

JOSTMED 18 (2), JUNE, 2022

ISSN: 0748 – 4710



JOURNAL OF SCIENCE, TECHNOLOGY, MATHEMATICS AND EDUCATION (JOSTMED)

website: www.futminna.edu.ng

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Phone: +234-816-680-7534



PUBLISHED BY:
DEPARTMENT OF SCIENCE EDUCATION
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,
NIGERIA, AFRICA

**JOURNAL OF SCIENCE, TECHNOLOGY,
MATHEMATICS AND EDUCATION
(JOSTMED)**



ISSN: 0748 – 4710

VOLUME 18 (2), JUNE, 2022

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ISSN 0748-4710

TABLE OF CONTENTS

1.	In-Vitro Anti-Tubercular Activity of <i>Syzygium Aromaticum</i> Extract Against Mycobacteria Species. Babayi, H., Oladosu, P. O., Olatunji, K. T., Aboyeji, D. O., Amali, E. D., & Lawal, F.	1
2.	Recursive Variable Expansion Based Optimization of Smith-Waterman Algorithm. Hassan Kehinde Bello	10
3.	Antibacterial Activities of Leech Salivary Extract-Mediated Silver Nanoparticles Against Some Pathogenic Bacteria. Babayi, H., Owolabi, B. I., Adelere, I. A., Mustapha, A., & Amali, E. D.	24
4.	Effects of Climate Variability on Arable Crop Farmers' Socio-Economic Status in Southwestern Nigeria. Sadiq, M.M., & Adeola, R.G.	35
5.	Evaluation of Climate Change Impact on Lagos Metropolis Using Corridor Mapping Technique of Open Defecation Sites along Mile2 - Okokomaiko Area of Lagos State Nigeria. Michael, A. Arove & Caroline Adudor	45
6.	Determinants of Economic Sustainability of Agricultural Activities Among Rural Women in Kwara State, Nigeria. Aremu, Adeola O., Muhammad-Lawal, Abdulazeez, & Oyelere, Gbolahan O.	57
7.	Investigating the Sanitation Profile of Households in Ogun State, Nigeria. Olasunkanmi Olapeju & Babalola Adewara	68
8.	Modelling the Effects of Heat and Mass Transfer on Steady Two-Dimensional Hydromagnetic Flow Over an Impermeable Surface. Nmeburulo, I. E., Durojaye, M. O., & Onyeozili, I. A.	88
9.	Stability Analysis of the Mathematical Modeling of Rumour Spreading Incorporating Two Media Apparatus. Gana, P., Akinwande, N. I., Olayiwola R. O., & Cole, A. T.	100
10.	A Note on Properties of Solution of Transient Mixed Convection Flow in a Vertical Micro-annulus with Internal Heat Generation and Temperature-Dependent Viscosity. Mkpedem, K. A., & Durojaye, M. O.	116
11.	A Class of Zero-Stable High Order Adams-Moulton Hybrid Type Methods for the Solution of Special Second Order Initial Value Problems of Odes. Usman, A. M., & Yahaya, Y.	122
12.	Modelling Transient Mixed Convection Flow In A Vertical Micro-Annulus With Internal Heat Generation And Temperature-Dependent Viscosity. Mkpedem K. A., & Durojaye, M. O.	136

13. Formulation Of k –Step Order $2k$ Fuzzy-Structured Block Hybrid Backward Differentiation Formulae Algorithms For The Approximate Solution Of Fuzzy Differential Equations. **Mohammed, U., Usman, A. M., Salihu, N. O., Ma’ali, A. I & Akintubobo, B. G.**.....156
14. Effect of Project and Mastery Based Learning on Academic Performance in Mathematics Among Junior Secondary School Students in Ibadan Metropolis, Nigeria. **Joseph Olusola Fehintola**.....171
15. Influence of Family Background, Study Habits, Peer Group and Social Media on Students’ Academic Achievement in Mathematics. **Khadijat, S. A., Semiu, A. S., Saidat, M. A., Nasrudeen, A. M., Rafiat, A. M., & Maryam, I. S.**.....184
16. Assessment of the Use of Synchronous E-Learning among Junior Secondary Schools Basic Science Teachers in Lagos State Nigeria. **Adetayo Adekunle Adebajo**.....194
17. Effect of Cognitive Behavioural Therapy for Isomnia on Mathematics Performance of Senior Secondary School Students with Sleep Disorder in Ibadan Metropolis. **Joseph Olusola Fehintola**.....203
18. Computer Based Test: Staff Perception on Quality of Administration and Satisfaction Experience of Undergraduates in Tertiary Institutions in Lagos State, Nigeria. **Adebowale Adebago & Lucas, B. Ojo**.....216
19. Effects of Reciprocal-Peer-Tutoring on Performance in Oxidation-Reduction Reaction among Secondary School Chemistry Students in Sabon Tasha Zone, Kaduna, Nigeria. **Tamar Kuwoṭ, Bodam; Jonathan Salihu, Mari; & Patience, Guyah**.....226
20. Effects of Study Technology Strategies in Tackling Barriers to Study on Students’ Achievement in Ecology in Ilorin, Nigeria. **Rihanat Aduke Ahmed & Professor Isaac Olakanmi Abimbola**.....234
21. Effects of Collaborative and Motivation-Based Adaptive Learning Strategies on Technical College Students’ Achievement in General Metalwork Niger State, Nigeria. **Alleh R. O., Ibrahim, I. K., Tukura C. S., Umar I. Y**.....249

