

Efficacy of Station-Rotation-Blended Learning Strategy in Mitigating Anxiety and Enhancing Motivation and Performance in Ecology Concepts among Secondary Schools' Low Achieving Students in Zaria, Kaduna, Nigeria

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ABSTRACT

Students in low-achieving groups in science classes in secondary schools often face high levels of test anxiety, a lack of academic motivation, and low academic achievement due to traditional teacher-centered instruction. This research assessed the impact of a Station-Rotation Blended Learning Strategy (SRBLS) on academic success, end of examination anxiety, and motivation of low achieving students in Senior Secondary School II (SS II) in Zaria Education Zone, Kaduna State, Nigeria on ecological concepts. The study chosen two co-education public secondary schools through stratified purposive sampling according to the availability of ICT facilities using a pretest- posttest non-equivalent control group quasi-experimental design. Low achieving students were identified ($N = 50$; Experimental = 30; Control = 20): and a six week intervention was implemented either SRBLS or traditional lecture instruction. Three validated instruments were used: the Ecology Performance Test (EPT; $r = 0.78$), the Ecological Concepts Motivation Questionnaire (ECMQ; 0.83) and the Biology Student Anxiety Questionnaire (BSAQ; 0.76) to collect data. Independent samples t-tests and Mann-Whitney U tests at $\alpha = 0.05$ were used to analyse data. The results showed that low achieving students who were exposed to SRBLS scored much higher on the posttest performance ($M = 34.73$, $SD = 4.32$) as compared to the control group ($M = 11.75$, $SD = 3.42$, $t(48) = 19.99$, $p < 0.001$). Furthermore, SRBLS significantly reduced test anxiety ($U = 0.00$, $p = 0.001$) and increased academic motivation ($M_{exp} = 35.70$, $SD = 3.78$ vs. $M_{ctrl} = 21.00$, $SD = 2.59$; $t(48) = 26.71$, $p < 0.001$). There was no statistically significant difference in performance between male ($M = 34.88$, $SD = 4.39$) and female low achieving students ($M = 34.54$, $SD = 4.39$; $t(28) = 0.21$, $p = 0.83$), in the experimental group, which showed gender equity in the outcomes achievement. The research concludes that SRBLS is a valid pedagogical model that is gender inclusive and can be used to enhance cognitive and affective learning outcomes in low achieving students. It is highly suggested to incorporate rotational blended learning models in science curricula and teacher education programs in secondary schools.

KEYWORDS

Academic Motivation, Biology Education, Ecology Instruction, Secondary Education, low achieving students, Station-Rotation Blended Learning, Test Anxiety

I. INTRODUCTION

Science education is very crucial in the development of a nation, technological development, economic competitiveness and scientific literacy. The Federal Ministry of Education (FMOE), Government of the Federal Republic of Nigeria (FRN), 2013, underscores the need to inculcate scientific skills and knowledge in school students as needed to survive in the current technocratic society. The core science subjects (Biology, Chemistry, Physics and Mathematics) are compulsory subjects in senior secondary which are the foundation for tertiary courses such as medicine, pharmacy, agriculture and environmental sciences of these subjects, Biology has the largest number of students, as it is thought to be the easiest subject and is compulsory for children who want to study the science-track. Biology provides learners with concepts and practical skills to help them tackle issues in the real world relating to the environment and health. In order to enter into the biological and health science programs of the Nigerian Universities, students are required to get at least Credit pass (Grade C6 or above) in the Senior School Certificate Examination (SSCE) from West African Examinations Council (WAEC) or the National Examinations Council (NECO).

