

Effect of 5Es Instructional Strategy on Student Academic Performance in Biology among Senior Secondary School in Zamfara State, Nigeria

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Abstract: *The purpose of this study was to examine the effects of 5Es instructional strategy on student academic performance in biology among senior secondary school in Zamfara State, Nigeria. Quasi-experimental Research design was adopted for this study. The population of this study consist of all senior secondary two (SS II) in Zamfara state and sample of 120 students was purposively selected from two schools. Two research questions were posed and two hypotheses formulated to guide the study Biology performance test (BPT) was used as instrument for data collection, were all validated by experts in science education and measurement and evaluation from Usmanu Danfodiyo University. The reliability of the instrument was determined and the coefficient using PPMC was found to be 0.89. The results obtained from the analyses showed that there were significant differences between the mean scores of the experimental and control groups in performance. This further showed that the 5Es model favoured the experimental group more. Therefore, it was recommended that students be engaged in an active process of learning such as minds-on, hands-on, learning discoveries which are some of the principles of model so that they create and discover Elementary Biological concepts for themselves.*

Key words: *Effect, 5Es instructional strategy, students' academic performance and secondary school.*

Introduction

Science, Technology, engineering and mathematics has become the major ingredients of economic and national advancement. Science, Technology, engineering and mathematic influences every aspect of our lives ranging from those of livelihood to those of peace and security. They are centrals to our welfare as individuals and society at large. The position and prestige of a Nation in world politics depends on the extent to which the country advances in science and technology. The major goal of any type of education is to shape and mould people in such a way that the individuals will adequately adjust well in the society. Chanchar (2004) reiterated that education is the most important and common binding activity amongst people in every society, nation and the entire world.

Science education in the world today demands not only that more students should be trained as scientists, but that every citizen should have sufficient knowledge of science to be able to understand and appreciate the many facilities and opportunities of this scientific age (Fwangle & Ving, 2000).

Biology as a field of science is concerned with study of living things. It deals with the origin, structure, development, function and distribution of animals and plants in the environment. Biology therefore studies all living things including human, other animals, plants and microscopic living things such as bacteria and protozoa that are too small to be seen by naked eyes.

Biology is the natural science that studies life and living organisms including their physical structure, chemical processes, molecular interactions, physiological mechanisms, development and evolution (Bernard 2015). Similarly, Albert (2017) defined Biology as natural science concerned with study of life and living organisms including their structure, function, growth, origin, evolution, distribution and taxonomy. Despite the importance attached to biology both as an academic discipline and the body of knowledge that everybody needs in society coupled with the effort of the government in making biology a compulsory subject at the post basic, the achievement/performance of students in biology at the school levels in Nigeria is not encouraging.

Constructivism is the philosophy of learning that proposes learners need to build their own understanding of new ideas. Constructivist based teaching is a method of instruction based on a descriptive theory about the thought process involved in learning. Constructivist views learning as a process in which the learner actively constructs or builds new ideas on concepts based upon current and past knowledge. In other words, "learning involves constructing one's own knowledge from one's own experience. Teaching philosophy based on the concept that learning (cognition) is the result of 'mental construction - students construct their own understanding by reflecting on their personal experiences, and by relating the new knowledge with what they already know. Each student creates his or her own 'schemas' or mental-models to make sense of the world, and accommodates the new knowledge (learns) by adjusting them. One of its main principles is that learning is search for meaning, therefore, to be effective, a teacher must help the student in discovering his or her own meaning (Fosnot, 2006).

Therefore, it is worthwhile to examine the effect of 5Es model that provide the necessary steps to learning cycle. The 5Es is an instructional model based on the constructivist approach to learning which says that learners build or construct new ideas on top of their old ideas. The 5Es can be used with students of all ages, including adults. Each of the 5Es describes a phase of learning, and each phase begins with the letter "E". Bybee (2005) has identified the 5Es model:

Biological Science Curriculum Studies, led by Bybee, developed an instructional model for constructivism, called the "Five Es" (Akar, 2005). The 5E Learning Cycle involves learning something new, or attempting to understand something familiar in greater depth. It is not a linear process. In trying to make sense of things, students use both their prior experience and the first-hand knowledge gained from new Explorations (Newby, 2004). The 5E Instructional Model consists of the following phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation. Each phase has a specific function and contributes to the teacher's coherent instruction, as well as the learners' formulation of a better understanding of scientific and technological knowledge, attitudes, and skills (Bybee, 2006).