EFFECTS OF STUDY TECHNOLOGY STRATEGIES IN TACKLING BARRIERS TO STUDY ON STUDENTS' ACHIEVEMENT IN ECOLOGY IN ILORIN, NIGERIA

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Abstract

Learning how to learn to achieve excellent performance is an indispensable strategy for students' academic achievement. In this study, attempts were made to determine the effect based on gender, of the three combined study technology learning strategies on students' achievement in ecology. The study was a quasi-experimental study with a 3x2 matrix. The population for this study was all biology students in senior secondary schools in Ilorin, Nigeria. The sample was 399 Biology Students that were purposively selected and they learnt in their intact classes. Two instruments, designed by the researchers, consisting of a training manual entitled "Learning How to Learn with Study Technology" and Ecology Achievement Test, with reliability coefficient of 0.71 and 0.78 respectively were used for the study. Three Research Questions were raised with the three hypotheses. They are, tested and answered with ANCOVA at 0.05 level of significance. The findings showed that the combined learning strategies had a significant effect on the students' achievement in Ecology, when compared with the conventional strategy of learning. Also, there is no significant statistical difference ($p > 0.05$) in the achievement of biology students in ecology based on gender. The study concluded that combined learning strategies of study technology have effects on the academic achievement. It was recommended that Biology students should be assisted to learn Biology with combined Study Technology learning strategies to improve their academic achievement.

Keywords: Barriers to Study, Combined learning strategies, Study Technology, Ecology and Achievement

Introduction

There are numerous factors that distract students in the learning process. Such factors include peer influence, bad study habit, inappropriate use of learning strategies, not using varied learning strategies, barriers to study, among many others. According to Hubbard, the pioneer of Study Technology, the 3 barriers to study that often distract students from studying with perfect understanding are lack of mass, skipped gradient and misunderstood word. The Applied Scholastics International (ASI), a non-governmental organization in the United States of America, developed Study Technology as a research-based system of learning how to learn for teaching and learning. The three major barriers to the learner's study according to ASI are demonstrated in Figure 1.

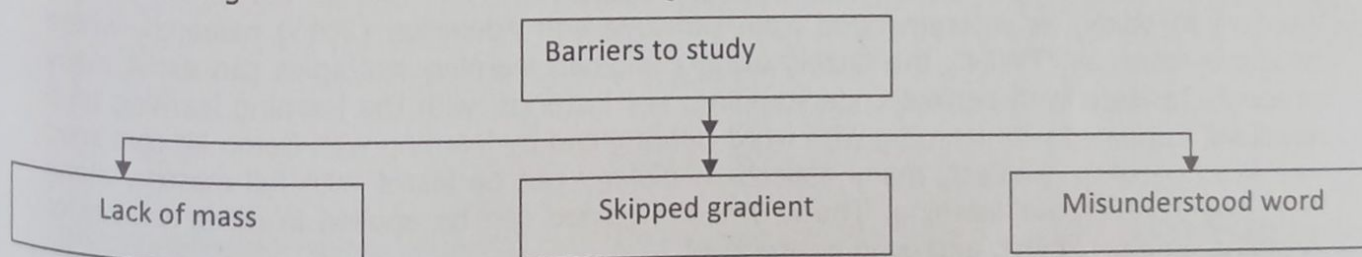


Figure 1: Barriers to Study

The knowledge of the remedies to the barriers to study led to the experimentation of the combined learning strategies to aid meaningful learning. One of the strategies to tackle the lack of mass is learning with Demo kit, or other alternatives like movies, sketching, drawing, and many others. Demo kit is a teaching and learning aid that consists of smaller items that can be used to demonstrate any word or concept in any subject. The learning learning on a gradient strategy could tackle skipped gradient. The gradient of a learning material is represented by three dimensions, which determine the difficulty of how it would be learned. They are the dimensions of abstractness, complexity and sophistication (Abimbola, 2018), as shown in the figure 2. The easiest concepts to learn are simple, concrete and descriptive while the most difficult concepts to learn are complex, abstract and quantitative. Alabi, & Abimbola, (2018). In this study, the basic ecological concepts were structured in such a way that one aspect was understood and mastered well before proceeding to another without jumping or skipping any part. In addition, the participants in this study equally learnt using concept difficulty matrix, where the simple ecological concepts were learnt before the complex ones, for easy learning.

