucial role in this context. Therefore, growing recognition of the importance of early childhood education has generated interest in identifying the most effective programs for educating young children. Parents want their children to attend high-quality programs that will provide them with a good start in life. They want to know that their children are being well cared for and educated. Parents want their children to get along with others, be happy, and learn.

How to best meet these legitimate parental expectations is one of the ongoing challenges of early childhood professionals (National Association for the Education of Young Children, 2005). Moreover, preschool period is very important in human life and education in this period affects the life of child in the future (Aral, Kandır, & Can Yaşar, 2001). One of the most important objectives of pre-school education is to prepare the child for primary school. This is to make the child ready to meet physical, mental and social requirements of future education (Güler, 2001). Studies on this issue indicate that parents and pre-school education institutions hold the greatest responsibility for the child's preparation to primary school. The skills child acquires in pre-school period form the basis for the skills children will acquire later in life. The deficiencies in the development of a child in 0-6 years can hardly be dealt with in periods ahead. In this sense, pre-school education institutions and pre-school education programs followed in these institutions have a great importance for preparing children for future education (Koçyiğit, 2009; Ülkü, 2007).

Today there are many alternative pre-school education programs and approaches. Each of these programs has different educational understanding, teacher training system, material development and classroom management approaches (Erişen & Güleş, 2008). Among them the Montessori Method stands out in many aspects. According to the basic philosophy behind the Montessori Method, human beings are innately bound for benevolence and their main aim is self-realization. The education method Montessori developed shows great parallelism with the personality theories developed by J.J. Rousseau, Adler, Prescott Lecky, Carl Rogers and Abraham. Just like these personality theoreticians, Montessori underscores the personality development as well (Cosgrove & Ballou, 2006). Montessori emphasizes that every child goes through a unique development process, and as a unique individual can learn in line with his/her capacity. Montessori frees knowledge from being memorized and made it concrete to an extent that children at any age can understand and develop a method and series of materials which can transfer it in an integrated way. Montessori approach is based on the tenet that children learn most effectively when information is developmentally appropriate (Ryniker and Shoho (2001). 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 (North American Montessori Teachers' Association, 2003).

Montessori reportedly identified genetically programmed "sensitive periods" in which children have exaggerated capacity and eagerness to acquire skills and information (Crain, 1992). Because each child's development is different, the individual child is allowed to choose activities, "trusting the child's sensitive periods will guide him to choose the work for which he is ready" (Pickering, 1992). In this 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 (Kendall, 1993). Harris and Callender (1995) contend that the emphasis on these aspects leads to "inner discipline." In the Montessori approach, teachers do not "direct learning," but respect the children's efforts toward independent mastery (Crain, 1992). Instruction is based largely on sensory materials developed by Montessori (Ryniker & Shoho, 2001). Furthermore, Montessori is distinct in that it does not use textbooks, worksheets, tests, grades, punishments, or rewards (Haines, 1995). Differences in classroom attitudes and management also have been noted. According to Chattin-McNichols (1992), Montessori classrooms are based on cooperation, while traditional classrooms are based on competition. In Montessori classrooms, teachers promote inner discipline in children by letting students direct their own learning instead of upholding an outer discipline where teachers act as authoritarians, dictating to students how to behave and what to do (Harris & Callender, 1995).

Montessori teachers reportedly have faith that the children will freely choose the tasks that meet their inner needs at the moment (Crain, 1992). In addition, Montessori programs target the development of human potential ... beyond the more narrow focus of skill development and transmission of societal values which shape the traditional educational system (Kendall, 1993). Another important characteristic of the Montessori approach is the practitioner's assertion that the approach produces superior academic achievement outcomes. Despite this contention, quantitative evidence to support the claim is limited. For example, Daux (1995) followed the performance of 36 broadly middle-class students from a private Montessori school from 2nd through 8th grade on annual standardized achievement testing. The students' initial 2nd-grade testing indicated that the group was above average when the study began. Gains exceeding the pretest were reported in the areas of total reading and total numeracy against the national norm. Despite the lack of reported statistical analyses in the article, Daux (1995) claimed that the results provide quantitative evidence that Montessori schools produce greater than expected academic achievement in students.