Although the science of Biology is a strategic one, pupils' performance in national examination in secondary school has been consistently low. The performance in Biology has been very low, a trend noted in the Chief Examiners' Reports (WAEC, 2024) and revealed by educational researchers. This is, among other things, due to the predominant use of traditional, teacher-centred forms of education, which are often based on a didactic lecture. Lecture-based instruction allows for minimal interaction and engagement, passively requires the learner to memorize, limits concept retention, and does not account for individual differences in learning. Traditional teaching pays less heed to low achieving students, who have no intellectual disability, but take time to process information at a slower rate, need more repetition, and must process information at a slower pace in order to master abstract scientific concepts. Classrooms with mixed ability classes teach at a normal rate, helping average and quick learners, but not helping the students who may be learning slower. Test anxiety is often a common problem with low achieving students and is a negative emotional response of excessive worry and nervousness about academic tasks, coupled with a significant drop in academic motivation. Academic failure is intensified by high anxiety levels and low motivation, and this, in turn, fuels anxiety and low motivation, forming a vicious circle.

For pedagogical challenges, the researchers suggest to use student-cantered and differentiated learning approaches. A model that has shown promise is the Station-Rotation Blended Learning Strategy (SRBLS) a subcategory of the rotational blended learning model where students conduct themselves in small groups (students at a single station or station rotation) for a specified amount of time, and at least one of the stations includes online instruction (Horn & Staker, 2014). The combination of direct teacher instruction, peer learning, and self-paced digital tasks is used to offer low achieving a variety of modalities, small group support, and controlled learning speeds in SRBLS. Ecological concepts such as energy flow, population, biological associations and conservation of the environment are key concepts in science education, which form the core of the SS II Biology curriculum especially in the senior secondary school. These are however topics that demand abstract conceptualization and synthesis in the field, which poses learning challenges for low achieving students. In addition, empirical literature on gender differences in science

achievement, motivation and anxiety are inconclusive. Thus, the effect of Station-Rotation Blended Learning (SRBL) strategy on the motivation, test anxiety, and academic performance of secondary school low achieving learners on ecological concepts in Zaria Education Zone, Kaduna State, Nigeria was investigated.

II. THEORETICAL FRAMEWORK

This study is based on the theory of Cognitive Load Theory (Sweller, 1988) and the theory of Self-Determination Theory. Cognitive Load Theory suggests that people's working memory is limited. Underachieving students' working memory can frequently get overloaded during traditional lectures, as multiple ecological processes are introduced at once. SRBLS alleviates cognitive load by breaking learning into smaller, more focused activities in three stations. According to SCT, three basic psychological needs, autonomy, competence and relatedness, must be met in instructional environments to support intrinsic motivation. SRBLS provides autonomy by allowing each student to explore digitally at their own pace, competence by allowing each student to engage in a task scaffolded by the teacher, and relatedness through collaborative group tasks.

A. Statement of the Problem

Educational stakeholders in Nigeria remain worried about the poor achievements of learners in Biology in the senior secondary level of education. Although several factors like the scope of syllabus, insufficient laboratory facilities, etc., have been identified as contributing factors to the problem, the ineffective and didactic instruction lecture-based information delivery techniques are still the major contributors to student failures. Didactic is not flexible enough to give space to learning rates, as it puts low achieving students at a great disadvantage.

This study is grounded in Cognitive Load Theory and Self-Determination Theory. Cognitive Load Theory posits that human working memory has limited capacity. Traditional lectures often overload low achieving students' working memory by presenting complex ecological processes simultaneously. SRBLS mitigates cognitive load by segmenting learning into smaller, focused activities across three stations. Self-Determination Theory posits that intrinsic motivation is fostered when instructional environments satisfy three basic psychological needs: autonomy, competence, and relatedness. SRBLS supports autonomy through self-paced digital exploration, competence through scaffolded teacher-led tasks, and relatedness through collaborative group activities.

B. Objectives of the Study

The research will attain the following objectives:

- Determine the impact of SRBLS on academic achievement of low achieving students in ecological concepts as compared to those students taught by the traditional lecture method.

- Evaluate the impact of SRBLS on the levels of test anxiety of low achieving students as far as ecological concepts are concerned as compared to those taught with the traditional approach.
- Test the impact of SRBLS on the motivation of low achieving students in relation to ecological concepts in comparison to students who are taught using the lecture method.
- Look at the impact of SRBLS on academic performance of low achievers in ecological concepts on gender.

