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Effects of Spaced – Learning and Blended Learning Strategies on Academic Performance of Ekiti State Students in Mathematics

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Abstract:

This study investigated the effects of spaced-learning and blended learning strategies on academic performance of Ekiti State students in mathematics in order to find out the probable best learning strategy and interactive effects of gender and location. The sample of the study was 107 Senior Secondary Schools II, Mathematics students selected from six local government areas in Ekiti State using multi stage sampling technique. Quasi experimental design was adopted for the study. Achievement Test in Mathematics (ATM) was used to collect data. The students in the three groups were homogeneous at the commencement of the study. The data collected in this study were subjected to Analysis of Variance, Multiple Classification Analysis and Scheffe Post-hoc analysis at $\alpha = 0.05$ level of significance. The findings revealed that students in the spaced learning group performed better than those in blended learning and conventional groups while students in blended learning group performed better than their counterparts in the conventional group. Also, there were no interactive effects of gender on academic performance of students exposed to spaced-learning, blended learning and Conventional strategies of teaching Mathematics. Based on the findings, it was recommended among others that mathematics teachers should adopt spaced-learning and blended learning strategies as effective learning strategies in order to improve student's performance in Mathematics.

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Introduction

Mathematics is an important subject in day to day activities that every human being practices in one way or the other. Mathematics helps one to develop ability in creative thinking, seeing things with the inner eye and deep focusing. The importance of Mathematics to the society at large cannot be overemphasized because it is one of the essential subjects of modern technology.

According to Kolawole and Popoola (2009), Mathematics is an instrument that facilitates the learning of all subjects. No wonder Plato (a philosopher and mathematician) opined Mathematics is the bedrock of all other subjects and that is the reason why he said "let no man make destitute of mathematics". Due to the uniqueness of mathematics, it is classified as a compulsory subject right from the primary school to the secondary school and a subject that must be passed in the first school leaving certificate examination and Senior School Certificate Examination. Mathematics is one of the compulsory subjects both in the primary and secondary school level, not because the students are expected to become a mathematician but because of its application in day to day activities.

The performance of students keeps declining in Senior School Certificate Examination (SSCE) in mathematics. The performance of students in 2014 SSCE in Mathematics as announced by West African Examination Council testified to this claim. WAEC recorded a mass failure in Mathematics where more than 67% of the candidates who sat for the examination failed Mathematics (Vanguard Newspaper, 14th August, 2014). This unfortunate trend should agitate the minds of Mathematics educators in Nigeria. Therefore, there is a need to investigate this national problem from other perspective such as teaching strategies and students' personal perspectives. Hence, in this study the researcher examined whether teaching Mathematics via spaced learning and blended learning strategies will enhance students' academic performance in Mathematics.

Spaced-learning is a learning method in which highly condensed learning content is repeated three times, with two 5 – 10 minutes breaks during which distractor activities such as physical activities are performed by the students. Scientists have tried to understand long-term memory (LTM) processes through a variety of approaches including using repeated, spaced stimuli (Pavlov, 2010). Most people know from personal experience that if one is trying to learn something well, be it a set of facts, concepts, skills, or procedures—a single exposure is usually inadequate for good long-term retention. We are all familiar with the adage "practice makes perfection." But what is less obvious is that the timing of the practice (when it occurs) matters a great deal. Having the initial study and subsequent review or practice be spaced out over time generally leads to superior learning than having the repetition(s) occur in close temporal succession (with total study time kept equal in both cases). This phenomenon is called the *spacing effect* (sometimes also referred to as the benefit of *distributed practice*) and was first observed by researchers over a century ago.

Blended learning is a teaching strategy that converts the curriculum into computerized topics and multimedia such as image and sounds to make the educational process more effective and valuable. The uniqueness of the blended learning is represented by its ability to use the refined techniques from both, e-learning and traditional method, thus, the output will be a version of the best from each method. According to Kuo, et al. (2014), blended learning is an approach that combines face-to-face interactions with technology-based learning. Blended learning can also be referred to as hybrid learning and it's based upon face-to-face interactions 67% of the time and technology interactions 33% of the time. Many educators

have implemented this model into their classrooms to enhance effective teaching. The classroom may also be set up in a variance of ways. While the idea is to have the technology portion less than 50% of the time, teachers want to use the technology-based pieces as a way to enhance their instruction. Blended learning is a pedagogical approach that explicitly integrates online and face-to-face learning, and where students have meaningful interactions with their teacher with and without the mediation of electronic technology.

