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EFFECT OF JIGSAW INSTRUCTIONAL STRATEGY EMBEDDED WITH PRIOR KNOWLEDGE OF BEHAVIOURAL OBJECTIVES ON BIOLOGY STUDENTS' ACADEMIC PERFORMANCE AND RETENTION

CHRISTINA TANKO AUDU (PhD)
Taraba State University, Jalingo

Abstract

This study investigated the effect of Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives on biology students' academic performance and retention in Taraba State. The study adopted the pre-test – post-test quasi experimental design. The population for the study was 3,870 senior secondary II students. The sample of the study comprised 148 senior secondary II Biology students selected using stratified random sampling technique. Biology Performance Test (BPT) and Biology Retention Test (BRT) were instruments used for data collection. The experimental group was taught using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives while the control group was taught using conventional method. Data collected were analysed using Mean and Standard Deviation to answer the research questions. Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Result indicated that there is a significant difference between the mean performance scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using conventional method. Also there is a significant difference between the mean retention scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using the conventional method. It was concluded that Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives improve students' academic performance and retention in biology more than the conventional method. The researcher recommended that teachers should apply the use of Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives to enhance academic performance and retention in Biology Students.

Keywords: Jigsaw Instructional Strategy, Biology Students, Academic performance, retention, Behavioural objectives, Secondary Education.

Introduction

Science and technology education is the bedrock of human civilization and development. Many of the developed nations were able to achieve their status of development through science and technology education. In Nigeria, at the senior secondary school level, science education is most commonly broken down into three fields of Biology, Chemistry and Physics. Among these three science subjects, Biology is the most widely offered by the students. Lim (2020) asserted that Biology deals with the study of life and it helps to make people aware of their health, environment and their body among other things. On the importance of Biology, Mardonov (2019) stressed that Biology plays a key role in the industrialization and other sectors of the economy. The importance of Biology spreads to various professions such as pharmacy, medicine, engineering, nursing, food technology,

public health, veterinary medicine and agriculture among others. The field of Biology holds a paramount place in the modern world, but there is poor performance of students in Biology at the senior secondary school level in Nigeria (Samba &Eriba, 2012).

A credit in Biology is a prerequisite for gaining university admission in courses such as medicine, pharmacy, food technology, veterinary medicine and nursing among others. Biology is a very crucial aspect of science education and life as a whole. Therefore, every nation must give high level of priority to the subject and its study. Despite much effort made to ensure that students' academic performance in Biology is improve, reports from the WAEC Chief Examiners shows that from 2010-2019 the students have never recorded an average of 50% credit pass in the West African Senior School Certificate Examination (WAEC, 2010-2019).

Akinyemi and Folashade (2010) have attributed the problem of poor performance to non-availability of instructional facilities for the teaching of Biology. Igboko and Ibeneme (2006) had earlier blamed the poor performance on inadequate laboratory facilities in most schools for the teaching of Biology. This makes the teachers to emphasize theory to the neglect of the practical activities. Similarly, Samba and Eriba (2012) have put the blame of poor performance in Biology on the classroom teachers' professional training which may have affected their methods of teaching. The teachers' use of ineffective teaching methods is a factor for students' poor performance, especially in Biology (Ogbeba, 2009). Agogo and Achor (2014) posited that situations surrounding the teaching and learning of science and technology in Nigeria makes students to perform poorly as students are not actively engage in the teaching-learning process. This then calls for better and improved approaches to the teaching of Biology where students are actively engaged in the teaching learning process.