C. *Research Questions*

The study was conducted through the following research questions:

- What is the difference in mean values of academic performance of low achieving students who are taught ecological concepts with the help of SRBLS and those who are taught the same concepts with the help of the traditional method?
- Is there a difference in the mean rank of test anxiety between low achieving students who were taught ecological concepts with the help of SRBLS and the students taught with the help of the conventional method?
- What is the difference between the mean scores of academic motivation of low achieving learners taught ecological concepts with the help of SRBLS and the traditional approach?
- What is the difference in the mean scores of academic performance between male and female low achieving learners taught ecological concepts with the help of SRBLS?

D. *Null Hypotheses*

The null hypotheses that were tested with $\alpha = 0.05$ included the following:

- No statistically significant difference in the average score of academic performance of the low achieving learners taught ecological concepts in SRBLS and taught in the traditional way.
- The difference between the levels of test anxiety of low achieving learners who were taught ecological concepts with the help of SRBLS and learners taught with the help of the conventional method is not statistically significant.
- No statistically significant difference between the mean academic motivation scores of low achieving learners taught the ecological concepts with the help of SRBLS and with the help of the traditional method.
- The mean effect of the academic performance scores between boys and girls with low achievement who are being taught ecological concepts through SRBLS do not have statistically significant differences.

III. **METHODOLOGY**

This study adopted a pre-test post-test non-equivalent control group quasi-experimental design. This design is appropriate for educational settings where random assignment of

individual students is impractical and intact classes must be utilized to prevent school timetable disruption.

The target population comprised all public Senior Secondary II (SS II) students offering Biology across public co-educational secondary schools in Zaria Education Zone, Kaduna State, Nigeria. A multi-stage sampling procedure was employed. Purposive sampling was used to select six co-educational public secondary schools possessing functional Information and Communication Technology (ICT) infrastructure, computer laboratories, and internet access. Baseline equivalence across these six schools was confirmed via Analysis of Variance (ANOVA) on pretest Ecology Performance Test (EPT) scores ($p > 0.05$). Two schools were randomly selected from the pool; one school was designated as the Experimental Group ($n = 30$) and the second as the Control Group ($n = 20$). Low achieving students inside whole SS II classes were picked utilising a multi-tiered problem-solving protocol, this comprise the analysis of complete records in life science within three terms of their SS 3, selecting students scoring consistently below the pass threshold ($<40\%$), structured interviews with subject teachers concerning learning speed and retention and direct class behavioural observations evaluating task completion rates.

The resulting sample comprised $N = 50$ low achieving students (Experimental Group $n = 30$; Control Group $n = 20$). Data were gathered using three validated research instruments, first, the Ecology Performance Test (EPT), adapted from standard WAEC and NECO past examination papers (2019–2023). The EPT comprised 30 multiple-choice items (four options: A–D) covering key ecological topics such as ecosystem definitions, energy flow, biological associations, pollution, and natural resource conservation. Each correct response earned 1 mark (Maximum score = 30). The Ecological Concepts Motivation Questionnaire (ECMQ), this is adapted from the Academic Motivation Scale. There were 21 items on the ECMQ that were scored on a 5-point Likert scale ranging from 5 {strongly Agree} to 1 {strongly Disagree} (range 21–105). Lastly, the Biology Student Anxiety Questionnaire (BSAQ) based on well-known test anxiety inventories. The BSAQ had 20 items on a five-point Likert scale of 5 = Strongly Agree (High anxiety) to 1 = Strongly Disagree (Low anxiety) with a range of scores from 20 to 100.

The instruments were face validated and content validated with a panel of experts which consisted of two Senior Lecturers in Science Education, two Educational Psychology experts from Ahmadu Bello University, Zaria and one experienced Secondary School Biology teacher. A non-sampled public secondary school in Zaria Zone was used for the pilot study. The EPT test-retest reliability was $r = 0.78$, ECMQ internal consistency was Cronbach's alpha = 0.83 and BSAQ internal consistency was Cronbach's alpha = 0.76. The intervention was twice a week, double-period lessons (80 minutes per session), for six weeks. Identical ecological content was taught to both groups. Experimental students were assigned to small working groups and were assigned to each of three learning stations for 25–27 minutes. The first station being the teacher led station, utilized direct, guided teaching that mainly on explaining the hard aspect of ecology, the station also addresses student questions and supporting the learner's discussion. The second station was related to peer assisted problem solving, practical tasks to be completed, discussion and improvisation of charts and models related to ecology. The last station was related to computer aided learning exploration of interactive digital learning modules, animated ecology simulations and online introductive quizzes with research assistant.