Engagement

The teacher helps students become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.

Exploration

Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions, and design and conduct an investigation.

Explanation

The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. In this phase teachers directly introduce a concept, process, or skill. An explanation from the teacher or other resources may guide learners toward a deeper understanding, which is a critical part of this phase.

Elaboration

Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept and abilities by conducting additional activities.

Evaluation

The evaluation phase encourages students to assess their understanding and abilities and allows teachers to evaluate student progress toward achieving the learning outcomes.

According to Duran (2004), the 5E learning model helps and serves teachers in that it provides an example of the application of the structuralist approach in course processing and provides good reform-based instruction. He also stated that the model could help to develop the curriculum.

The main aim is to educate science-literate individuals. The main feature of science literate individuals is they construct information themselves. Many methods, techniques, and models have been developed to reveal the constructivist approach in the program. One of these models is 5E learning model. The model can be used in science courses to increase the quality of practices and to design science courses based on structural approach and cognitive psychology (Bybee, 1997). Furthermore, Bybee (1997) argues that the use of this approach helps students redefine, organize, examine, and change the ideas they already have through interacting with their peers and environment. Senan (2013) reported that the technology-enriched 5E learning model is a good tool for students to acquire 21st-century skills as well as for teachers to teach a specific concept. In his study on the 5E learning model, Ayvaci, H. S., & Yıldız, M. (2015) observed that the students in

this model were more active and motivated than the students in lecture-based classrooms and that these students could find opportunities to share their knowledge and experiences. According to the 5E learning model, students' prior knowledge is identified and a research question is put forth about the concept or event to be learned, the first-hand experience and information are reached in the solution of the existing question through teacher's guidance and the concept or event is transferred to a different field and evaluated.

Statement of the Problem

The study of biology at the senior secondary school in Nigeria is eminent especially for the fact that it offers a wide range of choices to students intending to study medicine, pharmacy, biotechnology, and other medical courses at the tertiary institutions. Despite its important, the dominant traditional teaching method presently being used in schools by biology teachers is not effective and as such has not helped students in understanding and retention of biology concept as well as not improving the academic performance of students in the subject area.

However, contrary to the stated objectives of science education in Nigeria and despite the importance of Biology as a science subject, empirical studies such as those of Etobro and Fabinu (2017) and Adegboye, Ganiyu and Isaac (2017) have shown that students still perform poorly in Biology at Senior Secondary School level. Lawal (2010)

reported that Biology is one of the science subjects having downward trend in the performance of students at Senior School Certificate Examinations (SSCE). In fact, the failure rate in Biology is even more alarming compared to Chemistry and Physics despite its popularity among science students. In agreement to Lawal's position, Timothy (2013) noted that a review of students' enrolment in science subjects at senior secondary schools in Nigeria shows that more students register Biology than any other science subject but their academic performance in the subject is comparatively lower at SSCE.

The poor performance of biology students has been linked to many factors such as poor teaching techniques in the form of excessive talking, copying of note and rote learning of text book materials adopted by teachers, lack of instructional materials, lack of functional laboratories, and poor attitude of biology teachers to use of technology. Considering the nature of the subject, it is imperative to explore other methods that could be used for effective teaching of this subject. Based on this, the researcher therefore intends to conduct a study on effect of 5Es instructional strategy on academic performance in biology among senior secondary school students in Zamfara state.

Objectives of the Study

The aim of this study was to determine the Effectiveness of 5Es instructional Strategy on Academic performance in biology among senior Secondary School Students in Zamfara State. Specifically, the study sought to:

1. Determine difference in mean performance of Senior Secondary Schools Students taught biology using 5Es instructional strategies and those taught biology using lecture method

2. Determine Difference in mean performance between male and female Senior Secondary Schools Students taught biology using 5Es instructional strategies

Research Questions

Based on the above objectives, the following research questions are formulated to guide the study:

1. Is there any difference in mean performance of Senior Secondary Schools Students taught biology using 5Es instructional strategies and those taught biology using lecture method?
2. Is there any Difference in mean performance between male and female Senior Secondary Schools Students taught biology using 5Es instructional strategies?

