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Effects of Problem-Solving and Demonstration Methods on Students' Performance in Biology in Nsit-Atai Local Government Area, Akwa Ibom State, Nigeria

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ABSTRACT

This study investigated the effects of problem-solving and demonstration methods on students' performance in biology in Nsit-Atai local government, Akwa Ibom State, Nigeria. It also examined the gender on students' mean performance scores in Biology when taught using problem-solving and demonstration methods. Two hypotheses guided the study. The study focused on co-educational secondary schools in Nsit Atai Local Government Area of Akwa Ibom State, Nigeria. A sample of 131 senior secondary one (SS1) Biology students was selected from two intact classes of two co-educational public secondary schools in Nsit Atai Local Government Area. It comprised 58 males and 73 females. A purposive sampling was adopted. The two schools were experimental and control groups. Subjects in the experimental groups were taught using problem-solving and demonstration methods. A researcher-developed instrument (the Biology Performance Test on Ecology (BPTE)) with a reliability coefficient of 0.80 using the Kuder-Richardson formula – 21 was used for data collection. Data collected were analysed using descriptive statistics (mean and standard deviation) and analysis of covariance (ANCOVA). The findings showed that Biology students taught the concept of ecology using the demonstration method performed better than those using the problem-solving. Gender was an insignificant factor in students' performance. From the findings, Biology teachers should employ demonstration methods in teaching the concept of ecology to enhance students' performance in Biology.

Keywords: *problem-solving method, demonstration method,*

INTRODUCTION

Education is the key to national development. Education as a discipline is concerned with methods of teaching and learning in schools. It is a process whereby the acquisition of knowledge, skills, values, morals, beliefs, and habits is facilitated. Biology is a branch of natural science that deals with living organisms, including their structures, functioning, evolution, distribution, and interrelationship (Institute of Biology, 2013). The existence of

man and the thought of himself and the environment (plants and animals) led to the study of Biology (Michael, 2015). Biology is the science of living beings. Some of the main fields of biology involve studying microscopic organisms and animals or the relationship between biology and other sciences.

The Nigerian secondary school biology curriculum is designed to continue students' investigation into natural phenomena; to deepen students' ability to apply scientific knowledge to everyday life in person, community health, and agriculture (Federal Ministry of Education, 2013). Biology, a branch of science and a prerequisite subject, contributes immensely to the technological growth of a nation. The study of Biology enables one to become more aware of a changing environment, explore it better, and adapt to it (Salau, 2012). Biology is a science subject because it affects our daily lives and future. Many biologists are working on problems that critically affect our lives, such as the world's rapidly expanding population and diseases like cancer, AIDs, and infectious disease epidemiology, which is the science that evaluates the occurrence, determinants, distribution, and control of health and disease in a defined human population (Prescott, Harley and Klein, 2015). The knowledge of such studies could be fundamental to managing the world's resources suitably, preventing or curing disease, and improving the quality of our lives and those of our children (UNESCO, 2016).

Ecology is the scientific study of interactions that determine the distribution and abundance of organisms (plants and animals) and their environments. It is an interdisciplinary field that includes biology, geography, and earth science. Ecology is how organisms interact with each other and with abiotic components of their environment (Adolph, 2016). According to Prescott, Herley and Klein (2015), ecology is the microbial relationships with other organisms and their non-living environments. This relationship is interactive in the use of resources, which have effects extending to the global scale.

According to Michael (2017), ecology is the interaction of plants and animals with their non-living environment. Ecosystem processes primary production as paedogenesis, nutrient cycling, and various niche construction activities and regulates the flux of energy and matter (Hardin and Adolph, 2007). The processes are sustained by organisms with specific life histories, traits and organisms called biodiversity. Biodiversity refers to the life on earth, the number of species of plants, animals, and microorganisms, the enormous diversity of genes in these species, and the different ecosystems on the planet, such as deserts, rainforests and coral reefs (Anup, 2014). Ecology needs teaching methods that enhance students' understanding and performance, thus the demonstration and problem–solving methods of teaching.