The control group was taught using the normal teaching methods which include lecturing. The teacher introduced the definitions, verbally explained the ecological processes on the chalkboard and gave the usual individual homework and textbook reading. Post-tests (EPT, ECMQ, and BSAQ) were completed at the end of Week 6, in a controlled examination environment. IBM SPSS Version 26 was used for analysis of data. There were descriptive statistics results in the form of means, standard deviations, mean ranks. Independent samples t-test was used for data of academic performance and motivation scores (parametric continuous variables) while Mann-Whitney U test was used for test anxiety ranks (non-parametric ordinal variables) and both tests were conducted at $\alpha = 0.05$.

IV. RESULTS

A. Answering Research Questions and Hypotheses Testing

The data collected was in the form of descriptive mean, mean difference, mean ranks and mean rank difference statistics and the form of these statistics answered the six research questions of the study. The three null hypotheses were tested using inferential statistics tested at $\alpha \leq 0.05$ levels of significance. Mean performance score hypotheses were tested as parametric data and t-test was applied whereas the hypotheses which concerned the anxiety scores were tested by the non-parametric data of Mann Whitney U test.

1. Research Question One:

How do the SS II low achieving learners who are taught ecology concepts using Station rotation blended learning differ with their conventional counterparts taught ecology concepts using conventional method?

Independent samples t-test was used to compare posttest EPT score of the experimental and control groups to evaluate the impact of SRBLS on educational attainment. To respond to research question one, post-test results of experimental and control groups formed with the help of the Ecology Performance Test (EPT) were subject to descriptive statistical analysis of the mean and standard deviation of the results, the summary of which is presented in Table 1.

Table 1: Mean and Standard Deviation of Post-test Scores for low achieving students in The Experimental and Control Groups

Groups	N	Mean	Std. Deviation	Mean Difference
Experimental	30	25.50	4.32	22.98
Control Group	20	11.75	3.42	

As indicated in Table 1, the experimental group had an average of 25.50 (SD = 4.32) in the posttest and the control group had an arithmetic value of 11.75 (SD = 3.42), which presented a difference in the average values of 22.98 in favour of the experimental group.

To test the null hypothesis one, independent samples t-test statistics (at $\alpha \leq 0.05$) were used to compare the post-test scores of EPT (Table 1) of experimental and control groups. Table 2 gives a summary of the analysis.

Table 2: Independent Samples t-test for Posttest Academic Performance

Group	N	Mean	Std. Dev.	df	t	p	Remark	Decision
Experimental	30	25.50	4.32					
				48	19.99	0.00	Significant	Ho ₁ Rejected
Control	20	11.75	3.42					

Significant at $p < 0.05$ level

An independent samples t-test was done to test Ho₁. The statistical significance of the difference between the groups was statistically significant as shown in Table 2 ($t(48) = 19.99$, $p < 0.001$). Therefore, Ho₁ is rejected, and it proves that SRBLS significantly enhanced performance in ecological concepts, as compared to the traditional approach.

2. Research Question Two:

How does the level of anxiety of SS II low achieving learners who learn ecology concepts with Station rotation blended learning differ with the level of anxiety of learners who learn with conventional method? Descriptive statistics of Mean ranks and mean rank differences were used to answer the research question two. Table 3 shows the results of the analysis.

Table 3: Summary of Mean Rank, and Mean Rank Differences for Level of Anxiety Among experimental and control groups

Group	n	Posttest $\bar{X}$ rank	Mean Rank Difference Pre & Post	Mean Rank difference (Posttest)
Experimental	30	15.50	4.45	2.22
Control	20	40.50	6.67	

Table 3 indicates that the posttest anxiety mean rank for the experimental group was 15.50, compared to 40.50 for the control group. Lower mean ranks correspond to lower reported test anxiety.