Hypotheses.

The following null hypotheses are to guide this study: -

H₀₁. There is no significant difference in mean performance of Senior Secondary Schools Students taught biology using 5Es instructional strategies and those taught biology using lecture method.

H₀₂. There is no significant difference in mean performance between male and female Senior Secondary Schools Students taught biology using 5Es instructional strategies.

Methodology

In this study, quasi experimental design was employed, using pre-test post-test control group design. This involved two groups; experimental group on which the treatment was administered and the control group on which the treatment was not administered. The population of this study consist of all SS II biology students in senior secondary schools of Zamfara State, two schools was purposively selected to participate the study. A sample of one hundred and twenty (120) students was randomly selected from a pollution 2361 senior secondary school in Zamfara state. Pre-test was administered to both groups before treatment to determine their homogeneity. The experimental group was given treatment by exposing learners to biology using 5Es instructional Strategy while control group was taught the same concept using conventional lecture method. The teaching lasted for a period of six weeks, after which the post test was administered to both groups to determine the effectiveness of these teaching strategies.

Biology Performance Test (BPT) was used as an instrument for data collection, consisting of 15 multiple objective test items on biology. This was designed by the researchers and validated by biology teachers who are WAEC examiners and also senior lecturers one from the department of Biology, Shehu Shagari Collage of Education Sokoto and other from department of Science Education, Usmanu Danfodiyo University Sokoto The reliability of the instrument was ascertained using Pearson Product Moment Correlation and a reliability coefficient of 0.89

Research Question One

Is there any difference in mean performance of Senior Secondary Schools Students taught biology using 5Es instructional strategies and those taught biology using lecture method?

Table 1. Mean Scores of Students in Biology performance test using 5Es Instructional Models

Group	N	Pre-test		Post-Test		Mean Difference
		X	SD	X	SD	
5Es	60	12.56	8.66	33.40	9.31	20.84
Lecture	60	11.32	6.73	12.30	8.87	0.98

The table 1 above showed the mean scores of students taught biology using 5Es instructional strategy and conventional lecture method. The pre-test mean score of experimental group is 12.56 and standard deviation is 8.662 while pre-test mean score of control group is 11.32 and standard deviation is 6.738. The post-test mean score of experimental group is 33.40 and standard deviation is 9.305 while post-test mean score of control group is 12.30 and standard deviation is 8.871. The difference between mean gain score of students exposed 5Es instructional strategy and lecture conventional method is 19.86.

Research Question two

Is there any Difference in mean performance between male and female Senior Secondary Schools Students taught biology using 5Es instructional strategies?

Table 2. Analysis of Mean Scores of Male and Female Students Taught using 5Es instructional model

Gender	N	Pre-test		Post-test		Mean Difference
		X	SD	X	SD	
Male	43	24.49	9.06	34.28	9.28	9.33
Female	17	21.29	7.13	31.18	9.09	9.89

The table 2 above shows the mean score of students exposed to 5Es model based on gender. Male students got pre-test mean score of 24.95 and standard deviation of 9.063 while female students got pre-test mean score of 21.29 and standard deviation of 7.131. The difference between the mean gain score of male and female students taught with BPT is 0.56.

Hypotheses one

There is no significant difference in mean performance of Senior Secondary Schools Students taught biology using 5Es instructional strategies and those taught biology using lecture method

Table 3: Analysis of Covariance of Post-Test Score of Students taught biology using 5Es Model and conventional lecture method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	9743.493 ^a	2	4871.746	129.550	.002
Intercept	2797.402	1	2797.402	74.389	.001
Pre	5351.193	1	5351.193	142.299	.001
Group	24.401	1	24.401	.649	.022
Error	4399.807	117	37.605		
Total	103906.000	120			
Corrected Total	14143.300	119			

Table 3 above showed that the P value (.022) is less than alpha level of 0.050, ($P < 0.050$). Hence the null hypothesis which says there is no significant difference in mean performance of Senior Secondary Schools Students taught biology using 5Es instructional strategies and those taught biology using lecture method is hereby rejected.

