

Effects of Guided-Discovery and Student-Demonstration Strategies on Students' Performance in Biology Practical Activities on Plasmolysis in Secondary Schools in Ini Local Government Area

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Abstract

This study investigated the Effect of Guided-Discovery and Student-Demonstration Strategies on Students' Performance in Biology Practical Activities on Plasmolysis in Secondary Schools in Ini Local Government Area. Three research questions and three null hypotheses guided the study. The design for the study was a quasi-experimental research design. A sample size of one 120 SS2 students from two (2) public secondary schools out of the seven (7) public secondary schools in the study area selected using criterion sampling technique. A researcher-developed instrument, Practical Guide/On the Spot Assessment Checklist (PGOTSAC), was used for data collection. The instrument had a reliability coefficient of 0.78 determined using Kuder Richardson - 21 (KR -21) formula. Data collected from the test were analyzed using mean, standard deviation and ANOVA statistics. The findings showed that of the two instructional strategies investigated, Guided Discovery is more effective in facilitating students' performance than Student Demonstration. Also, that the influence of gender was not statistically significant. Consequently, it has been recommended, among others that Biology teachers should make effective use of Guided Discovery in teaching practical concepts in Biology.

Keywords: Guided-Discovery, Performance, Plasmolysis.

Introduction

Education has a key in training a knowledgeable and skilful generation and its effectiveness depends greatly on the methods of instruction the teacher chooses to teach the students. A good teaching method exposes the learners to challenging situation and provides them with opportunities so that they can develop their power of thinking and create meaningful learning experiences. The importance of science education to the economic and socio-political development of a multi-cultural country like Nigeria cannot be overemphasized. Biology is broadly defined as the science that involves the systematic study of living things; ranges from microscopic cellular molecules to the biosphere, encompassing the earth surface and all living organisms. The knowledge of such studies could be fundamental to the ability to manage the world's resources and to improve on our everyday life. However, the use of appropriate strategy is required for the reduction of the abstract nature of the subject during the teaching and learning sessions so as to increase the academic performance of students in biology.

The search for suitable and satisfactory methods of teaching Biology has been recurrent issues to the teaching/learning of this subject. Several investigations have been made to find out which teaching strategy provides effectiveness in Biology students' performance. Results indicate that innovative teaching strategies like problem solving, guided discovery and inquiry based learning provide more effective approach in developing students' cognitive, affective and psychomotor skills in Biology performance. In teaching and learning, Biology practicals are held at upper hand as it emphasizes experimentations and observations in which learners learn by doing through the utilization of laboratory materials (Gercek and Soran, 2005). The science learning objectives achieved in the carrying out of practicals include enhancing mastery of the subject matter, developing scientific reasoning abilities, increasing understanding of the complexity and ambiguity of the practical work, developing the basic science process skills, cultivating interest in science learning and inculcating team spirit among the learners (Tobin, 2013). When the learning procedures are designed, the processes are thoughtfully sequenced into the flow of science instruction and there is an integration of science content into the practical aspect. This promotes students' abilities to identify questions, develop research hypotheses that guide scientific research, make scientific investigations and challenges.

It is important to note that despite all efforts invested in the teaching of biology at the Senior Secondary School level, the performance of students has been quite unsatisfactory and unimpressive over the years (Onwioduokit, 2013). Nwagbo (2016) attributed the observed dismal poor performance to the use of inappropriate teaching methods by the biology teachers. Etukudo (2018) observed that there are several methods and approaches teachers can use to present biological information and impart skills to students. According to Etukudo (2018), such methods and approaches include demonstration, discovery (guided and unguided), discussion, project, laboratory, field trip, inquiry, Computer-Assisted Instruction approaches among others.

Guided-discovery is an instructional approach in which students discover knowledge through the guidance of a facilitator in order for the learner to reach mutually-agreed upon goals (Edoho and Abasi, 2019). The role of an instructor is merely to provide suitable learning environment and a guide. Bostock (2016) asserted that guided discovery could also be known as discovery, learning, instruction less learning, and is characterized by convergent ranking in the learner in which the instructor devices series of statement to guide the learner to make series of discoveries that lead to single pre-determined goals.

