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EFFECTS OF PLAY-BASED MATHEMATICS MATERIALS ON EARLY CHILDHOOD NUMERACY DEVELOPMENT AMONG NURSERY II PUPILS IN HADEJIA LOCAL GOVERNMENT AREA, JIGAWA STATE

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Abstract

This study determined the “effects of play-based mathematics materials on early childhood numeracy development among Nursery II Pupils in Hadejia Local Government Area, Jigawa State, Nigeria”. Two research questions were asked, and two null hypotheses were formulated to guide the study. A quasi-experimental design was employed with 105 Nursery-Two pupils selected from two co-educational schools. One group was taught using mathematics play materials (manipulatives), while the control group received conventional instruction. Data were collected using a validated Mathematics Achievement Test (MAT). Mean & standard deviation were used to answer research questions while Analysis of Covariance (ANCOVA) was used to test hypotheses at 0.05 significance level. Findings revealed a statistically significant improvement in numeracy achievement among children taught with play-based mathematics materials

compared to those taught using conventional methods. No significant gender differences were observed in learning outcomes. It was however, recommended among others that the pre-schools proprietors should provide more varieties of mathematics play materials to the pre-school pupils to help them improve in their numeracy development, the local government education authority should allow more time for play activities in the pre-school curriculum and timetable so as to expose the pupils to more play during numeracy lessons, and the head teachers of pre-schools should encourage the teachers to make use of mathematics play materials in teaching mathematics hence it improve numeracy development of the pupils.

Keywords: Play-based Learning, Numeracy Development, Early Childhood Education, Manipulative Materials and Gender.

Introduction

Early childhood is widely recognized as a critical stage for cognitive and numeracy

development, with research demonstrating that early mathematical exposure plays a significant

role in shaping future academic success, problem-solving skills, and overall cognitive flexibility (Aunio & Räsänen, 2016; Ginsburg, 2009). During these formative years, children's brains are particularly receptive to learning, making this a crucial period for laying the foundation for later academic achievement. Mathematical skills developed in the preschool years have been shown to predict later achievement in mathematics (Jordan et al., 2009), emphasizing the need for effective early mathematics instruction.

Contemporary theories in early childhood education advocate play-centered learning, emphasizing that young children learn best through hands-on, interactive, and discovery-oriented experiences. Play provides an ideal context for learning, as it fosters engagement, creativity, and social interaction, all of which are essential for cognitive growth (Bodrova & Leong, 2015). Furthermore, play-based approaches allow children to explore mathematical concepts such as number sense, patterns, and spatial relationships in meaningful ways that align with their developmental stages (Hughes & Dunn, 2002). This contrasts with more traditional, teacher-centered instructional methods, which often focus on rote memorization of facts and procedures without fostering deeper understanding.

Despite global recognition of play as a powerful learning mechanism, its application in many pre-primary schools, particularly in Nigeria, remains limited. In many Nigerian

classrooms, mathematics instruction remains predominantly teacher-centered, emphasizing repetitive drills and memorization over conceptual exploration. This approach not only reduces children's ability to engage in critical thinking and problem-solving but also stifles their intrinsic mathematical reasoning and curiosity (Bottmiller, 2012). As a result, many children may develop negative attitudes toward mathematics, viewing it as a subject to be memorized rather than explored and understood. Several Nigerian studies have highlighted this issue, indicating that children in Nigerian primary schools often struggle to develop a solid understanding of mathematics due to the emphasis on rote learning (Ogunyemi & Okebukola, 2006; Okeke & Nwosu, 2011).

Through this study, the researchers aim to determine the importance of integrating play with educational content to optimize early childhood numeracy outcomes, aligning with global best practices in early childhood education. Furthermore, we hope to provide a local context for the application of play-based pedagogies in Nigeria, taking into account both the challenges and opportunities within the country's educational framework. By exploring how play-based learning materials can be utilized effectively in Nigerian pre-primary schools, this research will contribute to ongoing efforts to improve early childhood education in the country and ensure that children enter primary school with strong numeracy foundations.

