Indonesian Journal of Education, Social Sciences and Research (IJSSR)
Vol. 5, No. 1, March 2024, pp. 1-8

EFFECTS OF PREDICT-OBSERVE-EXPLAIN INSTRUCTIONAL MODEL ON STUDENT'S COGNITIVE STYLES AND ACADEMIC ACHIEVEMENT IN BIOLOGY

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ABSTRACT

This study was designed to determine the Effects of Predict-Observe-Explain instructional model on students' cognitive styles and academic achievement in biology. Two research questions guided this study. A quasi-experimental pre-test, post-test control group design was used for this study. The sample for the study was two hundred and eighty (280) biology students. Data for this study was collected using a Two-tier diagnostic multiple choice biology achievement test and Cognitive style scale. Their validity and reliability indices were established using Kuder-richardson formula 21 and Cronbach alpha respectively. The findings of this study showcased that there was a significant difference in achievement scores between the experimental and control groups in favor of the experimental group and secondly there was no significant difference in the academic achievement of field-dependent and field-independent cognitive style students taught biology using POE model. The study concluded that the POE model enhanced students of both cognitive styles' academic achievement in biology. This study recommends that biology teachers should make use of the POE model and that POE instructional model should be incorporated into the educational system by curriculum planners due to its effectiveness in bridging the gap between students of varying cognitive styles.

Keyword: Achievement; Biology; Cognitive styles; Predict-observe-explain model; Science

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1. INTRODUCTION

One of the aims of science education as stated in the National Policy on Education (NPE) is to inculcate in the learner, the spirit of inquiry and creativity through the exploration of the child's environment. But over the years, there has been a consistently poor and unsatisfactory performance of students in the sciences especially in Biology in examinations conducted by WAEC, NECO, NABTEB, and other examination bodies. The 21st century is marked with advancement in science and technology. No nation of the world will attain its choice in technological development without giving adequate attention to the teaching and learning of science. Biology is a branch of scientific field of study that deals with living things, consisting of many topics some of which are loaded with difficult concepts. The Federal Ministry of Education developed a science and technology-oriented policy in August 2018, referred to as "National Policy on Science and Technology Education", as a redemptive approach to the declining performance in science education. The Science and Technical Education 21st Century must emphasize methods of teaching, which focus on child-centered and hands-on techniques rather than the theoretical, abstract, and teacher-centered methods, which were responsible for the decline in interest and consequently low enrollment and poor performance of students in Science and Technical Education subjects and programs. At the moment, the chief examiner of the West African Examination Council's reports from 2007-2012, revealed a downward trend in the performance of students in science subjects, especially biology. This poor performance has been attributed to many factors, one of which is the use of inappropriate teaching methods (Edet, 1997). The conventional lecture method of instruction, used currently, presents science learning as a mental process where facts are to be memorized, rather than a set of principles for application in the outside world. Onwuka cited in Ekon (2013), added that teachers use the lecture method spoon-feeds learners and so do not challenge them to discover new truths, new rules, and new methods of tackling problems as well as new values for themselves. There is a tendency, for the students to forget much of what they were taught by their teachers. The

conventional method lacks the capacity of stimulating students' interest in Biology because students' participation is reduced to the barest minimum. Despite the application of various methods such as discovery, guided inquiry and expository method among others, which have also been in use, the WASSCE Chief Examiner's annual reports and comments in biology show that students' performance in biology has not improved appreciably (WAEC, 2019). Thus this study is geared towards finding out if the prediction - Observe-Explain Model of Conceptual Change will help to improve the academic achievement of Biology students.

