The Effects of Predict-Observe-Explain (POE) Approach on Students' Achievement and Attitudes Towards Science

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Abstract This study determined the effectiveness of Predict-Observe-Explain (POE) Approach in enhancing the achievement and attitude of grade five students towards science Conducted in Gonzalo Gatchalian Elementary School-Las Piñas City in 2012, it employed the repeated measures two factors design. The dependent t-test was used to find the significant differences and changes between the two groups or within each group in terms of achievement and attitude towards science. Results suggest that both the experimental group and the control group registered significant differences and changes in terms of achievement and attitude towards science. However, the gain scores in the achievement and attitude revealed that the students in the experimental group (POE) approach performed better than the control group.

Keywords: Lecture method, Predict-Observe-Explain (POE), Quasi experimental design, Students' achievement, Students' attitudes

Introduction

In the horizon of a fast changing world, science education experienced substantial growth over the past several years. Its development in science education records various attempts in measuring and determining students' achievement and attitudes towards science. This development requires science teachers to be more innovative and creative for higher student achievement and favorable attitudes at the same time.

Teaching science is a great opportunity to explore the real world yet it remains a challenging task for science teachers, especially in the elementary years. The study of Allen (2006) explained that many elementary school teachers face these issues when it comes to teaching science: they do not like science, they do not feel confident in their knowledge of it, much less know how to teach it effectively. Allen's idea was supported by Ginns (2000), who claimed that many elementary teachers express lack of confidence in their ability to teach science.

In addition, the Philippine Educational System shows that there are shortages in classrooms, teachers, instructional materials and other resources. National funds are not enough to cater all those needs including materials that are used in every science classroom. As a result, the students' achievement in science is greatly affected. Previously, the National Achievement Test (NAT) showed low performance of students in science. Many elementary students find science as a difficult subject. Also, Teller and Stinner (2007) stated that students often do not demonstrate understanding of the underlying concepts in science nor they find their classes interesting, because they rely upon memorizing facts. This reality creates burden on the part of educators in enhancing the achievement of students in science and in developing positive attitudes among them.

Consequently, science teachers are being faced with both challenge and responsibility. Furthermore, Sihera (2002) found that attitudes associated with science appear to affect students' participation in science as a subject so as to impact performance in it. Teachers should consider that in order to attain higher achievement in science, they should also need to set proper attitudes towards the subject.

The primary goal of teaching, according to Dy (2011), is to provide appropriate and effective instructions to students. A science teacher therefore, is responsible to device and provide the necessary materials for use in science classes and use effective teaching approaches to bridge the difficulties of students. Indeed, there is a need to develop students' intellectual skills and heightened sense of motivation. To achieve this goal, some elementary science teachers utilize lecture method where there is little emphasis on laboratory activities. However, Haury and Rillero (2004) aver that teachers who embrace hands-on learning like Predict-Observe-Explain approach in science seem to recognize desirable learning outcomes. POE being a student-centered approach as a way of teaching was introduced by White and Gunstone (1992) to uncover students' knowledge through prediction, observation and explanation. Thus, the present society focuses on confirming the use of POE Approach as an effective way of enhancing students' achievement and attitudes towards science that suits the appropriate way of teaching and learning in the new generation.

Literature and Framework

In the Philippines, the development in science education is a great challenge. Today, statistics show that we are second from the bottom (Alonsabe, 2011). In fact, Arora (2012) reported that enrolment in the sciences and related fields is also very small for the Philippines and correlates

with the poor performance of Filipino students in the Trends in International Mathematics and Science Study (TIMSS).

These and other problems related to student achievement and attitude in the educational system are now being addressed by the government by adopting the K-12 program, an educational system that has been implemented since the year 2012 where education starts with Kinder until Grade 12. In this system, the approach in teaching seers toward student-centered, thus, they are given time to use their home language and are exposed to different activities applicable to real-life situations to express themselves. Gradually, the student's deeper thoughts are brought up and are indulged into a more student-focused setting. White and Gunstone (1992) recounted that in Predict-Observe-Explain (POE), the students use their science process skills such as prediction, observation and explanation in learning science to understand the concepts. This was supported by Liew and Treagust (1995 & 2004), Kearney (2001), Hernandez (2002) and Mosca (2007) who were able to note that POE is an approach that lets the students explore concepts and generate investigation. Furthermore, the students are given the chance to express their schema and experience the science ideas behind the activity to satisfy their curiosity.