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Demonstration Method

The demonstration method involves the teacher or the students doing activities in front of the class and giving appropriate explanations (Ikitde and Edet, 2013). In the demonstration method, the teacher is the principal actor while the learners watch to act later. Here the teacher does whatever the learners are expected to do at the end of the lesson by showing them how to do it and explaining the step-step process to them (Ameh, Daniel and AKUS, 2007). Mundi (2006) described the demonstration method as a display or an exhibition usually done by the teacher while the students watch. Adekoya and Olatoye (2011) described the demonstration as an activity carried out by a teacher (sometimes by the students) in full view of other students who do not participate but only watch.

Problem-Solving Method

The Problem-solving method has been defined concerning its philosophical and psychological backgrounds. According to Alio and Harbor-Peters (2010), the Gestalt Theorists posited that it is an insightful or initiative process involving the perceptual processes of the solver. To them (the Gestalt theorists), problem-solving is a type of discovery learning whose emergence depends on the structure of the task and is independent of the learners' previous knowledge. In support, Idoko and Ibitoye (2014) described problem-solving as a manipulation of the problem statement geared towards achieving the desired solution, which is cognitive in nature or domain dependent. Problem-solving is the identification and selection of problems arising from the individual experiences of the students (Omalle, 1996). As a teaching procedure, it involves scientific processes and reflective thinking; the role of the teachers often is to clarify the problems and provide necessary materials to help the students solve their problems. Success in problem-solving methods depends on the level of interest and creativity. It also depends on the resilience of the students as well as the level of difficulty of the activity involved. It is the view of Salami (2013) that problem-solving in science depends on a student's cognitive ability level.

Several studies within the Nigerian environment (Salami, 2013 and Ishaku, 2015) have shown that learners are qualitatively different in their ability levels and learning. Problem-solving, therefore, could be seen as a pathway to a solution of an identified problem using step-wise procedures (Mundi, 2006). Problem-solving method helps students gain knowledge through active participation and autonomously finding out information; it promotes their intellectual productivity. It also creates the ability to appraise problematic situations constructively and objectively among students (Mundi, 2006).

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Biology is practical-oriented, required instructions and applications for demonstration and problem-solving methods. Bello and Abimbola (2010) observed that classrooms are composed of students of different ability levels in the Nigerian educational system. Hence, innovation in instructional strategy must consider the influence of students' ability levels.

There has been a documented poor performance of students in Biology over the years, reflected in WAEC Chief Examiners Reports. One of the reasons for students' poor performance is the teaching strategies during classroom instruction. The teaching strategy is vital in a teaching-learning process as adopted by the teacher may promote or hinder learning. It may sharpen mental activities, which are the bases for social power, or discourage initiative and curiosity, making self-reliance and survival difficult for students. Teaching strategies affect the students and could determine whether they would be interested, motivated, or involved in a lesson. Students' poor performance has been attributed to teachers' failure to use effective teaching methods. Can the students' performance be enhanced when problem-solving and demonstration methods are used in teaching Ecology? Which method will most facilitate the students? The concern of this study is to assess the relative effectiveness of problem-solving and demonstration methods in teaching Ecology in senior secondary schools in Nsit Atai Local Government Area, Akwa Ibom State, Nigeria.

The study sought to determine the relative effects of problem-solving and demonstration methods on senior secondary school students' academic performance in Ecology. Specific objectives are:

1. Determine the difference between the performances of students taught Ecology using problem-solving and those using demonstration methods in senior secondary schools in Nsit Atai Local Government Area, Akwa Ibom State, Nigeria.

2. Compare the performance of male and female students taught ecology as a concept using problem-solving and demonstration methods in senior secondary schools in Nsit Atai Local Government Area, Akwa Ibom State, Nigeria.

Research Hypotheses

$H_0$1: There is no significant difference between the performances of students taught ecology as a concept using problem-solving and demonstration methods in Nsit Atai Local Government Area, Akwa Ibom State.

$H_0$2: There is no significant difference between the performances of male and female students taught the concept of ecology using problem-solving and demonstration methods in Nsit Atai Local Government Area, Akwa Ibom State.

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METHOD

The study employed a quasi-experimental research design, precisely a non-randomized pre-test, and post-test experimental group design. The research is a quasi-experiment or intact-class. The design avoided disruption to the school class structure and timetable of academic events. The population comprised all the senior secondary Biology students (SS1) in the six co-educational public secondary schools in Nsit Atai Local Government Area of Akwa Ibom State during the 2016/2017 academic session (Akwa Ibom State Secondary Education Board, Uyo). A size of 818 students in the 2016/2017 session class by class enrolments was used. A sample of 131 senior secondary one (SS1) students, purposively selected from two intact classes of two public secondary schools in Nsit Atai Local Government Area with class sizes of 64 and 67, was used for the study.