The basis of the Montessori education is to make the child independent and prepare the most suitable environment to support child's development. Montessori determined the qualities necessary for the child's development and then develops the method and materials appropriate for these qualities. According to Daux (1995), children were developed in different areas by using these materials. These areas are senses, mathematics, language, geography, history and culture, science and nature, kindness, behaviour, and sport. In order to determine which instructional models are most beneficial to children during the preschool years, Marcon, (1999) compared different models of early education. At the heart of this debate is whether young children are more effectively educated in child-centered environments where self-regulated learning activities are encouraged or in classrooms emphasizing direct teacher instruction and basic skill acquisition. Furthermore, long-term benefits of Montessori early childhood education was indicated for low-income children (Miller & Bizzell, 1984).

It was also suggested that the Montessori model could serve as a viable alternative to both teacher-directed and child-centered approaches to early education. A review of the comparative studies (Daoust, 1994) indicates that programs which adhered more closely to traditional Montessori practices, such as mixed-age groupings and extended periods of free choice in the classroom, exhibited more significant gains than those programs classified as Montessori which did not meet authentic Montessori criteria. Children education should be viewed as the instrument of agent of change who should be trained and nurtured as future leaders and law abiding citizens of any country, as they will one day be saddled with some responsibilities with all honesty, dignity and sincerity. But unfortunately, a greater number of these children are being educated in deteriorating school environment with low quality or none at all facilities, inadequate educational resources and unhealthy school social climate. They are at risk for educational failure due to socio-economic, cultural and/or socio-linguistic factors, constituting 10% to 20% of all young children in many countries. This is not conducive to increasing their motivation towards achieving enhanced cognitive skills and how they learn mathematics.

Moreover, the relatively prescribed curriculum of reading, writing, listening, numeracy, and so forth, has given rise to a continuing concern that it detracts not just from children's enjoyment of their first experience of schooling but also from their experience of childhood (Elkind, 2001). Sheehy, Trew, Rafferty, McShane, Quiery, and Curran (2000) in their study reported that the formal Year-1 curriculum was not meeting the needs of disadvantaged 4- to 5-year-old children. This formality in learning is proving difficult for the children, some of whom may not have the requisite motor or social skills to learn, and their future development may be inhibited by an early sense of failure. Therefore, this study appraises the way children learn mathematics and Montessori approach to teaching and learning in early childhood education and proffer suggestions that will help reduce the myth with which academic excellence is viewed by most educators and the general public.

Methodology

Research Design: The study employed the use of descriptive survey research design. This was to evaluate how children learn mathematics and Montessori approach to teaching and learning in early childhood education in Ifo Local Government Area of Ogun State.

Hypotheses: The following hypotheses were tested and answered in this study:

1. There is no significant relationship between Montessori-based curriculum, mathematics learning and teaching and learning process of pre-school children in Montessori schools.
2. There is no significant relationship between learning environment and teaching and Learning process of pre-school children in Montessori schools.
3. There is no significant relationship between assessment methods of Montessori schools and teaching and learning of pre-school children?
4. There is no significant relationship between teachers' qualifications and teaching and learning Process of pre-school children in Montessori schools

Sample and sampling technique: The population for this study comprised all children (ages 0 – 8 years) of early years and teachers in Ifo Local Government Area of Ogun State.

A total number of 150 respondents were involved in the study. These comprised 120 children (60 males and 60 females) and 30 teachers (15 males and 15 females) randomly selected from six crèches schools in Ifo Local Government Area of Ogun State. The sampling technique adopted was a simple random sampling technique where every participant had equal chance of being selected; 20 children and five teachers were selected from each school, making a total number of 150 respondents.

