JIGSAW LEARNING TEAMS, TEACHER-LED DISCUSSION AND SECONDARY SCHOOL STUDENTS' ACADEMIC PERFORMANCE IN BIOLOGY

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Abstract: *Secondary school students' poor performance in Biology has been blamed on large classes, difficult concepts and teachers' presentational competencies. This study which adopted a quasi-experimental, non-randomized, pretest, post-test design sought to find out the extent to which the jigsaw learning teams and teacher-led discussion teaching strategies would enhance students' performance in Ecology. Using the multi-stage random sampling technique, eighty senior secondary I students belonging to two intact classes in a public secondary school in Ikwuano local Government Area in Abia State were used for the study. A twenty-item Ecology Attainment Test with a Kuder-Richardson reliability co-efficient of 0.78 was the data collection instrument for the study. Although the students taught Ecology using Jigsaw learning team instructional strategy showed greater improvement in their performance in the Ecology Attainment test than those taught using the Teacher-led discussion instructional strategy, this improvement was not significantly different. Based on the findings of this study, it was recommended that Biology teachers: vary their instructional strategies in order to provide students with bounteous opportunities to take responsibility for their own learning; adopt interactive and collaborative teaching strategies so as to create settings in which learners would become teachers who explain concepts and procedures to one another; as well as improve students' performance in Biology.*

Introduction

The 2004 edition of the Nigerian National Policy on Education (NPE) mandated that all senior secondary school students in Nigeria must offer at least one science subject as part of the core curriculum. This rule led to the rapid increase in student enrolment in Biology in contrast to student enrolment in Chemistry and Physics. This trend in student enrolment was explained by students' assumption that Biology is the simplest to understand (Adewale, Nzewuihe and Ogunsola, 2016); and has numerous importance (Ahmed and Abimbola, 2011). Although the 2013 edition of the National policy on Education did not stipulate the compulsory offering of any science subject, students' enrolment in Biology has remained higher than that of other science subjects.

In spite of the overwhelming popularity of Biology in secondary schools, students' performance in external examinations has remained poor. Sakiyo and Badau (2015), report that on the average, only 37.27% of all candidates that registered for Biology from 2008-2012 obtained grades 1-6 in

the West Africa Senior School Certificate Examination (WASSCE). This is far lower than the average of 46.30 and 56.01% passes recorded by students who offered Chemistry and Physics respectively. In 2013 and 2014, students obtained 40.28% and 37.59% passes in WASSCE Biology (Ihejiamaizu and Ochui, 2016).

The persistent poor performance of students in Biology has been blamed on a number of school factors such as large classes (Ali, Toriman and Gasim, 2014); teachers' pedagogicalin competence in teaching of difficult concepts (Okebukola 2005; Ezekanagha 2008; Isiugo-Abanihe, Long-John and Tandi 2010); as well as concepts in Biology that are difficult to teach and learn (Agboghoroma and Oyovwi 2015). West African Examination Council (WAEC) chief examiners (2016) report that students did not correctly answer an essay question bordering on Ecology. This report seems to be authenticated by Etobro and Fabinu's (2017) report that 68.3% and 55.3% of the students sampled for their study perceived the concepts of ecological management and conservation of natural resources to be difficult.

To curb the challenge of Nigerian students' poor performance in Biology, several studies have advocated for the use of innovative, learner-centered instructional strategies such as the cognitive conflicts strategy (Alamina and Kalu-Uche, 2007); the Jigsaw instructional strategy (Mumuni, Dike and Uzoma-Nwogu, 2017); and Team teaching (Akpan, Uwandu and Ekanem, 2013) which have been proven to promote students' learning experiences, understanding and achievement in science. Learner-centered instructional strategies are anchored on the premise that when students are actively engaged with the physical environment, interact socially, engage in dialogue with the teacher and one another, learning is promoted. Researchers advocating for group learning assert that teaching strategies that encourage students to work in groups help students to inquire, share ideas, clarify concerns, collaborate, problem solve and ultimately construct new understandings (Gillies and Boyle, 2011).

