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Bamikole Oludare Ogunleye

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EFFECT OF PREDICT-OBSERVE-EXPLAIN INSTRUCTIONAL STRATEGY ON STUDENTS' PRACTICAL SKILLS IN PHYSICS

OGUNLEYE, B. O.
Department of Teacher Education
University of Ibadan,
Ibadan, Nigeria
E-mail:banklad200l @yahoo.com

and

BABAJIDE, V. F. T.
Emmanuel Alayande College of Education
Oyo, Oyo State,
Nigeria
E-mail:babajidevero2009 @vahoo.com

Abstract
This study determined the effect of Predict-Observe - Explain (POE) instructional strategy on Senior Secondary School students' practical skills in Physics. This initiative was borne out of the current status of science teaching generally, and physics instruction in particular, which provides for inadequate exposure of students to practical activities with resultant student poor practical skills. The pre-test post-test quasi-experimental design was adopted for the study. 213 SS II Physics students from six senior secondary schools in Ibadan, Nigeria constituted the sample for the study. Results obtained through the use of descriptive statistics and ANCOVA showed that the Predict- Observe-Explain instruction was more effective (adjusted mean = 33.37) than the conventional practical instruction (adjusted mean = 24.42), It was recommended that Physics teachers should adopt the Predict-Observe-Explain instruction strategy while school administrations should propagate the potentials inherent in the novel strategy among Nigeria science teachers.

Keywords: Predict-Observe Explain, Instructional Strategy, Practical Skills in Physics, Senior Secondary School Students.

Background and Literature

Sonic of the problems of science teaching and learning in Nigerian schools have been identified as lack of equipment (Onwioduokit, 1996; Onwioduokit & Akinbobola, 2005; Ogunneye and Lasisi, 2008), inadequacy of facilities and low level of improvisation of materials on the part of Physics teachers (Oyekan, 1993; Iroegbu, 1998; Ali 1998: Ogunneye. 1999; Ivowi, 1999; Okehukola, 2002) and poor exposure of students to laboratory activities (Daramola 1982: Raimi & Adeoye, 2002; Ogunleye, 2010). Also, Oludipe (2003) is of the view that the instructional strategies used in teaching science subjects in schools have not brought about excellent performance because learners still view their teachers as being distant from them in authority, status and knowledge As a consequence they ore afraid to ask questions and express their opinio05, even though some of the instructional strategies claimed to be learner-centered.

The West Africa Examinations Council (WAEC) Chief Examiners Reports of May/June 2002, 2003, 2004, 2007 and November/December 2002 admitted that candidates are weak in the areas of cording their observation correctly and arithmetic operations. Hence, learners need greater exposure to practical activities in order to develop their practical skills for improved achievement in school science (Ogunleye, 2010). Similarly, Adeyoyin (2001) and Raimi (2002), in their views, observe that instructional strategies used by teachers have not often given learners the maximum opportunities to adequately prepare for the practical aspect of science subjects. Agoro (2002) admits that there is the need to combine active instructional strategies for better achievement in science and practical skills. Also, Mansfield and Happs (1996) as well as Zuziwe (2006) observe that the traditional instructional strategy predominantly adopted in Nigerian school does not foster learners' conceptions not to talk of correction misconceptions.

In agreement with this submission, Agoro and Oyediran (2009) report that science teachers do not expose students to hands-on-laboratory activity where students will participate actively in the teaching-learning process as a result of teachers' poor awareness o effective hands-on laboratory activities. These researchers therefore, advocated the use of learner-centred activity-oriented instructional strategies. The Predict-Observe-Explain (POE instructional strategy (White & Gunstone, 1992) is credited with the possession of potentials for allowing self-efforts and abilities o learners through active process of learning leading to good performance. The strategy is based on the philosophy of learning by doing. It is also referred to as power of experience by Russell (2007) because learners learn best by experiencing things and events for themselves. This strategy probes understanding by requiring learners to perform three different tasks. Firstly, the learner predicts the outcome of some events presented by the teacher either through some procedure(s) or explanation(s) of who to do. The learner supports his predictions with lists o explanations. This task is followed by the observation of the real life event, which can he done through the performance of some demonstration or experiments. In this, some of the predicted outcomes may turn out to be correct or incorrect. Finally, the learner describes or explains what has been observed and compare the initial predictions with actual observations in order to reconcile conflicts between predictions and observation. This instructional strategy is a form of discovery learning and allows learners to discover facts, theories and principles on their own through active participation in some activities designed by the teacher for learners in the classroom.