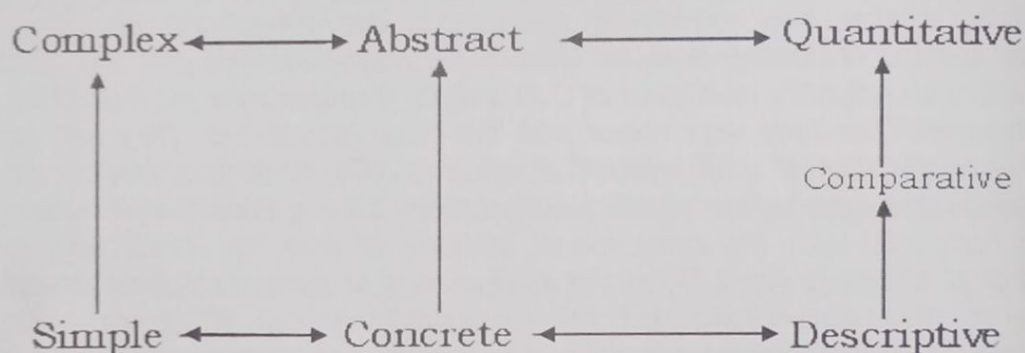


Figure 2: Concept Difficulty Matrix of Learning on a gradient

The word clearing strategy with dictionary could tackle misunderstood words. Word Clearing strategy involves the use of suitable and standard dictionaries to tackle misunderstood words. The first thing to learn is the exact procedure to clear any word or symbol, that one comes across in reading or studying that is not understood at all or wrongly understood. A misunderstood word will remain misunderstood until one clears the meaning of the word. Once the word is fully understood by the person, it is said to be cleared.

Many factors were attributed to the student academic achievement in Biology. The factors are the teaching techniques of the biology teachers, study habits of biology students, the economy situation in Nigeria, the class size, the school environment, parental factors, among others. A survey of factors affecting students' academic performance in biology in the secondary schools was carried out by Lawson (2021). It was concluded in that study that teacher use of instructional material, school facilities and class size significantly influence academic performance in Biology. Therefore, with further study on tackling barriers to study, as recommended from Olowoye and Adenaike, (2015) research, where students learnt in "TWIN", the factor, using combined learning strategies can assist many students to learn with perfect understanding. For instance, with the learning learning on a gradient combined with learning with word clearing and by learning with Demo kit combined with learning on a gradient, many aspects of biology can be learnt with full mastery along with the collaborative learning. The knowledge gained can be applied in other aspects of learning, in any subject, and even at any level.

In the research of Abidoye (2017), it was revealed that a lot of candidates usually avoid answering some biology questions on some topics that are perceived difficult in their external examinations, while those that attempted them also performed poorly. Ecology was identified among such topics. Avoiding some topics might be a factor responsible for poor achievement, on one hand, while on the other hand, it could be as a result of learning with a single strategy. Therefore, there is need for the combined learning strategies to improve the achievement. In recent times, as from 2016, from the observation of chief examiner reports, in the external examinations, there has been an increase and improvement in the academic achievement of many biology students in Nigeria, but up till date, 100% achievement have not been recorded. According to Onojah, Onojah, Olumori and Abimbola (2020), tackling barriers to study with study technology principles can assist in eliminating any difficulties in learning. In that study, it was concluded that 100% achievement can be attained if study technology is used appropriately. One of the efficient ways to use study technology principle appropriately is to combine these strategies, with the learning in pairs and correcting any reactions due to barriers to study as done in this study, would enhance perfect understanding.

Also, the influence of gender on academic achievement of students in science, as well as in Biology in particular, has been carried out by many researchers; yet, it has not reached a conclusive end. For instance, Amedu (2015) conducted research on the effect of gender on the achievement of students in biology, with the use of jigsaw method. It was concluded that gender influenced achievement in favour of the male. It was recommended that various methods or combination of them could be carried out to improve achievement. In another study by Telima and Ekineh (2019) on the influence of gender on students' performance in biology when taught Reproduction with the collaborative teaching strategy. It was concluded that gender influenced students' performance in biology in favour of the female. Therefore, in this study, attempt was made to examine the effect of combined study technology learning strategies based on gender on the achievement of senior school biology students.

Purpose of the Study

This study investigated the effects of combined study technology learning strategies on senior school students' achievement in Ecology. Specifically, the study examined the effects of combined study technology learning strategies by learning on a gradient combined with learning with word clearing on students' achievement in Ecology; by learning with Demo kit, learning on a gradient combined with word clearing on students' achievement in Ecology based on gender. This combination is described with a diagram in the Figure 3.