Demonstration instructional strategy simply means the use of apparatus (instructional materials) by the teacher to clearly show and explain the concepts being taught with convincing reasons or proofs. This approach involves displaying of the right instructional material, coaching the students with the aid of the instructional material to understand the concept at hand and drilling the students (Charles-Organ and George, 2016). In the same perspective, Ikidte and Edet (2013) see demonstration method as a method that involves the teacher or the

students doing activities in front of the classroom and explaining as the activity progresses. Demonstration method is a method of teaching in which sight rather than hearing is the major means of communication though the two are often combined (Daluba, 2013).

World Health Organisation (2018) saw gender as socially constructed roles, behaviours, activities and attributes that differentiate men and women. Nobelius (2017) asserted that gender refers to both social and biological differences attributed to both men and women. It is the differential attitude and behaviour between male and female. This is what tends to influence the academic performance between the male and female students in that, the male students seem to focus in educational areas that are constructive, manipulative and observational (psychomotor skills) while the female students tend to have interest in areas that demand cramming, memorization, reciting and regurgitating.

In high school, students tend to choose subjects conventionally associated with their gender, mathematics and science for boys while literature and arts for girls which tend to reflect in their performances (Arigbadu and Muji, 2014). One major difference in gender occurs in learning and education in which males and females learn differently (subjects and tasks); females are better at verbalizing and verbal tasks but males are able to spatially process information better, this advantage make them better at multiple skills such as motor skills, mental manipulation of objects, mathematical and abstract reasoning, processing symbols and pictures, navigating and computer processing.

Plasmolysis is a process in plant cells in which the cytoplasm pulls away from the cell wall due to loss of water through osmosis. Plasmolysis helps determine the toxicity (osmotic pressure) of the cell's environment as well as the rate in which solute molecules pass through the cellular membrane (Wikipedia, 2018). Plasmolysis occurs when plant cell is placed in hypertonic solution in which the solutes are more than water and this causes water to flow out of the cell into the surrounding environment and the cell become plasmolysed (Fakeye, et al, 2016). The process of plasmolysis involves the withdrawal of water from living cells to the extent which result in the pulling away of the cytoplasm from the cell membrane or cell wall. As a result of this, the cytoplasm shrinks causing the whole cell to collapse. Plasmolysis is the shrinkage of the protoplasm away from the cell walls that occurs as a result of excessive water loss especially in plant cells. Plant cells are surrounded by rigid cell walls and when they are exposed to concentrated solution, water rushes out of cell causing the cell to shrink, pulling away from the walls. The plasmolysed cells are dehydrated and lose most or all physiological functions while in the shriveled state. Animal cells lack rigid cell walls, when exposed to hypertonic environment, water rushes out of the cell and the cell shrinks thus, the cytoplasm, collapses (Teline, 2010).

In a study on the effects of guided inquiry and demonstration methods of teaching on science process skills acquisition among secondary school biology students, Ibe and Nwosu

(2013) observed that the student taught using guided inquiry method performed significantly better than those taught using demonstration and conventional (lecture) methods. The result of the study also showed that gender was not a significant factor on students' achievement.

Kibirige and Maake (2021) conducted a study on effect of guided-discovery learning method on students' performance in science. A sample size of forty (40) fifth grade students from two intact classes was used. The design adopted was a quasi-experimental design. The group assigned as experimental group was taught using guided discovery while the control group comprised of students taught with conventional method. The study lasted for 8 weeks. Science achievement test consisting of 30 items was administered to each group after the 8th week. Results revealed that students taught with guided discovery performed better than those taught with conventional method.

Ibrahim et al (2020) conducted a study to examine effect of demonstration method and lecture method on the teaching of biological science. The study adopted quasi experimental research design. A sample size of 367 senior secondary school students was drawn from the population of 7,687 in Maiduguri metropolis and used for the study. A researcher made test was used for data collection. Result showed that students taught using demonstration method had better academic achievement in biological science than those taught using lecture method.

