

Effects of Jigsaw and Blended Learning Strategies on Basic Science Students' Achievement and Retention taught the Concept of Genetics in Owerri, Imo State.

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Abstract

This study investigated the effects of Jigsaw and Blended Learning Strategies on achievement and retention of Basic Science students Taught Genetics in Owerri, Imo State. Two research questions and two hypotheses guided the study. Quasi-experimental, non-equivalent control group design precisely, Pre-test post-test control group design was used. Population was 3000 junior Secondary School III students in 2019/2020 academic year. Criteria and purposive sampling technique was used to select two schools out of 15 Co-education schools that met the criteria for this study. Sample was 120 students drawn from two schools of one intact class each. Instrument entitled Basic Science Achievement Test on Genetics was validated. Reliability obtained was 0.92 using Kuder-Richardson (KR-21) formular. Research questions were answered using Mean and Standard Deviation. Hypotheses were tested using Analysis of Covariance, at 0.05 probability level. Findings showed that, Students taught the concept of Genetics using Blended Learning Strategy had the highest achievement score, Students taught the concept of Genetics using Jigsaw Learning Strategy had the highest retention score. There was no significant difference between the achievement scores of students taught the concept of Genetics using Jigsaw and Blended Learning Strategies. There was significant difference between the retention scores of students taught the concept of Genetics using Jigsaw and Blended Learning Strategies. Based on these findings, it was recommended that, Jigsaw and Blended Learning Strategies should be used to teach the concept of Genetics.

Key Words: Jigsaw and Blended Learning Strategies, Genetics, Achievement and Retention

Introduction

Basic Education is an indispensable tool for national development. The National Policy on Education listed Basic Science and Technology as one of the subjects that make up the

reformed subjects in Junior Secondary School programme developed in September 2007 by Nigeria Education Research and Development Council (NERDC) reviewed in 2012, (NPE, 2014). Currently, Basic Science and Technology subject stands to replace Integrated Science subject in Junior Secondary School, where Basic Science stands to treat topics in Integrated Science. Basic Science is an integral core first part of Basic Science and Technology subject among other three parts, know as; Basic Technology, Physical and Health Education and Information Technology respectively.

One of the major topics that make up learning about the Environment in Junior Secondary School Basic Science curriculum is, Family Genetic Traits. Family Genetic traits is the study of continuity of family traits such as; shape of face, forehead, mouth, nose, color of skin, hair and eyes, height of body, quality of hair, eye brown and eyes lashes, blood group, genotype, Albinism Rhesus factors among other traits (Robb, 2023; Griffiths, *et al*, 2000). There are clear goals for the study of Genetics in schools. Genetics is the foundation of life. It provides the framework for the study of all living organisms, from the smallest bacteria to the largest mammals. Particularly, the achievement in genetics study is aimed to prepare future scientists and citizens alike, to participate in the development involving Genetics and Biotechnology, to apply new discoveries in medicine and agriculture to profit the society.

Despite the viable and relevant objectives of studying Genetics, studies showed that, Genetics has been considered by many students most difficult concept to learn (Ceren, *et al* 2001; Banet & Ajuso 2002; Duncan & Reser 2007). Some major difficulties experienced by students include; specific vocabulary used in genetics, terminology of genetics, mathematical concept of Mendelian's genetics tasks and cytological processed. Several studies suggest genetics is hard because students have difficulty connecting different concept, students have difficulty reasoning across levels of representation, multiple organization levels and ontological levels (Mussard & Reiss, 2022; Ezechi, 2022). Chief examiner reports on Junior Secondary School Certificate Examination (2012 - 2020) showed that, students provide answers to hereditary and genetics questions wrongly. This might lead to students' poor achievement in Basic Science at internal and external examinations. Poor achievement can be seen as academic failure of a student, academic failure mean lack of success in education and could lead to lots of high education costs, social and economic losses (Amini & Meftash, 2023). Academic failure is not only a student problem but also has effects on the whole society including the loss of human resources, time and educational costs. Test and examination are usually performed to determine students' academic achievement and retention.

