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EFFECTS OF PREDICT-OBSERVE-EXPLAIN INSTRUCTIONAL STRATEGY ON STUDENTS' LEARNING OUTCOMES IN PHYSICS PRACTICAL IN SECONDARY SCHOOLS

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Abstract:
The study investigated the effects of predict-observe-explain instructional strategy on students' performance and attitude towards Physics practical in secondary schools. The study adopted the quasi-experimental design of pre-test, post-test and control group. The sample for the study comprised 54 Senior Secondary two (SS II) Physics students who were randomly selected through multistage technique from two co-educational Senior Secondary Schools in Osun state, Nigeria. The schools were randomly selected to experimental and control group. The experimental group was exposed to predict-observe-explain instructional strategy while the control group was taught using conventional laboratory strategy. Physics Practical Test (PPT) and Physics Practical Attitude Scale (PPAS) were the two instruments used to collect relevant data for the study. The general questions raised for the study were answered using descriptive statistics. The hypotheses generated were analyzed using t-test. Decision was taken at 0.05 level of significance. The findings from the study showed that the treatment had positive effects on students' performance and their attitude towards Physics practical. Based on the findings of this study, it was recommended that Physics teachers should make use of predict-observe-explain instructional strategy to improve students' performance and cultivate their positive attitude towards Physics practical in secondary schools.

Keywords: predict-observe-explain, instructional strategy, performance, attitude, physics practical

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1. Introduction

Science teaching at various levels still retains the old conservative approach with the teacher in most cases acting as the repertoire of knowledge and the students the dormant recipient. There is over-reliance on textbooks with only occasional demonstrations and experimental classes. Classrooms are still a cycle of memorization, repetition and note coping. This method of teaching does not seem to be meeting the needs of the present generation, recognizing the ultimate poor output from schools especially secondary schools (Aladejana, 2015). Danmole (2011) noted that teachers need to employ different learning methods and strategies to ensure students understanding of scientific concepts. A shift is therefore advocated by researchers to methods that will enable the learner construct his/her own understanding (Samba, Achir and Ogbeba, 2010; Samba and Eriba, 2012). Such methods have their roots in constructivism. In other to get the best out of the students, attention must be shifted from the teacher in the process of teaching and learning of science in secondary school to students. This can be achieved by making lessons active, relevant, student oriented and participatory. Constant changes in teaching and learning processes have resulted to changes in instructional practices; exposing teachers to factors and conditions that would best be suitable for learning to facilitate, improve and increase students' learning experiences. The trend of changes in teaching and learning processes is now being tailored towards activity based and students-centered teaching methods.

One of the activity based and students-centered instructional strategies is Predict-Observe-Explain Instructional Strategy (POEIS) which is being investigated in this study. Here, learners perform three different tasks; predict, observe and explain. It starts with predicting solution to a problem, follow by conducting experiment to prove the prediction, and finally it ends with explaining the result of the experiment. Predict-observe-explain instructional strategy is based on the philosophy of practical activities which involves learning by doing. It involves students predicting the result of a demonstration and discussing the reasons for their predictions; carrying out and observing the demonstration and finally explaining any discrepancies between their predictions and observations. The POE works best with demonstrations which allow immediate observations. Famakinwa and Bello (2015) asserted that the POE procedure is based on the classic model of research where a hypothesis is stated and reasons are given for why this may be true, relevant data are gathered and results are discussed. Raj, Sreerekha and Sankar (2016) asserted that the predict-observe-explain instructional strategy requires three tasks to be carried out; first this strategy helps to uncover individual students' predictions, and their reasons for making these about a specific event. Second, students describe what they see in the demonstration-observation. Third, students must reconcile any conflict between their prediction and observation explanation. This strategy focuses on linking students existing ideas and beliefs relevant to a situation and exploring the appropriateness of these ideas and beliefs.

Learners come to class with knowledge which may or may not be compatible with the scientific conceptions (Svandova, 2013; Sesen, 2013). Educators should be aware of what learners think and know about concepts, some of which may contradict science concepts (Kurt, Ekici, Aktaú, and Aksu, 2013). Usually, the prior knowledge is acquired through learners' experiences and may be modified throughout the process of learning. During this process, learners may become dissatisfied with their existing knowledge and find the new knowledge plausible, intelligible and fruitful (Svandova, 2013). Learners may accommodate and assimilate the new knowledge.

