EFFECTS OF PREDICT-OBSERVE-EXPLAIN AND VIRTUAL LABORATORY INSTRUCTIONAL STRATEGIES ON SECONDARY SCHOOL STUDENTS' PERFORMANCE IN PHYSICS PRACTICAL

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Published: 31 January 2020

Cite this article: Ojo, O.M. & Owolabi, O.T. (2020). Effects Of Predict-Observe-Explain And Virtual Laboratory Instructional Strategies On Secondary School Students' Performance In Physics Practical. *European International Journal of Science and Technology*, 9(1), 1-11.

Abstract

The study investigated the effects of Predict-Observe-Explain and Virtual Laboratory Instructional Strategies on students' performance in Physics practical. The study adopted the quasi-experimental design of pre-test, post-test and control group. The sample for the study comprised 74 Senior Secondary two (SS II) Physics students who were randomly selected from three co-educational Senior Secondary Schools in Osun state through multistage technique. The schools were randomly selected to two experimental and a control group. The students in the experimental groups were exposed to Predict-Observe-Explain and Virtual Laboratory Instructional Strategies while the control group was taught using conventional laboratory strategy. Physics Practical Test (PPT) was the instrument used to collect relevant data for this study. PPT was a practical test consisting of two parallel tests (alternative A and alternative B).The reliability of PPT were determined by test-retest method and the reliability coefficient of 0.82 and 0.80 were obtained for alternative A and alternative B respectively using Pearson Product Moment Correlation Analysis. The hypotheses generated were analyzed using Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA), Scheffe Post Hoc Analysis and Multiple Classification Analysis (MCA). Decisions were taken at 0.05 level of significance. The findings from the study showed that there was significant teaching effect on students' performance mean scores in the three groups. Predict-observe-explain and virtual laboratory instructional strategies enhanced students' performance in Physics practical. Virtual laboratory instructional strategy was the best among the three and predict-observe-explain instructional strategy group performed better than the conventional group. Based on the findings of this study, it was recommended that Physics teachers should be encouraged to make use of virtual laboratory and predict-observe-explain instructional strategies to teach Physics practical in secondary schools.

Keywords: Predict-Observe-Explain, Virtual Laboratory, Instructional Strategy, Performance, Physics Practical

Introduction

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 students-centered teaching methods. 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. This trend is learner centered. Thus, teaching strategy which captures interest of students in science is imperative. Science should be taught in such a way that students will be allowed to experiment and discuss in groups as they make meaning of tasks and set out to solve challenging problems.

Activity based and students centered instructional strategies can attract and retain students in Physics classes by making lessons active, relevant, student oriented and participatory. Two of these activity based and students-centered instructional strategies are Predict-Observe-Explain Instructional Strategy (POEIS) and Virtual Laboratory Instructional Strategy (VLIS) which are being investigated in this study.

Predict-Observe-Explain Instructional Strategy is based on the philosophy of practical activities which involves learning by doing. Here, learners perform three different tasks; predict, observe and explain. 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. 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.

Virtual Laboratory Instructional Strategy (VLIS) is a computer-based instructional strategy made up of three components: text, video and simulated experiment. The text section exposes the students to the title, aim, theory, apparatus and procedures of the experiments. The video section exposes the students to the steps in carrying out the experiments via video. The simulated experiment is a section where students carry out or perform experiments in virtual environment using computer program. Gambari, Falode, Fagbemi, and Idris (2013) reported that the application of the virtual laboratory had positive effects on students' achievements, retention and attitudes when compared to physical laboratory method. Virtual laboratory makes students become active in their learning, provide opportunities for students to understand difficult concepts more easily. Virtual laboratory increases motivation and desire for lessons and laboratory activities in the process of learning (Pyatt and Sims, 2012).

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. 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) has shown the extent of poor performance of students in public examinations. 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 (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 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.

Purpose of the study

The purpose of this study was to investigate the effects of Predict-Observe-Explain and Virtual Laboratory Instructional Strategies on students' performance in Physics practical. Specifically, the study intends to find out which of the two instructional strategies would enable secondary school students to attain more in Physics practical.

Research Hypotheses

The following null hypotheses were generated for the study:

H_{01}: There is no significant difference in the pre-test performance mean scores of students before being exposed to predict-observe-explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy.