Activities in POE include making intellectual predictions, explaining reasons for such predictions, observation of events and explanation of one's observation. The teacher plays a minimal role. Instead of acting like a leader, he or she acts like a facilitator and allows the learner to act as the main event, The main idea behind the POE instructional strategy, according to Russel (2007), is that students learn best by "doing" and by "experiencing" things on their own- In the classroom, application of the POE instruction makes the learners to experience first-hand knowledge in science rather than being told the results of events by the teacher, This instructional strategy empowers learners to better master and remember the information as well as the reasons behind the facts, since they are directly involved in the experiential activities and events.

The Process of Predict-Observe-Explain Instructional Strategy consists of three procedural steps of prediction, observation and explanation phases. The Predict—Observe—Explain steps of Gunstone and White (1998) are:

Prediction Phase: Learners arc presented with some questions to which they are expected to supply answers (predictions). They are also to give and discuss reasons for their predictions. **Observation Phase:** This is an experimentation phase where learners verify their predict ions. Activities here include reading textual materials and performing experiments in order to observe the real life situations or events in the laboratory.

Explanation Phase: Learners explain their observations and compare them with their initial predictions. Conceptual changes occur here and new knowledge or ideas are generated. There is rejection, acceptance or modification of learners' initial predictions as the case may be.

The POE strategy is useful in identifying learners' ideas, conceptions and misconceptions in science. This will promote learners' reconstruction of ideas about the concepts while the teacher collates learners' elaborate reasons and allows them to debate the reasons. The teacher withholds judgment on the reasons until learners have observed the real life event. Finally, it is useful for exploring the consistency of learners' ideas, compares their initial predictions with observation and brings out the differences thereby correcting misconceptions. Predict-Observe-Explain instructional strategy is a form of deductive reasoning, that is, reasoning from predictions to observation and it is significant in allowing learners to engage in learning tasks in small groups rather than the traditional teacher-led whole class environment. It allows learners to work at their own paces gives them the opportunity to go back and edit their initial responses and take control of the demonstrations. It makes learners to be autonomous and to thoroughly discuss and reflect on their predictions, reasons and observations. The observation phase of' the instructional strategy is crucial and its effectiveness provides the feedback to learners on their predictions.

The Predict-Observe-Explain instructional strategy has been described as a relatively new approach to the teaching of science (Zuziwe, 2006). Champagne. klopfer and Anderson (1979) were the first to design the strategy as "Demonstrate-Observe –Explain" (DOE). This strategy was initially used to probe the thinking of first year Physics students at the University of Pittsburgh. Gunstone and White reworked the DOE into Predict-Observe-Explain model (POE) in 1981. Since then, researchers such as White and Gunstone (1902), Liew and Treagust (1995, 1998), Tao and Gunstone (1997) and Zuziwe (2006) had used the approach among secondary school Physics students to improve their understanding of science concepts. Also Palmer (1905) used the POE strategy on pre-service Physics students. All these researches produced conceptual change in students' previous misconceptions and led to the acquisition of knowledge on the part of We students under investigation. It is against this background that the present study was designed to investigate the effectiveness of an instructional strategy that could foster active participation of learners in the teaching-learning process and which has the potential of engendering improved students' practical skills.

Statement of the Problem

The persistent poor performance of students in science subject in Nigerian senior secondary schools has been linked to their poo exposure to laboratory activities, experimental procedure an consequent poor practical skills. Also, the science subjects Physics, Chemistry and Biology- which are all experimental in nature, have continued to be taught using convention instructional strategies that could not facilitate the acquisition of practical skills in the students. This study, therefore, investigation the effect of Predict-Observe-Explain instructional strategy senior Secondary school students' practical skills in Physics.