This study sought to address this gap by investigating the effects of play-based mathematics materials on children's numeracy development in Hadejia Local Government Area (LGA), Nigeria. By providing empirical evidence on the effect of play-based approaches in early childhood education, the study contributes to improving instructional practices in Nigerian pre-primary schools.

Statement of the Problem

The researcher's visit to the nursery schools to collect baseline data revealed that many pre-primary school mathematics teachers teach their pupils using a demonstration method that does not involve children in playing or performing activities other than answering questions posed by the teachers. It was also observed that many teachers, when using the demonstration method, did not usually provide enough materials, which could give their pupils opportunities to work with the materials and fully participate. Therefore, the present study determines the effects of play-based mathematics materials on early childhood numeracy development among nursery II pupils. Children's development trajectory is critically mediated by appropriate, effective relationships with loving and consistent caregivers as they relate to children through play. When caregivers or teachers observe their pupils in play or join with them in child-driven play, they are given a unique opportunity to see the world from their child's vantage point as the child navigates a world perfectly created just to fit his or her needs. The interactions that

occur through play help guide children toward academic success and healthy behaviors that can lead to even greater academic breakthroughs in their careers as adults.

Despite the numerous benefits of play, especially when using play materials to foster both children's academic and psychological development, time for free play has been insufficient for some pupils in our conventional schools in Nigeria. On average, most pre-primary school pupils have only 20-30 minutes for extensive play, which is usually not guided by adults and lacks play materials, leading to a daily school hour of 6-9 hours of knowledge. This trend has even affected pre-primary pupils, who have had free play reduced in their schedules to make room for more sit-down-and-listen class lessons, which are usually completely devoid of play-based methods. For some children, this hurried lifestyle is a source of stress and anxiety and may even contribute to depression. Increased pressure on children to learn without play or to use mathematics play materials to achieve results is likely to manifest as school avoidance and somatic symptoms. The challenge for society, schools, and teachers is to strike a balance that allows all pupils to reach their potential without pushing them beyond their personal comfort limits, and while allowing them personal free playtime and using play as part of their learning strategies. Restricting the pupils' academic performance seems the best academic strategy for many schools and class teachers in elementary school level, but it's actually the worst approach because it limits the chances for the pupils to attain academic performance.

Play among pre-primary school pupils has been treated as a second priority in addressing their learning needs in Hadejia LGA of Jigawa State, across many private and publicly owned pre-primary schools. It's against these backdrops that the researcher determined the effect of play-based mathematics materials on early childhood numeracy development among nursery II pupils in Hadejia LGA of Jigawa State.

Objective of the Study

The aim of the research work was to investigate the effects of play-based mathematics materials on early childhood numeracy development among nursery II pupils in Hadejia Local Government Area of Jigawa State. Specifically, the study sought to:

1. determine the numeracy development of pupils taught with play-based mathematics materials and pupils taught mathematics using conventional method in Hadejia Local Government Area of Jigawa State.
2. find the numeracy skills of pupils taught mathematics using play-based materials based on gender in Hadejia Local Government Area of Jigawa State.

Research Questions

The following research questions were asked to guide the study:

1. What is the mean numeracy skills of pupils taught with play-based mathematics materials and pupils taught mathematics using conventional method in Hadejia Local Government Area of Jigawa State?

2. What is the mean numeracy skills of pupils taught mathematics using play-based materials and conventional method based on gender?

Statement of the Hypotheses

Two null hypotheses were formulated from the research questions:

1. There is no significant difference between the mean numeracy skills of pupils taught with play-based mathematics materials and those taught using the conventional method.
2. There is no significant difference between the mean numeracy skills of male and female pupils taught with play-based mathematics materials and the conventional method.