The poor performance in Biology in particular could be as a result of poor retention of learnt concepts. *Lieberman (2012)* defined retention as the ability of an individual to hold factual knowledge, skills, processes, images and figures in memory and at the same time retrieved for use when the need arises. *Lieberman further affirmed that* learning is dependent on memory processes because previously stored knowledge functions as a framework in which newly learned information can be linked. Memory is a site of storage and enables the retrieval and encoding of information, which is essential for the process of learning (*Radvansky, 2017).* This implies that learning cannot take place in the absence of retention. In confirming this, Radvansky (2017) stated that how well students retain taught scientific concepts can be traced back to the teaching approach used. Radvansky further submitted that teaching strategies that involve the active participation of the learner encourage retention while strategies that the learner receives information passively leads to little or no retention. According to Agogo (2011) the way science students process information they received from their teachers differ and it affects their retention levels too. *Radvansky (2017)* affirm that retention is enhanced when the teacher uses approaches that appeal to the learners' different sense organs and also actively involve the learner in the teaching-learning process.

One innovative instructional strategy that is capable of actively engaging the students in the teaching-learning process is the jig-saw cooperative instructional strategy. The jigsaw technique is a method of organizing classroom activity that makes students dependent on each other to succeed. It breaks classes into groups and breaks assignments into pieces that the group assembles to complete the (jigsaw) puzzle. It was designed by social psychologist

Elliot Aronson to help weaken racial cliques in forcibly integrated schools. The technique splits classes into mixed groups to work on small problems that the group collates into a final outcome. Teacher arranges students in groups. Each group member is assigned a different piece of information. Group members then join with members of other groups assigned the same piece of information, and research and/or share ideas about the information. For example, an in-class assignment is divided into topics. Students are then split into groups with one member assigned to each topic. Working individually, each student learns about his or her topic and presents it to their group. Next, students gather into topic groups. Each member presents again to the topic group. In same-topic groups, students reconcile points of view and synthesize information. They create a final report. Finally, the original groups reconvene and listen to presentations from each member. The final presentations provide all group members with an understanding of their own material, as well as the findings that have emerged from topic-specific group discussion.

There are little research efforts that embedded prior knowledge of behavioural objectives in Jigsaw classroom. Embedding prior knowledge of behavioural objectives in Jigsaw classroom is an innovation in Nigerian education system. Based on this, the present study examined the effect of Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives on biology students' academic performance and retention in Taraba state, Nigeria.

Use of Jigsaw Strategy Along with Advanced Behavioural Objectives

Usually, a jigsaw lesson has eight steps. However, in this study, the researcher modified the steps by embedding in the jigsaw prior knowledge of the behavioural objectives before the other steps of the usual jigsaw lesson. Over the years, the general practice has been that teachers state instructional objectives but these objectives are not made known to the students. Ogbeba (2009) confirmed that many teachers teach without letting the students know what is expected of them at the end of lesson or course. This practice according to Abdulahi (2003) is like leading a group of persons to a destination without letting them know where they are going and as such once the leader is not there the group becomes confused and the journey end without reaching the actual destination. Abdulahi further stated that when teachers did not make known to students what is expected of them at the end of an educational activity, students will not know whether they have achieved or not. Students will have to guess from the behaviour of the teacher what is considered relevant and what is expected of them.

Another justification for introducing the students to behavioural objectives prior to the jig-saw lesson is based on the affirmation by Ogbeba (2009) that making behavioural objectives known to students prior to the presentation of the lesson do sharpens the students' focus and direction about how best to go about attaining the objectives. Similarly, Aboho and Muodumogu (2006) declared that prior knowledge of behavioural objectives gives the learner a sense of direction on what to do and how to do it, that when the learners are told what is expected of them, they gain an insight into how to achieve the desired learning outcome with minimal supervision and assistance. These authors also observed that the knowledge of behavioural objectives will provide the learners the means of evaluating their efforts as the lesson progresses.

Thus, the Jigsaw steps used in this study include:
Step One: Teacher introduced the topic and all the behavioural objectives by writing them on the board for students to see. Teacher emphasizes that students should focus first on achieving the objective(s) relating to the sub-topic or section of the project that is assigned to them.