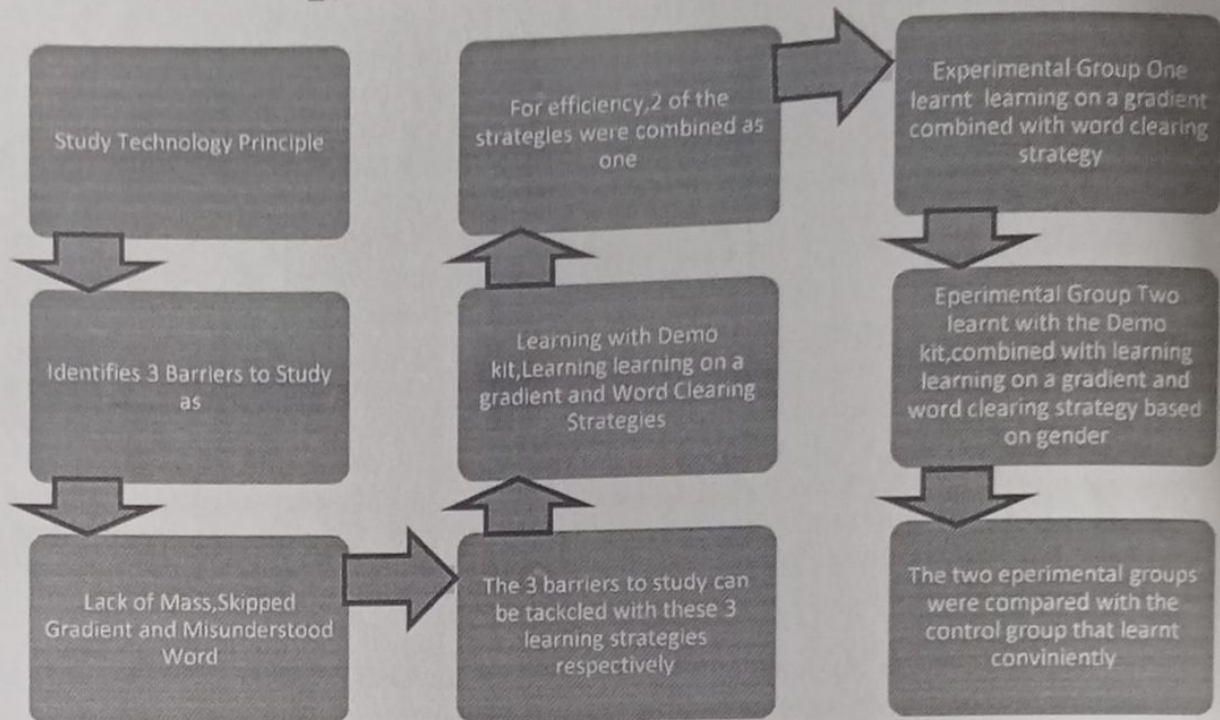


Figure 3: Demonstration of the Research Process

Research Questions

Based on the purposes of this study, the following research questions were formulated:

- RQ₁** Is there any significant difference in the effect of learning on a gradient and word clearing on students' achievement in Ecology?
- RQ₂** Is there any significant difference in the effect of learning with Demo kit combined with learning on a gradient and word clearing on students' achievement in Ecology?
- RQ₃** Does gender have significant effect in the use of combined study technology learning strategies by learning with Demo kit combined with learning on a gradient and word clearing on students' achievement in Ecology?

Research Hypotheses

Three Research Hypotheses were generated from the Research Questions for the study and were tested:-

- (i) There is no significant difference in the effects of combined study technology learning strategies of learning learning on a gradient combined with word clearing strategy on students' achievement in Ecology
- (ii) There is no significant difference in the effects of combined study technology learning strategies of learning with Demo kit combined with learning learning on a gradient and word clearing strategy on students' achievement in Ecology
- (iii) There is no significant difference in the effects of combined study technology learning strategies of learning with Demo kit combined with learning learning on a gradient and word clearing strategy on students' achievement in Ecology based on gender?

Methodology

This study adapted the quasi-experimental research of the pre-test, post-test control group design. Specifically, it was a 3x2 experimental design, with the three (3) groups. Two (2) of which were exposed to the treatments that is, X_1 - X_2 while one group served as a control group and learnt without the Study Technology combined strategies. The 2 was gender occurring at the two (2) levels of either male or female. This research design was adapted

from Schoonenboom and Johnson (2017) where mixed method approach was used with the sample participants that were divided into groups, of the experimental groups with one control group. The layout of the design is shown in Figure 4. Also, it is equally non-randomized control group. The treatment (X_1) was for the Experimental Group 1 that learnt learning on a gradient combined with word clearing strategy. The treatment (X_2) was for Experimental Group 2 that learnt with Demo kit combined with learning on a gradient and word clearing strategy. The three groups were pre-tested before the treatments while after learning the basic ecological concepts with these treatments, they were post-tested.

Y_{a1} is the Pre-test for all the experimental groups

X_1 is the treatment (word clearing combined with learning on a gradient strategy), for group 1

Y_{a2} is the Post-test for all the experimental groups

X_2 is the treatment (Demo kit combined with learning on a gradient and word clearing strategy), for group 2

The Independent Variable was the Study Technology learning Strategies which were used for the experimental groups. The Dependent Variables were students' achievements in the pre-test and post-test that was administered before and after treatments. The moderating variables are gender occurring at the two (2) levels.

