

EFFECTIVENESS OF TEACHING: JIGSAW IV STRATEGY IN BIOLOGY ACHIEVEMENT AND RETENTION OF SENIOR SECONDARY TWO STUDENTS

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ABSTRACT

The study investigated the effectiveness of teaching: The jigsaw iv strategy (JIVS) in Biology achievement and retention in senior secondary two students. The quasi-experimental research design of the non-equivalent control group pre-test, post-test type was used. One hundred and eighty-three senior secondary two (SSII) students were sampled from two co-educational secondary schools. A total of 50-item multiple-choice instrument called Biology Achievement Test (BSAT) was used to test students on the concepts of excretion with the reliability estimated at 0.85. Two research questions were raised and answered using mean, while two hypotheses were stated and tested at $\alpha = 0.05$ using Analysis of Covariance (ANCOVA). Findings revealed that students taught excretion using JIVS achieved and retained more than students taught under the lecture method (LM). The study made recommendations which included encouraging Biology teachers to employ JIVS in teaching heat energy, measurements and excretion.

Keywords: Jigsaw IV Strategy, Students' Achievement, Retention, Excretion, Biology

INTRODUCTION

Developments around the world in this 21st century shows that advancement in Science and Technology has greatly shaped the society and brought improvement on the quality of life in it scientifically and technologically. In realization of this, science and technology education which involves the teaching and learning of science and technology, forms a big segment at both basic (junior secondary) and post-basic (senior secondary) levels of education in Nigeria where solid foundation is laid for the acquisition of higher scientific knowledge and skills to be built upon. Biology is one of the core science subjects categorized by Federal Republic of Nigeria [FRN], (2014) as a biological science that is concerned with the study of life in plants and animals. Biology provides an in-depth scientific literacy of living and non-living organisms and gives insight on the nature of the diverse life forms and how they interact with the environment. It has contributed in National development in such area as Agriculture, Medicine, Biochemistry, health and diseases, pharmaceutical and nursing science, to mention but a few (Agbowuro, C. 2016). The content of Biology curriculum extends to other fields that are related to sustainability of life such as the environmental science, ecology, eco-system, food qualities, causes of illnesses and many others. The study of life has helped in shaping the world by giving credible and reliable answers that explains how life is formed and how it functions.

Biology as one of the core sciences subjects is studied at the Senior Secondary Schools (SSS) in Nigeria and contributes in shaping the professional ambition of students to read science related careers such, as doctors, chemist, drugs researchers, pharmacist and biomedical Engineers, Environmentalists, Nurses, Psychologists, nutritionist and biology teachers among others. Conceptualization of Biological concepts such as movement, growth, respiration, irritability, reproduction, nutrition and excretion provide students with understanding that has multiple effects on the study of higher ordered concepts and a decline in the comprehension of Biology concepts is capable of underpinning the understanding of other fields. Therefore, the fact remains that the importance of the teaching of Biology cannot be underestimated.

However, despite the importance of biology as one of the major subjects required for technological advancement and career development, the Biology Panel Report of Science Teachers Association. (STAN, 2018, 2021, 2022), noted that excretion has been one of the areas that students achieve poorly. Academic achievement has long been recognized as one of the important goals of education the world over. Students achievement in Biology has recently has been poor which is evident in Plateau State as noted with particular concern in students' achievement in excretion components of Biology examination, where students failed to relate theory to practice, when required to draw and label the excretory system, learners also loosed marks for carelessness in spelling the excretory system in insects and earthworm. (WAEC chief examiners' report, 2013 and 2019). This possibly can be the reason for the fluctuations and the unsatisfactory learner's achievement in School Certificate Examination (SSCE) organized by the West African Examinations Council (WAEC/SSCE) examinations and National Examinations Council (NECO) in Nigeria.

This calls for the exploration of the best instructional approaches for teaching science subject like Biology of which teacher -centred approach has been predominant over a very long time in Nigerian schools (Ayodele, 2016). The use of teacher -centred method in teaching concepts Biology may not lead students to properly understand the concept or be able to carry out tasks involving the concepts in their daily lives. The method which teachers of Biology adopt for teaching and learning may be among other factors that contribute to low retention and achievement by students. In this 21st century where technological advancement is the order of the day and where the nature of learners has changed, there is need for change in pedagogy from the predominant teacher-centred method in the teaching of Biology. Students therefore, lack sufficient functional understanding since the method lacks the effectiveness of an active learning approach. The consequences of using a teacher-centred strategy results in passive or rote learning which may make students to lack creative, analytic thinking ability, reading skills, low retention and achievement levels. However, in many Nations with Nigeria inclusive, theoretical work might have been done in the area of student-centred strategies but the retention and achievement of students has not reached the desired level yet. This calls for urgent need to bridge this gap, explore and apply a student- centred approach that could improve retention and students' achievement in Jos North, Nigeria.