The concept of POE Approach is anchored on the two theories of learning, namely: Social Constructivism and Humanistic Learning Theory.

Social Constructivism

Social constructivism was strongly influenced by Lev Vygotsky (1978), cited by Eggan and Kauchak (2004). It encourages the learner to arrive at his background, culture or embedded worldview. According to social constructivists, the process of sharing each student's point of view called collaborative elaboration (Meter & Stevens, 2000) results to

learner's building understanding together that would not be possible alone. In this study, the students exposed to POE Approach learned science concepts by stating their own ideas and coming up with an acceptable answer together with their classmates.

Humanistic Learning Theory

The traditional teachers often do not delineate the cognitive and affective domains because the students relied on memorization and note taking/lecture. Carl Rogers (1993) introduced humanistic learning theory with the belief that both feelings and knowledge are important in the student's learning process. As Rogers put it, "The teacher tends to be more supportive than critical, more understanding than judgmental, more genuine than playing a role". The feelings and knowledge of students towards science are taken into consideration to attain the main objectives of this study.

Anchored on two theories, Social Constructivism and Humanistic Learning Theory, the idea in POE gives students time to state their background knowledge before the activity starts and by stating their ideas in class, they are able to form acceptable ideas and explanation by interacting with their classmates. Teachers, being facilitators of learning lead the students to discover the science concept behind their activities. In this way, the students understand the concept guided by positive attitudes. Since the students become responsible for their own learning, positive attitudes are equally developed as the activities go on.

In this study, the method of instruction varies in both groups. The experimental group used the POE approach and the control group used the traditional approach of teaching. This study is guided by the conceptual framework presented in Figure 1
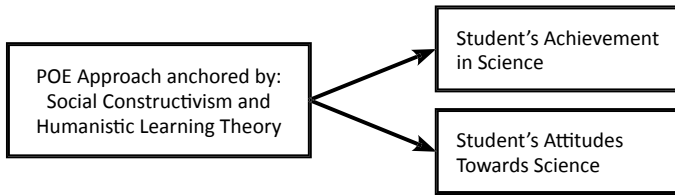
Figure 1. The conceptual framework.

Predict-Observe-Explain Approach is a powerful instructional approach that guides and motivates learners to express their own ideas about a certain topic based on their experiences and background knowledge. The students are given a chance to learn independently at first and sooner come up with ideas agreed upon by the class. The use of POE approach may affect students achievement and attitudes towards science.

Objectives of the Study

The study sought answers to the following objectives:

1. Develop and validate POE activities that will enhance students achievement and attitudes towards science.
2. Determine the difference in matching the control group and experimental group in terms of the following profile: sex , age ,gender, and general average in science (first and second grading)
3. Differentiate the achievement of the students in science in the control group (non-POE) in science before and after they were exposed to the traditional method of instruction.
4. Identify the difference in the achievement of the students in science in the experimental group before and after they were exposed to POE Approach.

5. Point out the gain scores of POE and non-POE group in terms of achievement.
6. Compare and contrast the gain scores of POE and non-POE group in terms of attitude.

Methodology

Using the Quasi-Experimental Research Design, the study gave all subjects a pretest and a posttest, and these two tests served as a within-subject factor (test). The control group was subjected to lecture method (use of ready-made activities on workbook) of teaching while the experimental group to POE approach.

Research Participants

The participants were grade five students heterogeneously divided into five sections. Two among the five with almost the same class size were chosen randomly. By tossing a coin, one class was assigned as the experimental group (Grade V-Einstein) and the other one as the control group (Grade V-Newton). Both classes were handled by the researcher for two weeks. The following factors were considered in choosing the two groups: a) the same classroom condition, b) the researcher was their science teacher; and c) they had the same curriculum.