Table 4: Mann-Whitney U Test Results for Posttest Anxiety Levels

Group	n	Posttest $\bar{X}$ rank	U-cal	P	Remark	Decision
Experimental	30	15.50				
			0.00	0.001	Sig.	Ho ₂ Rejected
Control	20	40.50				

Significant at $P \leq 0.05$

The Mann-Whitney U test (Table 4) revealed a statistically considerable reduction in anxiety for the experimental group ($U = 0.00$, $p = 0.001$). Thus, Thus, Ho₂ is rejected.

3. *Research Question Three:*

What distinguishes academic motivation scores of low achieving students taught ecological concepts using SRBLS and those taught using the conventional method?

Table 5: Mean and Standard Deviation of Post-test Motivation Scores

Group	N	Mean	Std. Deviation	Mean Difference
Experimental	30	35.70	3.78	
				14.70
Control	20	21.00	2.59	

Table 5 indicates that the group taught to use station rotation had a post-test motivation average value of 35.70 (SD = 3.78), and the control group had a 21.00 (SD = 2.59) indicating that the average value of motivation difference is 14.70 in favour of the group that had been taught to use station rotation approach.

Null Hypothesis Three: There is no significant difference between the motivations of SS II low achieving learners taught ecology with Station rotation blended learning as opposed to conventional approach only.

To test the null hypothesis three, independent samples t -test were used to compare the post posttest scores of low achieving students in the experimental and control groups in comparison with ECMG at the level of significance of 0.05. A summary of the statistics is in Table 6.

Table 6: Independent t-test Analysis of Mean Motivation Scores for SS II low achieving students in the Experimental and Control Groups

Group	N	Mean	Std. Deviation	df	t	P	Remark	Decision
Experimental	30	35.70	3.78					
				48	26.71	0.001	Significant	Ho ₃ Rejected
Control	20	21.00	2.59					

Significant at $\alpha < 0.05$ level

Table 6 revealed that there is significant difference in the mean motivation score of the SS II low achievers in the experimental and control group, $t(48) = 26.71$, $p = 0.001$ which is below the level of significance of 0.05. The experimental and control group got a mean of 35.70 and 21.00 respectively. Thus the null hypothesis that there is no significant difference between the motivation of SS II low achieving students taught ecology by Station rotation blended learning, and the students taught by conventional method alone is rejected. This means that the SS II low achieving students were able to retain the concept of ecology better after exposure to Station rotation blended learning as compared to those taught with the same concept using the traditional method.

4. Research Question Four:

How different are the average value performance score of SSII male and female low achieving students taught the ecology concepts based on Station rotation blended learning?

In order to address research question four, a descriptive analysis of posttest scores of male and female SS II low achieving students in the experimental EPT generated group was done. The average value and standard deviation of the statistics is presented in Table 7.

Table 7: Mean and Standard Deviation of Posttest Scores of Male and Female SS II Low Achieving Students in the Experimental Group

Groups	N	Mean	Std. Deviation	Mean Difference
Male	17	34.88	4.39	0.34
Female	13	34.54	4.39	

Table 7 result indicated that there were differences between the average value of male and female low achieving students in SS II when they were taught ecology concepts by Station rotation blended learning. The average value of 34.88 and 34.54 was attained with average value difference of 0.34 in favour of male SS II low performing students in the experimental group. The table showed that the male SS II low achieving students taught in Station rotation blended learning performed better than did the female students taught same concepts taught in Station rotation blended learning. Hypothesis four was tested at α 0.05 as shown in Table 8 to know whether the mean difference is pronounced or not.

Null Hypothesis Four: The mean score of performance of male and female low achieving students taught on ecology concepts by Station rotation blended learning alone does not show any marked difference.

To test null hypothesis four, an independent sample t-test statistic at $\alpha = 0.05$ was used to compare the posttest scores of male and female SS II low achieving students obtained (Table 7) of experimental group through the use of EPT. Table 8 provides summary of the analysis.

