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Effect of Spaced Learning on Primary School Pupils' Interest and Retention in Mathematics

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Abstract

The study investigated the effect of spaced learning on primary school pupils' interest and retention in mathematics. To achieve the study objectives, we used the quasi-experimental method of pre-test posttest group design to collect and analyze data and interpret the results. The participants consisted of 65 primary six pupils in two intact classrooms drawn using two stage sampling technique. Data were analyzed using SPSS and Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypotheses at .05 level of significance.Pupils achievement and interest in mathematics were measured using pupils mathematics Achievement Test (PMAT) and pupils Interest inventory (PII). Our findings revealed that spaced learning had a significant positive effect on pupils' interest and retention in mathematics. It was recommended that spaced learning approach should be used in schools to teach concepts that requires retention as it could improve pupils' interest and retention ability.

Introduction

The issue of students' underachievement in mathematics is a major source of worry for researchers, educators, and other stakeholders. This is because mathematics is critical to an individual's development, future job choices, as well as the development of the nation and society as a whole. As a result, according to Azuka (2014), no nation can develop without mathematics. This is because the distinction between developed and developing countries is based on math's proficiency (Yunus, 2017). Mathematics has been made compulsory for children in primary and secondary schools in Nigeria due to the emphasis placed on the subject (Federal Republic of Nigeria, (FRN), 2014). Despite the subject's relevance, pupils' performance in it has been dismal (Saad, et al., 2014, Zakariya, 2016, Zalmon &Wonu, 2017).

Unfortunately, the subject is a cause of anxiety, fear, and unpleasant feelings among pupils in primary and secondary schools (Ogon& George, 2018). The inference is that students at these levels of education are also disinterested in mathematics study. As a result, Anigbo (2016) claims that poor mathematics achievement in Nigerian primary and secondary schools might be related to pupils' lack of interest in the subject. According to the author, students' preparation or mastery of a subject –matter background information that can enable them to cope with learning the subject or related learning activity –is a component of interest. Interest is defined as a person's desire to engage in any action that brings them pleasure (Owora& Chika, 2019), or a person's involvement with specific items and activities (Nyman, 2017). Interest is vital in learning, according to Ezeugwu et al (2016), since when one is interested in an activity, one is more likely to perform well. As a result, a lack of interest in mathematics may influence students' participation in areas that require a strong mathematics foundation, thereby leading to poor mathematics achievement (Allahnana, et al, 2018).

The employment of inadequate teaching pedagogical approaches by teachers, among other issues, has been blamed for this trend (Achor, et al, 2009; Zakariya & Bamidele, 2015). The lecture method is the most common pedagogical style for teaching mathematics in Nigerian primary and secondary institutions. This strategy is teacher-centered, dull for students, and does not result in significant learning gains. The method has been criticized because it stresses passive knowledge acquisition, with the learner acting as a passive receiver of information. It also encourages rote learning, which is defined as memorizing and recalling facts based on cognitive level of development rather than conceptual understanding (Zakariya, et al, 2016). The learners are not

actively involved in the teaching and learning process in this method. In this style, the teacher gives instructions to the students, who sit silently and take in the material without contributing much. As a result, the adoption of this method may be the primary cause of students' low performance in the subject, as it does not assist students in acquiring sufficient knowledge to help them function optimally (WAEC, 2019). As a result, researchers have advocated for a paradigm change away from lecturing and toward more learner-centered and innovative pedagogies.

As a result, all efforts must be made to make mathematics more meaningful, appealing, stimulating, and friendly. As a result, teachers should adopt interactive teaching methods while teaching mathematics (WAEC, 2019), and school pedagogies should be changed to include more interactive and learner-friendly teaching strategies (Alsowat, 2016). As a result, researchers like (Ceremonia& Casem, 2017; Ehsan, et al, 2020; Mat-jizat et al, 2020) feel that using a spaced learning technique can assist students improve their learning results. The spaced method, according to Mat-jizat et al (2020), was discovered by Field in 2005 and explains how long-term memories are created in the brain. Fields observed that the interval between cell stimulations, rather than the length of such stimulations, was crucial for long-term memory, according to the authors. This phenomenon, which they called spaced learning, was created to improve long-term recall of the material taught (Davey, 2014). According to Davey, spaced learning involves short bursts of intense study followed by ten-minute periods of distraction activities. Physical activities such as playing, painting, or modeling can be used as distractor activities to keep the mind off the lesson for a brief period of time. According to Ceremonia and Casem (2017), spaced learning is a technique in which teachers give learners with a topic to learn and then present the same concept after a short gap.