Instruments

Four research instruments were used to attain the objectives of this study: the Achievement Test, Learning Science Attitude Inventory-LSAI, Lesson Plans, and Predict-Observe-Explain (POE) Activity Sheets. Other instruments were used as additional parameters of the study: Learning Style Quiz, Observation's Checklist and rubric in grading the POE Activities.

Achievement Test

Researchers-made 50 multiple-choice items validated by the Chemistry professors and elementary science coordinators that cover the following topics: Mixing Materials, Common Conditions that affect how Materials are Mixed, and Separating Mixtures. Some items were based on the least mastered skills of science.

Learning Science Attitude Inventory (LSAI)

A 10-item attitude inventory with eight positive statements and two negative ones in learning science from the study of Luseco (2011) was translated in Filipino to help the students fully understand the statements. Those students with mean scores less than 2.50 were classified as having negative attitude, while those with mean scores greater than or equal to 2.50 positive.

Lesson Plan

The researcher prepared eighteen semi-detailed researcher-made lesson plans for each POE activity, with objectives aligned with the Basic Education Curriculum-Philippine Elementary Learning Competencies (BEC-PELC 2010). Nine lesson plans were developed for the experimental group and nine lesson plans for the control group. The developed lesson plans for the experimental group employed the POE Approach, while the control group the lecture method.

Predict- Observe-Explain Activities

Nine researcher-made activities were constructed for the study covering Mixtures and Solutions. The sub-topics included in each activity were the least mastered skills of

the students based on the third grading periodic test. This instrument included (a) Prediction Sheet- where the teacher asked the student's prior knowledge of topics in each given task. (b) Observation Sheet- where the students wrote their observations, while the teacher demonstrated the activity and, (c) Explanation Sheet- where the students wrote their comparison between their predictions and observations. The chemistry professors and science coordinator had the activities validated.

Procedure

The study followed four phases in gathering data.

Phase I: Development and Validation Phase of Research Instruments

Prepared lesson plans, POE activities and researcher-made test used the Basic Education Curriculum-Philippine Elementary Learning Competencies (BEC-PELC) as the basis. The study also adopted the Learning Science Attitude Inventory (LSAI) developed by Luseco (2011) and translated to Filipino. Other instruments gave additional parameters in the study such as learning styles, student's profile, rubric and observation checklist.

Phase II: Administration of Pretest

Phase II involved the administration of achievement test and Learning Science Attitude Inventory before intervention. The 40-item Achievement pretest and Pre-attitude test were administered to the students, a day before the actual discussion of the lessons.

Phase III: Actual Instruction and Post Implementation

The researcher conducted the lesson using the POE approach and the traditional method of teaching in the control group for two weeks. The students in the experimental group were given three sheets to record their prediction, observation and explanation. At the end of the lesson, all students were given a 5-item formative assessment and assignment to extend their learning.

To further determine the effect of POE Approach in science teaching and learning, class observations were done for both groups of subjects. Students in both groups took the post tests (achievement test and LSAI), after the actual instruction. To find if there is a significant difference between the control group and experimental group in terms of achievement and attitudes, the results of the study were analyzed. The results of the class observations were also used as additional parameter in determining the effectiveness of POE in students' achievement and attitudes towards science.

Statistical Treatment of Data

To ensure systematic presentation and objective analysis of research data, statistical tools and techniques were applied. Frequency and percentage distribution summarized the student's profile and determined if both groups matched. Arithmetic mean and standard deviation quantified the test scores in the pretest and pre-attitude test, while the descriptive statistical measures interpreted the results of the pretest and posttest of the achievement test and LSAI. The chi-square of homogeneity interpreted the sex and learning styles of subjects for both groups. The t-test for separate variance approach and correlated t-test employing the single group just as matched groups design determined the significant difference of the pretest and posttest result within and between the two groups of subjects achievement and attitude.