Methodology

This study adopted a quasi-experimental research design. The choice of this design was because the study used intact classes in the selected schools, without interfering with the normal school structures. Two schools were randomly selected, with one assigned to the experimental group and the other to the control group. The experimental group was taught using play-based mathematics materials, such as bottle caps, number cards, and blocks, to encourage hands-on, interactive learning. This intervention lasted for 4 weeks. In contrast, the control group received conventional instruction through demonstration and lecture, with the teacher providing explanations and examples, and the students following along.

The control group also participated in the intervention for 4 weeks. While both groups received instruction on similar mathematical concepts, differences in teaching methods allowed a comparison between play-based learning and traditional instruction. The two groups were given a pre-test and a post-test after the treatment.

The study population comprised all coeducational schools in Hadejia Local Government Area of Jigawa State. Only two ECCDE schools were selected for the study. They were Abdulkadir Model Special Primary School in Hadejia and Maje Model Nursery and Primary School.

The simple random sampling technique was employed in the study. The two schools selected were randomly assigned to the experimental and control groups. The researcher obtained an introductory letter from the Hadejia Local Education Authority to enable him to seek permission from the Heads of the sampled schools to use their schools.

Results

Research Question One

What is the mean numeracy skills of pupils taught with play-based mathematics materials and pupils taught mathematics using conventional methods in Hadejia Local Government Area of Jigawa State?

The instrument for data collection in the study was a Mathematics Achievement Test (MAT) for the pre-primary school pupils in Hadejia. The MAT consisted of two sections: A and B. Section A contained the pupils' biographical data, while Section B contained 10 elementary mathematics questions for the pupils to solve. The test was designed to assess the pupils' skills in key areas of early mathematics, including counting, sorting, shapes, and number recognition, and each correct answer attracted 5 marks. The MAT was validated by three experts in early childhood education and mathematics, ensuring the test items were appropriate for measuring the intended skills.

The data collected for the study were computed using both descriptive and inferential statistics. The mean and standard deviation were used to answer the research questions, and Analysis of Covariance (ANCOVA) was used to test hypotheses at the 0.05 level of significance.

Table 1: Mean Achievement Scores and Standard Deviation of Pupils Taught Numeracy Using Play-Based Material and Those Using Conventional Method

Group	Type of Test	No. of Students	Mean Score	Std. Dev.
Experimental	Pre-test	55	19.64	3.87
	Post-test	55	23.84	4.65
Control	Pre-test	50	19.60	3.81
	Post-test	50	20.54	4.04

Table 1 shows that the pre-test mean achievement scores and standard deviation of the experimental group were (19.64, 3.87), and the post-test mean achievement scores and standard deviation were (23.84, 4.65), while the pre-test and post-test mean achievement scores and standard deviation of the control group were (19.60, 3.81) and (20.54, 4.04).

Hypotheses One

There is no significant difference in the mean numeracy skills of pupils taught with play-based mathematics materials compared with those taught using conventional methods.

Table 2: The Results of Analysis of Covariance of the Difference between Post-test Mathematics Mean Scores of the Experimental and Control Groups

Source	Type III Sum Of Square	df	Mean Square	F	Sig.	Partial Squared
Corrected Model	1481.116 ^a	2	462.381	35.320	.000	.345
Intercept	1721.571	1	1721.571	157.310	.000	.401
Pre-Test	631.428	1	631.428	90.308	.000	.320
Group	581.058	1	251.429	25.312	.001	.211
Error	1524.113	102	11.151			
Total	37229.000	105				
Corrected Total	3105.624	104				

a. R Squared = .345 (Adjusted R Squared = .357)

Table 2 reveals a significant difference in the mean achievement scores of students exposed to play-based mathematical materials and demonstration method. $F_{(1, 102)} = 25.312$ was obtained, with an associated p-value of 0.001. Since the associated probability (0.001) is less than the level of significance (0.05), the null hypothesis was rejected. The result implies that mathematics play materials method produced a significant effect on the post-test achievement scores of pupils when covariate effect (pre-test) was controlled. Hence, there was a significant difference between the two

groups of play-based mathematical material and the conventional method.