Retention according to Nikos (2017) is the process, by which new information is transferred from short term memory to a long-term memory. It is the process to make new information stick for future use. Retention is the process to have information stored in long term memory in such a way that, it can be readily retrieved despite the interval of time between the learnt materials. Therefore, academic retention is defined as the proportion of knowledge

retained by students after specific retention interval. Emerald (2023) stated that, good retention strategies are strongly linked with instructional strategy that encourages active and independent learning. Therefore, there is urgent need to provide ways to learn genetics through various Active Learning Strategies.

Learning Strategy is a method developed by teacher to improve students' study ability, they are design by teacher to help students achieve, retain and recall concept content in a self-dependent manner (Herrity, 2023). According to Herrity (2023) there are six Learning Strategies, these include: mnemonic learning, text-visual combination, spaced learning, revision without books and notes, mixed study subjects and active learning strategy. This study focused on Active Learning Strategy.

Active Learning Strategy is an Instructional Learning Strategy where teacher and students is actively engage in a learning process. Active Learning Strategy is the style in which classroom interaction occurs between teacher and students or students and students to learn a concept. The active learning approach empowers students to learn in a collaborative and shared manner, since its focuses on students rather than teacher. According to Isabel (2020) four Learning Interaction Strategies occurs in classroom this include;

1. Teacher-Student Interaction Strategy,
2. Teacher - Material Interaction,
3. Students- Material Interaction
4. Students-Student Interaction.

The Students-Students Interaction Strategy is further divided into three;

- i. Individualistic Interaction Strategy,
- ii. Competitive Interaction Strategy and
- iii. Co-operative/ Jigsaw Interaction Strategy.

Co-operative Learning Strategy is the integration and application of all plausible classroom interaction. Thus, it is called 'Whole-class' Interactive Learning. Although, there is a significant relationship between Co-operative and Jigsaw Learning Strategy with the key difference of Jigsaw as a Co-operative Learning Strategy is that, it enables each student in the classroom to have a Student Home Group to specialize in one aspect of a topic. Jigsaw is a Co-operative Learning Strategy that asks groups of students to become "experts" on different aspects of a topic and then share what they learn with their classmate. Each student in the Students 'Home Group servers as a piece of a topic's puzzle and when they work together as whole, they create the complete Jigsaw puzzle (www.readingrockets.org, 2024). This lead to Jigsaw reading approach where students speak and summarizes concept via, reading of articles, answer questions and check understanding.

Orji & Ogar (2024) investigated the effects of Jigsaw-Based Learning Strategy on Basic Science students' achievement taught Basic Science concepts in Gwagwalada, Abuja, Nigeria. The study finding showed that, Jigsaw Learning Strategy was more significant than the

Conventional Learning Strategy. Again, Samuel & Lliyasu (2020) investigated the effects of Cooperative Learning Strategy and Jigsaw II Learning Strategies on Upper Basic II Science' students' achievement and retention taught Basic Science concepts in Nassarawa State, Nigeria. The finding showed that, there was significant difference in the achievement of students taught Basic Science using Cooperative Learning Strategy and those taught the same concept using Jigsaw II Learning Strategy, this difference lies in Cooperative Learning Strategy. Also, there was significant difference between the retention of students taught Basic Science concepts using Cooperative Learning Strategy and Jigsaw II Learning Strategy, this significant lies in Jigsaw II Learning Strategy.

Again, Fatoku and Samuel (2018) investigated the effects of Computer-Assisted Jigsaw II, Team Assisted Instruction and Learning Together Co-operative Instructional Strategies on Basic Science students' achievement and retention in Federal Capital Territory Abuja. Finding showed that, there was significant difference in the achievement and retention of Basic Science students taught Basic Science concepts using Computer-Assisted Jigsaw II, Team Assisted Instruction and Learning Together Co-operative Learning Strategies.

Another Active Learning Strategy is Blended Learning. This is often called Hybrid Learning, it offers a combined platform for both face -to-face and online learning experience (Movchan, 2024). A Specific example of Blended Learning Strategy is the combination of technology based package and face to face presentation of content. Blended Learning provides safer learning environment, increases students engagement, increases the rate of retention in students, keeps students more motivated (Movchan, 2024). A study by Sarikwpoi and Mustafa (2015) showed that, students' achievement was higher in Blended Learning process when compared to either fully online or fully face to face learning experience. Iga (2017) studied effects of Blended Learning Model and Expository Teaching Model on Basic Science students' achievement in science. The result showed that, the Experimental Group score higher than Control Group.