The instrument for data collection was "Biology Performance Test on Ecology (BPTE). The BPTE is a researcher-made instrument with 30 multiple-choice items having four options A, B. C and D with one correct answer. The items in Ecology, types of organisms, calculation of population size, density, and frequency, and enumerating things to be investigated in the population of a particular habitat were used to determine the performance of students when taught using demonstration and problem-solving methods.

The same test content was used to gather data for the pre-test and post-test; item number rearranged in a different order. The BPTE was faced and content validated by two experienced Biology teachers and a specialist in test, measurement and evaluation. The validators' scrutinized the instrument in terms of clarity to the subject, proper wording of items, and appropriateness and adequacy of the items for the study. The comments and recommendations of the validators helped to modify the items in the instrument. So questions were drawn from the initial forty items designed by the researcher. The reliability of the instrument was obtained after administrations were subjected to Kuder-Richardson's formula 21. The results showed a reliability coefficient of value 0.79.

RESULTS AND DISCUSSION

Table 1: Mean and standard deviation of students' pre-test and post-test scores classified based on teaching methods

Teaching Methods	**N**	**Pre-test**		**Post-test**		**Gain score** $\bar{x}$
		$\bar{x}$	**SD**	$\bar{x}$	**SD**	
Demonstration	64	14.64	4.67	24.43	4.83	9.79
Problem-solving	67	13.04	2.92	20.18	4.40	7.14

The mean performance gain scores of students taught ecology as a concept using the demonstration method was 9.79, while those using the problem-solving were 7.14. The mean gain score difference between the two groups is 2.65, with students taught ecology using the

demonstration method being the highest. However, the standard deviation score of students using the problem-solving method was lesser than those taught using the demonstration method, showing that scores of students taught using the problem-solving method clustered more closely around the mean than was obtained with the demonstration method (Table 1).

Table 2: Descriptive statistics of male and female students taught ecology as a concept using problem-solving and demonstration methods

Teaching Methods	**Gender**	**N**	**Pre-test**		**Post-test**		**Gain score**
			$\bar{x}$	**SD**	$\bar{x}$	**SD**	$\bar{x}$
Demonstration	Male	28	14.86	4.90	24.39	4.81	9.53
	Female	36	14.47	4.53	24.44	4.92	9.97
Problem-Solving	Male	30	12.63	3.39	20.37	3.74	7.74
	Female	37	13.38	2.49	20.03	4.91	6.65

Table 2 indicates the mean gain scores of male students taught Ecology using the demonstration method was 9.53; while female students taught using problem-solving was 9.97. The difference in the mean gain score of male and female students using the demonstration method is 0.44, with female students scoring the highest. Therefore, male and female students taught the concept of Ecology using demonstration methods differ in their academic performance. However, the standard deviation score of male students taught using the demonstration method was less than that of females showing that scores of male students clustered around the mean score for female students. Table 2 also indicated that the mean gain scores of male students taught Ecology using the problem-solving method was 7.74, while that of female students was 6.65. The difference in the mean gain score of male and female students is 1.09, with male students scoring the highest. Therefore, male and female students taught Ecology using problem-solving methods differ in academic performance. Also, the standard deviation score of male students was lesser than female students in the problem-solving group. It indicates that the scores of male students clustered around the mean more than that of female students.

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Table 3: Summary of Analysis of Covariance of Students' Performance under Problem-Solving and Demonstration Methods Using Pre-test Scores as Covariates

Source	Types III sum of squares	df	Mean square	F	Sig.	Decision
Corrected model	1168.582[a]	2	584.291	34.424	.000	*
Intercept	2047.013	1	2047.013	120.601	.000	*
Pre-test	575.007	1	575.007	33.877	.000	*
Teaching Method	360.449	1	360.449	21.236	.000	*
Error	2172.594	128	16.973			
Total	68250.000	131				
Corrected Total	3341.176	130				

a . R Squared = .350 (Adjusted R Squared = .340)
* = Significant at P<0.05 alpha
NS = Not Significant at .05 level of significance

As shown in Table 3, the calculated P-value effect of teaching methods is less than the alpha level of 0.05. Therefore, the null hypothesis that there is no significant difference between the performances of students taught Ecology using problem-solving and demonstration methods in Nsit Atai Local Government Area, Akwa Ibom State is rejected. It implies there is a significant difference between the mean performance scores of students using demonstration and problem-solving methods in Ecology.