Step Two: Teacher divides the students into group of 5 or 6 students depending on the population of the class

Step Three: Teacher assigns a section of the topic to each student. For instance, if the topic is "Excretion in Mammals" the teacher will divide the topic into sections such as definition of excretion, organs of excretion: the kidney, liver, skin and lungs, need for excretion among others and assign one section to each student in the group.

Step Four: All students go about researching and gathering information on the section of the topic they have been assigned.

Step Five: Students return to form experts group which is made up of all students with same section of the topic. For example, those who are assign "kidney as excretory organ" form one expert group and discuss various functions of kidney as excretory organ. Students were given adequate time to discuss the main points of their segment and to rehearse the presentations they will make to their jigsaw group.

Step Six: Students return to their original groups and present their section to the entire group. The group form a complete report on the whole topic for onwards presentation to the whole class.

Step Seven: Students return to the classroom and each group present their report on the topic of the day.

Step Eight: Teacher allows time and encourage others in the group to ask questions for clarification. Questions are asked at every point of the presentation.

Step Nine: Teacher guides students to select the best points from each section and form a summary of lessen note on the topic.

Role of the teacher in a Jigsaw classroom is to facilitate the arranging of groups, explaining of roles and timing for each portion. The teacher doesn't have to lecture or be the focal point of attention. When the students are in groups for steps 5 and 6, the teacher should walk among the groups and lend support or explanation where necessary.

While the instructional values of jigsaw cooperative strategy in enhancing academic performance among students in Biology have been established by Moreno (2009) and Altipartmak and Nakiboglu-Tezer (2009). Also Gambari (2010) found Jigsaw effective in enhancing academic performance in physics. Despite the effectiveness of Jigsaw in enhancing academic performance it is time consuming and it is very difficult implementing Jigsaw in Nigerian education where the maximum duration for a lesson is forty minutes (Amosa, Mudasiru&Shittu, 2015). It therefore follows that effort must be made to reduce time

consuming in Jigsaw instruction. Making students have prior knowledge of behavioural objectives is a strategy to focus the students' attention on the main concern of the topic in question which is hoped to reduce time spend on search for information.

Statement of the Problem

The results of candidates released by WAEC from 2010-2019 revealed that the candidates have never recorded 50% credit pass in the senior school certificate examination. Many researchers such as Samba and Eriba(2012) and Smora (2013) have agreed that the poor performance in Biology is as a result of wrong and inappropriate use of instructional strategies by Biology teachers and inadequate infrastructures such as libraries and laboratories. The students' persistent poor performance in Biology makes it imperative to search for better teaching approaches for effective teaching and learning of Biology concepts. This poor performance in Biology must be taken as a wake-up call to re-examine the instructional methods been used by teachers to prevent the situation from constituting a clog on the wheel of educational progress of many Nigerian students offering Biology. This is because a credit pass in biology is required for admission into courses such as Medicine, Pharmacy, Nursing and other Science related courses at the university level. It therefore follows that if nothing is done to check the poor performance in Biology at the secondary school, there may be few candidates (less than 50%) for admission into these courses at the tertiary level. Therefore, there is need to search for innovative teaching approaches that could improve students' performance and retention in Biology. More so that the incorporation of prior knowledge of behavioural objectives in jigsaw classroom is an innovation that is yet to be tried in the study area base on author's search. Thus, the problem of this study put in question form is what are the effects of Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives on biology students' academic performance and retention in Taraba state, Nigeria?

Research Questions

The following research questions guided the study:

1. What is the difference between the mean performance scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using conventional method?
2. What is the difference between the mean retention scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using the conventional method?

Hypothesis

The following hypotheses were tested at 0.05 level of significance:

1. There is no significant difference between the mean performance scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using conventional method.
2. There is no significant difference between the mean retention scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using the conventional method.