Blended learning is one successful approach to integrating technology, including mobile technologies, into standard classrooms (Moskal, et al., 2013). Blended learning can provide a more personalized and student-centred learning experience while still allowing students to readily access teacher support. The importance of using the Internet and computers is gradually increasing in terms of the teaching of Mathematics. Activities carried out during the usual teaching hour are not sufficiently effective because of time constraints hence, with the blended learning model, students are able to carry out multimedia applications – which cannot be sufficiently taught during lessons - via the Internet. In addition, ability to see the syllabus content before coming to the class enables students to learn the concepts and thus to come to the class as prepared for the lesson. Students can discuss important subjects in the Internet environment (in forums) and establish communication both with their teachers and with other students.

Statement of the Problem

Mass failure of students in Mathematics has been a source of concern to parents, students, teachers and the society at large. The mass failure has been attributed to teachers' methodology, non-availability of teaching materials and parental factors. All of these appeared to have been investigated yet the problems seem to have remained persistent going by the recurring mass failure in Mathematics external examinations in the state.

There is the need to look at the effect of using modern innovative methods to teach Mathematics. Evidences abound that spaced-learning and blended learning could be used to effectively facilitate better performance in Mathematics. It appears that the conventional method does not give attention to individual differences and that there is no-in-built mechanism to measure the level of the students' interest. This study, therefore, is a response to this challenge, and is faced with the problem of verifying the effects of spaced-learning and blended learning on students' performance in Mathematics.

Purpose of the Study

The purpose of the study was to investigate the effects of spaced-learning and blended learning strategies on the academic performance of Ekiti state students in Mathematics. It also determined the probable best and as well as most effective strategy out of spaced-learning, blended learning and conventional strategies in teaching Mathematics. It further examined gender difference in the academic performance of students taught Mathematics using spaced-learning, blended learning and conventional strategies.

Research Hypotheses

Based on the aforementioned questions the following hypotheses were generated

1. There is no significant difference in the pre-test mean scores of students exposed to spaced-learning, blended learning and conventional strategies.
2. There is no significant difference in the post-test mean scores of students exposed to spaced-learning, blended learning and conventional strategies.
3. There is no significant gender difference in the academic performance of students exposed to spaced-learning strategy.

4. There is no significant gender difference in the academic performance of students exposed to blended learning strategy.
5. There is no significant gender difference in the academic performance of students exposed to conventional strategy.

Research Design

The research design adopted for this study is quasi – experimental pre-test and post-test three group design (two experimental groups and one control group).
The pattern of the design is as shown below.

O_1 X_1 O_2: Experimental group (i) (Spaced-learning)
O_3 X_2 O_4: Experimental group (ii) (Blended learning)
O_5 - O_6: Control group (Conventional)

Where
O_1, O_3, O_5,– Pre-test (Performance before treatment)
O_2, O_4, O_6, – Post-test (Performance after treatment)
X_1 – Treatment via Spaced-learning strategy
X_2 – Treatment via Blended learning strategy
- – Control group: Conventional strategy

The study consisted of three independent variables. These include: spaced-learning, blended learning and conventional strategies. The dependent variable was the learning outcome which was the students' performance in Mathematics. The intervening variable consisted of gender (male and female).

Population

All Senior Secondary Two (SS II) Mathematics Students in all the Senior Secondary Schools in Ekiti State.

Sample and sampling techniques

The sample of this study is made up of one hundred and Seven (107) from three public secondary schools in Ekiti State, Nigeria. The sample was selected using multistage sampling technique. One Senatorial district was randomly selected from the three senatorial districts in Ekiti. Three Local Government Areas were randomly selected from the senatorial district earlier selected. One public secondary school was purposively selected from each of the three local government areas chosen for the study. The class intact size of each of the three schools was used for the study. Purposive Sampling technique was used to group the schools into different experimental and control groups.