In practice, spaced learning entails breaking down a lesson into three learning periods separated by two ten-minute intervals. During these intervals, the same content is presented in the same way, with or without variation in the method of presentation. Students are provided an alternate activity during their ten-minute break periods, which may be in the form of a game or a physical activity. As a result, in spaced learning, the delivery time entails spacing a few or many repeats of a learning point, which do not have to be verbatim repetitions (Ceremonia& Casem) (2017). Because a single exposure is usually insufficient for good long-term memory, it is required to repeat a topic over and again to learn it successfully. This is founded on the idea that perfect practice leads to flawless performance. Learning occurs when the items to be learned are repeated in spaced sequences rather than in concentrated presentations (Hosseini et al., 2017). According to Adeleye and Omotayo (2020), spacing out the review and practice of an initial study leads to better learning than massing the repetitions. These repeats will slow down the rate at which information decays, allowing for a longer time interval between repetitions in order to keep long-term memory (Voice & Stirton, 2020). Regular updating of course content, according to the authors, would be a more effective strategy than a massed study. This suggests that using spaced learning to boost learners' interest in mathematics and their memory of concepts taught owing to mastery of mathematics concepts could be beneficial. This is due to the fact that once students have mastered a topic, they are more likely to maintain it in their long-term memory for a longer amount of time.

Previous studies have backed up these assertions. Varela (2020) showed that spaced repetition appears to play an essential effect in long-term vocabulary retention in a longitudinal field research with high-school language learners in a spaced repetition longitudinal field study. Mat-jizat et al., (2020) did a study to see how effective Spaced Learning as a Pedagogical Strategy is at improving student learning and motivation. They found that Spaced Learning can assist students improve their performance and motivation. Ehsan et al. (2020) evaluated the effects of spaced versus massed distribution instruction on EFL learners' vocabulary recall and retention, finding that the spaced distribution group outperformed the massed distribution group significantly. Adeleye and Omotayo (2020) researched the impacts of Spaced and Blended Learning on Senior Secondary School Students' Interest in Biology in Ekiti State and discovered that using Spaced and Blended Learning increased students' interest in Biology more than using the traditional technique.

Despite the fact that spaced learning has the potential to improve learners' attention and retention, it is still not widely used in Nigerian classrooms. Instead, the massed practice of teaching and learning dominates. In addition, few real-world experiments have looked at the impact of a spaced learning technique on students' interest and retention in mathematics. However, further study is needed to determine the effect of spaced learning on pupils' interest and retention so that policies and interventions that could lead to the integration of spaced learning in Nigerian classrooms can be developed. Hence, the present study sought out to investigate the effect of spaced learning on primary school pupils' interest and retention in mathematics. The study investigated the effect of spaced learning on primary school pupils' interest and retention in mathematics. The following research question were addressed.

1. What is the difference in the mean interest scores in mathematics for pupils exposed to spaced learning and those exposed to massed learning?
2. What is the difference in the mean retention scores in mathematics for pupils exposed to spaced learning and those exposed to massed learning?

Method

Research Design

We employed quasi-experimental research of pre-test post-test group design. The pretest was used to establish homogeneity of the groups while the posttest was used after the treatment to measure pupils' interest and retention in mathematics. The study was conducted in Boki Local Government Area in Cross River State, Nigeria.

Participants

The population of the study comprised of all the primary six pupils in the 96 primary schools in the area. The reason for using primary six pupils is that they are preparing for the Common Entrance Examination and as such will need to retain most of the concept taught to them in their long-term memory to assist them in writing the examination. The sample of the study consisted of 65 pupils' in two intact classes selected using two stage sampling technique. In the first stage simple random sampling technique was used to select two schools. In the second stage simple random sampling technique is used to assign on class to the experimental group and one to the control group. The experimental group had 34 pupils while the control group had 31 pupils.

Data Collection Tools

Two instruments developed by the researchers were used to collect data. The instruments were titled: 'Pupils' Interest Inventory' (PII) and 'Pupils' Mathematics Achievement Test' (PMAT). The PII elicited information on pupils' interest in mathematics and was made of twenty items rated on a four-point Likert-styled scale. The ratings for the items ranged from 1-4 depicting Strongly Agree, Agree, Disagree and Strongly Disagree respectively. The PMAT was used to elicit information on pupils' retention in mathematics and had 20 dichotomously scored multiple choice items with four response options of A, B, C and D. The instrument was constructed based on Blooms' taxonomy of learning objectives.