Over the years student academic achievement in biology has become negatively questionable. For example the 2008 WASCE chief examiner reported a decline in students' academic achievement in biology especially the theoretical aspects (WAEC 2008). Statistics from May June 2007- 2012 Senior Secondary School Certificate Examination by WAEC tell the same story. Also 2013 was not different from the other years. In 2014 only 31.28% of the students that sat for the May/June WASSCE obtained five credits as compared to 38.82% in 2012 and 36.57% in 2013. The consequences of this perpetual poor performance of students in Biology is that a large percentage of students fail to get grades that will take them to higher institutions for higher studies where biology has it's applications such as in medicine, pharmacy, food production and processing industries, biotechnology, genetic engineering, agriculture and horticulture, environmental protection, biological gardens, zoology, botany, physiology, biochemistry, micro-biology, histology, anatomy evolution, chemistry, geography etc . This resultant problem, posed by this poor academic achievement among biology students in NECO and WAEC examinations has been a source of concern for well-meaning Nigerians, Parents, Government Researchers, stakeholders in education and Biology-Science educators. It is worthy of note that children entering our science classes already have a vast store of knowledge about natural phenomena from previous classes and or personal experiences or observations. This would be fine if it were not for the fact that the new concepts have to compete with old information already present in their minds. As children process information, many apparent explanations they formulate may not agree with science. Therefore, when such a child is faced with the former scientific knowledge, the previous concept in their mind may interfere strongly with what the teacher is trying to convey. It has been discovered that such misconceptions are tenacious and challenging to change.

Ajaja (2013), opined that one common mistake teachers commonly make is to assume that their students are like somewhat blank slates and that what one needs to do is to start from the scratch and build new scientific concepts in their minds. He concluded that the conventional method lacks the capability to deal with students prior concepts brought into the classroom which may confuse their rate of understanding scientific concepts taught in the classroom. The implication of this is that learning may be difficult and uninteresting, and students see science subjects , especially biology as a difficult subject. Preconceptions may be a result of incorrect thinking or flawed misunderstanding of a concept or a belief that is not based on correct information. In recent times, several efforts are being made by researchers and policy makers toward designing better methodologies for effective teaching of science subjects especially, biology. Among them is the Predict-Observe-Explain (POE) Conceptual Change Model. In agreement with this summary, Agoro and Oyediran (2009) revealed that science teachers do not expose their students to hands-on-laboratory activities where students will participate actively in the teaching-learning process due to teachers' poor awareness of effective hands-on laboratory activities capable of influencing conceptual changes among biology students. Furthermore, Rifzal, etal (2015) explained that the POE model can be used by teachers as a way to improve the understanding of students of a concept and training skills. According to John Haysom and Michael Bowen (2010), the POE instructional model allows students to reflect on their experiences and understanding of a concept before making a prediction about the outcome of an experiment and discussing the prediction with classmates. Haysom (2010) said and I quote “The POE Model has given me more insight into the misconceptions students bring with them into a science class. They have shown me that it is important for all students to reflect on their understanding of concepts and to verbalize it before and after the POE experience.”

How can several students glance at one common object or concept and interpret it correctly, but in so many varied ways? Why is it that people express the same variability when encountering similar circumstances? Psychologists speculate that individual biological and psychological variations affect the ways in which people perceive circumstances, objects, concepts, sights, sounds, and feelings. Thus, when several people encounter a similar object or situation, each might experience a different understanding of that object, concept or situation. There is no question that the orientation of infants and children to different experiences shapes their temperaments and impacts who they are and how they analyze things. And many educators and researchers are now directing their interest on these variations to further understand how students in the classroom perceive information and learn in several ways. One of the most significant approaches that specifies the structure of learning and how to handle the components of the posture of

learners is Cognitive Style. Cognitive style is the way by which individuals perceive information in the surroundings and the patterns of thinking that they use to formulate a knowledge base about natural phenomena in the world around them. There is an inclination that some instructional techniques used by teachers may, by the nature of presentation, solicit varied responses from students with varying cognitive styles. This is in agreement with Agboghoroma (2015) whose study shows that there is a significant interaction effect between cognitive style and instructional mode on students' knowledge. Biology is a very important subject to all living things, especially humans. Due to its enormous importance, researchers in science education carry out researches to improve and sustain it's endeavors but surprisingly researchers in science education have shown that the teaching-learning process of biology is faced with some difficulties. And they attributed these difficulties to the problem of ineffective instructional methods used by biology teachers, which fails to or lacks the technical quality of considering students' prior knowledge, recognizing common scientific misconceptions among students and it's teacher-centered rather than student-centered, which in turn denied students from the right of being active participants to passive participants leading to poor assimilation, retention and poor academic achievement of the biology students (Auwal, 2013). This poor strategy is the lecture method. If these students' misconceptions are not effectively addressed, they may become tenacious as they advance academically by the day. Second, one of the side effects of the lecture method used by biology teachers is that students have diverse cognition styles, which influences their learning and academic achievement. The WASSCE chief Examiner's report from 2015 to 2019 shows a continued poor performance of students in Biology. He thus stated that Students are not favorably disposed towards biological concepts most especially in Genetics as contained in his highlighted report on the weakness of Biology Students. Chiefly among these weaknesses are...