Moses *et al* (2020) determined the effects of Blended Learning Strategy on Junior Secondary School Students' retention in Basic Technology subject in Biu Educational Zone of Borno State. Finding showed that, there was significant difference in the mean retention scores of students in Basic Technology taught using Blended Learning Strategy and Lecture Teaching Method. However, scholars have been optimistic that, the use of Actives Learning Strategies to teach difficult concepts could improve students' achievement and retention more in science. It is upon this backdrop that the researchers investigated the effects of Jigsaw and Blended Learning Strategies on Basic Science Students' achievement and retention taught the concept of Genetics in Owerri, Imo State.

Statement of the Problem

The National Examination council for Junior Secondary School 2012- 2020 reported an increase in percentage of students who failed Basic Science. Chief examiner reports of Junior Secondary school showed that, students answer Genetics questions wrongly. This may have contributed to their poor result in the examinations. This problem might be reduced when teacher use Active Learning Strategies to teach difficult concept in Basic Science to improve students' achievement and retention. Therefore, the gap this study seeks to fill is to determine, the comparative Effects of Jigsaw and Blended Learning Strategies on Basic Science students' achievement and retention in the concept of Genetics in Owerri, Imo State.

Research Questions

The following research questions were formulated to guide this study:

1. What difference exists between the mean achievement scores of Basic Science students taught the concept of Genetic using Jigsaw and Blended Learning Strategy respectively?
2. What difference exists between mean retention scores of Basic Science students taught the concept of Genetic using Jigsaw and Blended Learning Strategy respectively?

Research Hypotheses

The following null hypotheses were tested in this study.

H₀₁: There is no significant difference between the mean Achievement scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategies.

H₀₂: There is no significant difference between mean Retention scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategies

Methodology

This study employed Quasi-experimental, non-equivalent control group design precisely Pre-test post-test control group design was used. This study was carried out in public secondary schools in Owerri Education Zone I and II. The zones consist of 11 Local Government Areas, the Education Zones was chosen for this study because it has one of the largest numbers of secondary schools with 108 Junior Secondary School World Owerri People's Congress (WOPC, 2023) Population of this study was all the 86 Co-education secondary schools out of 108 public secondary schools in Owerri Educational Zones. The population of this study was all the 17,600 students in JSS III of 2019/2020 session in 86 Co-education Secondary Schools in Owerri Education Zones. Zonal Education Management Board Owerri, (ZEMBO, 2019). The set of students were used for this study due to, the topic Genetics is taught at JSS III. Criteria Sampling Technique was used in this study. The criteria used were as stated below;

- i. The schools using the current Basic Science curriculum
- ii. The schools with good performance history over the years in external examination

- iii. The schools with integrated science teacher specialist.
- iv. The schools with teachers teaching Basic Science for at least four years
- v. The schools with computers

15 Co-educational public secondary schools out of 86 schools met the criteria. Purposive sampling technique was used to select two schools for this study, out of the 15 schools the population was 3000 Junior Secondary School III students. Random sampling was also used to select class arm in the two schools that met the criteria for this study. One intact class arm was used for this study. A total of 120 JSS III students were in the two arms from the two schools. An instrument developed by the researchers' entitled Basic Science Achievement Test on Genetics (BSAT) was made of 50 objective questions, was used to collect data for this study. A shuffled objectives question of the BSAT was used as retention test for the study. The instrument was subjected to face, content and table of specification validity.

Validity was done by three experts one Basic Science Teacher from secondary school in Imo State, one Science Education Lecturer from University of Uyo and one expert of Research Measurement and Evaluation Lecturer from Imo State University. Their finally contributions modified the instrument for this study. The instrument was further validated by a pilot study using test retest method. Scores of the test was appraised by using item analysis and then, reliability coefficient of the instrument was determined. Basic Science Achievement Test on Genetics was administered to 40 Basic Science students from secondary school within the population that was not part of the main study. The Instrument was subjected to Kuder-Richardson (KR-21) formula because the formula is use for instrument with dichotomous scored. The instrument BSAT on Genetics obtained the reliability coefficient of .92 index value.