Although learner-centered instructional strategies have been proven to improve performance by individualizing teaching and learning, the reasonableness of its implementation in large classes remain hindered. The National Policy on Education (FRN, 2013) stipulates that the teacher to student ratio in secondary schools should be 1:40. This connotes that any class that exceeds this ratio is a large class. Researchers have advocated for the use of several strategies that have been found to produce positive outcomes inlarge classes. These strategies include all forms of active and collaborative learning. Active learning is a wide range of instructional strategies which strives to get students to participate in the learning process by engaging them in doing

things besides passive listening. To learn actively, students must be engaged in reading, writing, discussing, and solving problems. Active learning helps to maintain student concentration, deepen learning, promote higher level skills such as critical thinking as well as engage students who may be struggling (Koselyn, Nelson and Kerry, 2017). Examples of active learning strategies/techniques include: role-playing, case studies, group projects, team quizzes, debates, peer-teaching, short demonstrations, class discussions, and collaborative groups among others.

Class discussions are a variety of forums for open-ended, collaborative exchange of ideas among a teacher and students or among students for the purpose of furthering students' learning and understanding. Variants of the discussion instructional strategy include small group, whole group, teacher-led or student-led forms. Class discussions help students to test their ideas and opinions against the ideas and opinions of their peers (Yale center for Teaching and learning, 2014). It provides students with opportunities to acquire knowledge and insight as they engage in face-to-face exchange of information, ideas and opinions. Discussions actively gets students involved in learning the learning process and as such helps improve students' comprehension and critical thinking skills (Davis, 1993). As a teaching strategy, group learning refers to any activity in the classroom that involves two or more students solving a problem or working as a team to complete a long-term project. Variants of the group learning teaching strategy include cooperative learning, problem-based learning, learning pyramids, group work, team learning, peer instruction, circle of voices, rotating trios, snowball groups, buzz groups, think-pair-share, collaborative learning and jigsaw learning teams among others (Kennette and Hanzuk, 2017; Centre for Teaching excellence, 2018; and Brame and Biel, 2015).

Against the backdrop of large student enrolment and students' unimpressive performance in external examinations in secondary school Biology, it has become pertinent to make conscious efforts to determine viable teaching strategies that will facilitate students' understanding of Biology concepts that have been identified by research, as being difficult for students to learn. Thus, this study sought to investigate the relative effects of the Jigsaw Learning teams and Teacher-led Discussion strategies on the academic performance of secondary school students in Biology.

Two research questions and one hypothesis guided the study:

What is the performance of the students in the Ecology Attainment Test before they were taught with the Jigsaw learning teams and Teacher-led discussion strategies?

What is the relative effect of the use of Jigsaw learning teams and Teacher-led discussion strategies on students' academic performance in the Ecology Attainment Test?

There is no significant difference in the mean performance of Biology students taught with the Jigsaw learning team and Teacher-led discussion strategies as measured by the test scores of the Ecology Attainment Test.

Method

The study adopted a quasi-experimental non-randomized pre-test, posttest design. The population of the study consisted of 897 SSI students offering Biology in the eleven public senior secondary schools in Ikwuano Local Government Area (LGA) of Abia State. Using the multi-stage random sampling technique, two intact classes from the same school consisting of 80 students were used for the study. The classes were assigned to experimental (Jigsaw learning teams) and control (Teacher-led Discussion) groups by balloting. The students were not randomly assigned into experimental or control groups. The classes had 40 students each. The instrument for data collection was a 20-item multiple choice Ecology Attainment Test adapted from WASSCE past questions. A test-blue print guided the choice of the test items. To establish the reliability of the instrument, equivalent forms of the instrument were administered twice, with an interval of two weeks, to SSI students in a secondary school in Ikwuano LGA, who were part of the target population but not among the sample selected for the study. The instrument had a Pearson product-moment correlation co-efficient of 0.78. The study was carried out when pre-service teachers were on teaching practice in the school, these pre-service teachers served as teachers (research assistants) used for the study. The pre-test instrument was administered to the students, as part of their continuous assessment, by their regular Biology teacher. This controlled for all threats to validity and bias.