Hypothesis two

There is no significant difference in mean performance between male and female Senior Secondary Schools Students taught biology using 5Es instructional strategies.

Table 4: Analysis of Covariance on the Post-Test Scores of Male and Female Students Taught Biology Using 5Es model.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2967.077 ^a	2	1483.538	39.490	.000
Intercept	1309.171	1	1309.171	34.849	.000
Pre	2849.799	1	2849.799	75.859	.000
Gender	.144	1	.144	.004	.951
Error	2141.323	57	37.567		
Total	72042.000	60			
Corrected Total	5108.400	59			

Table 4 above showed the result of Analysis of Covariance on the post-test mean scores of male and female students taught biology using 5Es model. P value (.951) is greater than P alpha level of 0.05, ($P > 0.050$), therefore, the null hypothesis which says There is no significant difference in mean performance between male and female Senior Secondary Schools Students taught biology using 5Es instructional strategies is hereby retained.

Discussion of Findings

The results in table 1 indicate that students taught biology using 5Es instructional strategy (experimental group) performed better than the students taught with conventional lecture method (control group). From the research question one, it was observed that there was an appreciable difference in the mean score of the experimental group. The post-test mean score of experimental group is 33.40 and standard deviation is 9.305 while the post-test mean score of the control group is 12.30 and standard deviation is 8.871. A significant difference exists between the performance of students taught biology using 5Es instructional strategy and those exposed to Lecture method. It may be argued that students exposed to the 5Es Instructional Model had the opportunity to observe, measure, record and interpret data while they were involved in the investigative activities as against those exposed to Conventional Method. The significant difference can further be attributed to the fact that the 5Es Instructional Model provides the opportunity for students in the experimental group to experience interactive learning where in they communicate, infer and predict future occurrences from data collected while they explore materials. This finding agrees with the earlier findings of Boddy, Watson and Abusson (2003), Hirca (2015) and Cakir (2017).

These researchers revealed that students exhibited significant improvements in science process-skills acquisition as a result of treatment with the 5Es Model as compared to the Traditional Lecture Method. From the meta-analysis undertaken by Cakir (2017), this finding corroborates those of Biyikli (2013), Acisli (2014) and Ozturk, Geren and Dokme (2015). The finding of this study also concurs with the assertion of CPB (2002) that through constructivist teaching particularly with the 5Es Model, better learning experiences and new patterns of thinking are fostered among students. The finding also establishes empirical evidence for the statement of Senan (2013) that the 5Es Instructional Model promotes strategies for inquiry as well as acquisition of skills such as the science process-skills, creative thinking and problem-solving skills that are essential to an inquiring mind.

This result supports the observation by Bilgin, İ., Ay, Y., & Coskun, H. (2013) that teaching methods affects the response of students and determine their interest level, motivation and involvement in the lesson. Other studies by Mukherjee (2007), Lawson (2002) and Anderson and Krathwohl (2001), have also shown that learners cognitive process and academic performance can be enhanced through effective method of instructions.

The research findings also showed that there was no difference in performance of students taught biology using 5Es instructional strategy based on gender. Table 4 confirmed that gender had no significant influence on students' performance in biology when exposed to 5Es learning strategy. This may be due to the fact that activities based on the 5Es Instructional Model to which the experimental group was exposed enabled both male and female students in their heterogeneous groups to practice the art of scientific inquiry, thereby promoting their science processskills abilities. This finding is in agreement with the report of Usman (2006), Bichi (2002), Ogunboyede (2003), Gandu (2006) who independently reported that male and female students perform the same in academic achievement when exposed to activity based teaching method such as 5Es learning cycle.

Conclusion

The 5Es instructional strategy proved effective in enhancing students' academic performance in Biology in senior secondary schools used for the study. It is clear that 5Es model enabled the experimental group to improve on their knowledge and skills to be able to participate well in the experiment hence their better performance than the control group in schools.

Recommendations

Based on the research findings, the following recommendations were made;

1. The use of 5Es Model should be encouraged during teaching and learning of biology in Senior Secondary School since it enhanced better performance of students irrespective of the scoring level.
2. The use of lecture method in teaching and learning of Biology should be reduced because the method did not enhance academic performance in the subject.

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