Table 4a: Summary of Analysis of Covariance of the Difference in the Performance of Male and Female Students Taught ecology Using Demonstration Method

Source	Types III sum of squares	df	Mean square	F	Sig.	Decision
Corrected model	1047.569[a]	2	523.785	75.324	.000	*
Intercept	780.717	1	780.717	112.272	.000	*
Pre-test	1047.565	1	1047.565	150.647	.000	*
Gender	1.953	1	1.953	.281	.598	NS
			6.954			
Error	424.181	61				
Total	39692.000	64				
Corrected Total	1471.750	63				

a . R Squared = .712 (Adjusted R Squared = .702)
* = Significant at P < 0.05 alpha
NS = Not Significant at .05 level of significance

Table 4a showed that the calculated F(1,64) = 0.281, P>0.05 is insignificant. Therefore, the null hypothesis that there is no significant difference between the performances of male and female students taught Ecology using problem-solving and demonstration methods in Nsit Atai Local Government Area, Akwa Ibom State is retained.

Table 5: Summary of Analysis of Covariance of the Difference in the Performance of Male and Female Students Taught ecology Using Problem-Solving Method

Source	Types III sum of squares	df	Mean square	F	Sig.	Decision
Corrected model	36.355[a]	2	18.177	.939	.397	*
Intercept	1718.911	1	1718.911	88.754	.000	*
Pre-test	34.444	1	34.444	1.778	.187	*
Gender	.387	1	.387	.020	.888	NS
Error	1239.496	64	19.367			
Total	58.000	67				
Corrected Total	1275.851	66				

a . R Squared = .028 (Adjusted R Squared =-002)
* = Significant at P < 0.05 alpha
NS = Not Significant at .05 level of significance

In Table 5, the calculated F(1,67) = 0.020, P-value 0.888 > 0.05 is insignificant. Therefore, the null hypothesis of no significant difference between male and female students taught Ecology using the problem-solving method is retained.

The results of these findings showed that there is a significant difference in the academic performance of students taught ecology using demonstration and problem-solving methods. It is noticed from the result that students who studied ecology using demonstration methods performed better than those using problem–solving. The reason for the better performance recorded by students taught ecology using the demonstration method was probably because students' attention was captivated by how their teacher carried out the demonstration and recalled each of the steps sequentially. On the other hand, students in the problem–solving group who engaged in many options before getting the desired results might not have remembered the procedures easily, hence their low performance. It is in line with the findings of Ibitoye (2000), who found out that Agricultural Science students taught weeds using the demonstration method performed better than those taught using the lecture method.
Based on the findings, there is no significant difference in the academic performance of male and female students who studied Ecology using demonstration and problem-solving methods. The reason could probably be due to the equal treatment given to male and female students in the two groups. The arrival of equivalent results between male and female students in the two

groups could also be that the two methods are not gender sensitive. This finding is in line with the findings of Oludipe (2012), who found no significant difference between the academic performance of male and female students who studied Basic Science using cooperative learning strategies. Also, Nworgu and Ezenwogu (2013) found out that male students who study Biology using a peer tutoring strategy performed better than their female counterparts.

CONCLUSION AND RECOMMENDATIONS

Based on the findings, students who studied ecology using the demonstration method performed better than those who used the problem-solving method. Hence demonstration method is considered more effective in teaching Ecology. Also, male and female students showed no significant difference. Demonstration method is considered more effective for the teaching population. Both teaching methods are gender friendly. The following recommendations were based on the findings of the study;

i. Teachers should adopt demonstration methods in teaching Ecology in senior secondary schools in Nsit Atai Local Government Area, Akwa Ibom State.
ii. Seminars, workshops and conferences should be organized for Biology teachers to update their knowledge on demonstration teaching methods in Nsit Atai Local Government Area, Akwa Ibom State.

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