Statement of the Problem

There had been continuous increase in the poor academic performance of biology students in both internal and external examination. This poor academic performance has generated a lot of concern in the educational sector. Reports of the chief examiner of West African Examinations Council (WAEC) and NECO in ordinary level Biology show a persistent low percentage passed in Biology. Several factors have contributed to students' poor performance in Biology. One of such reason associated with this poor performance has to do with the teaching strategies adopted by teachers during classroom instruction. Teachers shy away from more effective activity-oriented teaching strategies in preference to the constant use of lecture method especially for teaching/learning of science based subjects. From the foregoing, it has been observed that practical activities are the major facet of science learning and this motivates students to active learning but the teaching of Biology have generally conformed to inappropriate, ineffective methods and continue to be a teacher-dominated type of approach making the lesson uninspiring.

With the deterioration in students' learning outcome in Biology, resulting in high failure rate, it is therefore pertinent at this time when high premium is placed on science and technology as bedrock of national development and advancement to explore the use of demonstration and guided-discovery methods in the teaching of practical-based concept, plasmolysis, with a view to reversing the resultant poor learning outcome and for enhancing students' performance in Biology in secondary schools. The researcher is motivated to carry

out this study on effects of guided discovery and student-demonstration instructional strategies on students' performance on practical on plasmolysis. The question then is: how effective is guided discovery method compared with student demonstration in facilitating students' performance in biology practical activities?

Purpose of the Study

The purpose of the study is to investigate the effect of guided-discovery and student-demonstration strategies on students' performance in biology practical activities on plasmolysis in secondary schools in Ini Local Government Area.

Specifically, the study sought to;

1. examine the difference in the mean performance scores of biology students taught the concept of plasmolysis using student-demonstration and those taught using guided-discovery instructional strategies;
2. assess the difference in the mean performance scores of male and female biology students taught the concept of plasmolysis using student-demonstration and those taught using guided-discovery instructional strategies; and
3. assess the interaction effects of instructional methods and gender on mean performance scores of biology students taught the concept of plasmolysis using student-demonstration and those taught using guided-discovery instructional strategies.

Research Questions

Based on the purposes of the study, the following research questions were formulated to guide the study:

1. What difference exists between the mean performance scores of biology students on the concept of plasmolysis when taught using student-demonstration and when taught using guided-discovery instructional strategies?
2. What is the difference between the mean performance scores of male and female biology students on the concept of plasmolysis when taught using student-demonstration and when taught using guided-discovery instructional strategies?
3. What is the interaction effect of instructional methods and gender on mean performance scores of biology students taught the concept of plasmolysis using student-demonstration and those taught using guided-discovery instructional strategies?

Research Hypotheses

To further guide the study, the following null hypotheses were stated:

1. There is no significant difference between the mean performance scores of biology students taught the concept of plasmolysis using student-demonstration and those taught using guided-discovery instructional strategies.

2. There is no significant difference between the mean performance scores of male and female biology students on the concept of plasmolysis.
3. There is no significant interaction effect of instructional methods and gender on mean performance scores of biology students on the concept of plasmolysis.

Research Methodology

The research design adopted for the study was a post-test only, quasi experimental design. The design was selected because it involved practical activities; also, that it provides opportunity for the manipulation of independent variables so as to observe the effects on the dependent variable. The study was conducted in Ini Local Government Area. Ini Local Government Area is one of the local governments in Akwa Ibom State located South South geo-political zone of Nigeria (Akwa Ibom Hello, 2014).

The population of the study consisted of all the 3520 senior secondary Two (SS2) Biology students in the seven (7) public secondary schools in Ini Local Government Area. A sample size of one 120 SS2 students from two (2) public secondary schools in Ini Local Government Area was used for the study. The schools were selected using criterion sampling technique. Only schools with functional Biology laboratory were selected for the study.