Validity and Reliability

The PII, PMAT, together with lesson plans were face-validated by three experts; two from Mathematics Education and one from Measurement and Evaluation, all in the Department of Science Education, University of Nigeria, Nsukka. The PII and PMAT were later trial-tested on 20 primary six pupils in a primary school that was not among those used for the actual study. The internal consistency reliability was established for the PII using the Cronbach Alpha technique and Kuder-Richardson20 method for the PMAT. The reliability coefficients for both instruments were .77 and .82 for the PII and PMAT respectively.

Procedure

The researcher obtained the authorities' informed approval and authorization from the two schools that were sampled for the study. When authorization was granted, the researchers engaged regular classroom teachers as research assistants for the intact classes. The researcher employed regular classes to ensure that the students were unaware that they were taking part in a study. The research assistants were briefed on the study's goals and instructed on how to deliver the spaced learning technique and administer the data collection equipment.

The experiment lasted for a duration of eight weeks. In the first week, coaching of the research assistants was done after which the instruments were pretested on the pupils for both groups as pretest. The actual experiment commenced in both control group and experimental group from the second through the fourth week. Normal class lesson periods on the school's timetable were used to conduct the experiment. Each session lasted for 80 minutes per day for three weeks. The same lesson plan with the same content, specific objectives, duration and evaluation were developed for the two groups. The only difference is that the lesson plan for the experimental group (spaced learning) had two periods of breaks in between the lessons. The lesson was divided into three sessions and two break periods. Each session lasted for 20 minutes after which the children were given a play activity that lasted for 10 minutes after which the return for the second session and be taught the same concept for another 20 minutes before proceeding the next break of 10 minutes and return for the last session. The pupils

in the control group were taught the concept in a massed form (without any break period between lessons) for the entire 80 minutes.

At the end of the fourth week, items in the PII administered at pretest were reshuffled and re-administered to the pupils as posttest. At the end of the eighth week, the items in the PMAT administered as pretest were also reshuffled and administered to the pupils as posttest to measure their retention of concepts. The essence of allowing a time gap was to ensure that the pupils must have forgotten the content taught to them. The administration of the posttests was done to ascertain the effect of the different treatments on the pupils' interest and retention in mathematics. The PII was rated by the pupils and they also answered questions in the PMAT. The PMAT answers were scored by the class teachers. Each correct option in the PMAT was awarded four marks whereas each wrong option was awarded zero marks.

Data Analysis

The researchers used SPSS version 23 to analyze the collected data and to answer the study questions. Means and standard deviations were calculated to answer all study questions; analysis of covariance (ANCOVA) was used for testing the hypotheses. The hypotheses were tested at 0.05 level of significance. The use of ANCOVA served as a means of controlling the extraneous variables from the dependent variables, thereby increased the precision of the experiment as well as reduced error of variance. Moreover, the statistical technique of ANCOVA enabled the researchers to adjust the initial group differences (that is, non-equivalence) since intact classes were used.

Results

Table 1: Mean and Standard Deviation of Interest Scores of Pupils Exposed to Spaced Learning and Those Exposed to Massed Learning

Groups		Pretest		Posttest		
	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Difference
Experimental (spaced learning)	34	37.76	4.19	47.18	6.05	9.42
Control (massed learning)	31	40.39	4.77	44.65	6.29	4.26

Result in Table 1 shows that pupils who were exposed to spaced learning had mathematics interest score of ($\bar{x}$ = 37.76, *SD* = 4.19) at the pretest and mathematics interest score of ($\bar{x}$ = 47.18, *SD* =6.05) at the posttest, while pupils who were exposed to massed learning had mathematics interest score of ($\bar{x}$ = 40.39, *SD* = 4.77) at pretest and mathematics interest score of ($\bar{x}$ = 44.65, *SD* =6.29) at posttest. Mean difference of 9.42 and 4.26 for the experimental and control groups respectively imply that spaced learning had positive effect on the mean interest scores of pupils in mathematics.

Table 2: Analysis of Covariance (ANCOVA) of the Effect of Spaced Learning on Pupils' Interest in Mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1028.464[a]	2	514.232	21.667	.000	.411
Intercept	128.076	1	128.076	5.396	.023	.080
pre_int	924.563	1	924.563	38.956	.000	.386
Methods	339.469	1	339.469	14.303	.000	.187
Error	1471.474	62	23.733			
Total	139856.000	65				
Corrected Total	2499.938	64				

Note: S = Significant, NS = Not Significant, η^2_p = partial eta squared

The result in Table 2 shows that the effect of spaced learning on pupils' interest in mathematics was significant ($F(1, 64) = 23.733$, $p < .05$, $\eta^2_p = .187$), thus the hypothesis is rejected This is because the exact probability value

of 0.00 is less than 0.05 set as level of significance. The effect size of (η^2_p = .187), moreover, shows that 18.7 percent changes in pupils' interest in mathematics is accounted for by the use of spaced learning. Hence, inference drawn is that spaced learning approach has a significantly positive effect on pupils' interest in mathematics.