Fostering the understanding of science concepts, there is need for teachers to recognize learners' initial behaviour and modify their teaching styles accordingly. This can be done by investigating learners' science concepts (Sesen, 2013). According to Dalziel (2010), predict-observe-explain strategy aims at revealing the ability of students in making individual predictions. The POE strategy is based on constructivism learning theory which assumes that with activities of prediction, observation, and explain the observation result, the students are able to build their knowledge. In addition, POE strategies can be used to detect and correct students' misconceptions about a concept (Ipek, Kala, Yaman, and Esra, 2010; Keles and Demirel, 2010). The strategy therefore uncovers learners' misconceptions by considering their prior knowledge and offers them an opportunity to examine their existing ideas against the new knowledge and then construct new meanings.

Conventional Laboratory Instructional Strategy is a teacher-centered teaching method in the laboratory where teacher dominates the activities turning the students to passive learners. Bits of information are given by the teacher and the students receive the information passively. It is hand-on experiment where students observe/watch their teacher demonstrating experiment for them; after which the students also repeat what the teacher demonstrated.

The most important feature of effective Physics teaching is to support theoretical explanations with actual practices in the laboratory. Physics involves a lot of practical works carried out in the laboratory. Physics practical involved the investigation of nature by means of observation, induction, hypothesis, experiment, calculation, prediction and control (Owolabi, 2011). It implies that Physics is an empirical subject through which students relate concepts, theories, experiments and observations as a means of exploring ideas. Practical works in Physics are activities carried out in the laboratory in order to discover unknown and to test formulated hypothesis.

Laboratory activities generally aim at improving students' understanding of principles in Physics by making observations from experiments, analyzing and drawing inference. Laboratory helps the students to develop a broad array of basic skills of experimental Physics and data analysis. Since it is imperative that students have a broad experience with techniques using laboratory equipment in order to improve their abilities in conducting experiments, it is advisable to allow them make use of many different types of laboratory apparatus, whether in the classroom or in the laboratory, to make observations.

Research findings for some years have shown the appalling performance of secondary school students in Physics in public examinations (Asikhia, 2010; Owolabi and Oginni, 2013; Josiah and Gana, 2019). The poor performance of the students in Physics is an indication of lack of understanding of the subject matter. The persistent decline in students' performance in Physics is not only frustrating to the students and the parents, its effects are equally grievous on the society.

The poor trend of secondary school students' performance in Physics has been linked with inappropriate teaching methods, curriculum content, teacher's quality, negative attitudes of students towards Physics, students' ignorance of the relationship between Physics and environment (Owolabi and Oginni, 2013; Jegede and Adedayo, 2013). There is need also to look into the likely effects of Physics practical which is being assessed separately as an integral part of the subject carrying substantial weight in grading the students on students' performance in Physics. The allocation of marks to theoretical and practical aspects of the subject in WAEC and NECO examinations is a clear evidence to show that it will be very difficult for a student to make a credit pass in the subject if the student performs poorly in practical aspect of the examination. Therefore, proper exposure of students to practical works in Physics in secondary schools is inevitable.

It has been observed that in most schools, Physics teachers do not expose their students to practical works until few weeks to the examination after the examination bodies (NECO and WAEC) have released practical instructions. And when the students are expose to practical works; the teachers dominate the activities turning the students to passive learners. Chukwunenye and Adegoke (2014) and Chukwunenye (2015) asserted that laboratory sessions are hardly organized for students as a result of ill-equipped laboratories in most schools, lack of interest on the path of the teachers and some students.

Obviously, lack of functional Physics laboratory and inadequate equipment for Physics practical couple with teacher center teaching method adopted by Physics teacher to teach Physics practical in secondary schools are impeding laboratory activities and these may be contributing to poor trend of performance of students in Physics.

Attitude is one of the variables in affective domain of learning which plays a dominant role in understanding the concepts taught to the students and influences their psychomotor ability. It is also a predictor of academic performance. Attitude can either be positive or negative. Students with positive attitude towards Physics practical pay rapt attention in laboratory and participate actively in careful handling and manipulation of apparatus. Some researchers are of the opinion that achievement and academic performance depend on students' attitude (Fakeye, 2010; Godwin and Okoronka, 2015). Physics curriculum contents emphasize understanding of concepts, experimentation and right attitude. The development of students' positive attitudes towards Physics practical is one of the responsibilities of every Physics teacher because positive attitude towards Physics practical could enhance performance in Physics while negative attitude of the students towards Physics practical may partly be responsible for their poor performance in the subject. Jegede and Adedayo (2013) cited negative attitudes of students towards Physics as one of the factors responsible for poor trend of secondary school students' performance in Physics. Without positive attitudes, students have little chance of learning proficiently if at all learning will occur. Students' positive attitudes could be achieved through active involvement of the students in the learning process.