Instrumentation

The instrument used for this study is Achievement Test in Mathematics (ATM). The researcher constructed the instrument; the instrument was used for pre-test and post-test. The pre-test was designed to test the homogeneity of the three groups (spaced-learning, blended learning and control groups). The content of ATM used for pre-test was reshuffled for the post-test in order to prevent carry-over effect and test-wiseness.

Validity and reliability of the instrument

The instrument was validated by content and face validity methods. It was given to experts of Mathematics Education and two mathematics teachers teaching Senior Secondary Schools. Fulon formula was used to establish the reliability coefficient of 0.83 for ATM.

Experimental Procedure

A purposive sampling technique was used to divide the sample into three groups (spaced-learning, blended learning and control groups). The Achievement Test in

Mathematics (ATM) was administered to all groups as Pre-test in order to ascertain the homogeneity of the three groups and the entry point of each group. To ascertain the homogeneity of the three groups, data of the Pre-test was subjected to Analysis of Variance which resulted to $F_{cal}<F_{table}$ (i.e. P>0.05). Thus, the null hypothesis is not rejected. Hence the three groups was homogeneous at the commencement of the study. The reshuffled Achievement Test in Mathematics which served as post-test was administered to the three groups after teaching the groups for 6 weeks using the same scheme of work.

Data Analysis

After treatment, the scores in pre-test and post-test in the three groups were collated and subjected to appropriate statistical analysis. The five hypotheses were analyzed by Analysis of Variance (ANOVA), Post-hoc Analysis (Scheffe) and t-test analysis at α = 0.05 level of significance.

RESULTS

Hypothesis 1: There is no significant difference in the pre-test mean scores of students exposed to spaced-learning, blended learning and conventional strategies.

Table 1: Analysis of Variance (ANOVA) for pre – test mean scores of students under the groups

Groups	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.105	2	.053	0.036	0.964
Within Groups	151.054	104	1.452		
Total	151.159	106			

P>0.05

The result presented in table 1 showed that there is no significant difference in the pre-test mean scores of students exposed to spaced-learning, blended learning and conventional method as P= 0.964>0.05. There is a strong evidence not to reject the null hypothesis. This makes hypothesis 1 to be non-rejected. Hence, there was no significant difference in the pre-test mean scores of students exposed to spaced-learning, blended learning and conventional strategies. The students in three groups are homogeneous at the beginning of this study.

Hypothesis 2: There is no significant difference in the post-test mean scores of students exposed to spaced-learning, blended learning and conventional strategies.

Table 2: Analysis of Variance (ANOVA) for post – test mean scores of students under the groups

Groups	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4954.605	2	2477.302	397.458*	.000
Within Groups	648.218	104	6.233		
Total	5602.822	106			

* P < 0.05

The result presented in table 2 showed that there is significant difference in the post-test mean scores of students exposed to spaced-learning, blended learning and conventional method as P= 0.000<0.01<0.05. There is a strong evidence to reject the null hypothesis. This makes hypothesis 2 to be rejected. Hence, there was significant difference in the post-test mean scores of students exposed to spaced-learning, blended learning and conventional

strategies. In order to investigate the source of the differences observed, Post – hoc analysis (Scheffe) with mean difference was carried out.

Table 3: Scheffe Post – hoc test and mean for observed difference in students' performance in the groups

Groups	**Mean**	**Spaced-learning** 41.12	**Blended learning** 32.66	**Conventional** 23.78
Spaced-learning,	41.12			
Blended learning	32.66	8.4591*		
Conventional	23.78	17.3364*	8.8772*	

* P < 0.05

In table 3, a significant difference was found between spaced-learning and blended learning in favour of spaced-learning. Also there was significant difference between spaced – learning and control in favour of spaced-learning. There was difference between blended learning and control in favour of blended learning. The result of post – hoc test also showed that students exposed to spaced – learning performed best. They performed significantly better than their counterparts in other two groups. Moreso, those exposed to blended learning performed better than those in conventional strategy, which indicate the conventional strategy group performed worst.