H_{02}: There is no significant difference in the post-test performance mean scores of students exposed to predict-observe-explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy.
H_{03}: There is no significant difference in the students' pre-test performance and post-test performance in predict-observe-explain instructional strategy and virtual laboratory instructional strategy.

Methodology

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:	O_1	x_1	O_2
G_2:	O_3	x_2	O_4
G_3:	O_5	x_3	O_6

Where
G_1 - Experimental group 1
G_2 - Experimental group 2
G_3 - Control group
O_1, O_3 and O_5 are the pre-test observations
O_2, O_4 and O_6 are the post-test observations
x_1 - Treatment for group 1 (Predict-Observe-Explain Instructional Strategy)
x_2 - Treatment for group 2 (Virtual Laboratory Instructional Strategy)
x_3 - Treatment for control group (Conventional laboratory Strategy)

Population, Sample and Sampling Technique

The population for this study consisted of all Senior Secondary two (SS II) Physics students in the three Senatorial Districts of Osun State. 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 74 Physics students of Senior Secondary two (SS II) in three co-educational Senior Secondary Schools in Osun State. The multistage sampling procedure was used to select the sample. Stage one involved the selection of one Local Government Area from each of 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 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.

Research Instrument

The research instrument used to collect data for this study was Physics Practical Test (PPT). 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.

Validation of Instruments

The face and content validity of the instruments were carried out by experts in Physics education and Test, Measurement and Evaluation. The reliability of the instruments 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 respectively.

Data Analysis

The data collected were collated and analyzed. The hypotheses generated were analyzed using Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA), Scheffe Post Hoc Analysis and Multiple Classification Analysis (MCA). All the hypotheses were tested at 0.05 level of significance.

Results

Testing of Hypotheses

H_{01}: There is no significant difference in the pre-test performance mean scores of students before being exposed to predict-observe-explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy.

In testing the hypothesis, pre-test performance mean scores of students before being exposed to predict-observe-explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy were computed and compared for statistical significance using Analysis of Variance (ANOVA) statistics at 0.05 level of significance. The result is presented in Table 1.

Table 1: **ANOVA summary of students' mean scores in the predict observe - explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy groups before treatment**

Source	**SS**	**Df**	**MS**	**F**	**P**
Between Groups	1.633	2	0.816	0.194	0.824
Within Groups	298.583	71	4.205		
Total	300.216	73			

p>0.05

The result in Table 1 showed that the computed F-value (0.194) obtained for the groups with a p value (0.824) > 0.05 was not significant. The null hypothesis is not rejected; this implies that there was no significant difference in the pre-test performance mean scores of students before being exposed to predict-observe-explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy.

H_{02}: There is no significant difference in the post-test performance mean scores of students exposed to predict-observe-explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy.

In testing the hypothesis, post-test performance mean scores of students exposed to predict-observe-explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy were computed and compared for statistical significance using Analysis of Variance (ANOVA) statistics at 0.05 level of significance. The result is presented in Table 2.

Table 2: ANOVA showing post-test performance mean scores of students in the three groups

Source	SS	Df	MS	F	P
Between Groups	8735.430	2	4367.715	190.195*	0.000
Within Groups	1630.475	71	22.964		
Total	10365.905	73			

$^{*}p<0.05$

Table 2 showed that the computed F-value (190.195) obtained for the groups with a p value (0.000) < 0.05 was significant. The null hypothesis is rejected; implying that there was significant difference in the post-test performance mean scores of students exposed to predict-observe-explain instructional strategy, virtual laboratory instructional strategy and conventional laboratory strategy.

In order to locate the sources of pair wise significant difference among the groups, ScheffePosthoc test was carried out. The result is presented in Table 3.

Table 3: ScheffePosthoc analysis of students' performance in Physicspractical after treatment

Group	1	2	3	N	Mean
Predict-Observe-Explain **(1)**		*	*	24	27.38
Virtual Laboratory **(2)**			*	20	44.65
Control **(3)**				30	17.70

$^{*}p<0.05$

Table 3 revealed that there was significant difference between the performance of students exposed to predict-observe-explain instructional strategy and virtual laboratory instructional strategy at 0.05 level of significance. Similarly, the mean difference between the performance of students exposed to predict-observe-explain instructional strategy and control, virtual laboratory instructional strategy and control groups was statistically significant at 0.05 level in each case.