Research Question

What are the pre and post test Physics practical skills mean scores of students exposed to the Predict-Observe-Explain instruction and those in the control group?

Hypothesis

There is no significant difference in the adjusted post-test practical skills score, of students exposed to the Predict-Observe-Explain and those taught using the conventional practical instruction in Physics.

Research Methodology

The study adopted the pretest, posttest control group quasi-experimental design schematically represented as:

$O_1\ X_1\ O_3$ Experimental Group

$O_2\ X_2\ O_4$ Control Group

Where O_1 and O_3 represent pretest and posttest observations for the experimental group respectively.

0_2 and 0_4 represent pretest and posttest observations for the control group respectively

X_1 = Experimental treatment of POE instruction

X_2 = Control treatment of conventional practical instruction

The only dependent variable measured is the students practical skills in Physics.

A total of 213 SS II students from six senior Secondary schools form Ibadan North Local Government Area of Oyo State in Nigeria participated in the study. The six schools emerged through purposive selection based on availability of well-equipped science laboratories One intact class of science students was then purposively selected from each of the six schools and all students in such intact classes were included in the study, Three of the schools Were randomly assigned to the each of experimental and control treatments respectively. Three research instruments were developed and used for the study which lasted six weeks of treatment implementation

These are:

1. Guide on Predict-Observe-Explain Instruction Strategy
2. Guide on Conventional Practical Instructional Strategy
3 Students Physics Practical Skills Test

Guide on Predict-Observe-Explain Instructional Strategy

This instructional guide was used for treatment group. It is an Instructional guide made up of five procedural steps. These include the Introductory, Prediction, Observation and the Explanation phases. This instructional guide which was prepared by the researcher was presented to experts in Physics education and experienced secondary school Physics teachers for critique, suitability of the content and instructional steps, language of presentation and the workability of the steps proposed.

Guide on Conventional Practical Instructional Strategy

This instrument was used in the control group and it is the teaching approach commonly used for practical science teaching in most Nigerian schools. The following arc the steps involved in the strategy:

- The teacher introduces the concept to he learnt and asks questions on Learners' prior knowledge. Learners sit down facing the chalkboard while the teacher writes on the chalkboard.
- The teacher explains the new concept, while learners listen to the teacher.
- The teacher demonstrates, solves numerical and non-numerical problems and performs experiment using relevant procedural steps.

- The instructional guide was peer and expert reviewed and their reactions, suggestions and advice were used to improve the instrument

Students Physics Practical Skills Test

This instrument consists of two practical Physics questions on experiments based on the concept of ‘Heat’. They were designed to test learners’ abilities to follow procedural steps in performing experiments correctly and accurately. It also tests students’ abilities to report correctly the experiment they have performed and abilities to make some deductions on the experiment performed. Some procedural steps to carry out the experiments were provided for each experiment after which short questions follow. These questions were in the form of deductions from the experiments performed. These mainly tested learners’ ability to make deductions from the performance of the practical activities.

Draft copies of these questions were subjected to content and face validation, Necessary corrections were effected as recommended in the comments received. The final copy was administered to 30 SS II Physics students from a school outside the scope of the study. This was done twice with a time lag of two weeks and the reliability of the test was determined using test-retest method and a reliability coefficient of 079 was obtained.

Procedure for the Study Pre Test

The pre test of Physics practical skills was administered to the students in both the experimental and control groups.

Treatment Implementation

Steps Involved in the Predict-Observe Explain Instruction

The Introduction Phase: The facilitator introduced the concept to he learned to learners and goes ahead to present materials to each learner (real objects, improvised objects, equipment, apparatus, pictures, posters and worksheets), This was followed by familiarisation of learners with the method to be used in performing the tasks at every phase. The importance of the task to be performed was also spelt out.

The Prediction Phase: The facilitator presented the problem to learners in a question form and allows them to predict the expected outcome, Answers to these predictions were written in the worksheets by each student.

The Observation and Discussion Phases: This is an activity session. Each learner was allowed to interact with the materials provided following the procedures specified in the set of instructions. Observations made by the students were then recorded in the appropriate columns in the worksheet.