Research Method

This study adopted the pretest - posttest quasi experimental design. This design implies that all groups took pre-test before the treatment and post-test at the end of the treatment. The

population for this study was 3, 870senior secondary II students in 34 public secondary schools in Wukari and Takum Local Government Areas of Taraba State. The sample of this study comprised 148senior secondary II Biology students located in four intact classes in four secondary schools in two Local Government Areas in Taraba State. The sampling procedure was stratified random sampling technique. Two instruments were used for data collection. The instruments were: Biology Performance Test (BPT) and Biology Retention Test (BRT). The instruments were validated by three experts. Kuder Richardson formula ($K\text{-}R_{21}$) was used to determine the reliability coefficients of the instruments and it was found that the BPT had a reliability coefficient of 0.78 while the BRT has a reliability coefficient of 0.81.

Before the commencement of the treatment, a pre-test was administered to both the experimental group and control group. The experimental group was Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives while the control group was taught using conventional method. After teaching for five weeks post-test was administered to both groups. Data collected were analysed using Mean and Standard Deviation to answer the research questions. Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

The results are presented based on the research questions and hypotheses:

Research Question One

What is the difference between the mean performance scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using conventional method?

Data analysis providing answer to research question one is presented in Table 1.

Table 1: Mean and Standard Deviation of Performance Scores of Students Taught BiologyUsing Jigsawand Those Taught Using Conventional Method

Group	**N**	**Pre-Test**		**Post-Test**		
		Mean	**SD**	**Mean**	**SD**	**Mean Gain**
Jigsaw	76	38.30	8.93	76.64	13.98	**38.34**
Conventional method	72	36.68	8.58	54.91	11.41	**18.23**
Mean difference		**1.62**		**21.73**		**20.11**

Table 1 shows that 76 senior secondary II students were taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and 72 students were taught using the conventional method. The table reveals that the mean performance scores of students taught using Jigsaw is 38.30 with a standard deviation of 8.93 during pre-test and 76.64 with a standard deviation of 13.98 in post-test. Table 1 also reveals that the mean performance scores of students taught using conventional method is 36.68 with a standard deviation of 8.58 during pre-test and 54.91 with a standard deviation of 11.41 in post-test. Table 1 further shows that the mean gain of students that were taught using Jigsaw is 38.34 and those of students taught using conventional method is 18.23. The mean difference between the Jigsaw group and the conventional group is 21.73 in favour of the Jigsaw group.

Research Question 2

What is the difference between the mean retention scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using the conventional method?

Data analysis providing answer to research question two is presented in Table 2.

Table 2: Mean and Standard Deviation of Retention Scores of Students Taught Biology Using Jigsaw and Those Taught Using Conventional Method

Group	N	Pre-Test		Retention-Test		
		Mean	SD	Mean	SD	Mean Gain
Jigsaw	76	38.30	8.93	68.65	12.48	**30.35**
Conventional method	72	36.68	8.58	55.90	11.11	**19.22**
Mean difference		**1.62**		**12.70**		**11.13**

Table 2 shows that 76 senior secondary II students were taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and 72 students were taught using the conventional method. The table reveals that during pre-test, students taught Biology using Jigsaw have a mean of38.30 with a standard deviation of 8.93and 68.65 with a standard deviation of 12.48 in retention-test. Table 2also reveals that during pre-test, students taught Biology using conventional method have a mean of 36.68 with a standard deviation of 8.58 and 55.90 with a standard deviation of 11.11 in the retention test. Table 2 further shows that the mean retention gain of students that were taught using Jigsaw is 30.35 and those of students taught using conventional method is 19.22. The mean retention difference between the Jigsaw group and the conventional group is 11.13 in favour of the Jigsaw group.

Hypothesis 1

There is no significant difference between the mean performance scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using conventional method.

Data analysis for testing hypothesis one is presented in Table 3.