Results and Discussion

The data gathered in the study have been analyzed and interpreted to provide answers to the problems raised in the study. As aforesaid, POE activities were used in this study to enhance the students achievement and attitudes towards science. Each activity contained science concept on Mixtures and Solutions, shown in the results given below.

To achieve equivalence, the groups were matched in terms of age, sex (gender), learning style, and general average, as indicated in the following tables:

Table 1.   Distribution of subjects by sex.

Variable	Level	Experimental Group		Control Group	
		N	%	N	%
Sex	Female	26	53.1%	33	66.0%
	Male	23	46.9%	17	34.0%
Total	**Both Sexes**	**49**	**100.0%**	**50**	**100.0%**

Of 49 subjects in the experimental group, 53.1 % are females and 46.9% males. The control group was dominated by females which had 66.0% while males comprised 34.0%. This table reveals that sex (gender) cannot be used in matching the two groups. Table 2 presents the learning styles of subjects for both groups.

Table 2.   Distribution of subjects by learning style.

Variable	Level	Experimental Group		Control Group	
		N	%	N	%
Learning Style	Visual	8	16.3%	11	22.0%
	Auditory	10	20.4%	9	18.0%
	Kinesthetic	31	63.3%	30	60.0%
Total	**All levels**	**49**	**100.0%**	**50**	**100.0%**

Table 2 shows the frequency of subjects in relation to the three types of learning style. The experimental group, had 8 visual learners (16.3%), 10 auditory learners (20.4%), and 31 kinesthetic learners that compromise the biggest percentage of 63.3%. Meanwhile in the control group, most of the subjects also kinesthetic has 60.0%. There are 11 (22.0%) visual learners and 9 auditory learners (18.0%). These data revealed that most of the subjects for both groups are kinesthetic.

Comparison of the two groups prior to instruction are presented in Table 3

Table 3. Differences between control group and experimental group.

Variable	Statistic Test	df	Value	p-value	Remarks
Sex	x^2	1.761	1	0.184	Not Significant
Learning Styles	X^2	0.655	2	0.414	Not Significant
Age	t_{ssp}	0.015	96.9	0.988	Not Significant
General Average	t_{ssp}	0.643	96.6	0.522	Not Significant
Achievement Pretest	t_{ssp}	3.577	92.8	0.001	Significant
Attitude Pretest	t_{ssp}	2.014	97.0	0.047	Significant

Table 3 shows that the students are matched in terms of four relevant variables, namely; sex, learning style, age, and general average. The achievement pretest and pre-attitude test are significant in this study; therefore, it can be used as variables in comparing the test results between and within the two groups of subjects.

Students Achievement

Students Achievement refers to the result of pretest and posttest composed of 40-item multiple choice type of test which was administered before and after the actual instruction for both groups of subjects.

Table 4 summarizes the difference between the pretest and posttest in the experimental group in terms of achievement.

Table 4.   Difference in the pre-test and the post-test of the participants in the experimental group.

Variable	Pretest			Posttest			Difference	t-value	df	p-value	Remarks
	Mean	SD	Int.	Mean	SD	Int.					
Achievement	15.90	3.337	Average	27.86	4.016	High	11.96	19.355	48	<0.05	Significant

The experimental group showed higher post test mean and standard deviation (x=27.86; SD = 4.016)than the pre-test mean and standard deviation (x=15.90, SD=3.337), a difference that is statistically significant ($p < 0.05$).

This study also confirms those studies of Hernandez (2002) and Mosca (2001). The latter held that POE is an effective teaching strategy in science which was proven in the posttest result of the students. Mosca's findings were supported by the study of Hernandez. The students achieved higher when they were exposed to the POE approach. It is safe to say then that the experimental group showed improvement in their achievement test when exposed to the POE approach.

T-test for independent sample deduced the student achievement when exposed to the traditional method of instruction.

Table 5.   Difference in the pre-test and the post-test of the participants in the control group.