The students were taught twice a week for three weeks. During the first lesson, which lasted for 80 minutes, the students in the experimental group were taught "Basic Ecological Concepts" using explanations and illustrations. After 30 minutes, they were taken to the flower hedges and gardens in the school premises to identify organisms, habitats and population of species of plants and animals that were in the school field. After 30 minutes in the field, the students returned to the class. For closure, the students were assigned to groups by balloting. Each student picked a piece of paper from a bag handed out by the teacher. The teacher asked the students having the same numbers to gather together. With this, eight groups of five students each were formed. Each group was given a sub-concept of Ecology to read up, brainstorm and to

prepare the assigned content into a teaching presentation for the class. The students were informed that any member of their group could be called up to represent the group and to make the presentation to the class. For the second contact, the teacher gave a recap of the first lesson, then students were asked to break into their groups to brainstorm on what they had learned individually, so as to come up with their group presentation. On the third contact, all the groups were given seven minutes each to make their presentations to the entire class and two extra minutes to answer any questions from students that were not members of their group. The groups were given the privilege of choosing their spokesperson. For the fourth contact, the groups were reshuffled and collapsed into five new groups made up of eight students. Each new group had a member of the former group. These "experts" were mandated to teach their new group members the content they had learned in their first group. The content that was discussed by the students during this period was streamlined by the teacher. This group was maintained for the fifth contact. During this contact, the students also taught themselves for 30 minutes. At the end of the 30 minutes, the teacher presented a recap of what the students had been discussing as well as answered students' questions, were they needed clarifications. For the sixth contact, students were encouraged to ask questions on any portion of the content they still had difficulty with. These questions were thrown open to the class and any student in the class could answer the question. The teacher summarized the content that had been learnt at the end of the lesson.

The students in the Teacher-led Discussion group (the control group) were also taught twice a week for three weeks. For the first lesson, which lasted for 80 minutes, the students were taught "Basic Ecological Concepts" using explanations and illustrations, this lasted for 30 minutes. The students were taken to the flower hedges and gardens in the school premises where they identified organisms, habitats and population of species of plants and animals that were in the school field. After 30 minutes in the field, the students returned to the class. The teacher asked the students a few prodding questions based on what they had observed in the field. The students were told that the rule for answering questions or making contributions in the class was that they were not allowed to interrupt others who were making their own contributions. For closure, the students were asked to study the content on Relevance of Biology to Agriculture and Micro-organisms around us in their textbooks and to write down any questions they had about it in preparation for the next class. During subsequent contacts, the teacher started the lesson by asking students questions to help them recall what they had learnt the previous lesson. The teacher used brief lectures and explanations to introduce the new concepts.

The students were also asked prodding questions based on the content they were asked to study at home and were given ample opportunity to explain to each other what they understood by the concepts under consideration. To ensure all students participated, students that did not raise their hands to ask or answer questions were often asked to answer other students' questions. The teacher re-directed students' questions to the students such that students responded directly to one another's ideas. Students were encouraged to ask questions on any issue that needed clarification. Students were encouraged to contemplate and think critically before proffering a response. All important ideas and major concepts that were discussed in the class, were noted on the board by the teacher.

The posttest instrument, which was an equivalent form of the pre-test instrument was administered as part of the students' continuous assessment in the fourth week after the commencement of the study. To answer the research questions, the data collected were analyzed using mean and standard deviation and the hypothesis was tested using the 2-Sample student t-Test.

Results

Table 1: pretest mean scores of students taught Ecology using Jigsaw learning teams and Teacher-led discussion strategies.

	Instructional Strategy		
	Jigsaw learning teams	Teacher-led discussion	Difference in mean
Number of students	40	40	
Pre-test Mean	16.5	16.8	0.3
Standard Deviation	1.41	1.70	

The students taught using the jigsaw-learning-teams strategy had a pretest mean score of 16.5 with a standard deviation of 1.41, while the students taught using the Teacher-led discussion strategy had a pretest mean score of 16.8 with a 1.70 standard deviation. The 0.3 difference in pre-test mean scores of the two groups indicate that the two groups were equivalent before they were taught using either of the two strategies.