Table 1: Layout of the Design

Groups	Pre-test Treatment	Post-test
Experimental group 1	$Y_{a1}X_1$	Y_{a2}
Experimental group 2	$Y_{a1}X_2$	
Control group	Y_{a1}	Y_{a2}

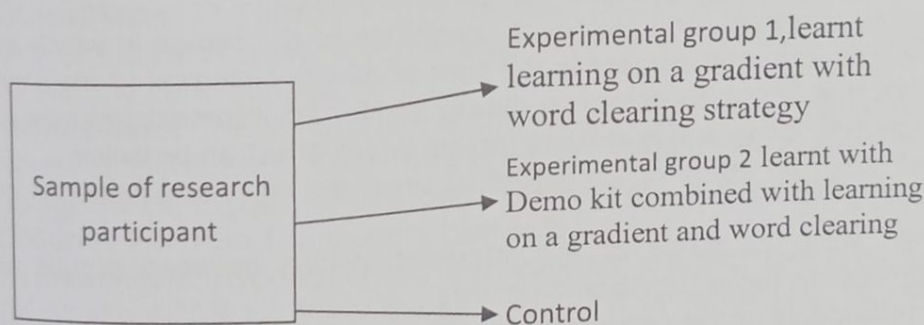


Figure 4: Research design adapted from Schoonenboom and Johnson (2014)

Population, Sample, and Sampling Techniques The population for this study consists of all Senior Secondary School One (SS1) Biology Students in all Senior Public Secondary Schools in Ilorin, Kwara State, Nigeria. The SS1 students was considered appropriate because it was assumed that the learning of Basic Ecological Concepts in SS1 could be a determining factor for proper understanding of other topics of Ecology at SSII and SSIII. Biology students from three purposively selected schools constituted the sample. Although, Purposive Sampling Techniques were used to select the three schools, 399 Biology students in the selected schools were involved in study, in their intact classes as sample. The procedure on how the empirical study was done:

How to Learn learning on a gradient

- i. To achieve this, students were provided with the structured content of the topic with the check sheet on how to study with study technology principles as a guide.
 - a. To learn learning on a gradient, therefore, requires:-
- ii. Identification of all the concepts;
- iii. arrange and organize the basic ecological concepts from simple to complex, i.e. from the definition of Ecology > types of Ecology > Eco system > Biosphere;
- iv. define and study each concept; check these with the word list
- v. apply the information gained to generate three (3) examples;
- vi. list three (3) non-examples;
- vii. note the concepts that you understood well;
- viii. note the concept that confuses you. This point of confusion is where to repeat the exercise;
- ix. ensure that one part is completely mastered with full understanding before proceeding to the next;
- x. show this to your "twin"; and,
- xi. the twin shows it to the instructor, then the instructor will append his/her signature that mastery has occurred. Then, the students move to the next concept.

Structured Text of Basic Ecological Concepts

Ecology is the study of interrelationship between organisms and their natural environment; both living and non-living. Ecology can equally be defined as the study of interrelationships of organisms among themselves and the physical environment. There are two types of Ecology namely: autecology and synecology. Ecology is studied in the context of the "population" and "communities" in which they can be grouped and the "ecosystem" of which they can form part. Therefore, from the definition above, the key words that can be clarified out are:

Interrelationship: The way in which two or more things or people are connected and affect each other.

Organisms: are living things, especially those that are extremely small.

Environment: The physical, chemical, and biological conditions of the region in which an organism lives. In other words, the environment is the sum of all the biological (living) and physical (non-living) factors that affect an organism during its life. Environment includes all the factors external and internal, living and non-living factors which affect an organism.

Autecology is concerned with the study of an individual organism or a single species of organism and its environment

Synecology is concerned with the study of the interrelationships between groups of organisms or species of organisms living together in an area..

Population: A group of individuals of the same species within a community. The nature of a population is determined by such factors as density, sex ratio, birth and death rates, emigration and immigration. A population can also be defined as all the organisms of the same species in the ecosystem. Examples include: All citrus fruits in a plantation; all of the *Paramecium caudatum* in brackish water.

Community: A naturally occurring assemblage of plant and animal species living within a defined area or habitat. Communities are named after one of their dominant species, e.g. a pine community or the major physical characteristics of the area e.g. a freshwater pond community. Community can also be defined as the population of plants and animals inhabiting a common environment at a particular area that are interacting with one another.

Species: are a population or group of populations of interbreeding organisms that are reproductively isolated from all other populations. The term "species" is used as a category

of the species name of the house cats. The African leopard belongs to a different species of the same genus and is named *Felis pardus*.

Habitat: Habitat is defined as an area occupied by biotic community. In other words habitat is any environment in which an organism lives naturally or the kind of place where an animal or plant species lives, such as "the bottom of a pond," and, "on a tree." It is natural home of an organism. For example, the habitat of the fish is water.

Population: Is defined as total number of living organism living together in a particular area at a particular time.

Ecosystem: is a basic functioning unit of nature. It composes of two (2) components: **living component** and **non-living component** (environment). This component does not only interact, but are linked by various physical, chemical and biological process. Ecosystem could also be regarded as a biological community together with the associated abiotic environment. An ecosystem contains both biotic (living) and abiotic (non-living) environments. There are two broad categories of ecosystem-terrestrial and aquatic.

It can equally be defined as a self-supporting unit that is made up of a living part and non-living parts. Various ecosystems form the biosphere.

Living Component: are the plants and animals in an environment

Non-living Component: various physical, chemical and biological process.

Terrestrial ecosystems: include grasses, shrubs and trees based on the dominant type of vegetation.

Aquatic ecosystems include freshwater and marine ecosystems.

