IMPROVING SOME NIGERIA SECONDARY STUDENTS' ACHIEVEMENT AND RETENTION IN TRIGONOMETRY: A FIELD REPORT IN SPACED LEARNING STRATEGY

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Abstract
The study investigated effect of Spaced Learning Strategy (SLM) on students' achievement and retention in trigonometry concepts of mathematics in Minna metropolis. The design of the study was quasi-experimental. The target population of study was 4,707 SSII students out of which a sample of 255tudents was selected using simple random sampling. Two research questions were asked to guide the study while two hypotheses were formulated and tested at 0.05 level of significance. Two research instruments: Trigonometry Performance Test (TPT) and Trigonometry Achievement Test (TAT) were developed and validated by two experts. The instruments yielded reliability coefficients of 0.70 and 0.81 respectively using split half reliability method to ensure internal consistency of the instruments. Data collected were analyzed using t-test. Findings from the study revealed that there was a significant difference in the achievement scores of students taught using SLS than those taught with CTS. There was significant difference in the retention ability of students taught by SLS has those taught by CTS. Based on the findings, it was recommended among others that the use of spaced learning strategy should be adopted by mathematics teachers and they should be exposed to SLS through seminars, conference and workshops.

Keywords: Conventional teaching strategy, Spaced learning strategy, Academic achievement, Retention ability, Trigonometry.

Introduction

Mathematics as one of the science subject taught in the primary, secondary and tertiary in Nigeria, deals with the study of numbers, shapes and space which involve problem-solving activities and a very powerful way of communication (Ahmad, 2016). Mathematics concepts taught at the secondary school level in Nigeria are in seven major areas, namely: Number and Numeration, Algebra, Measurement, Geometry, Trigonometry, Statistics and Probability. Trigonometry is a area in mathematics that studies relationships involving lengths and angles of triangles (Musa, 2020).

Mathematics teachers at all levels of education can hardly say that it is very well with the teaching and learning of mathematics especially trigonometry concepts. Studies conducted by Emmanuel, Benjamin &Nguuma (2011), and Odupe & Opeisa (2019) indicated a poor achievement in mathematics. According to the researchers they attributed poor performance in mathematics, such variables, lack of interest by students, teachers' attitude, lack of instrument materials and instructional method.The report by WAEC Chief Examiner (2018) has confirmed this ugly situation and revealed that students encounter problems of inability to recall mathematical process. These are associated with methods by which it is being taught in the class. Hence mathematics concepts especially trigonometry need to be taught to the students in a way this can trigger quick reproducing of the concept being taught or experienced. Since teaching of mathematics in Nigeria still follows the conventional approach even when the approach is neither promoting students' interest, retention ability nor achievement in the subject (Emmanuel, Benjamin & Nguuma, 2011). Furthermore, Ahmad (2016) of opinion that the conventional teaching is a teacher–centred with little or no participation of the learner who remains a passive listener. The persistent use of the traditional mode of instruction is one of the major shortcomings affecting performance and higher achievement in mathematics. This situation, therefore call for shifting from conventional method of teaching to trial spaced learning strategy.

The concept of spaced learning strategy is a teaching methodology useful to quickly seize information in long term memory (Michael, Adejoh & Ochu, 2017), based on a particular arrangement of the lesson time

that comprises three input sessions and two intervals. In the first input session, the teacher provides information that students need to learn during the lesson. This may last between 10-15minutes. The first session is followed by a 10minute interval, which must not have any relevance to the content of the lesson, but this increase the chances for the neutral pathway to have "rest" and to form stronger connections. In the second input session, the teacher revises the content of the first session, recalling key issues, arousing memories and changing the manner of presenting the content (e.g, using a variety of examples that are characterized by high interactivity level). In the second interval the same principles as the first are applied, leaving a rest/relaxation period of about 10minutes. In the third input, the teacher remains on the content of the first session but proposes activities centred on the student: the learners will have to demonstrate what they have acquired and understood. The content shared in the first two inputs, applying their new knowledge in drilling activities or problem-situation contexts. At this stage, the teacher simply stays among the students aid, eventually, verifies their actual understanding of the lesson content (Bala, 2006, Ace & Remalyn, 2017).