Table 2: post-test mean scores of students taught Ecology using Jigsaw learning teams and Teacher-led discussion strategies.

	Instructional Strategy		
	Jigsaw learning teams	Teacher-led discussion	Difference in mean
Number of students	40	40	
Post-test Mean	30.20	27.1	3.1
Standard Deviation	3.13	2.56	

The students taught using the jigsaw-learning-teams approach had a post-test mean score of 30.20 with a standard deviation of 3.13, while the students taught using the Teacher-led discussion strategy had a post-test mean score of 27.1 with a standard deviation of 2.56. The post-test mean score of the jigsaw learning team group was higher by 3.1 than that of students taught using the Teacher-led discussion strategy.

Table 3: t-test for independent samples analysis of students' score in the Ecology Attainment Test

Group	Number of students	Group mean	Standard deviation	Degree of freedom	Significance level	t-calculated	t-tabulated
Jigsaw learning teams	40	30.20	3.13	78	0.05	0.204	1.664
Teacher-led Discussion	40	27.1	2.56				

Decision: Since the calculated t-value of 0.204 is lower than the tabulated t-value of 1.664, the Null Hypothesis, that there is no significant difference in the mean performance of Biology students taught with the Jigsaw learning teams approach and those taught using the Teacher-led discussion strategy as measured by the test scores of the Ecology Attainment test, is accepted.

Discussion

1. The students taught using the Jigsaw learning Teams strategy had a pre-test mean score of 16.5 with a standard deviation of 1.41 while those taught using the Teacher-led discussion strategy had a pre-test mean score of 16.8 with a standard deviation of 1.70. These scores indicate that the students had a prior knowledge of Ecology and Population studies. These results uphold the constructivist view that learners have an idea of all concepts to be taught and as such bring their previous conceptions into the classroom. The standard deviations of 1.41 and 1.70 also indicate that the students' scores in the pre-test were not so divergent. This result also affirms the social constructivist view that some constructed meanings are shared as students share a lot of experiences such as school life, hobbies, and magazines and as such may bring similar ideas about natural phenomena to the classroom (Goodman 2009; Scott in Kalu-Uche, 2010).
2. Although the students in both groups made noteworthy gains in their achievement, the post-test mean score of students taught using the Jigsaw learning teams was slightly higher than that of the students taught using

the Teacher-led discussion strategy in the Ecology Attainment Test. This indicated that the students in the Jigsaw learning team had achieved better conceptual understanding of Ecology than their colleagues taught using the Teacher-led Discussion strategy. This observed difference could be attributed to the use of a strategy that allowed the students to work in small teams. This finding endorses Kalaian and Kasim's (2011) assertion that "all forms of small group learning methods have positive impacts on students' achievement in Science".

3. The findings of this study indicate that there is no significant difference in the mean performance of Biology students taught with the Jigsaw learning teams approach and those taught using the Teacher-led discussion strategy as measured by the test scores of the Ecology Attainment test. This indicates that the two teaching strategies were effective in improving students' understanding of Ecology and their performance in the Ecology Attainment Test.

Conclusion

From the analysis of data, it was pertinent to conclude that although the students taught Ecology using the Jigsaw learning teams approach had slightly better post-test scores in the Ecology Attainment Test, this performance was not significantly different from the performance of the students taught using the Teacher-led discussion strategy. This result seems to suggest that when students are actively involved and responsible for their own learning, they will achieve better conceptual understanding of Biology concepts.

Recommendations

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

1. Instructional strategies for Biology teaching in secondary schools should be varied in order to arouse and sustain students' interest as well as improve students' performance in Biology.
2. Instructional strategies adopted in Biology teaching should be such that provides students with bounteous opportunities to take responsibility for their own learning.
3. Biology teachers should be encouraged to adopt interactive and collaborative teaching strategies so as to create settings in which learners would become teachers who explain concepts and procedures to one another.

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