Instruments: Two research instruments were used in this study viz: Montessori Evaluation Questionnaire (MEQ) and Observational Assessment Scale (OAS).

1. Montessori Evaluation Questionnaire (MEQ): This was a 40-item self-structured questionnaire to evaluate the curriculum, teachers' method of teaching, learning environment, assessment and resources. It is divided into two sections A and B. Section A deals with the bio data of the respondents such as sex, age, etc., while section B contained portion of curriculum evaluation, teachers' evaluation, learning environment evaluation, assessment and resources evaluation and it employed Likert-type of 4 rating scales of Strongly Disagree(SD), Disagree(D), Agree(A), Strongly Agree(SA).
2. Observational Assessment Scale (OAS): This was a 50-item self-structured questionnaire designed to evaluate the overall domain of the teaching effectiveness and pupils' achievement. It measured their learning process and general behaviour. It is divided into two sections A and section B. Section A deals with the bio data of the respondents such as sex, age, etc., while section B contained portion of teachers' effectiveness, children learning and general behaviour and it employed the Likert-type of 4 rating scales using of Strongly Disagree(SD), Disagree(D), Agree(A), Strongly Agree(SA).

Data Analysis: Data collected were analysed using Pearson's Product Moment Correlation Coefficient statistic.

Results and discussion

The results are discussed according to how the hypotheses are stated above.

Hypothesis One: There is no significant relationship between Montessori-based curriculum, mathematics learning and teaching and learning process of pre-school children in Montessori schools.

Table 1: Relationship between Montessori-based curriculum, mathematics learning and teaching and learning process of pre-school children

Variables	Mean	SD	df	r-calc.
Curriculum	12.32	2.66		
Mathematics learning	14.25	2.75	120	0.21
Teaching-learning process	13.15	2.81		

p < 0.05; df = 120; r-critical = 0.195

From the above table, the r-calculated (0.21) is significantly greater than the r-critical (0.195) given 120 degrees of freedom at 0.05 levels of significance. As a result, the null hypothesis was rejected while the alternative hypothesis which states that there is a significant relationship between Montessori-based curriculum, mathematics learning and teaching and learning process of pre-school children in Montessori schools was accepted.

Hypothesis two: There is no significant relationship between learning environment and teaching and learning process of pre-school children in Montessori schools.

Table 2: Relationship between learning environment and teaching and learning process of pre-school children

Variables	Mean	SD	df	r-calc.
Learning environment	12.07	2.28		
Teaching-learning process	13.15	2.81	120	0.35

p < 0.05; df = 120; r-critical = 0.195

The above data showed the relationship between learning environment and teaching and learning process of pre-school children. The calculated r-value of 0.35 is positive and greater in magnitude than r-critical (r-crit. = 0.195) at 0.05 significant level and 120 degrees of freedom. It means that there is a positive relationship between learning environment and teaching and learning process of pre-school children. This translates to the fact that an enabling environment encourages teaching and learning process of pre-school children. Similarly, a distracted atmosphere jeopardizes teaching and learning process, because both variables are positively correlated. Moreover, since the calculated value is greater than the critical value, then the relationship between the two variables is significant.

Hypothesis three: There is no significant relationship between assessment methods of Montessori schools and teaching and learning process of pre-school children.

Table 3: Relationship between assessment methods of Montessori schools and teaching and learning process of pre-school children

Variables	Mean	SD	df	r-calc.
Assessment methods	12.39	2.60	120	0.27
Teaching-learning process	13.15	2.81		

p < 0.05; df = 120; r-critical = 0.195

The above data showed the relationship between assessment methods of Montessori schools and teaching and learning process of pre-school children. The calculated r-value of 0.27 is positive and greater in magnitude than r-critical (r-crit. = 0.195) at 0.05 significant level and 120 degrees of freedom. This result showed that there is a positive relationship between assessment methods of Montessori schools and teaching and learning process of pre-school children and that the methods of assessment in Montessori school promote teaching and learning process of pre-school children because both variables are positively correlated. Moreover, since the calculated value is greater than the critical value, then the relationship between the two variables is significant.