Practical Guide/On the Spot Assessment Checklist (PGOTSAC), a researcher developed instrument was used for data collection. The instrument had two sections: Sections A and B. Section A solicited the students' personal information while Section B carried a 10-step procedure for carrying out the practical and the scoring guide. PGOTSAC was validated by experts in Biology and also the supervisor. The reliability of the research instrument ascertained using Kuder Richardson - 21 (KR -21 reliability coefficient formula was .78 Twenty (20) students who were not part of the main study was used as the trial test sample. On the spot assessment schedule was used in scoring the students' performance. Each step carried out correctly was scored 10 marks; hence the maximum score was 100 marks.

Before using the students for the study, the researcher met the principals of the selected schools and obtained permission to carry out the research.. Thereafter, she met the Biology teachers of the selected SS2 classes and solicited for their cooperation to serve as research assistants. This was followed by teaching the concept to the students in their intact class setting by the research assistants using the researcher's practical guide. The Experimental Group 1 was taught using guided-discovery method; and Experimental Group 2 was taught using student-demonstration method. Two weeks were used for the treatment after which the students were asked to repeat the activities on their own and PGOTSAC was used to assess their performance. The scripts were handed over to the researcher for scoring.

Data collected from the test were analyzed using mean, standard deviation and ANOVA statistics.

Results

The results are based on the three research questions and null hypotheses.

Research Question 1: What difference exists between the mean performance scores of biology students on the concept of plasmolysis when taught using guided-discovery and when taught using student-demonstration instructional strategies?

Table 1: Mean and standard deviation of students' post-test scores classified by treatment groups

Treatment	N	$\bar{X}$	SD	Std. Error Mean
Guided-discovery	70	60.54	15.729	1.880
Student demonstration	50	46.80	11.285	1.596

In Table 1, the post-test mean scores of the two groups of students taught using guided-discovery and Student demonstration methods are 15.729 11.285, respectively; and their standard deviation scores are 1.88 and 1.60 respectively. This observation show students in the guided discovery group did better than their counterparts in the student demonstration group though those in the student demonstration group had the closest scattering of the raw scores about the mean. Whether the observed differences in the mean scores of the two groups were statistically significant is assessed by the results for testing of hypothesis one displayed in Table 2.

Null Hypothesis 1: There is no significant difference between the mean performance scores of biology students taught the concept of plasmolysis using guided-discovery and those taught using student-demonstration instructional strategies

Table 2: Summary of Analysis of Variance (ANOVA) of students' post-test scores classified by treatment groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at $p < .05$ alpha
Intercept	336072.60	1	336072.60	1701.17	.000	s
Treatment	5508.60	1	5508.60	27.88	.000	s
Error	23311.37	118	197.55	-	-	-
Total	389404.00	120	-	-	-	-
Corrected Total	28819.97	119	-	-	-	-

In Table 2 the calculated F-ratio for the main effect of instructional strategies on the students' performance at df 1, 118 is 27.88, while its corresponding calculated level of significance is .000 alpha. This level of significance is less than .05 in which the decision is based, indicating that there was a significant difference in the mean performance scores of the students in the concepts taught. With this observation, null hypothesis 2 was rejected. The results in Table 1 showed students taught using Guided Discovery performed better than those taught using Student Demonstration.

Research Question 2: What is the difference between the mean performance scores of male and female biology students on the concept of plasmolysis when taught using guided-discovery and when taught using student-demonstration instructional strategies?

Table 3: Mean and standard deviation of students' post-test scores classified by treatment groups and gender

Treatment	Gender	N	Post-test	
			$\bar{X}$	SD
Guided Discovery	Male	29	57.66	15.27
	Female	41	62.59	15.91
Student demonstration	Male	29	48.41	12.53
	Female	21	44.57	9..13

In Table 3, the post-test mean scores of the male and female students taught using Guided-Discovery method are 57.66 and 62.59 respectively while those of their counterparts in student demonstration group are 48.41 and 44.57, respectively. This observations show that the female students in guided discovery group had the best performance, followed by their male counterparts in the same group. Whether the observed differences in the mean scores of the two groups were statistically significant is assessed by the results for testing of hypothesis one displayed in Table 4.

Null Hypothesis 2: There is no significant difference between the mean performance scores of male and female biology students on the concept of plasmolysis when taught using guided-discovery and when taught using student-demonstration instructional strategies.