Table 3: ANCOVA of Performance Scores of Students Taught Biology Using Jigsaw and Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2672.42[a]	2	1336.21	36.92	.00	.22
Intercept	8268.52	1	8268.52	228.48	.00	.46
Strategies	**2649.93**	**1**	**2649.93**	**73.22**	**.00**	**.22**
Pre-test	.67	1	.67	.02	.89	.00
Error	9409.33	145	64.89			
Total	196800.00	148				
Corrected Total	12081.75	147				

Table 3 reveals that F (1, 145) = 73.22; p = 0.00< 0.05. Thus, the null hypothesis is rejected. Thus, it can be concluded that there is a significant difference between the mean performance scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using conventional method. The partial Eta square of 0.22 was obtained for the method meaning that 22% of the performance can be accounted for by the method employed in the teaching of Biology.

Hypothesis 2

There is no significant difference between the mean retention scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using the conventional method.

Data analysis for testing hypothesis two is presented in Table 4.

Table 4:ANCOVA of Retention Scores of Students Taught Biology Using Jigsaw and Conventional Method

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1364.07[a]	2	682.04	27.84	.00	.18
Intercept	7567.56	1	7567.56	308.89	.00	.54
Strategies	**1337.42**	**1**	**1337.42**	**54.59**	**.00**	**.17**
PreBPT	5.61	1	5.61	.23	.63	.00
Error	6369.90	145	43.93			
Total	183293.00	148				
Corrected Total	7733.97	147				

Table 4 reveals that F(1, 145) = 54.59; p = 0.00< 0.05. Thus, the null hypothesis is rejected. This implies that there is significant difference in the mean retention scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using the conventional method. Thus, it can be concluded that based on evidence from data analysis there is significant difference in the mean retention scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using the conventional method. The partial Eta square of 0.17 was obtained for the method meaning that 17.0% of the Biology students' retention can be accounted for by the method employed in the teaching of Biology.

Discussion of findings

Finding from hypothesis one revealed that there is a significant difference between the mean performance scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using conventional method in favour of the Jigsaw group. This finding is possible because the Jigsaw strategy involves extended opportunities for research, sharing of ideals, personal responsibility and ownership of learning with high levels of student interactions and creation of a supportive environment featuring group evaluation and, in some instances, more systematic instruction. Another reason for the significant difference between the Jigsaw group and the conventional group could be that students in the Jigsaw group were exposed to prior knowledge of behavioural objectives. Making behavioural objectives known to students prior to the presentation of the

lesson do sharpens the pupils' focus and direction about how best to go about attaining the objectives which result to improved academic performance.

The finding that Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives enhanced academic performance corroborate that of Amosa, Mudasiru and Shittu (2015) and Moreno (2009) who in their separate researches found Jigsaw cooperative learning strategy effective in enhancing students' academic performance. Finding from hypothesis two indicates that there is a significant difference between the mean retention scores of students taught Biology using Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives and those taught using the conventional method in favour of the Jigsaw group. The Jigsaw group retained what they learnt in Biology more than the control group because the knowledge they acquired was properly anchored since the Jigsaw group learnt by interacting with one another in the classroom. The individual and group presentation on the various sections of the topic in the Jigsaw class makes retention possible. This finding is in agreement with that of Amosa, Mudasiru and Shittu (2015) who also found Jigsaw effective in improving retention of knowledge learnt. The finding also corroborate that of Van Dat (2016) that Jigsaw instructional strategy enhanced students retention of learnt concepts. The presentation of advance organisers inform of behavioural objectives enable learners to organized the acquired knowledge which make retention more effective.

Conclusion

It is concluded in this study that Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives improve students' academic performance and retention in biology more than the conventional method.

Recommendations

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

1. Teachers should apply the use of Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives to enhance academic performance and retention in Biology.
2. Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives reduce time spend by students researching their given topics thereby making Jigsaw suitable for use in Nigerian education system.
3. Ministry of education and Teachers Registration Council (TRC) should organize workshops on the use of Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives.
4. Teachers' training institutions such as National Teachers Institute (NTI), Colleges of Education and Universities should include Jigsaw instructional strategy embedded with prior knowledge of behavioural objectives in their curriculum for English education programmes.

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