2. Purpose of the Study

The purpose of this study was to investigate the effects of Predict-Observe-Explain Instructional Strategy on students' performance and attitude towards Physics practical in secondary schools. Specifically, the study intends to find out students' performance and attitude towards Physics practical when exposed to Predict-Observe-Explain Instructional Strategy.

2.1 Research Questions

The study answered the following questions:

1) What is the performance of the students in Physics practical in the two groups before and after treatment?
2) What is the attitude of the students towards Physics practical in the two groups before and after treatment?

2.2 Research Hypotheses

The following null hypotheses were generated for the study:

H_{01}: there is no significant difference in the students' attitude towards Physics practical using predict-observe-explain instructional strategy before and after the treatment.

H_{02}: there is no significant difference in the students' performance mean scores in Physics practical using predict-observe-explain instructional strategy before and after the treatment.

3. Methodology

3.1 Research Design

This study adopted quasi-experimental design of the pre-test, post-test and control group. The design is represented schematically as follows:

$$G_1: \quad O_1 \quad x_1 \quad O_2$$
$$G_2: \quad O_3 \quad x_2 \quad O_4$$

Where
G_1 - Experimental group
G_2 - Control group

O_1, and O_3 are the pre-test observations
O_2, and O_4 are the post-test observations
x_1 - Treatment for experimental group (Predict-Observe-Explain Instructional Strategy)
x_2 - Treatment for control group (Conventional laboratory Strategy)

3.3 Population, Sample and Sampling Technique

The population for this study consisted of all Senior Secondary two (SS II) Physics students in Osun State Nigeria. The Senior Secondary two (SS II) students were considered appropriate for this study because they would have been exposed to a considerable knowledge of Physics in Senior Secondary one (SS I). The sample for the study consisted of 54 Physics students of Senior Secondary two (SS II) in two co-educational senior secondary schools in Osun State. The multistage sampling procedure was used to select the sample. Stage one involved the selection of two Local Government Areas from the three Senatorial Districts in Osun State using simple random sampling by balloting. The second stage involved the use of purposive sampling technique to select one secondary school with relatively-equipped Physics laboratory from each of the Local Government Area selected, and the third stage involved the use of students in an intact class of an arm randomly selected from each school considered.

3.4 Research Instruments

Two instruments were used for the study. The two instruments were Physics Practical Test (PPT) and Physics Practical Attitude Scale (PPAS). PPT was a practical test consisting of two parallel tests (alternative A and alternative B) adapted from West African Examination Council past examination papers. There were two practical tests in each alternative. Each of the tests carries 25 marks, making the maximum score obtainable to be 50 marks for each alternative. Alternative A was used for pre-test and Alternative B was used for post-test. The Physics Practical Attitude Scale (PPAS) was developed to measure the attitude of students towards Physics practical. The PPAS had two sections A and B. Section A consisted of students' personal bio-data such as name of school, gender, age range and class while section B consisted of 40 items-questionnaire intended to measure students' attitude towards Physics practical. The PPAS was structured in 4-points Likert scale: Strongly Agree (SA) – 4 points, Agree (A) – 3 points, Disagree (D) – 2 points and Strongly Disagree (SD) – 1 point. Each respondent was made to tick appropriate options, the responses were collated and scored for data analysis.

3.5 Validation of Instruments

The face and content validity of the instruments were carried out by experts in Physics Education, Test, Measurement and Evaluation and Guidance and Counselling. The reliability of PPT was determined by test re-test method. The two sets of results were collated and analyzed using Pearson Product Moment Correlation Analysis. The reliability coefficient of 0.82 and 0.80 were obtained for alternative A and alternative B of

PPT respectively, while 0.73 was obtained for PPAS using Cronbach's Alpha. These values were regarded as high enough to be used for the study.

3.6 Data Analysis

The data collected were collated and analyzed. The general questions were answered using descriptive statistics of mean, standard deviation and bar chart. The hypotheses generated were analyzed using t-test. The hypotheses were tested at 0.05 level of significance.

4. Results

Question 1: What is the performance of the students in Physics practical in the two groups before and after treatment?

In order to answer the question, mean scores of performance of the students in Physics practical in the two groups before and after treatment were computed and compared. The result is presented in Table 1 below.