H_{03}: There is no significant difference in the students' pre-test performance and post-test performance in predict-observe-explain instructional strategy and virtual laboratory instructional strategy.

In testing the hypothesis, pre-test and post-test performance mean scores of students exposed to predict-observe-explain instructional strategy and virtual laboratory instructional strategy were computed and compared for statistical significance using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The result is presented in Table 4.

Table 4: ANCOVA of students' performance in Physics practical by treatment

Source	**SS**	**Df**	**MS**	**F**	**P**
Corrected Model	3275.889[a]	2	1637.944	53.732	0.000
Covariate (Pretest)	20.337	1	20.337	0.667	0.419
Group	3274.100	1	3274.100	107.404*	0.000
Error	1249.838	41	30.484		
Total	59128.000	44			
Corrected Total	4525.727	43			

$^{*}p<0.05$

Table 4 showed that the computed F-value (107.404) obtained for the groups with a p value (0.000) < 0.05 was significant. The null hypothesis is rejected; implying that there was significant difference in the students' pre-test performance and post-test performance in predict-observe-explain instructional strategy and virtual laboratory instructional strategy.

In order to determine the effectiveness of treatment (instructional strategies) at enhancing students' performance in Physics practical, Multiple Classification Analysis (MCA) was used. The result is presented in Table 5.

Table 5: Multiple Classification Analysis (MCA) of students'performance in Physics practical by treatment

Grand mean=35.23					
Variable + Category	**N**	**Unadjusted Devn'**	**Eta^2**	**Adjusted For Independent + Covariate**	**Beta**
Predict-Observe-Explain	24	-7.85	0.72	-7.83	-.02
Virtual Laboratory	20	9.42		9.40	
Multiple R 0.020					
Multiple R^2				0.000	

Table 5 revealed that students exposed to virtual laboratory instructional strategy had the higher adjusted mean score of 44.63 (35.23+9.40) in Physics practical than those taught using predict-observe-explain instructional strategy with an adjusted mean score of 27.40 (35.23+ (-7.83). This implies that virtual laboratory and predict-observe-explain are effective instructional strategies for enhancing students' performance in Physics practical. The treatment accounted for about 72% (Eta^2=0.72) of the observed variance in students' performance in Physics practical.

Discussion

The finding of this study revealed that students' performance in Physics practical in both experimental and control groups in pre-test did not differ statistically. This implies that there was no significant difference in the pretest performance mean scores of the students in the experimental groups (Predict-Observe-Explain Instructional Strategy and Virtual Laboratory Instructional Strategy) and control group (Conventional Laboratory Strategy). This established the homogeneity of the three groups involved in the study prior to the experiment. In other words, it could be said that the knowledge baseline for the groups involved in the study were equal. The finding of this study also showed that there was significant difference in the performance mean scores of the groups after the treatment. The experimental groups performed better than their counterparts in the control group. This implies that there was improvement in the performance of students resulting from their exposure to the treatment. The implication is that Predict-Observe-Explain Instructional Strategy and Virtual Laboratory Instructional Strategy are instructional strategies for enhancing students' performance in Physics practical. The study further found out that there was significant difference in the performance of students exposed to Predict-Observe-Explain Instructional Strategy and Virtual Laboratory Instructional Strategy. The adjusted mean score of students exposed to Virtual Laboratory Instructional Strategy is higher than the adjusted mean score of students taught using Predict-Observe-Explain Instructional Strategy. This implies that the students exposed to Virtual Laboratory Instructional Strategy performed better than those exposed to Predict-Observe-Explain Instructional Strategy. It implies that Virtual Laboratory Instructional Strategy is more effective for enhancing students' performance in Physics practical. This is in agreement with Gambari, Falode, Fagbemi, and Idris (2013) who asserted that the application of the virtual laboratory had positive effects on students' achievements when compared to physical laboratory method.

Conclusion

From findings of this study, it was concluded that predict-observe-explain and virtual laboratory instructional strategies enhanced students' performance in Physics practical. Virtual laboratory instructional strategy was the best among the three and predict-observe-explain instructional strategy group performed better than the conventional group.

Recommendations

Based on the findings of this study, it was recommended that:

1. Physics teachers should be trained on the use of virtual laboratory to improve the teaching of Physics practical in secondary schools.
2. Physics teachers should be encouraged to make use of predict-observe-explain and virtual laboratory instructional strategies to teach Physics practical in secondary schools.

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