Research Question Two

What is the mean numeracy skills of pupils taught mathematics using play-based materials and conventional method based on gender?

Table 3: Mean Achievement Scores and Standard Deviation of Male and Female Pupils

Group	Type of Test	No. of Students	Mean Score	Std. Dev.
Male	Pre-test	58	18.24	3.57
	Post-test	58	22.96	4.69
Female	Pre-test	47	19.59	3.91
	Post-test	47	21.87	4.01

Table 3 shows that the pre-test mean achievement scores and standard deviation of male pupils were (18.24, 3.57), and post-test mean achievement scores and standard deviation were (22.96, 4.69), while the pre-test and post-test mean achievement scores and standard deviation of female pupils were (19.59, 3.91) and (21.87, 4.01).

Hypotheses Two

There is no significant difference in the mean numeracy skills of male and female pupils taught with play-based mathematics materials compared with those taught with the conventional method.

Table 4: Result of Analysis of Covariance of Male and Female Pupils' Achievement Scores Taught with Play-Based Mathematics Materials and Conventional Method

Source	Type III Sum Of Square	df	Mean Square	F	Sig.	Partial Squared
Corrected Model	189.226 ^a	2	78.692	7.697	.001	.242
Intercept	841.455	1	841.455	72.645	.001	.503
Pre-test	143.571	1	143.571	15.278	.000	.271
Gender	1.536	1	1.536	.115	.523	.004
Error	466.632	102	13.725			
Total	12285.000	105				
Corrected Total	645.236	104				

a. R Squared = .242 (Adjusted R Squared = .219)

Table 4 reveals that there was no significant difference in mean achievement scores of male and female pupils in mathematics, $F(1, 102) = .115$ was obtained with an associated exact probability value of 0.523. Since the associated

Discussion

The results showed that there was no significant difference in the pre-test mean achievement score of pupils taught with mathematics play materials between the Experimental and Control groups. This is in line with findings by Marzano (2013), who found that when pupils are exposed to the same learning conditions before taking any form of test, there won't be a significant difference in their mean scores.

It also revealed that the post-test mean score achievement of pupils taught with mathematics play materials in the Experimental group surpassed that of the Control group taught with the demonstration method. This aligns with the work of Okoronka & Wada (2018), who investigated the effects of play-based learning on pupils' achievement in Mubi Metropolis, Nigeria. These results showed a significant main effect of treatment on pupils' achievement, with the play-based method being more effective.

The results showed no significant difference in mean achievement scores between male and female pupils taught mathematics using mathematics play materials. This aligns with

probability (0.523) is greater than the 0.05 level of significance, the null hypothesis was not rejected. The result implies that there is no gender difference in pupils' achievement in mathematics.

the work of Okoronka (2019), who examined the comparative effects of play as an instructional strategy on pupils' cognitive development in Nigeria. This study found that play strategy was effective with a positive and significant relationship on pupils' cognitive skills; also, the findings revealed that analytical female pupils and non-analytical male pupils were homogeneous.

Conclusion

Based on the findings of this study, it was concluded that teaching pre-school pupils' mathematics using play materials is more beneficial than the demonstration method. The use of mathematical play materials gives pupils opportunities to discern, express, explore, and use mathematical concepts more, and helps them connect concepts better than the demonstration method. Use of play-based mathematics materials helps pupils gain greater mastery of mathematics concepts than the demonstration method, and the use of mathematics play materials creates a more conducive environment that improves pre-school pupils' numeracy skills more than the demonstration method.

Recommendations

The following recommendations were made:

1. Preschool proprietors should provide adequate and diverse mathematics play materials
2. Teachers should incorporate play-based instructional strategies into mathematics lessons
3. School administrators should allocate more time for structured play activities in the timetable

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