Hypothesis 3: There is no significant gender difference in the academic performance of students exposed to spaced-learning strategy.

Table 4: t-test analysis for gender difference in the academic performance of students exposed to spaced-learning strategy

Variations	**N**	**Mean($\bar{X}$)**	**SD**	**df**	**t_{cal}**	**P (Sig)**	**Rem.**
Male	16	41.25	1.69	32	0.469	0.642	Not Significant
Female	18	41.00	1.41				

P<0.05

Table 4 shows that the t-cal value of 0.469 is not significant because the P value (0.642) > 0.05 level of significance, this implies that null hypothesis is not rejected. Hence, there is no significant gender difference in the academic performance of students exposed to spaced-learning strategy.

Hypothesis 4: There is no significant gender difference in the academic performance of students exposed to blended learning strategy.

Table 5: t-test analysis for gender difference in the academic performance of students exposed to blended learning strategy

Variations	**N**	**Mean($\bar{X}$)**	**SD**	**df**	**t_{cal}**	**P (Sig)**	**Rem.**
Male	23	32.61	3.35	39	0.114	0.910	Not Significant
Female	18	32.72	2.92				

P<0.05

Table 5 shows that the t-cal value of 0.114 is not significant because the P value (0.910) > 0.05 level of significance, this implies that null hypothesis is not rejected. Hence,

there is no significant gender difference in the academic performance of students exposed to blended learning strategy.

Hypothesis 5: There is no significant gender difference in the academic performance of students exposed to conventional strategy.

Table 6: t-test analysis for gender difference in the academic performance of students exposed to conventional strategy

Variations	N	Mean($\bar{X}$)	SD	df	t_{cal}	P (Sig)	Rem.
Male	15	23.00	1.93	30	1.796	0.083	Not Significant
Female	17	24.47	2.60				

P<0.05

Table 6 shows that the t-cal value of 1.796 is not significant because the P value (0.083) > 0.05 level of significance, this implies that null hypothesis is not rejected. Hence, there is no significant gender difference in the academic performance of students exposed to conventional strategy.

Discussion

Table 1 revealed a no difference in the pre-test scores of students in Mathematics among the groups showing that the groups were homogenous at the commencement of the study. Findings from Table 2 revealed that a significant difference exists in the post – test mean scores of students in Mathematics among the three groups (spaced-learning, blended learning and conventional method). This is evident from the fact that students' performance varies from spaced-learning, blended learning and conventional method. Table 4 further revealed a significant difference between spaced-learning and blended learning; spaced-learning and conventional method; and between blended learning and conventional method. The findings showed that students in the spaced learning group performed better than those in blended learning and conventional methods while students in blended learning group performed better than their counterparts in the conventional method. This agrees with Seweje (2010) that good teaching strategies have the potent to improve cognition of students. This also justifies the earlier postulate of this study that spaced learning and blended learning could facilitate meaningful learning of Mathematics.

The findings from hypotheses on gender difference in the three groups showed no significant difference. This means that gender has nothing to do with students response to the use of any of the instructional strategy i.e. spaced-learning, blended learning and conventional. The findings agreed with that of Kolawole (2012) and Oludipe (2012) who observed that gender has no interactive effect on students' academic performance.

Conclusion

It can be concluded from the findings of this study are as follows:

- The students in the three groups are homogeneous at the beginning of this study.
- Spaced learning strategy is the most effective strategy, followed by blended learning strategy and conventional strategy being the worst
- Spaced-learning, blended learning strategies have impact on the academic performance of students in Mathematics.
- Gender of the students has no influence on the academic performance of students exposed to Mathematics through spaced-learning, blended learning and conventional strategies

Recommendations

Based on the following findings, it is hereby recommended that: Mathematics teachers should adopt spaced-learning and blended learning strategies as an effective learning strategy in order to improve student's performance, social inter-action skills and foster meta-cognition in students. Mathematics teachers should be given adequate orientation through workshops and seminars to update their knowledge in the use of spaced-learning and blended learning strategies in teaching.

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