The Explanation and Comparison Phases: In this phase, each learner in the class explained their independent observation and then compares it with the initial predictions so as to identify any conflict between observations and predictions made. The aim was to accept, reject or modify initial predictions

Steps in the Conventional Practical Instruction

In this group, the researcher presented the content and objectives of each lesson to the teachers in control groups. The following steps were followed.

Step I. The teacher introduced the concept.

Step II. The teacher explained the new concept.

Step III. The teacher solved problems.

Step IV. The teacher performed some experiments/demonstrations

(a) The teacher set up time apparatus for the experiment.

(b) The teacher manipulated the apparatus.

(c) The teacher took readings of measurements made.

(d) The teacher constructed table of values.

(e) The teacher plotted graphs from the table of values,

(f) The teacher at towed learners to copy notes.

(g) The teacher concluded the lesson and marked learners notes.

This stage of treatment implementation lasted six weeks in both groups.

Post Test

The post-test of Physics practical skills was administered t students across the two groups.

Method of Data Analysis

Data collected were analysed using descriptive statistics sue as frequency count, mean, standard deviation and charts while the inferential statistic of Analysis of Covariance (ANCOVA) was used to test the null hypothesis at 0.05 level of significance.

Results and Discussion

Research Question: What are the pre- and post test Physics practical skills mean scores of students exposed to the Predict-Observe-Explain instruction and those in the control group?

Table 1: Pre and Post Test Practical Skills Experimental and Control Groups

Group	N	Pre-Test		Post-Test		Mean Gain
		Mean	Std. Dev	Mean	Std. Dev	
Predict-Observe-Explain (Experimental)	122	14.69	3.68	33.25	7.26	18.56
Conventional Instruction (Control)	91	12.02	3.65	24.58	4.68	12.68

Table I shows that in [he pro-test, students in the predict—observe — explain instruction obtained a mean score of 14.69 as against the 1 2.02 obtained by control group. The Table also shows that the post-test mean score of the experimental group was 33,25 while the control group had a mean score of 24.58. These statistics arc represented in Figure 1.

Figure I: Pre and Post Test Scores of Experimental and Control Groups

Figure I shows that students in the Predict-Observe-Explain instructional group performed better with higher mean scores in both the pre-test and post-test Physics practical skills.

Table 1 further shows that the mean gain of students in the Predict Observe-Explain instructional group (18.56) is higher than that the control group (12.56). This is further illuminated on figure II.

Figure II: Mean Gain in Respect of Experimental and Control Groups

Figure II shows that the bat for the mean gain of the Predict- Observe-Explain instructional group is higher than that for the Conventional instruction (Control) group. The implication of this is that the practical skills mean gain by students in the experimental group (Predict-Observe-Explain instruction) is of a higher magnitude- compared with the students taught with the conventional practical instruction

Hypothesis

There is no significant difference in the adjusted post-test practical skills scores of students exposed to the Predict-Observe-Explain and those taught using the conventional instruction in Physics.

Table 2: Summary of ANCOVA of Post-Test Practical Skills Scores by Treatment

Source of Variance	Hierarchical Method				
	Sum of Square	dt	Mean Square	F	Significant
Covariates Pre Test	253.17	1	253.17	6.39	.01
Main Effects	3962.19	1	3692.19	93.27	.00*
Treatment	3945.36	2	1972.69	49.83	.00
Mode	83.13.4	210	39.59		
Residual	12258.8	212	57.83		

*significant at P<.05

From Table 2, there is significant effect of treatment on students' practical skills score in Physics ($F_{(1,210)} = 93.27$; $p<.05$). This implies that there is significant difference in the adjusted post-test practical skills mean scores of students exposed to the Predict- Observe-Explain instruction and those in the conventional practical instruction group. Hence, the null hypothesis in rejected. The magnitude of the respective mean scores for the two groups are obtainable from Table 3.