1. Poor grasp of Genetics.
2. Not putting 'X' as a sign of crossing in questions
3. Inability to cross the genetic questions properly
4. Inability to explain the reason why a rhesus-negative woman married to a rhesus-positive man might lose her second pregnancy. The remedy he gave is that Teachers should emphasize Genetics.

To challenge the dwindling academic achievement of biology students, there is a need to explore and adopt a teaching strategy that caters to students' prior knowledge, misconceptions, and is student-centered, which gives students the right to active participation in the teaching-learning process in other to improve the academic achievement of biology students. This is because It has been revealed by different that the POE model is as effective in science education (Hong et al., 2021; Karaer, 2007) as it is in many other fields of study (Arsy et al., 2020) . On a second note, the knowledge of students' cognitive style is a very important key ingredient for teachers for effective expositions of the content of biology to students as it enhances the teaching-learning process. The purpose of this study is to investigate and explain the effects of predict-Observe-Explain instructional model on student cognitive styles and academic achievement in biology in delta central senatorial district.

Research Questions

The following research questions guided this survey;

1. Is there any significant difference in the mean Pre-test and Post test achievement scores of students taught with Predict, Observe and Explain model and those taught with the conventional lecture method?
2. Is there any significant difference between the biology mean score achievement of students with field-dependent cognitive style and those with field-independent cognitive style taught with POE model at Post-test?

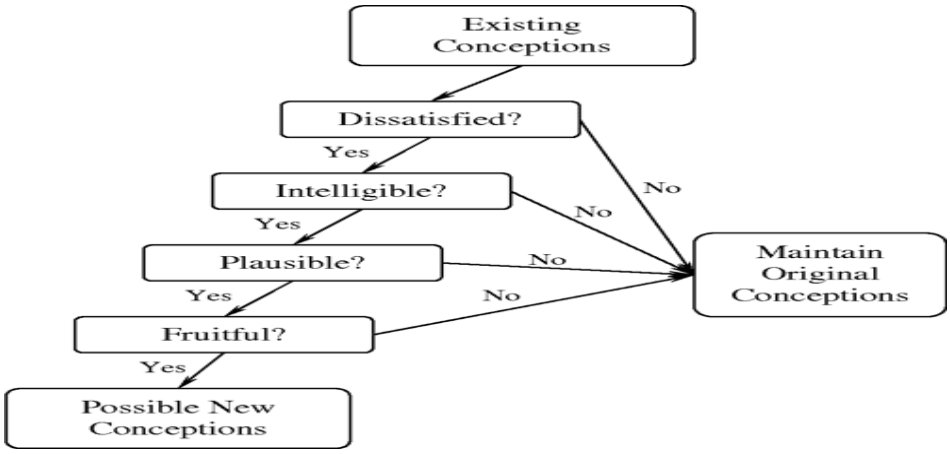
2. RESEARCH METHOD

The study made use of quasi-experimental pre-test, post-test non-equivalent control groups. This is due to it's effectiveness in investigating cause-and-effect correlations between variables (Büyüköztürk, 2007). The population of this study consists of twelve thousand, one hundred and sixty-three (12,163) senior secondary schools two (SS2) biology students in all the public senior secondary schools in Delta Central. The researcher based on purposeful sampling, a non-probabilistic sampling method, selected a total of 280 senior secondary school two (SS2) biology students from randomly-selected intact classes from the eight (8) local government areas in delta central were used for this study. Four (4) of the selected groups were selected randomly into the experimental group as well as the other four (4) into the control group. Two instruments: Two-tier diagnostic multiple choice Biology Achievement Test (BAT) and Cognitive style scale (CSS) were used for data collection. The Biology Achievement Test (BAT) developed by the researcher was designed to measure students' achievement in biology. It was a 25-tem multiple choice objective test alongside the

reasons for each option selected focused on Genetics. The Cognitive Style Scale (CSS) harmonized from Martin (1998) consists of twenty (20) items designed to investigate student's ideology on their cognitive styles. The responses to the Cognitive Style Scale were drafted on a 4-point-Likert scale of Strongly Agree (SA, 4), Agree (A, 3), Disagree (D, 2) and Strongly Disagree (SD, 1) were designed to group students into Field-dependent and Field-independent cognitive styles. The students were required to write a number in the blank spaces to the left of each statement number A to T . The two instruments were validated by experts and indices for reliability established as 0.72 for two-tier diagnostic multiple choice BAT using Kuder-richardson formula 21 and 0.79 for Cognitive Style Scale (CSS) using Cronbach alpha. This study is built on Posner's theory of conceptual change and the Bring theory.