Table 1: Performance of the students in Physics practical in the two groups before and after treatment

Group	N	Pre-test		Post-test		Mean Difference
		Mean	SD	Mean	SD	
Predict-Observe-Explain	24	6.83	2.01	27.38	5.79	20.55
Control	30	6.70	2.25	17.70	3.53	11.00
Total	54					

The performance of the students in Physics practical in the two groups before and after treatment are further depicted in Figure 1.

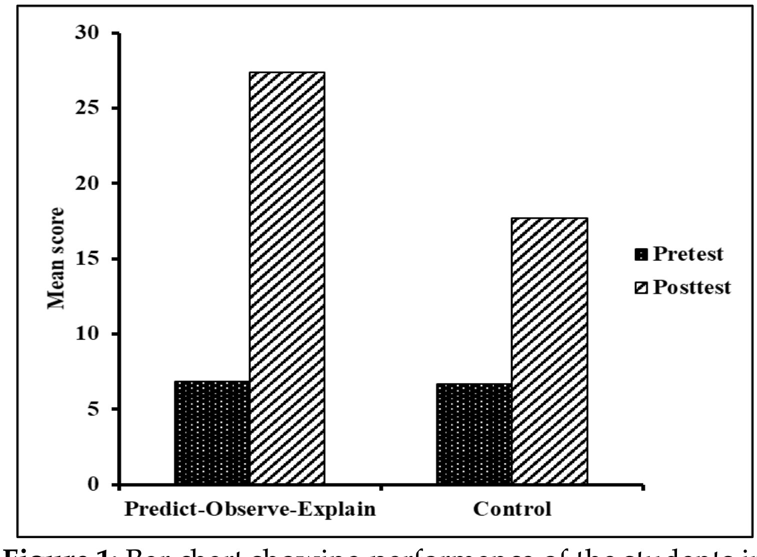

Figure 1: Bar chart showing performance of the students in Physics practical in the two groups before and after treatment

Question 2: What is the attitude of the students towards Physics practical in the two groups before and after treatment?

In order to answer the question, mean scores of attitude of the students towards Physics practical in the two groups before and after treatment were computed and compared. The result is presented in Table 2.

Table 2: Students' attitude towards Physics practical in the two groups before and after treatment

Group	N	Pre-test		Post-test		Mean Difference
		Mean	SD	Mean	SD	
Predict-Observe-Explain	24	62.37	4.14	135.73	4.59	73.36
Control	30	64.21	6.08	90.10	8.77	25.89
Total	54					

The attitude of students towards Physics practical in the two groups before and after the treatment are further depicted in Figure 2

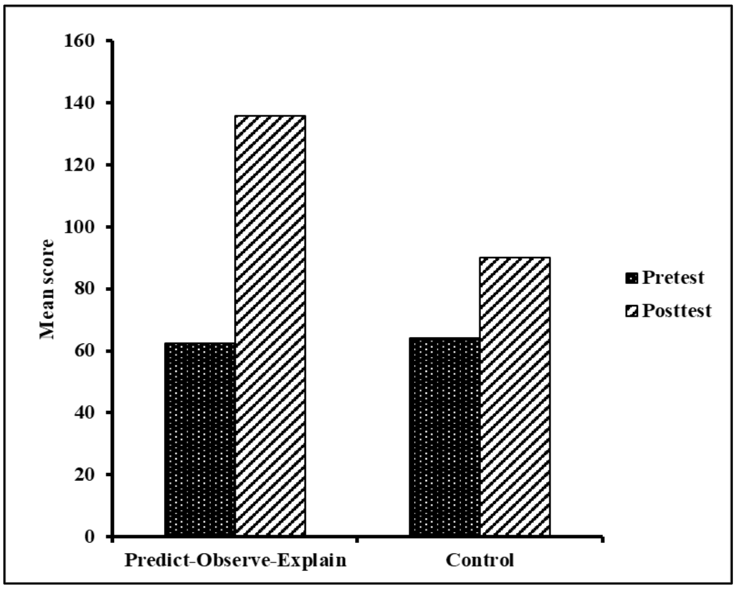

Figure 2: Bar chart showing attitude of the students towards Physics practical in the two groups before and after treatment

4.1 Testing of Hypotheses

H01: There is no significant difference in the students' attitude towards Physics practical using predict-observe-explain instructional strategy before and after the treatment.

In testing the hypothesis, scores of students' attitude towards Physics practical using predict-observe-explain instructional strategy before and after the treatment were computed and compared for statistical significance using t-test statistics at 0.05 level of significance. The result is presented in Table 3 below.