Table 3: Multiple Classification Analysis of Practical Skills Scores by Treatment Groups. Grand Mean = 29.54

Treatment Levels	N	Predicted Mean		Unadjusted Deviation	Beta	Deviation Adjusted for Factors and Covariates	Beta
		Unadjusted	Adjusted for Factors and Covariates				
Predict-Observe-Explain	122	33.25	33.37	3.70	57	3.83	.58
Conventional	91	24.58	24.42	-4.96		-5.13	

Table 3 shows that the adjusted mean practical skills mean score for the experimental i.e. Predict-Observe-Explain instructional group (mean = 33.37; Dev. =3.83) is higher than that of the control i.e. conventional practical instruction group (mean = 24.42; Dev. = -5.3). Hence, students exposed to the Predict-Observe-Explain instruction performed better than their counterpart in the conventional practical instruction group. This trend is represented using the pyramid bar chart in Figure III.

Figure III: Overall Performance of students in Predict-Observe- Explain and Control Groups

From figure III, students in the POE instructional group had adjusted post test practical skills score than their control group counterparts. This implies that the POE instruction was more effective than the conventional practical lesson.

Discussion

The Predict-Observe-Explain Instructional Strategy proved superior to the Conventional Teaching Strategy due to the fact that learners in the group performed simple and specific tasks in order to clarify their conceptions and make some intellectual guesses on the topic of the lesson, Examples of such tasks and guesses are:

“Predict the outcome of an event”, “Justify your predictions”, “Observe the real life event and “explain your observations”.

Specifically, learners were expected to perform the activities, identify their pre-conceptions, be responsible for. them, identify any misconceptions and correct such themselves. These intellectual guesses assisted learners to be more involved and be responsible learners in the classroom situation by making contributions to what the teacher taught, rather than being passive listeners. Learners were therefore at the centre of the teaching-learning process. The roles played by learners helped to develop their self-confidence roles played by learners helped to develop their self-confidence thus removing the barriers of inferiority complex among them especially in handling apparatus and equipment. It also empowered them to be responsible for their own learning. The resultant effects of the roles of learners in Predict-Observe-Explain Instructional Strategy are overall improvement in their ability to perform better in the practical activities they participated in during the lesson.

Learners’ better performance in Predict-Observe-Explain Instructional Strategy was also due to the fact that Predict-Observe Exp1ain Instructional Strategy is a deductive method of reasoning, which is from ‘predictions’ otherwise known as ‘generalizations’ to observation. This is due to the fact that through ‘predictions’, learners’ pre—conceptions were identified: learners were responsible for their predictions through the explanation given to such predictions. The predictions were further tested through their direct observations and involvement in some practical activities such as following laboratory instructions in performing relevant experiments. The correct decisions of learners on whether to accept or reject their initial predictions are the sole responsibility of learners themselves. The strategy enabled them to he totally responsible for identifying their pre-conceptions and misconceptions thereby, correcting such misconceptions. In effect, their potentials were developed and learning was enhanced and permanent. The effectiveness of Predict-Observe-Explain Instructional Strategy in this study is in agreement, with the earlier research results obtained by Liew and Treagust (1995) Gunstone and Mitchell (1998) Lee and Law (2001) and Zuziwe (2006).

Conclusion and Recommendations

The Predict-Observe-Explain Instructional Strategy has proved to be effective at improving secondary school students’ practical skills in Physics better than the conventional strategy. The use of the strategy is therefore recommended to teachers for the teaching of Physics at the senior secondary school level towards acquisition of practical skills in the subject. To this end, students should be encouraged by Physics teachers to construct their own ideas, identify their conceptions and misconceptions and they should be allowed to coned their own misconceptions with little assistance and direction from the teachers in science instruction generally and Physics specifically. Students should be given the opportunity to perform all tasks whether simple, complex, specific or general in science instruction so as to lest and evaluate their initial knowledge for necessary conceptual change. Finally, government should organise a form of sensitization programme in the effective use of the Predict—Observe-Explain Instructional Strategy through organisation of workshop, seminars and conferences for science teachers. This would help them to effectively apply the Predict- Observe-Explain Instructional Strategy in teaching Physics as well as other science subjects such as Biology, Chemistry, Agricultural Science and Basic Science.

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