Hypothesis four: There is no significant relationship between teachers' qualifications and teaching and learning process of pre-school children in Montessori schools.

Table 4: Relationship between teachers' qualifications and teaching and learning process of pre-school children

Variables	Mean	SD	df	r-calc.
Teaching qualifications	13.19	2.09	120	0.30
Teaching-learning process	13.15	2.81		

p < 0.05; df = 120; r-critical = 0.195

The results above showed the relationship between teachers' qualifications and teaching and learning process of pre-school children. The calculated r-value of 0.3 is positive and greater in magnitude than r-critical (r-crit. = 0.195) at 0.05 significant level and 120 degrees of freedom. The results showed that there is a positive relationship between teaching qualifications and teaching and learning process of pre-school children. This means that a higher qualification possessed by teachers enhances teaching and learning process of pre-school children. Conversely, lower academic qualification jeopardizes teaching and learning process. Moreover, since the calculated value is greater than the critical value, then the relationship between the two variables is significant. It can therefore be concluded that there is a significant relationship between teachers' qualifications and teaching and learning process of pre-school children in Montessori schools.

Discussion of results:

The first hypothesis that there is no significant relationship between Montessori-based curriculum and teaching and learning process of pre-school children was found to be significant. It was therefore concluded that there is a significant relationship between Montessori-based curriculum, mathematics learning and teaching and learning process of pre-school children. This implies that Montessori-based curriculum is good for teaching-learning process of pre-school children. This finding agrees with the view of Blount (2007) and Wortham (2006) that the curriculum model promotes self-discipline in children and it encourages the use of hands that supports their sensory development. It further supports the view of Dohrmann, Nishida, Gartner, Lipsky and Grimm (2007) that the Montessori-based curriculum provides a range of materials to stimulate the child's interest through self-directed activity. It goes with Montessori(1984) who posited that practical life materials and exercises respond to the young child's natural interests to develop physical coordination, care of self and care of the environment; that specific materials provide opportunities for self-help dressing activities, using various devices to practice buttoning, bow tying, and lacing; that other practical life materials include pouring, scooping and sorting activities, as well as washing a table and food preparation to develop hand-eye coordination, the activities that provide a useful opportunity for children to increase their level of concentration.

The finding also supports the view of Montessori (2004, 2006) that the curriculum should be embedded with cosmic education, which allows elementary children to store and organize a great amount of knowledge from among a wide range of different subject matter areas and disciplines. In contrast, Ruenzel(1997) argued that the Montessori method cannot be accepted as a legitimate pedagogy due to the lack of standardized concepts and training methods, because of the 5,000 schools in the United States of America using Montessori programs, only 20% are formally associated with an official Montessori governing or sanctioning body and 60% of Montessori schools are completely unaffiliated to an academic or professional institution that usually assists in curriculum development and evaluation; that the name and method known as "Montessori" have never been formally licensed or trademarked, so anyone can open a Montessori-based school without having to follow standard curriculum guidelines.

The hypothesis that states that there is no significant relationship between learning environment and teaching and learning process of pre-school children in Montessori schools was found to be significant. A positive relationship between learning environment and teaching and learning process of pre-school children was also found. That is, an enabling environment encourages teaching and learning process of pre-school children. Similarly, a distracted atmosphere jeopardizes teaching and learning process, because both variables are positively correlated. The results of the study supports that of Morrison(2010) who asserted that children learn best in a prepared environment, 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; that Montessori's classrooms is child-centered and promotes active learning. Contrary to the finding, Weiss (2007) opined that though the Montessori tools were planned and designed for a particular pedagogy and places were viewed as essential to learning, but the information technologies of today have not been planned around any specific pedagogy, but rather are assumed to be integrated into any and all instructional settings (Weiss, 2007). The results of the study also support the view of Good (2008) and Rinaldi (2003) who argued that aesthetics, access to resources and opportunities can work in different ways to accentuate student learning outcomes. The results also corroborate that of Lomas (2005) that by increasing comfort for students and teachers, it is assumed that teachers and students will be able to concentrate on the task at hand.