Table 3: Mean and Standard Deviation of Retention Scores of Pupils Exposed to Spaced Learning and Those Exposed to Massed Learning

Groups		Pretest		Posttest		
	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Difference
Experimental (spaced learning)	34	36.24	4.72	46.82	6.11	10.58
Control (massed learning)	31	36.00	5.05	42.97	5.26	6.97

Result in Table 3 shows that pupils who were exposed to spaced learning had mean retention score of ($\bar{x}$ = 36.24, SD = 4.72) at pretest and a mean score of ($\bar{x}$ = 46.82, SD = 6.11) at posttest while those exposed to massed learning had a mean retention score of ($\bar{x}$ = 36.00, SD = 5.05) at pretest and a mean score of ($\bar{x}$ = 42.97, SD = 5.26) at posttest. Mean difference of 10.56 and 6.97 for the experimental and control groups respectively implies that spaced learning had positive effect on pupils' mean retention scores in mathematics.

Table 4: Analysis of Covariance (ANCOVA) of the Effect of Spaced Learning on Pupils' Retention in Mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	930.187[a]	2	465.094	20.975	.000	.404
Intercept	472.351	1	472.351	21.302	.000	.256
pre_ret	689.112	1	689.112	31.077	.000	.334
Methods	221.427	1	221.427	9.986	.002	.139
Error	1374.797	62	22.174			
Total	133840.000	65				
Corrected Total	2304.985	64				

Note: S = Significant, NS = Not Significant, η^2_p = partial eta squared

Result in Table 4 shows that the effect of spaced learning on pupils' retention in mathematics was significant ($F(1, 64) = 22.174$, $p < .05$, $\eta^2_p = .139$), hence, the null hypothesis is rejected. This is because the exact probability value of 0.02 is less than 0.05 set as level of significance. Additionally, the effect size of (η^2_p = .139), shows that 13.9 percent changes in pupils retention scores in mathematics is accounted for by the use of spaced learning approach. Consequently, inference drawn is that spaced learning approach has a significantly positive effect on retention in mathematics.

Discussion

The purpose of the study was to investigate the effect of spaced learning on primary school pupils' interest and retention in mathematics. The findings of the study revealed that the spaced learning approach had a significant effect on pupils' interest and retention in mathematics. The means that the spaced learning approach was a more efficacious learning approach than the massed learning in improving pupils' interest and retention in mathematics. The results of the study lend support to previous studies from Adeleye and Omotayo (2020) whose research result indicated that the use of Spaced Learning and Blended Learning enhanced the interest of students in Biology than the conventional strategy. Moreover, the above findings is in agreement with previous findings of Mat-jizat et al., (2020) whose result revealed that spaced learning help in increasing students' performance and motivation. The findings also corroborate the previous finding of Ehsan, et al, (2020) whose results revealed that spaced distribution group significantly outperformed the massed distribution group vocabulary recall and retention.

This could be so because the spaced learning provides pupils with the opportunity to play amidst learning sessions. This could help arouse their interest in them while learning. Pupils like play and as such any activity that includes play would be interesting to them which could make them persist longer in the activity. This could lead to more mastery of the subject matter being taught. Also, the repetitions of concepts being taught could also

lead to mastery of subject content being taught. This could be so because practice makes perfects and as such the pupils could attain the stage of perfection because of repetition of learning concepts.

Conclusion

The problem of pupils' underachievement in mathematics is a major concern to researchers and educationist. Pupils' achievement is a major area of interest to these people. Hence, the present study provided awareness on the effect of spaced learning on primary school pupils' interest and retention in mathematics. Based, on the findings of the study, the researchers concluded that the spaced learning approach had a significant positive effect on pupils' interest and retention in mathematics. This study showed that Spaced Learning can help in increasing pupils' interest and retention in mathematics. The implication of the study is that students' centred teaching approach like spaced learning is capable of improving students' interest and achievement in mathematics and other school subjects. The major limitation of the study was that the researchers did not control for other variables like intelligent level of the pupils. This may have an influence on the results of the study. Drawing from the findings of the study, the following recommendations were made:

1. The spaced learning approach should be used in schools to teach concepts that requires retention as it could improve pupils' interest and retention ability.
2. School timetables should be prepared to allow for the integration of spaced learning approach.
3. Teachers and researchers could use spaced learning approach as a basis for future studies for more awareness on pedagogical techniques that use repetition and conduct studies with wider scope using different population in different areas for better generalizability of the method.

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