Table 3: t-test of students' attitude towards
Physics practical in predict-observe-explain group before and after treatment

Variable	N	Mean	SD	Df	t_{cal}	P_{value}	Decision
Pretest-Attitude	24	62.37	4.14	23	76.516*	0.000	Significant
Posttest-Attitude	24	135.73	4.59				

*p<0.05

Table 3 showed that the effect of the treatment on students' attitude towards Physics practical was statistically significant at 0.05 level (t=76.516, p<0.05). The null hypothesis is rejected. It implies that there was significant difference in the students' attitude towards Physics practical using predict-observe-explain instructional strategy before and after the treatment.

H_{02}: There is no significant difference in the students' performance mean scores in Physics practical using predict-observe-explain instructional strategy before and after the treatment.

In testing the hypothesis, scores of students before and after being exposed to predict-observe-explain instructional strategy were computed and compared for statistical significance using t-test statistics at 0.05 level of significance. The result is presented in Table 4 below.

Table 4: t-test showing students' performance before
and after being exposed to predict-observe-explain instructional strategy

Variable	N	Mean	SD	Df	t_{cal}	P	Decision
Pretest	24	6.83	2.01	23	16.400*	0.000	Significant
Posttest	24	27.38	5.79				

*p<0.05

Table 4 showed that the effect of treatment on students' performance in Physics practical was statistically significant at 0.05 level (t=16.400,p<0.05). The null hypothesis is rejected. This implies that there was significant difference in the students' performance mean scores in Physics practical using predict-observe-explain instructional strategy before and after the treatment.

5. Discussion

Table 1 above revealed that Physics students in the predict-observe-explain instructional strategy group had mean score of 6.83 while those in conventional laboratory group had mean score of 6.70 prior to treatment. This implies that the performance of the students in Physics practical in the two groups before treatment were generally low. On exposure to treatment, students taught using predict-observe-explain instructional strategy had the mean score of 27.38 while the students in the conventional laboratory strategy group had the mean score of 17.70. This implies that the performance of the students in Physics practical in the two groups after treatment were high.

Figure 1 above showed the students' performance mean scores in Physics practical in the two groups before and after treatment. The Bar Chart showed that students exposed to predict-observe-explain instructional strategy performed better than the students taught using conventional laboratory strategy. The comparison between the pre-test and post-test mean scores in the two groups showed that the post-test mean scores were higher than the pre-test mean scores. This implies that the treatment had positive effect on students' performance in Physics practical. The Bar Chart further showed that predict-observe-explain instructional strategy is more effective for enhancing students' performance in Physics practical.

Table 2 above revealed that Physics students in the predict-observe-explain instructional strategy group had mean score of 62.37 while those in conventional laboratory strategy group had mean score of 64.21 prior to treatment. This implies that the attitude of the students towards Physics practical in the two groups before treatment was unsatisfactory. On exposure to treatment, students taught using predict-observe-explain instructional strategy had the mean score of 135.73 while the students in the conventional laboratory strategy group had the mean score of 90.10. This implies that the attitude of the students towards Physics practical in the two groups after treatment was high.

Figure 2 showed the students' attitude mean scores towards Physics practical in the two groups before and after treatment. The Bar Chart showed that the post-test attitude mean score of students taught using predict-observe-explain instructional strategy was higher than that of the students exposed to conventional laboratory strategy. The comparison between the pre-test and post-test attitude mean scores in the two groups showed that the post-test attitude mean scores were higher than the pre-test attitude mean scores. This implies that the treatment had positive effect on students' attitude towards Physics practical. The Bar Chart further showed that predict-observe-explain is more effective strategy for enhancing students' attitude towards Physics practical.

Table 3 showed that there was significant difference in the students' attitude towards Physics practical using predict-observe-explain instructional strategy before and after the treatment.

Table 4 showed that there was significant difference in the students' performance mean scores in Physics practical using predict-observe explain instructional strategy before and after the treatment.

6. Conclusion

From findings of this study, it was concluded that the treatment had positive effects on students' performance and their attitude towards Physics practical.

6.1 Recommendation

Based on the findings of this study, it was recommended that Physics teachers should make use of predict-observe-explain instructional strategy to improve students' performance and cultivate their positive attitude towards Physics practical in secondary schools.

Conflict of Interest

The authors declare no conflict of interest.

About the Authors

Oluwasegun Matthew Ojo is a doctor of philosophy in science education. He bagged Ph.D in Science Education from Ekiti State University, Ado-Ekiti, Nigeria. He is a seasoned Physics Educator committed to academic excellence. He is a member of Science Teacher Association of Nigeria. He has a number of journal articles in Physics Education published in reputable journals.

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