Posner's Theory of Conceptual Change

This theory states that Conceptual change is the systematic way by which concepts and relationships between them change over the course of a person's lifetime or over the course of history by a scientific concept. According to Posner et al. (1982), the scientific conception must be intelligible, plausible, and fruitful for successful conceptual change to occur. Intelligible means that the new conception must be clear enough to make sense to the learner. Plausible means the new conception must be seen as true.



Picture 1: Posner et.al (1982) Conceptual Change Model -Adapted from Dole and Sinatra (1998)

Predict-Observe-Explain (POE) Instructional Model of Conceptual Change

Predict-Observe-Explain is a learning strategy based on constructivism approach in which new knowledge is built based on students' prior knowledge (Barke et al., 2010; Joyce, 2006). The POE strategy was developed by White and Gunstone (1992) to uncover individual students' predictions, and their reasons for making these predictions about a specific event. Rahman (2012) states that the POE learning model consists of three steps namely, prediction, observation and explanation.

Cognitive Styles

Cognitive style are psychological constructs which describe individual's mode and women's mode of information perception, agency and illustration (Witkin and Moore, 1991). According to Emmanuel (2003), there are only field-dependent and field-independent cognitive styles individuals. It is also known that college students who desire a field-dependent learning style tend to discover the world globally, find it tough to clear up – problems, tend to favor the “Specter method to get to know and would undertake the agency of statistics to be learned. According to Musya (2015) there are various forms of cognitive styles that distinguish individuals in their dealings with various circumstances to which they are exposed to. But there are three very important cognitive styles: Field-dependence/field-independence. There have been significant differences among exclusive fundamental corporations with regard to cognitive styles . A study carried out by Agboghoroma (2015) showed that there is a significant interaction effect of cognitive style and instructional mode on students' knowledge of integrated science. A study by Khodabakhsh (2011) revealed that math students' rankings are appreciably associated with their cognitive patterns (field dependence/independence).

3. RESULT AND DISCUSSION

The students in the experimental group where taught biological concepts using the POE model, while those in the control group were taught the same biological concepts using the lecture method. The treatment lasted for five weeks and data were collected and analyzed appropriately. The content validity of the Two-tier diagnostic multiple choice BAT was done using a table of specifications of Blooms Taxonomy of Objectives as shown in table 5 below.

Table 1: Table of Specifications for 25 BAT items

Content	Knowledge 24%	Comprehension 24%	Application 32%	Interpretation 20%	Total 100%
Meaning of genetics, Traits in Organisms and definition of important concepts used in genetics. (24%)	4	2	0	0	6
Mendel's and Jean lamarck's Experiments and their theories and Laws. (40%)	2	2	5	1	10
Chromosomes and DNA and the principles of genetics (36%).	0	2	3	4	9
Total	6	6	8	5	25

Analysis of Data

The data collected were analyzed using mean and standard deviation to answer the research questions, after which t-test was used to determine whether a difference between the sampled groups was significant (Büyüköztürk, 2007), at 0.05 level of significance.

Findings

Research Question One**:** Is there any significant difference in the mean Pre-test and Post-test achievement scores of students taught with the redict-observe-explain model and those taught with the conventional lecture method?

Table 2 : Mean and Standard deviation for pre-test and post-test Achievement scores of students taught Biology using POE model and those taught using Lecture method

Sources of Variation	N	Pre-Test		Post-Test		Pre-Test and Post-Test Mean Gain
		Mean (X)	elementary school	Mean (X)	elementary school	
POE	126	20.26	3.31	67.14	6.18	**46.88**

Lecture Method	154	20.39	3.21	50.86	12.17	**30.47**
Mean Difference		**0.13**		**16.28**		**16.41**

Table 2, above shows the mean scores for pre-test and post-test of POE Model and lecture methods with their mean and standard deviation scores accordingly. As shown in the table, the mean achievement gain for the POE model is 46.88 while the mean gain of the Lecture method is 30.47 indicating that there is a significant difference of 16. 41 in favor of the POE model.