The hypothesis that states that there is no significant relationship between assessment methods and teaching and learning process of pre-school children Montessori schools was significant. It implied that positive relationship existed between assessment methods of Montessori schools and teaching and learning process of pre-school children. This implies that the methods of assessment in Montessori school promote teaching and learning process of pre-school children, because both variables are positively correlated. This finding is consistent with Downs & Strand, (2006) and Gredler (2000) who viewed assessment as the crucial part of early childhood education system because the changes in theoretical issues, increasing emphasis on interventions in early childhood, increased focus on assessments on determination of at risk children, growing influence of parental concerns and legal decisions foster educationalists to focus on more trendy assessment techniques in early childhood years. It is also in agreement with Karakuş & Kosa, (2009) who opined that assessments are techniques that help in learning about characteristics of children and the program used in their schools. It is also concomitant with the view of Blount (2007) that the Montessori approach facilitates targeted and personalized learning and development experiences for each child, the timing of individualized lessons determined by the detailed observations of each child by the teacher.

The last hypothesis that states that there is no significant relationship between teachers' qualifications and teaching and learning process of pre-school children in Montessori schools was found to be significant. A positive relationship was also found between teacher's qualifications and teaching and learning process of pre-school children. This means that a higher qualification of teachers enhances teaching and learning process of pre-school children. Conversely, lower academic qualification of teachers jeopardizes teaching and learning process of children. This finding supports the view of Fang(1996) and Kagan (1992) that teacher's prior schooling experiences affect the interpretation of ideas presented during an educator's professional development, and shape a practitioner's perceptions, judgments, and behaviors. It also agrees with Hyson (2003b) who supported the idea higher education programmers should develop in those preparing to teach young children; all teachers and administrators need access to professional development and to professional time and opportunities for collaboration that will enable them to develop, select, implement, and engage in ongoing critique of curriculum and assessment practices that meet young children's learning and developmental needs.

Conclusion and recommendations

From the results of the study, there is a significant relationship between Montessori-based curriculum and teaching and learning process of pre-school children. Montessori-based curriculum is good for teaching-learning process of pre-school children. There is a significant relationship between learning environment and teaching and learning process of pre-school children in Montessori schools. A positive relationship between learning environment and teaching and learning process of pre-school children was also found. An enabling environment encourages teaching and learning process of pre-school children. A distracted atmosphere jeopardizes teaching and learning process. There is a significant relationship between assessment methods and teaching and learning process of pre-school children in Montessori schools. There is a positive relationship between assessment methods of Montessori schools and teaching and learning process of pre-school children. Methods of assessment in Montessori school promote teaching and learning process of pre-school children. There is a significant relationship between teachers' qualifications and teaching and learning process of pre-school children in Montessori schools. A positive relationship was found between teacher's qualifications and teaching and learning process of pre-school children. Higher qualifications enhance teaching and learning process of pre-school children. Conversely, lower academic qualification jeopardizes teaching and learning process. Based on the findings of this study, we recommend that Montessori schools should adopt standardized concepts and training methods, as well as cooperate with an official Montessori governing or sanctioning body in order to assist in curriculum development and evaluation. Montessori schools should incorporate and integrate the use of modern technology as tools into their educational programmes to encourage learners to explore their environments through self-directed and cooperative learning activities. Norm referenced standardized performance tests, teacher ratings and authentic assessment should be encouraged. Teachers' qualifications should be greatly emphasized in the Montessori Method of education.

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