Table 4: Summary of Analysis of Variance (ANOVA) of students' post-test scores classified by treatment groups and gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<.05 alpha
Corrected Model	6101.286 ^a	3	2033.76	10.38	.000	s
Intercept	322506.01	1	322506.02	1646.69	.000	s
Treatment	5269.38	1	5269.40	26.91	.000	s
Gender	8.39	1	8.39	.04	.836	ns
Treatment * Gender	545.90	1	545.90	2.79	.098	ns
Error	22718.68	116	195.85	-	-	-
Total	389404.00	120	-	-	-	-
Corrected Total	28819.97	119	-	-	-	-

a. R Squared = .212 (Adjusted R Squared = .191)

In Table 4 the calculated F-ratio for the main effect of gender on the student's achievement at df 1. 116 is .04, while its corresponding calculated level of significance is .836 alpha. This level of significance is greater than .05 in which the decision is based, indicating that there was no significant difference in the mean performance scores of the students in the concepts taught. With this observation, null hypothesis 2 was upheld.

Research Question 3: What is the interaction effect of instructional methods and gender on mean performance scores of biology students taught the concept of plasmolysis using guided-discovery and those taught using student-demonstration instructional strategies?

This research question was answered alongside research hypothesis 3 using the results in Table 5

Null Hypothesis 3: There is no significant interaction effect of instructional methods and gender on mean performance scores of biology students on the concept of plasmolysis.

Table 5: Summary of Analysis of Variance (ANOVA) of students' post-test scores classified by treatment groups and gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<.05 alpha
Corrected Model	6101.286 ^a	3	2033.76	10.38	.000	s
Intercept	322506.01	1	322506.02	1646.69	.000	s
Treatment	5269.38	1	5269.40	26.91	.000	s
Gender	8.39	1	8.39	.04	.836	ns
Treatment * Gender	545.90	1	545.90	2.79	.098	ns
Error	22718.68	116	195.85	-	-	-
Total	389404.00	120	-	-	-	-
Corrected Total	28819.97	119	-	-	-	-

a. R Squared = .212 (Adjusted R Squared = .191)

In Table 5, the calculated F-ratio for the interactions effect of treatment and gender at df 1,116 was 2.79 while its significant level is .098. This significant level is greater than .05 alpha in which the decision is based, indicating that there was no significant interactions effects between the two variables. In other words, the effect of treatment was the same at all levels of gender and vice versa. With this observation, null hypothesis 3 was upheld.

Discussion of Findings

The findings with regard to the effects of, guided discovery and student-demonstration methods on students' performance on biology practical on the concept of plasmolysis showed that there was a significant difference in their performance in favour of students taught using guided discovery. This observation is in line with that of Ibe and Nwosu (2013), Kibirige and Maake (2021). The better enhancing effect of guided discovery could be attributed to the fact that students were more involved in the learning process. The observation underscores the fact that guided discovery facilitates students' acquisition of practical skills better than student-demonstration.

On the influence of gender on students' performance, it was observed that its influence was not statistically significant given the instructional strategies used. This observation indicates that gender is not a strong determinant of students' academic outcomes. The no

significant influence of gender observed in this study is also in line with those of Ibe and Nwosu (2013), Edoho and Abasi (2019).

With reference to treatment-gender interactions on the students' performance, the findings on Table 5 showed no significant interaction effects of teaching methods and gender on biology students' academic achievement on the concept; indicating that the effect of treatment was the same at all levels of gender, and that the influence of gender on treatment was the same at all levels of treatment.

Conclusion

Based on the findings of the study, it is hereby concluded that of the two instructional strategies investigated, guided discovery is more effective in facilitating students' performance than student demonstration. Also, that gender is not a strong determinant of students' academic outcome.

Recommendations

Based on the findings and the conclusions reached, the following recommendations are made:

1. Biology teachers should make effective use of guided discovery in teaching practical concepts in biology.
2. Government in conjunction with professional bodies like STAN should endeavour to organize and sponsor regular workshops to train science teachers on the use of guided discovery in teaching practical concepts in sciences.

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