In other to address the inadequacies of the lecture method which is teacher- centred, scholars have suggested the use of active strategy which is students -centred such as discussion method, discovery or inquiry-based approach and the Hill's model of learning through discussion (LTD) and co-operative learning. There are various versions of co-operative learning which includes; think-pair share, Jigsaw strategy among others. The Jigsaw strategy are of various types, ranging from

Jigsaw I, II, III, IV etc. The Jigsaw IV strategy was picked because of the features that allows for evaluation. The jigsaw IV strategy if skilfully used give students opportunities to determine cause and effects relationship, as students interact with one another in the learning materials (Timayi et al., 2015). Such engagement encourages them to explore, share ideas, take risk, question each other's views, conception and retention until a clear decision is reached to the agreement of every members of the group (Chollom, 2013b).

There is an indication that teachers' instructional strategy and students' retention could exert some influence on the success of the academic achievement of students. Retention is an important variable in learning which is viewed by Gonzalez (2015), as the faculty of the mind that stores experience and information in the long-term memory and produces or retrieves it when required at a later time. The author further stressed that within an hour of instruction, learners forget an average of 50% of information, 70% within a day and up to 90% in a week with highest percentage in teacher -centred approach. What students cannot retain cannot be written down during examination. Therefore, student-centred strategy such as Jigsaw could boost learner's retention rate since they are involved in the learning process and consequently improve students' academic achievement.

The continuous use of teacher centred teaching method and the consistent failure of students in Biology in National examination is a cause for concern that needs to be tackled for improved students' achievement. Though academic achievement is a product of a number of factors operating within and outside the individual, gender is one of such factors leading to inconsistency in the achievement of male and female students in Biology and teachers have continued to use such methods that encourages gender stereotype. The objective of the study therefore, was to find out the effectiveness of the use of Jigsaw IV strategy on the retention and achievements of SSII Biology students in Jos North, Plateau State. Consequently, the following research questions were raised to which answers were sought:

1. What is the pre-test and post-test achievement of SS II Biology male and female students for both the experimental and control groups?
2. What is the post-test retention of SS II Biology students for the experimental group?
3. What is the post-test retention of the SSII Biology male and female students for the experimental group after exposure to the Jigsaw strategy?

One null hypothesis was formulated and tested at a 0.05 level of significance, thus: There is no significant difference in the post-test retention of the SS II Biology male and female students for the experimental group.

LITERATURE REVIEW

Cooperative learning is an instructional strategy which organizes students in small groups so that they can work together to maximize their own and each other's learning. Specifically, the cooperative learning approach to instruction is where students are arranged in pairs or small groups to help each other learn assigned material. Interaction among students in cooperative learning groups is intense and prolonged (Slavin, 2012). They, Achor and Musa (2014) defined cooperative learning methods as structured systematic and instructional strategies which are used at any grade level and most school subjects. All of these methods consist of having the teacher assign the students groups comprising two to six members, each group made up of high, average and low achievers, boys and girls, main streamed classmates to meet individual needs of each student. The cooperative learning strategies includes think-pair-share, round-robin brainstorming and jigsaw cooperative learning strategy (JCLS).

The cooperative learning strategies includes think-pair-share, round-robin brainstorming and jigsaw cooperative learning strategy (JCLS). Jigsaw IV is one of the Jigsaw strategies developed by Holiday in 2002 as a modification of the Jigsaw III strategy (Timayi, Bolaji and Kajuru, 2015). There are three important new features as an improvement on the jigsaw III which are the addition of a cooperative test review process: this is to accommodate an introduction of materials, quizzes, and re-teaching that was not taught properly.

Jigsaw, one of the cooperative learning strategies, is based on group dynamics and social interactions. It is one of the "pure" cooperative learning techniques (Açıkgöz, 2010, Hance, 2016). Students are then assigned to heterogeneous groups the jigsaw group and all students are assigned topics to read. Macmillan and Mangut, (2021) gave the advantage of this group formation in ensuring that groups are heterogeneous in terms of academic ability, ethnic background, gender and any other factor that may be relevance. Here each student discusses the expert sheet that is based on a list of all topics (Tabiolo, & Rogayan, 2019). Again, the students with the same expert sheet move to their expert group to discuss their topic. In order to check accuracy and understanding of students in the expert group, they are assessed by means of a quiz based on the expert sheet. The students return to their home group, teach themselves and take quizzes all based on the original material. Salvin (2013) adds that the teacher reviews and clarifies any concepts which seem to be difficult to the students. The students take individual quizzes, and scores are combined to produce an overall team score. Finally, the teacher re-teaches any material which was misunderstood after the individual assessment process.