Data for this study was gathered through the administration of BSAT on Genetics to 120 Basic Science students in two Co-education Secondary Schools in Owerri by two Basic Science Teachers. The teachers were trained for two weeks on how to use the instrument BSAT and Instructional packages for this study. The instrument BSAT on Genetics was administered to obtain the students' pre test scores before applying Jigsaw and Blended Learning Strategies in the three lessons on Genetics. Thereafter, the same instrument was administered to the same students to obtain the students achievement scores (Post Test). After three weeks of the post test, retention test was administered to the same students using the same instrument that was reshuffled to obtain students' retention score.

Method of Data Analysis

Research questions 1 - 2 were answered using descriptive statistic of Mean and Standard Deviation. The null hypotheses 1- 2 were tested using Analysis of Covariance at 0.05 probability level, with pretest scores as covariate. The null hypotheses were rejected or not rejected based on the following rules: If F-cal. value is less than 0.05 probability value, null

hypothesis will be rejected. If F-cal. value is greater than 0.05 probability value, null hypothesis will be retained

Results

Research Question 1: What difference exists between the mean achievement scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategy?

Table1: Summary of Mean and Standard Deviation Pretest and Posttest Achievement scores of students taught Genetics using Jigsaw and Blended Learning Strategy

Strategy	No	Pretest		Post Test		Mean Gain
		Mean	SD	Mean	SD	
Jigsaw	58	14.69	3.90	34.61	5.40	19.92
Blended	62	14.78	4.00	35.06	5.05	20.28
Total	120					

Table I shows the mean gain achievement scores of students taught the concept of Genetics, using Jigsaw Learning Strategy was 19.92 and Blended Learning Strategy was 20.28. This shows that, students taught the concept of Genetics using Blended Learning Strategy had the highest achievement score than their counterpart taught the same concept using Jigsaw Learning Strategy.

Research Question 2: What difference exists between mean retention scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategy?

Table 2: Summary of Mean and Standard Deviation Posttest and Retention scores of students taught Genetics using Jigsaw and Blended Learning Strategy

Strategies	No	Retention Test	
		Mean	Standard Deviation
Jigsaw	58	29.38	5.30
Blended	62	25.55	5.31
Total	120		

Table 2 shows mean retention scores of Basic Science students taught the concept of Genetics using Jigsaw Learning Strategy was 29.38, Blended Learning Strategy was 25.55. This shows that, students taught the concept of Genetics using Jigsaw Learning Strategy retained higher than those students taught the same concept using Blended Learning Strategy.

H₀₁: There is no significant difference between the mean Achievement scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategies.

Table 3: ANCOVA Summary of Students' Achievement Post-test Scores Classified by using Strategy with Pre-test Scores as Covariate

Source	Type III Sum of Squares	d.f	Mean Square	F	SSig.	Decision
Corrected Model	1733.619 ^a	32	54.176	3.467	.000	Significant
Intercept	8097.716	1	8097.716	518.262	.000	Significant
Pretest	157.989	14	11.285	.722	.745	Not Significant
Strategies	2.983	1	2.983	.191	.663	Not Significant
Pretest* Strategies	61.570	14	4.398	.281	.995	Not Significant
Error	1140.607	73	15.625			
Total	131328.000	120				
Corrected Total	2874.226	119				

a. R Squared = .603 (Adjusted R Squared = .429)

Table 3 shows mean effect was not significant base on the strategies used for Basic Science students' achievement in the concept of Genetics ($F .191$; $P (.663) > 0.05$. the null hypothesis (H_{01}) was retained. This implies that, there was no significant difference between the mean achievement scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategies.