Truly, mastery of concepts and skills should be strictly observed by the teacher in this strategy. Kondektar (2013) opined that one way of master concepts is to repeat it, thus, effective repetition of topics is good support to mastery learning. Moreover, based on the findings of Thalheimer (2015) revealed that spaced learning strategy is effective in sustaining and improving learning but gaps must be observed. He also cited that spaced repetition is good in retaining more concepts taught. Supported by Thalima (2015), spacing is particularly beneficial if long term retention is the goal. Spacing assists minimize forgetting. Wider spacing is generally more effective than narrower spacing. In relation to student achievement, Klinton (2015) mentioned that performances of students exposed in repetitive teaching attained high scores compared with students exposed in traditional teaching as well as their attitude towards the learning content becomes responsive. Jolass (2015) also stated that students with retention able to get high scores in the test. Teachers of mathematics in teaching trigonometric concept will have a positive influence of students' achievement in trigonometry; it is with this in mind that the researchers wish to find out if using spaced learning strategy will influence students' achievement and retention ability in trigonometry.

Steps in the Use of Spacing Learning Strategy

Klinton (2015) identified five (5) steps involves is the use of spacing learning strategy and are as follows:

- First input session: Teacher present, the information (task).
- First interval: Short break
- Second input session: The teacher repeat information in the first input and revising the key items
- Second interval: Short break
- Third input session: Applying of information acquired during first-second input.

It is the break in activities which is key to the spaced learning approach, during these intervals the brain actively forms connections between the concepts learnt and the learners existing knowledge. The repetition of the same content strengthens these connections and the information is committed to long term memory despite being covered in such a short time.

Theoretical Framework for the Study

There are two main theories considered relevant to the present study. They are theory of spacing effect and testing effect. The spacing effect theory is that learning is more effective when study sessions are spaced out. That is, you present information over intervals of time; the information is encoded into long term memory by spaced sessions that are known as spaced presentation. The phenomenon was first identified by Ebbinghans in the 1885 in (Ace & Remelyn, 2017). Emphasis is therefore given to repetitions and short break. The second theory is testing effect; Lambert (2015) said that testing effect happens when the teacher present information in a "test" format, rather than just reading it, long term retention is dramatically improved. He also maintained that testing effect revealed that long – term memory is increased when some of the learning period is developed to retrieving the information through testing with proper feedback. This phenomenon has considerable potential for improving educational effectiveness (Maeca, Aiuseppina 'Leonarda& Maria, 2016). It is also useful for people to test their knowledge during the studying process, instead of solely studying or reading the materials. For example, a student can use flash cards to self test and receive feedback as they study. According to (Ace &Remalyn, 2017), that testing effect provides a larger benefit to long term memory when the tested material is difficult enough to acquire effort, the rate of retrieval success is high, and feedback with correct answers is given after testing. This theory is sometimes referred

to retrieval, practice testing or test-enhanced learning. Since the spacing instruction provides repetitions, testing and practices, the two theories are relevant to this study.

Purpose of the Study

The purpose of the study was to examine the effect of spaced learning strategy on achievement in trigonometry. Specifically, the study has the following objectives:

1. Examine whether students who were taught trigonometry using spaced learning strategy perform better than those taught using conventional teaching strategy.
2. Assess whether students who were taught trigonometry using spaced learning strategy will improve retention ability than those who were taught using conventional teaching strategy.

Research Questions

The study has the following research questions to guide the study:

1. What is the effect of spaced learning strategy and conventional teaching strategy on the achievement of students taught trigonometry concepts.
2. What is the effect of spaced learning strategy and conventional teaching strategy on the retention ability of students learning trigonometry concepts?

Research Hypotheses

The following null hypotheses were formulated and tested at $P \leq 0.05$ level of significance

Ho_1: There is no significant difference in the achievement of students taught trigonometry using spaced learning strategy and those taught using conventional teaching strategy.

Ho_2: There is no significant difference in the retention ability of students taught trigonometry using spaced learning strategy and those taught using conventional teaching strategy.

Research Methodology

Design

The study adopted quasi experimental design as described by (Sambo, 2008). The study has two (2) groups (control and experimental group). Trigonometry Performance Test (TPT) was administered at beginning of the study and was used as a pre-test measure of background knowledge of the participants in the domain of trigonometry. After, the treatment, the groups were subjected to post test to assess their achievements. Then later post-post test was administered to test their retention ability.