Biosphere or ecosphere is the zone of the earth occupied by living organisms. It is a layer of life which exists on the earth surface. The biosphere is a narrow zone where complex biological and chemical activities occur. It can be found on land, soil, water and air.

Earth is the world; the planet that we live on.

Lithosphere: The lithosphere is the solid portion of the earth. It is the outermost layer or zone of the earth crust. It is made up of rocks and mineral materials and it also represents 30% of the earth surface.

Atmosphere: The atmosphere is the gaseous portion of the earth. It is a layer of gaseous surrounding the earth. Over 99% of gaseous portion of the earth surface. It contains 78% nitrogen, 21% oxygen, 0.03% carbon dioxide and 0.97 rare or inert gases.

Gaseous Portion: Is a mixture containing gases

Hydrosphere: Hydrosphere is the liquid or aquatic part of the earth or living word. It covers about 70% or 2/3 of the earth crust. It holds water in various forms-solid (ice), liquid (water vapour).

Aquatic part is the part containing water

Niche is the functional role and position of an organism in an ecosystem. This is like the profession of an organism A niche is not the same as habitat.

How to learn with Word Clearing

The procedures involved in word clearing are:

- Identify the word/words that are not understood or wrongly understood
- Use dictionary to define them
- With the dictionary, select meaning of words that would suit the context
- Make sentences with such words
- Repeat the reading process again to gain full understanding and mastery

The students are to identify the reactions that could result from either "Skipped gradient" and "misunderstood word". Such reactions can be identified by the students themselves or from their "twin" partner. Teacher notes down such reactions as she watches the students.

How to use "Demo kit" for learning

- i. identify a particular concept, e.g., Ecology; habitat; biosphere, etc.
- ii. study these concepts using your Biology textbook
- iii. write out all the key words in the definition of each concept
- iv. read out again all these key words
- v. bring out different items in the Demo kit to represent each of these key words.
- vi. use another item for word link (is, are, by, to, with, for, etc.)
- vii. try and link each of these items with another item to represent them all
- viii. finally, illustrate such definitions with the Demo kit to Demonstrate sentence/s that you have understood.
- ix. Show this to your "twin".
- x. "Twin A" will Demonstrate to Twin B of any key words that he has understood well
- xi. While both have agreed, then both will append their signature and the instructor will check them out, but
- xii. If only one Twin has understood well, he cannot proceed to the next step, until he has assisted the other twin to gain full mastery
- xiii. If otherwise again, then pink sheet shall be issued by the instructor if he observed any reactions as a result of the study barrier faced by such Twin.
- xiv. Such "Twin" shall re-study by going back to read either the textbook or glossary again; and learn following the procedures involved
- xv. students are instructed to remedy the identified reactions that are "barriers" as a result of either "skipped gradient" or "misunderstood word" or progress until mastery attained by reading their course guide again. Such students are to make use of the word list designed and use it with their twin.
- xvi. Students that are exhibiting learning difficulties were asked to repeat the part of the study they understand well before confusion and proceed from there till mastery. The twin that has gained full understanding will assist those with learning difficulties. students with study barriers are to read their checksheet again and learn with their subject dictionary or standard dictionaries and remedy their difficulties in learning the Basic Ecological Concepts.

Word list	Student A	Student B
Ecology	-----	-----
Environment	-----	-----
Autecology	-----	-----
Synecology	-----	-----
Biosphere	-----	-----
Lithosphere	-----	-----
Atmosphere	-----	-----
Hydrosphere	-----	-----
Habitat	-----	-----

Research Instruments

Two instruments, designed by the researchers, consisting of training manual entitled "Learning How to Learn with Study Technology (LHLST) and Ecology Achievement Test (EAT) with reliability coefficient of 0.71 and 0.78 respectively were used for the study. The

LHLST was validated by 2 study technology experts, from Science Education Department University of Ilorin, Nigeria. The second instrument was "Ecology Achievement Test" (EAT) was subjected to face and to content validity). It was made up of 70 Multiple Choice Test adapted from past questions of the West African Senior School Certificate Examinations (WASSCE) and National Examinations Council (NECO) that were partially modified. In the tests, from the four options, the students chose a correct option as answer. The 2 biology teachers in each of the selected schools and their students were firstly trained on how to use LHLST and were assessed and ensured that they understood it well. After an interval of two weeks, the students in the experimental groups were allowed to study with the manual on their own. The researchers' and their teachers act as instructors. In study technology classroom, teacher do not teach but only instruct. So, for the experimental groups, the students learnt "in pair" known as TWIN in study technology term, interact with one another and with their biology textbooks, Demo kit and dictionaries supplied. The control group was taught by their teacher and they learnt conventionally. Both groups were later assessed as post- test. The process lasted for 12 weeks and usually take place during the lesson hours, after closing, daily, so as not to interrupt the schools' activities.