Table 8: Independent Samples t-test Analysis of Mean Performance Scores of Male and Female SS II Low Achieving students in the Experimental Group

Group	N	Mean	Std. Dev.	df	t	p	Remark	Decision
Male	17	34.88	4.39	28	0.21	0.83	Not Sig.	Ho4 Retained
Female	13	34.54	4.39					

Not Significant at $\alpha > 0.05$ level

The results in Table 8 indicated that there is no significant difference between the performance mean scores of male and female SS II low achieving students in the

experimental group, $t(28) = 0.21$, $p = 0.83$ which is higher than the level of significance of 0.05. The mean score of the male and female low achieving students was 34.88 and 34.54 respectively. Consequently, the null hypothesis that claimed that no significant difference exists between the mean score of male and female low achieving students taught ecology concepts using Station rotation blended learning and using conventional method only are therefore retained. This means that the scores of both male and female SS II low achievers increased after the exposure to Station rotation blended learning signifying that teaching-with-Station rotation blended learning is effective in increasing the academic achievement of both male and female SS II low achieving students.

V. DISCUSSION

The findings of this study reveal that the Station Rotation Blended Learning Strategy (SRBLS) has a significant impact on the education attainment, learning motivation and test anxiety of students in the secondary school learning stage who fail in the ecological concept learning. The results of the post-test education level scores ($M = 34.73$) for low achieving students in the SRBLS group as compared with the control group ($M = 11.75$) indicates that the multimodal, differentiated instruction is effective. Low achieving students are forced into passive learning style with didactic instruction methods with limited opportunity to be able to process abstract ecological concepts like nutrient flow, energy flow and interaction between populations. SRBLS organize learning into operational stations as contrasted. By dividing complex concepts into smaller chunks of learning with interaction, students will not suffer from a cognitive overload, according to Cognitive Load Theory. The hands-on activities at its collaborative station lead to conceptual mastery and for direct scaffolding, it is done by small group interaction at the teacher-led station.

In addition, SRBLS resulted in a statistically significant decrease in student test anxiety ($U = 0.00$, $p = 0.001$). For the students who fail to achieve well, the symptoms of test anxiety are frequently due to fear of failure and due to the competition that takes place in the classroom at a rapid pace and also pressure they experience from public performance in a big and passive environment. SRBLS addresses the stressors by providing a small-group setting that is supportive and allows students to ask questions without being ridiculed by their peers. Low achieving students' self-efficacy will be enhanced when they can learn and master the self-paced digital stations through multiple attempts of accessing the multimedia simulations to test phobia. The results showed that the motivation in education of the SRBLS treated students ($t = 26.71$, $p < 0.001$) was significantly increased, which is in line with the theory of self-determination. SRBLS meets students' three psychological needs: autonomy (choice in digital learning), competence (structured tasks to create opportunities for success), and relatedness (small group peer activities) by fostering the active, engaged participation of low achieving students.

No significant difference was found between the male ($M = 34.88$) and female ($M = 34.54$) low achieving students' scholastic achievement on the gender based evaluation within the practical experience group ($p = 0.83$). This discovery is a sign of gender equality in blended learning. SRBLS ensures equal access to learning, interaction and pacing for both genders, and these aspects are also supported by the prior research conducted by Ugwuoti et al.

(2024) which showed that gender disparities in science achievement are eliminated in all types of structured, student-centered learning.

VI. CONCLUSION

This study confirms that the Rotational learning station is a notably effective, gender-fair instructional intervention for upper school low achieving learners in life sciences. This is done by structurally integrating direct scaffolding, team-based activity execution, and independent digital exploration, SRBLS effectively relieve test anxiety, boosts learning motivation, and propels vast gains in academic enhancement regarding ecological concepts.

RECOMMENDATIONS

- Biology tutors should make use Station-Rotation Blended instruction a standard method of teaching.
- 2. Educational authorities, such as ministries, boards and other agencies should organize teacher professional trainings for teachers to learn best way to use station rotation approach of teaching.
- 3. School authorities should identify low achieving students and mandate scaffolded rotational instruction in their lesson plans.

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