Variable	Pretest			Posttest			Difference	t-value	df	p-value	Remarks
	Mean	SD	Interpretation	Mean	SD	Interpretation					
Achievement	13.70	2.742	Average	18.22	3.119	Average	4.52	9.467	49	<0.05	Significant

Table 5 shows a higher post-test mean and standard deviation (x = 18.22, SD = 3.119) than the pre-test mean (x = 13.70, SD = 2.72). Statistically, the difference in the means is also significant ($p < 0.05$), a finding that supports that of Fanega (2001) who claimed that traditional method may give introduction and increase students achievement in science. The study also concurs with that of Hernandez (2002).

Gain scores of POE and non-POE group in terms of achievement

Both groups (experimental and control) obtained the same significant result. Result of this study implies that the traditional approach in teaching is somehow effective in enhancing students achievement with slight difference. Difference in the gain score between the control group and the experimental group in terms of the achievement test, however, showed a varied course of events as presented in Table 6.

Table 6.   Gain score mean in the achievement test.

Control			Experimental			Difference	t-value	df	p-value	Remarks
N	Mean	SD	N	Mean	SD					
50	4.52	3.376	49	11.96	4.325	7.44	9.502	97	<0.05	Significant

Table 6 provides the gain score mean of the control group and the experimental group found to be statistically significant in favor of the experimental group (p-value <0.05.) Thus, the students in the experimental group (POE) performed better in the achievement test compared to the control group (non POE). It indicates that the POE Approach

had a great effect in enhancing the students' achievement in science.

Student's Attitudes

Learning Science Attitude Inventory (LSAI) developed by Luseco (2011) deduced the students' attitudes towards science. It consisted of 10 items and utilized a four-point rating scale with corresponding qualitative interpretation, 4 (Strongly Agree), 3 (Agree), 2 (Disagree), and 1 (Strongly Disagree).

T-test for independent sample determined the changes in the attitude of the students in the experimental group before and after exposing them to the POE Approach, as presented in Table 7.

Table 7. Difference in the pre-test and post-test of the participants in the attitude inventory in the experimental group.

Variable	Pretest			Posttest			Difference	t-value	df	p-value	Remarks
	Mean	SD	Interpretation	Mean	SD	Interpretation					
Attitude	34.35	2.437	High	37.98	1.266	High	3.63	11.293	48	<0.05	Significant

The change from the pretest to the posttest attitude mean scores of the experimental group is found to be extremely significant, ($p=<0.05$). This finding confirms the study done by Luseco (2011),as equally supported by Liew and Teagust (1998). According to them, POE is an effective tool in understanding science and developing positive attitudes towards it. This study implied that there is an improvement in the attitude of the experimental group after exposing the students to the POE approach. They tend to develop favorable attitudes towards science.

Also, table 8 presents the changes in the student attitude before and after exposure to the traditional method of instruction in the attitude inventory of the control group.

Table 8. Difference in the pre-test and post-test of the participants in the attitude inventory in the control group.

Variable	Pretest			Posttest			Difference	t-value	df	p-value	Remarks
	Mean	SD	Interpretation	Mean	SD	Interpretation					
Attitude	33.36	2.439	High	35.58	2.071	High	2.22	9.076	49	<0.05	Significant

Students obtained a mean score of 33.36 and standard deviation of 2.439 that fall in the high level interpretation. The posttest also falls in the high level interpretation with mean score of 35.58 and standard deviation of 2.071, registering 2.22 in the mean difference between the pretest and posttest. The computed t-value is 9.076, df is 49 and p-value is 0.000 which shows that there is a highly significant difference between the pretest and posttest scores of students in the control group in terms of attitude. This finding conforms to that of the study done by Fanega (2001). The traditional method of instruction tends to increase students' achievement in science and develop proper attitudes towards science. This result contradicts the study of Johnson (2006) where he compared the students' attitude on performance-based instruction and traditional teaching method. At the end of the study, all classes disliked the traditional method which is the lecture method and favored the performance-based instruction. The data presented indicate that the use of traditional method significantly changed the attitude of the students belonging to the control group in terms of attitude.

To test if there is a significant change in the attitude between the experimental group and the control group, the following table is shown:

Table 9. Change in the attitude inventory.