Data Analysis and Results

The descriptive statistics involving percentages were used to describe the respondents' demographic data, which were collected from pre-test and post-test for the control and experimental groups. The mean and standard deviation were used to answer the Research Questions that were transformed into hypotheses and tested using inferential Statistics of Analysis of Covariance (ANCOVA) at 0.05 level of significance. Pallant (2010). The Multiple Comparison Analysis was depicted in Table 2 to show the actual effect of the treatment on students' achievement. The students in Experimental Group I had a higher mean score of 61.06% while those that are in the Control Group had the mean score of 52.73%. Thus, the effect of learning on a gradient combined with Word Clearing on students' achievement in Ecology was shown by the mean difference of 8.33

Table 2: Pairwise Comparisons Analysis Showing the Effect of the Treatment on Students' Achievement in Ecology

Treatment	Mean	Mean Diff. (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
Learning on a gradient and Word Clearing (I)	61.06 ^a	8.33 [*]	.846	0.00	6.075	9.412
Control (J)	52.73 ^a	-8.33 [*]	.846	0.00	-9.412	-6.075
Grand Mean = 56.90						

* the mean difference is significant at 0.05 level

b. Adjustment for Multiple Comparisons: Bonferroni

RQ₁: Is there any significant difference in the effect of learning with learning on a gradient combined with word clearing strategy on students' achievement in Ecology?

Results in Table 3 revealed that there is a statistically significant effect of learning on a gradient and word clearing strategies on the achievement of students in Ecology ($F_{(1, 205)} = 83.755, p < 0.05$).

Table 3: Analysis of Covariance Showing the Effect of Learning on a gradient combined with Word Clearing Strategies Combined on the Achievement of Students in Ecology

Source	Type III Sum of Squares	df	Mean Square	F-value	Sig.
Corrected Model	3852.203 ^a	2	1926.102	55.497	.000
Intercept	7946.971	1	7946.971	228.979	.000
Pretest	256.903	1	256.903	7.402	.007
Learning on a gradient and Word Clearing	2906.808	1	2906.808	83.755	.000
Error	7114.754	205	34.706		
Total	690069.000	208			
Corrected Total	10966.957	207			

a. R Squared = .351 (Adjusted R Squared = .345)

*Significant at $p < 0.05$

RQ₂: Is there any significant difference in the effect of learning with Demo kit combined with learning on a gradient and word clearing on students' achievement in Ecology?

The results in Table 4 revealed that there is a statistically significant effect of learning with Demo kit combined with learning on a gradient and Word Clearing strategies on the achievement of students in Ecology ($F_{(1, 161)} = 68.185, p < 0.05$).

Table 4: Analysis of Covariance Showing the Effect of Learning with Demo kit combined with learning on a gradient and Word Clearing Strategies on the Achievement of Students in Ecology

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2555.988 ^a	2	1277.994	34.142	.000
Intercept	8661.610	1	8661.610	231.397	.000
Pretest	46.114	1	46.114	1.232	.269
Demo kit, Learning on a gradient and Word Clearing	2552.294	1	2552.294	68.185	.000
Error	6026.518	161	37.432		
Total	521879.000	164			
Corrected Total	8582.506	163			

a. R Squared = .298 (Adjusted R Squared = .289)

The Multiple Comparison Analysis was depicted in Table 4 to show the actual effect of the treatment on students' achievement. Results in Table 5 showed that students in Experimental Group 2 had a higher mean score of 63.12% while those in the Control Group had the mean score of 52.73%. Thus, the effect of tackling barriers study with the learning with Demo kit, learning on a gradient and Word Clearing on students' achievement in Ecology was shown by the mean difference of 10.39.

Table 5: Pairwise Comparison Analysis Showing the Effect of the Demo kit, learning on a gradient and word Clearing on Students' Achievement in Ecology

Treatment	Mean	Mean Diff. (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
Demo kit, Learning on a gradient and Word Clearing (I)	63.12 ^a	10.39*	0.989	0.00	6.213	10.119
Control (J)	52.73 ^a	-10.39*	0.989	0.00	-10.119	-6.213
Grand Mean = 57.93						

* the mean difference is significant at 0.05 level

b. Adjustment for Multiple Comparisons: Bonferroni

RQ₃: Does gender have significant effect in the use of combined study technology learning strategy of learning with Demo kit combined with learning on a gradient and word clearing on students' achievement in Ecology?

There is no statistically significant interaction effect of learning with Demo kit combined with learning on a gradient and Word Clearing strategy and gender on the achievement of students in Ecology ($F_{(1, 159)} = 0.374$, $p > 0.05$). This is expressed with the analysis in the Table 6 and the descriptive statistics in Table 7. It was revealed that the F-value 0.374 is obtained with a p-value of 0.542 computed at 0.05 alpha level. Since P-value (0.542) is greater than alpha level (0.05).