H₀₂: There is no significant difference between mean retention scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategies

Table 4: ANCOVA Summary of Students' Retention Post-test Scores Classified by using Strategy with Pre-test Scores as Covariate

Source	Type III Sum of Squares	d.f	Mean Square	F	Sig.	Decision
Corrected Model	2228.194 ^a	22	101.282	7.727	.000	Significant
Intercept	2648.155	1	2648.155	202.03	.000	Significant
Strategies	274.421	1	274.421	20.936	.000	Significant
Post-Post-Test	1845.720	21	87.891	6.705	.000	Significant
Error	1087.929	83	13.108			
Total	82055.000	120				
Corrected Total	3316.123	119				

a. R Squared = .672 (Adjusted R Squared = .585)

Table 4 mean effect was significant base on the strategies used for Basic Science students' retention in the concept of Genetics (F. 6.705; P (.000) < 0.05. the null hypothesis (Ho₂) was rejected. This implies that, there was significant difference between the mean retention scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategies

Summary of Findings

1. Students taught the concept of Genetics using Blended Learning Strategy had the highest achievement.
2. Students taught the concept of Genetics using Jigsaw Learning Strategy retained higher than student taught using Blended Learning Strategy.
3. There was no significant difference between the mean achievement scores of students taught the concept of Genetics using Jigsaw and Blended Learning Strategies.
4. There was significant difference between the mean retention scores of students taught the concept of Genetics using Jigsaw and Blended Learning Strategies.

Discussion of Findings

This study investigated the effects of Jigsaw and Blended Learning Strategies on Basic Science students' achievement and retention taught the concept of Genetics in Owerri, Imo State.

Basic Science students Achievement taught the concept of Genetics using Jigsaw and Blended Learning Strategies

This study finding showed that, students mean achievement score taught the concept of Genetics using Blended Learning Strategy was higher than that of the students taught the same concept using Jigsaw Learning Strategy. This observation could be as a result that, the computer video used to teach students the concept of Genetics was attractive enough to appeal the students' sense of sight and hearing. While, the students' achievement taught using Jigsaw was low, this may be due to the materials used to study the concept of Genetics were not attractive enough to appeal the students' senses

This study finding also showed that, there was no significant difference between the mean achievement scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategies. This finding is in line with the study of Sarikwpoi & Mustaf (2015) that, students' achievement was higher in Blended Learning process when compared to either fully online or fully face to face learning experience. This study finding is not in line with Orji & Ogar (2024) that, students taught Basic Science concept using Jigsaw

Learning Strategies was more significant than students taught the same concept using Conventional Learning Strategy .

Basic Science students Retention taught the concept of Genetics using Jigsaw and Blended Learning Strategy

Finding of this study showed that, students taught the concept of Genetics using Jigsaw Learning Strategy retained higher than students taught the same concept using Blended Learning Strategy. This observation could be that, the students taught using Jigsaw had sufficient time to actively participate in their Students' Home Group. While, the students taught the concept of Genetics using Blended Learning may not have sufficient time to actively participate in their Students' Home Group due to the time allocated to watch the computer program, this could also pose as distraction to students.

The study finding showed that, there was significant different between the mean retention scores of Basic Science students taught the concept of Genetics using Jigsaw and Blended Learning Strategies, this difference lies between Jigsaw Learning Strategy. This finding is in line with Samuel & Lliyasu (2020) that, there was significant difference between the retention of students taught Basic Science concepts using Cooperative Learning Strategy and Jigsaw II Learning Strategy, this significant lies in Jigsaw II Learning Strategy.

Conclusion

Jigsaw and Blended Learning Strategies promotes conceptual understating, motivates and excites students' participations in the concept of Genetics. This learning Strategies facilitate and improve Basic Science students' achievement and retention in the concept of Genetics. This study finding supports the view of Cognitive Constructivism theory by Piget in 1973. This states that, knowledge is something that is actively constructed by students based on their existing cognitive structures. The findings also support the view of Social Constructivism theory by Vygotsky in 1978. This states that, knowledge is co-constructed and that students learns from one another.

Recommendation

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

1. Basic Science Teachers should used Jigsaw and Blended Learning Strategies to teach the concept of Genetics
2. Basic Science Teachers should be trained and retrained through organizing seminars, workshops and conferences to improve Jigsaw and Blended Learning Strategies.

3. Government, school administrators, private organization, and parent through Parent Teacher Association (PTA) Fund to provide fund for procuring Information and Communication Technology packages needed to instruct Basic Science concepts.
4. Parents and Guardians should make deliberate effort to procure smart technology devices and computer software program such as Microsoft Encarta for their wards

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