Control			Experimental			Difference	t-value	df	p-value	Remarks
N	Mean	SD	N	Mean	SD					
50	2.22	1.730	49	3.63	2.251	1.41	3.501	97	<0.05	Significant

Table 9 sums up the changes in the mean scores of the experimental group and the control group in terms of attitude the inventory of which posted a gain score of 1.41. This gain score is considered highly significant (p < 0.01).

This result concurs with the study done by Yucel (2007) who reported that the positive attitude of students toward science affects achievement to a significant extent. Since the POE Approach was used by the experimental group, it could be speculated that the instruction had established a learning atmosphere suited to the student's learning style.

Class Observations

Classroom observations validated the cited results and substantiated the results of the study as presented below:

Table 10. Difference of POE and non-POE group in the class observations.

Area	POE			non POE			Difference	t-value	df	p-value	Remarks
	Mean	SD	Int.	Mean	SD	Int.					
I. Classroom Management	4.94	0.110	A	4.92	0.125	A	0.02	0.555	8	>0.05	Not Significant
II. Teaching-Learning	4.94	0.108	A	4.52	0.408	A	0.42	2.945	8	<0.05	Significant
III. Student-Learning	5.00	0.000	A	3.56	0.464	P	1.44	9.339	8	<0.05	Significant
IV. Learning Objective	5.00	0.000	A	3.78	0.441	P	1.22	8.315	8	<0.05	Significant
Composite	**4.97**	**0.043**	**A**	**4.20**	**0.216**	**A**	**0.77**	**11.466**	**8**	**0.000**	**Significant**

[a] *POE-non POE

[b] Legend: A - Advanced
        P - Proficient

The class observation was focused on four areas, namely: Classroom Management, Teaching-Learning Process, Student-Learning Process, and Learning Objective. Table 10 revealed that the students exposed in POE Approach performed better than the non-POE in terms of achievement and attitude. These claims were supported by the following verbatim comments of the observers composed of selected Science and English teachers, Science Coordinator, Science Supervisor and School Principal

Table 11. Observers' comments and suggestions on the actual instruction in the experimental group(POE) and the control group (non-POE).

POE	non POE
"The teacher gave experiment to make Lesson more challenging and interesting."	*"The class will be more interesting if the students indulge in more activities."*
"The lesson was presented in a way which captured the interest of the learners"	*"The students' interest may be developed if exposed to hands-on activities."*
"The students enjoyed the lesson. The approach used in teaching caught students' participation"	*"There is a need to use more effective approach in teaching because the topics are difficult for the students."*
"The students cooperate in the activities and able to generalize ideas using POE Approach"	*"The flow of discussion was well-followed. However, it is suggested to use more applicable activities."*
"The students can relate themselves in the topics presented through prediction, observation and explanation"	*"Let all the students participate in class discussion"*

Their comments in the experimental group revealed positive feedback on the use of POE Approach in the class. These class observation results confirmed that the POE Approach enhanced the achievement and attitude of students towards science than the traditional approach in teaching.

Conclusions and Recommendations

The results of this research highlight the following: there was a marked improvement in the academic achievement of students in the experimental group after exposing them to the POE Approach; their attitude was significantly enhanced,

since the activities were basically learner-centered and they performed better than those in the non POE group in terms of achievement. Their use of more skills may be due to the nature of the POE tasks wherein learners recognize and seek solutions to problems, to understand the science concepts, to use knowledge effectively, to predict results, and to make real-life connections. Another possible explanation for the significant effect in the experimental group the POE tasks, which are constructivist in nature, where the students are heavily involved in the teaching-learning process. Such approach offers greater opportunities for conceptual modeling, hence provides a link between the students' existing ideas and new knowledge.

Based on the outcomes of this study, it is recommended that science teachers use the POE Approach to help the students learn, do, and love science more. Teachers should insightfully design the POE tasks to help students understand difficult concepts and abstract ideas. An appropriate training program on the mechanics of the POE Approach maybe planned and conducted for teachers for them to become aware of and competent on its use. Likewise, the study may be replicated in other schools utilizing a larger sample to validate and generalize the results of this research.

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