Population and Sample

The target population for this study was all the 4,707 SS II students in seven (7) public Senior Secondary Schools in Minna Metropolis of Niger State. Simple random sampling was adopted. In the first stage, two (2) schools were randomly selected through balloting. The two of the selected schools were assigned to be experimental and control groups. In the second stage of the randomization process in each of the schools selected, one intact class was selected out of the total number of SS II classes in each school. The intact classes were selected to avoid disrupting the school activities. The sample for the study was 255 students (experimental group 135, control group 120).

Instrumentation

Two instruments were developed by the researchers for this study. The Pre-test: Trigonometry Performance Test (TPT) is made to measure the background knowledge of the participants in the domain of trigonometry and are items drawn from the mathematics textbooks used in SS I classes in the selected schools. The items are pre requisite of SS II topics and consist of twenty (20) multiple questions with four options. The test items covered Trigonometric ratios, Fundamental identities and Trigonometric formulas. The Post-test: Trigonometry Achievement Test (TAT), this was used as post-test and post-posttest and items were drawn from solving triangles using the Sine and Cosine rules, bearings and distances, based on the contents covered during the treatment sessions. The test items consist of twenty (20) items with four (4) options. Two weeks after that TAT was re-administered as post-post test to assess retention ability.

The instruments were validated by two experts from Science Education Department of IBB University Lapai and Department of Mathematics Niger State College of Education, Minna. After careful study, corrections were effected based on their recommendations before administering. In addition, a pilot test was conducted to ascertain the effectiveness of the instruments. Similarly, the reliability coefficient of TPT and TAT was determined using of split-half reliability method. The scores on odd and even items were subjected to Spearman Brown formula using Statistical Package for Social Sciences (SPSS). The instruments were found to have 0.70 and 0.81 respectively.

Pre-test was administered before the treatment. The treatment lasted for 6 weeks. Two lesson models were designed for treatment session. The post test (TAT) was administered after the treatment. After two (2) weeks, Trigonometry Achievement Test (TAT) was reshuffle to served as post-post test and administered to assess the students' retention ability. The data collected were analyzed using independent sample t-test statistic to arrive at decisions for null hypotheses formulated.

Data Analysis

In answering the research questions, the data collected were analyzed using Descriptive statistic of means and standard Deviations, while in analyzing the null hypotheses the data collected were analyzed using independent sample t-test statistic at $p< 0.05$. The details of the analysis were as follows:

Table 1: Pre-Test Sores of Experimental and Control Groups

Groups	N	Mean	SD	DF	T-cal	T-cri	Mean Differences
Experimental	135	47.99	28.22	243	0.75	1.96	1.8
Control	120	46.19	25.42				

**Not significant at 0.05 level

Table 1 shows the comparisons of the pre-test scores of the groups. It was recorded that the t-cal (0.75) is less than t-critical (1.96). This indicates that there is no statistically significant difference between their scores. Therefore, the groups are comparable or equivalent before the treatment.

Research Question One

What is the effect of spaced learning strategy and conventional teaching strategy on the achievement of students taught trigonometry concept? To answer this question, a descriptive statistic using means and standard deviations were carried out. The result showed in Table 2.

Table 2: Post - Test Sores of Experimental and Control Groups

Groups	N	Mean	SD	Mean Differences
Experimental	135	63.42	15.75	12.95
Control	120	50.47	14.96	

The Table 2 showed that the mean score of the experimental group was 63.42 and control group was 50.47. The recorded mean difference was 12.95 in favour of experimental group after the treatment.

Null Hypothesis One

There is no significant difference in achievement of students taught Trigonometry using spaced learning strategy and those taught using conventional teaching strategy. To test this hypothesis an inferential statistics of an independent sample t-test was carried out and presented in Table 3.

Table 3: T-Test Analysis of Experimental and Control Groups in Post-test

Groups	N	Mean	SD	DF	T-cal	P-value	Remark
Experimental	135	63.42	15.75	253	6.71	0.00	Sig
Control	120	50.47	14.96				

*Significant at $P < 0.05$

Result of Table 3 showed that P-value was 0.00 which was much less than p=0.05. This indicated that there was significance difference in the achievement of students taught using spaced learning strategy and those taught using conventional teaching strategy. The null hypothesis was therefore rejected.