Table 6: Analysis of Covariance Showing the Interaction Effect of Learning with Demo kit, learning on a gradient and Word Clearing Strategies and Gender on the Achievement of Students in Ecology

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2576.588 ^a	4	644.147	17.053	.000
Intercept	8675.608	1	8675.608	229.677	.000
Pretest	49.547	1	49.547	1.312	.254
Demo kit, Gradient & Word Clearing	2568.958	1	2568.958	68.010	.000
Gender	3.333	1	3.333	.088	.767
Demo kit, Gradient & Word Clearing * Gender	14.125	1	14.125	.374	.542
Error	6005.918	159	37.773		
Total	521879.000	164			
Corrected Total	8582.506	163			

a. R Squared = .300 (Adjusted R Squared = .283)

$p > 0.05$

Table 7: Descriptive Statistics of Students that learnt with Demo kit combined with learning on a gradient and Word Clearing Strategy based on gender on the achievement in Ecology

Treatments		No	Mea n	S.D.	Std. Error	95% Confidence Interval	
						Lower Bound	Upper Bound
Demo kit, Gradient and Word Clearing	Male	32	61.5	4.7	.476	60.891	62.765
	Femal e	34	8	4	.499	60.500	62.462
			63.1 2	9.7 6			
Conventional Method	Male	41	49.0	3.7	.421	53.226	54.880
	Femal e	57	9	9	.371	53.136	54.595
			52.7 3	4.5 6			

Summary of the Findings

- There was a statistically significant difference in the effect of learning on a gradient combined with word clearing strategies on the achievement of students in Ecology ($F_{(1, 205)} = 83.755, p < 0.05$).
- There was a statistically significant difference in the effect of learning with Demo kit, combined with learning on a gradient and Word Clearing strategies on the achievement of students in Ecology ($F_{(1, 161)} = 68.185, p < 0.05$).
- There was no statistically significant effect of learning with Demo kit, combined with learning on a gradient, and Word Clearing strategies and gender on the achievement of students in Ecology ($F_{(1, 159)} = 0.374, p > 0.05$).

Discussion

The findings revealed that there was a statistically significant difference in the achievement of students that learnt learning on a gradient combined with word clearing when compared with the control group. The researchers were motivated by the investigations of this strategy because finding on this strategy has not been adequately established in the previous studies on Study Technology. The previous study technology experts only worked with one strategy that are not in combined forms as carried out in this study. Thus, the learning on a gradient combined with word clearing strategy promotes functional learning among the participants. The benefit of learning on a gradient with the clearing of difficult words and concepts, especially with the use of dictionaries resulted in full understanding. This finding confirms with the findings of Alabi (2018) investigation on the Comparative Effect of Text Structures on Students' Achievement in Genetics. In that study, findings showed that when content of instruction is well structured, learning on a gradient becomes easier, and students could achieve better.

Similarly, it was equally observed that students that learnt with the combined strategies of learning with Demo kit, learning on a gradient and word clearing, the three as one strategy, achieved significantly better than their counterpart that learnt with conventional method. This finding is similar to the findings of Olowoye and Odumade (2016) that reported that the achievements of students that know how to learn and are able to apply knowledge were better than those that were not taught how to study. This finding has a strong implication on the advancement of Education in Nigeria because the learning difficulties that usually constitute barriers to meaningful and perfect understanding which invariably influences

students' achievement in external examinations can now be improved upon with the combined learning strategy.

Furthermore, the interaction effect of the learning with Demo kit, learning on a gradient, combined with word clearing and gender on the students' achievement in Ecology were also examined. This was the interest of the researchers because issue of the effects of gender on the students' achievement is very controversial in academic discussion. Findings on gender particularly in the developing nations have not been clearly established. The researcher therefore considered gender as a moderating variable in this study. The finding of this study showed that there is no statistically significant interaction effect of treatments (Demo kit, gradient and word clearing) and gender on students' achievement in ecology.

This finding should not be a surprise because the three strategies showed a significant higher mean score in the students' academic achievement. Significant to note here is that the males out-performed the females when the three strategies were combined with the descriptive statistics, while with the ANOVA, the difference was not significant. Commonly reported in studies are that the females out-performed the males in Biology generally. Thus, the males might be more interested in the topic than the females that were involved in the study. It is therefore an interesting finding that might further be investigated in the future. Another reason might be caused by the locale of the study which was purely in urban area where such knowledge is remote to female students, which their interest might not be at the same level with the males that might be more inquisitive than the females. This finding was not in support of the study of Eseine-Aloja (2021) and Amedu (2015) on the effects of gender on students' academic performance in Biology. Similarly, the finding of this result does not corroborate with the findings of and Telima and Ekineh (2019). The finding of that study indicated that there was a significant difference between the mean gain scores in favour of the female.

Conclusion

The previous researchers had indicated that students are faced with learning difficulties because they are usually not taught how to learn. The learning difficulties were overcome with the combined learning strategies of Study Technology. Also, an attempt was made to find a lasting solution to one of the observed problems, that students usually avoided questions on ecology. With the participation of SS1 students involved in this study, it shows that, with the good study technology learning strategies in a combined form, the biology students achieved better.

Recommendations

Based on the findings of this study, the following recommendations were made:

- (i) Biology students need to understand what constitute barriers to study and know how to tackle them with different study technology learning strategies. This would make them be actively engaged, learn with full mastery and avoidance of just rote-memorization.
- (ii) Biology students should be given real objects as learning materials to facilitate understanding of various concepts that are perceived difficult. Other alternative like the use of demo kit should be used when the real objects are not available..
- (iii) The contents of abstract concepts should be structured in order to avoid skipped gradient that could constitute study barrier.
- (iv) Biology students should possess standard and subject dictionaries to facilitate their understandings and clear any misconception, or difficult words that they come across.

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