Table 3: T-test Comparison of pre-test and post-test Achievement Scores of experimental and control groups

Groups	N	Mean(X)	elementary school	df	t- $_{Cal}$	P-value	Decision
POE Model	126	67.14	6.18				
				278	13.64	0.00	**Significant**
Lecture method	154	50.86	12.17				

Results from table 3 above show that t-Cal 13.64, p=0.00. This indicates that there is a significant difference in the mean Pre-test and Post-test achievement scores of students taught with POE model and those taught with lecture method. Therefore, the null hypothesis which says there is no significant difference in the mean Pre-test and post-test achievement scores of students taught with POE model and those taught with lecture method, is rejected.

Research Question Two**:** is there any significant difference between the Biology mean score achievement of students with field-dependent cognitive style and those with field-independent cognitive style taught with POE model at Post-test?

Table 4: Mean and standard deviation for Field-independent and Field-dependent cognitive styles students taught Biology using POE model at post-test.

Cognitive styles	N	Mean (X)	elementary school
Field-independent	**59**	**66.81**	**5.44**
Field-dependent	**67**	**67.43**	**6.79**

The results in table 4 above show the mean score for the field-independent students, 66.81 and the mean score of the field-dependent students, 67.43. However the results reveal a slight difference in academic achievement in favor of the Field-dependent students. The statistical analysis to show if this difference is significant is shown in the table 14 below.

Table 5: T-test Comparison of Post-test Achievement Scores of Field-independent and Field-dependent Students taught Biology using POE Model

Cognitive styles	N	Mean (X)	elementary school	Df	t- $_{Cal}$	P-value	Decision
Field-independent	**59**	**66.81**	**5.44**				
				124	**0.560**	**0.576**	**Not significant**

Field-dependent	**67**	**67.43**	**6.79**

The results on table 5 above show that t- $_{Cal}$ (0.560), p(0.576). Therefore, the null hypothesis four is retained. This means that there is no significant difference in the academic achievement of Field-independent and Field-dependent students taught biology using the POE model. The findings of this study are discussed as follows;

Effect of Teaching Models on Biology Students' Achievement

The results obtained from the findings showed a significant effect of the POE instructional model on students' achievement in biology, with the students in the experimental group taught biology using POE model obtaining a higher mean score of 67.14 at post-test as against 50.86 for the control group. This implies that the POE model is superior to the method lecture and that it enhanced students' achievement in biology as revealed by Hong et al., (2021); Karaer, (2007) ; Arsy et al., (2020) . This finding is in support of prior findings of all the researchers like et.al (2015), Haysom, J. & Bowen, M. (2010), Joyce, C. (2006), that shows that there is a connection between instructional methods and students academic achievement and Ajaja (2013) who opined that one common mistake teachers commonly make is to assume that their students are somewhat like blank slates. The summary t-test also reveals a significant difference between students taught biology using POE model and those taught using lecture method. The higher achievement scores of students taught biology using POE model over those thought using lecture method is predicated on the student's degree of participation during the teaching-learning process.

Effect of POE on Students' Cognitive styles

The findings of this study show that there is no significant difference in the academic achievements of field-independent and field-dependent cognitive style students indicating that POE model covers the lapses of students varying cognitive styles. This implies that both field-independent and field-dependent cognitive style students perform equally during the teaching-learning process, indicating that they participate in an equal degree. This corroborates with the findings of Auwal (2013) and Musya (2015), who found out that cognitive styles differ from individual intelligence but they may influence personality development and how students learn and relate information. This is also in line with the findings of Russell (2007) who stated that students learn best by doing and by experiencing things on their own.

4. CONCLUSION

Based on the findings and discussion of this study, the following conclusions were made. The researchers concluded that the POE instructional model used in teaching biology is a better instructional model as the students taught with this model out-performed those taught with traditional methods. The model promotes inter-personal relationships while the students were actively involved in the teaching-learning process, which helped deal with their previous-conceptions thus, bridged the gap between the various cognitive style students as they both experienced better cognitive achievement in biology

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