The theory of sociocultural and cognitive development propounded by Lev Vygotsky in 1934 states that social interaction precedes development; consciousness and cognition are the end product of socialization and social behaviour. The theory holds that every function in the child's cultural development appears on the social level (inter-psychological), and later, on the individual level (intra-psychological). Social context- social interaction plays a key role in the process of cognitive development. The MKO (More Knowledgeable Other) refers to anyone with a better understanding of a concept/task than the learner with which the learner is in contact with. Learning through right pedagogy leads to development and results in zones of potential development ZPD which is the distance between a student's ability to perform a task under supervision with peer and the student's ability to solve the problem independently. Scaffolding is the support level the teacher provides to mentor the learner and allow them learn new concepts through experience.

Jigsaw iv strategy is a suitable method of teaching associated with constructivism learners are grouped in small groups of fours to allow for social interaction among their peers both at home and Jigsaw groups. Active learning is enhanced through participatory learning where the MKO from Jigsaw group with a better understanding of the assigned task/ or concept teaches the learner in the home group and answers their questions. This takes the learner to ZPD where learning occurs and the learner is able to perform the task in collaboration with the peer independently at the home group. Scaffolding in the Jigsaw strategy allows the teacher facilitate the learning for reciprocal experience where learners construct knowledge actively. Such experience leads to the internalization of concepts which results in high thinking skills, eventually leads to improved retention and achievement in Biology.

The cognitive theory propounded by Piaget in 1964, proposes that good pedagogy must present students with situations where they can experiment, manipulate, pose questions and seek their own answers, reconciling what they find at one time with what they find at another time and comparing the findings with those of other students. Piaget believes that the learning process, as self-regulated, involves the transformation of old knowledge to new knowledge and students should be given the time they need to explore, understand and remember. Jigsaw strategy is found in assimilation, accommodation which involves putting a new experience into already existing mental structure and equilibrating new information to fit together for logical understanding. The Jigsaw is interactive so it helps students to listen and retain information and retrieve it easily. In a Piagetian Jigsaw classroom, the presentation of ready-made knowledge is de-emphasized and students are encouraged to discover things for themselves through spontaneous interaction with the environment.

Students' achievement in Biology WAEC and NECO examination continues to be a cause for concern for students, parents and policy makers in education. The consistent low achievement in Biology have a great consequence for students seeking admission into tertiary institution, and could be a serious setback for attaining their potentials in profession that requires good performance in Biology. Although there has been some attempt at solving the problem, it seems to persist as noted with particular concern in students' achievement in excretion components of the Biology examination where students failed to relate theory to practice, when required to draw and label the excretory system (WAEC, 2013). The main reason for such low achievement could be attributed to teacher content, instructional methods which limits students to exposure to active participation on Biology classes and consequently, low retention.

Retention as the faculty of the mind that stores information acquired due to individual's interaction with his environment (Gonzalez, 2015). This stored information promotes academic achievement and retention of school students. Yet poor achievement and retention exist in Biology results of Plateau State students in West African Examination council for many years. Achievement in Biology is very important for scientific and technological advancement in turn leads to economic development of a nation. This points to the fact that inconsistent achievement and low retention in Biology will hinder economic growth of a nation and increase suffering for the people. The

importance of Jigsaw IV strategy from the result of this study cannot be over emphasized in taking the nation to the desired level.

RESULTS

Research Question One

What is the pre-test and post-test achievement of SSII Biology male and female students for both the experimental and control groups?

Table 1:

Pre-Test and Post-Test Achievement Mean Scores of SS II Biology Male and Female Students in Experimental Group

Gender	Test	N	Mean	SD	Mean Gain	Mean Difference
Female	Pre-test	58	22.62	7.76	38.21	7.59
	Posttest	58	60.83	11.31		
Male	Pre-test	65	24.43	7.04	30.62	
	Posttest	65	55.05	10.22		

Table 1 reveals the pre-test and post-test achievement mean scores of SS II Biology male and female students in experimental group. Female students in the experimental group had a pre-test mean score of 22.62 with a standard deviation of 7.76. Also, Female students in experimental group had a posttest mean score of 60.83 with standard deviation of 11.31 with a mean gain of 38.21. Male students had pre-test mean score of 24.43 with a standard deviation of 7.04, while posttest mean score 55.05 with standard deviation 10.22 with a mean achievement gain score of 30.62. In addition, the mean achievement score difference between female and male stood at 7.59 in favour of Females students.