Research Question Two

What is the effect of spaced learning strategy and conventional teaching strategy on the retention ability of students learning trigonometry concepts? To answer this question, a descriptive statistics was used and presented in Table 4.

Table 4: Means and Standard Deviations of Experiments and Control Group in Post-post-test

Groups	N	Mean	SD	Mean Differences
Experimental	135	56.74	14.44	6.74
Control	120	50.00	16.17	

Table 4 indicated that experimental group has mean score 56.74 with standard deviation 14.44, while control group has mean score 50.00 with standard deviation 16.17. The recorded mean difference was 6.74 in favour of experimental group.

Null Hypothesis Two

There is no significant difference in the retention ability of students taught using spaced learning strategy and those taught using conventional teaching strategy. In order to test the hypothesis of post-post test scores of the students in experimental and control groups, they were subjected to an independent sample t-test statistic and the result was presented in Table 5.

Table 5: T-test Analysis of Experimental and Control Group in Post-post test

Groups	N	Mean	SD	DF	T-cal	P-value	Remark

Experimental	135	56.74	14.44	253	1.43	0.00	Sig
Control	120	50.00	16.17				

*Significant at $P < 0.05$

Result of Table 5 showed that P-value was 0.00 which was much less than p=0.05. This indicated the null hypothesis was rejected.

Discussion of Result

This study was carried to investigate the efficacy of spaced learning strategy on students' achievement in trigonometry at Senior Secondary School level. The result in Table 3 of this study showed that students who were taught using spaced learning strategy improved in their achievement scores than those taught with conventional teaching strategy. This result is consistent with the findings of Klinton(2015) and Ace & Remalyn (2017) who found that spacing learning strategy if effectively employed would improved students' achievement in a given task. Bala (2006) and Thalheimer (2015) believed that the spacing is beneficial for expanding intricate skills beyond conventional method. They also stated that spacing instruction is useful for the learners to be actively recall items learnt and assists prolong the forgetting curve. Similarly, to the findings of other researchers such as (Michael, Adejoh & Ochu, 2017) that spaced learning strategy significantly improved problem solving skill, interest and performance of students in mathematics. The spacing effect demonstrates that learning is more effective when study sessions are spaced out. This effect shows that more information is encoded.

Table 5 results indicates that there was significant difference in the retention ability of students exposed to spaced learning strategy and those who are exposed to conventional teaching strategy. This is, to say that subjects exposed to spaced learning strategy retained learnt concepts than their counterpart who are exposed to conventional teaching method. That is, the participants recalled or remembered pieces of knowledge, processes, or skills that were learned. In concurrent with findings of (Thalheimer, 2015). He cited that spaced repetition is good in retaining more concepts taught and also beneficial if long term retention is the goal. Spacing helps minimize forgetting. Bala (2006) and Michael, Adejoh and Ochu (2017) also stressed that students exposed to spaced learning strategy had high retention and high score in the tests. This study have approved to mathematics teachers and other stakeholder in educational industries that spaced learning strategy is effective on students' achievement and retention in learning trigonometry.

Conclusion

The findings of this study revealed that spaced learning strategy has significant effect on students' achievement and retention in mathematics especially trigonometry with reference to some selected senior secondary schools in Minna metropolis of Niger State, Nigeria. The study reviewed related and recent literatures which gives a strong empirical consistent with some of the earlier findings and asserting by researchers such as (Bala, 2006; Kondektar, 2013; Jolass, 2015 and Michael, Adejoh & Ochu, 2017). This could be attributed to the fact that the spaced learning approach is learning processes through an active involvement of students and also producing enhancement in their attention span.

Recommendations

Based on findings of this study, the researchers recommended that:

1. The use of spaced learning strategy should be adopted by mathematics teachers who experienced the same situation regarding to mastery/achievement of the learners towards certain topics. This helps students to recall things and perform well in the academic achievement.
2. Teachers of Mathematics should be exposed to spaced learning strategy through seminars, symposium and in-service training.
3. Since it proven that spaced learning improves the mathematical achievement of students and has a large effect, it is further recommended to also apply spaced learning with other disciplines.

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