Research Question Two

What is the post-test retention of SSII Biology students for the experimental and control groups?

Table 2:

Post-Test Retention Mean scores of SS II Biology Students in Experimental and Control Groups

Groups	N	Mean	SD	Mean Difference
Experimental	123	57.77	11.09	13.27
Control	60	44.50	9.55	

Table 2 shows the post-test retention mean scores of SS II Biology students in experimental and control groups after intervention. The SS II Biology students in experimental group had a post-test mean score of 57.77 with and standard deviation 11.09, while SS II Biology students in control group had a post-test mean score of 44.50 with a standard deviation of 13.27. This implies that students in experimental group who were exposed to Jigsaw strategy had a higher retention mean scores compared with students in the control group.

Research Question Three

What is the post-test retention of the SSII Biology male and female students for the experimental group after exposure to the Jigsaw strategy?

Table 3: Post-Test Retention Mean Scores of SS II Biology Male and Female Students in Experimental Group

Groups	Gender	N	Mean	SD	Mean Difference
Experiment	Female	58	57.86	8.71	2.37
	Male	65	55.49	9.36	

Table 3 reveals the pre-test and post-test retention mean scores of SS II Biology male and female students in experimental and control groups. Female students in experimental group had a post-test mean score of 57.86 with standard deviation of 8.71 and male students had post-test mean score 55.49 with standard deviation 9.36. The post-test means score difference between female and male students in the experiment group stood at of 2.37. This implies that after intervention the retention mean scores of SS II Biology female was a little higher than male students.

Test of Hypothesis

There is no significant difference in the post-test retention of the SSII Biology male and female students for the experimental group.

Table 4:**Summary of ANCOVA on Post-Test Retention of SS II Biology Male and Female Students in Experimental Group**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	172.126 ^a	1	172.126	2.096	.150	.017
Intercept	393833.654	1	393833.654	4796.496	.000	.975
GENDER	172.126	1	172.126	2.096	.150	.017
Error	9935.143	121	82.109			
Total	404281.000	123				
Corrected Total	10107.268	122				

a. R Squared = .017 (Adjusted R Squared = .009)

Table 4 reveals the analysis of covariance (ANCOVA) on post-test retention of the SS II Biology male and female students for the experimental group. In experimental group, female students had a post-test retention mean score of 57.86 and standard deviation of 8.71 and male students had 55.49 Post-test retention mean score and standard deviation of 9.36 with a Retention Post-test mean score difference of 2.37 in favour of female students.

Based on groups experimental group with F-value of 2.096 and p-value of 0.150. Since the p-value is greater than 0.05, partial $\eta^2 = .017$, with an effect size of 1.7%, the null hypothesis was retained, indicating that therefore there is no significant difference between the post-test retention of the SS II Biology male and female students in experimental group. The result further reveals an adjusted R squared value of .017 which means that 1.7 percent of the variation in the dependent variable which is achievement in biology is explained by variation in the treatment using Jigsaw strategy of instruction, while the remaining 98.3% is due to other factors not included in this study. This implies that post-test retention mean scores of SS II Biology female and males students in experimental group improved more than female and male students.

IMPLICATION TO RESEARCH AND PRACTICE

Findings of this study revealed that JIVS can enhance students' achievement and

retention if used by Biology teachers when teaching concepts since it is not gender bias. Biology teachers should use the Jigsaw IV strategy to teach Biology concepts for improved retention and achievement

CONCLUSION

At the end of the treatment, students taught the concepts of Biology using JIVS had a higher achievement and retention mean scores than those taught using LM. It was also found out that both male and female students' achievement in physics improved when they were taught using J4CLS. Furthermore, the study revealed that the achievement of students that were taught physics in both private and public secondary schools using J4CLS increased.

RECOMMENDATIONS

The following recommendations were made based on the findings of this study:

1. Biology teachers should be encouraged to use the Jigsaw IV strategy (JIVS) in teaching Biology in secondary schools since it improves students' retention and achievement.
2. Ministries of education should ensure that JIVS is enforced as one of the methods of teaching since it is not gender bias.
3. STAN should be encouraged to use JIVS for teaching Biology concepts in secondary school publication/textbooks.

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