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Predict-Observe-Explain Strategy: Effects on Students' Achievement and Attitude towards Physics

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Abstract: This study employed a quasi-experimental research using the pretest-posttest design to determine the effect of Predict-Observe-Explain (POE) Strategy on students' achievement and attitude towards physics. A total of fifty-nine grade seven students from two intact heterogeneous classes participated in this study. The engage-explore-explain-elaborate-evaluate (5E's) learning cycle was utilized in teaching the control group while the POE strategy was utilized in teaching the experimental group. T-test was used in determining the significant differences between the two groups and within each group in terms of achievement and attitude. The findings of the study showed a significant difference (p = 0.00) in the achievement scores of the two groups in the posttest. It was further revealed that the experimental group (m = 11.47) performed better in the posttest than the control group (m = 8.86), and registered a significant change in attitude towards physics (p = 0.00) from neutral (m = 3.38) to positive (m = 3.76), while the control group maintained a neutral attitude. This suggests that the POE strategy positively influenced the academic performance and attitude of the students towards physics.

Keywords: predict-observe-explain, 5E's learning cycle, attitude towards physics, students' achievement.

Abstrak: *Penelitian ini merupakan penelitian quasi-eksperimental dengan desain pretest-posttest untuk menentukan pengaruh Strategi Predict-Observe-Explain (POE) pada prestasi dan sikap siswa terhadap fisika. Sebanyak lima puluh sembilan siswa kelas tujuh dari dua kelas heterogen dipilih secara acak dalam penelitian ini. Siklus belajar engage-explore-explain-elaborate-evaluate (5E) digunakan untuk mengajar kelas kontrol sedangkan strategi POE digunakan untuk mengajar kelas eksperimen. Uji T digunakan dalam menentukan perbedaan yang signifikan dalam hal prestasi dan sikap siswa antar kedua kelas dan pada masing-masing kelas. Temuan penelitian menunjukkan perbedaan yang signifikan (p = 0,00) dalam skor prestasi kedua kelompok pada ujian akhir. Lebih lanjut, terungkap bahwa kelompok eksperimen (m = 11,47) berkinerja lebih baik daripada kelompok kontrol (m = 8,86), dan teramati perubahan yang signifikan dalam sikap terhadap fisika (p = 0,00) dari netral (m = 3,38) ke positif (m = 3,76), sedangkan kelompok kontrol mempertahankan sikap netral. Hal ini menunjukkan bahwa strategi POE mempengaruhi kinerja akademik dan sikap siswa terhadap fisika.*

Kata kunci*: memprediksi-mengamati-menjelaskan, siklus belajar 5E, sikap terhadap fisika, prestasi siswa.*

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▪ INTRODUCTION

Learning science is doing science. Teaching science concepts to 21st-century learners who are noted to be 'naturally-born investigators' has become even more challenging than ever for the last decades. Learners nowadays no longer enjoy a kind of learning situation wherein the teachers become the sole fountain of knowledge in the classroom while making them passive receivers of information. Instead, they learn best when they are being engaged in active learning situations that foster their inquisitiveness, enable them to apply the different process skills in doing science and allow them to construct conceptual understanding on their own (Sezgin Selçuk, Çalişkan & Şahin, 2013; Zion & Mendelovici, 2012). This changing nature of 21st-century learners has prompted many countries all over the world to initiate a major curriculum reform to keep abreast of the changing trends in education and deliver the most relevant education to the learners (Sarvi, Munger & Pillay, 2015).

In the Philippines, the Department of Education (DepEd) has already shifted from the old Basic Education Curriculum (BEC) to Enhanced Basic Education Curriculum (EBEC). In this new curriculum, the science education framework had undergone major revisions and has become more gearing towards the development of critical thinking skills and science process skills among learners using constructivist approaches such as the inquiry-based approach (Montebon, 2014). If executed properly, the inquiry-based approach is very effective in helping learners acquire, analyze and explain data from investigations which may help them enhance their conceptual understanding (Van Uum, Verhoeff & Peeters, 2017). Thus, teachers should employ this strategy to match the needs and interests of the 21^{st}-century learners.

One of the teaching strategies under the inquiry approach prescribed by the curriculum is the Engage-Explore-Explain-Elaborate-Evaluate (5E's) learning cycle. This strategy is very much aligned in the goals of the new curriculum because it is inquiry-based; thus, it allows learners to generate a conceptual understanding of the subject through inquiry and investigations (Sen & Oskay, 2017; Abdi, 2014). However, some challenges are linked to the utilization of this strategy. One of the challenges is the nature of being time-consuming (Skamp & Peers, 2012). Bybee (2014) mentioned that each phase of the learning cycle must be carried out in an ample amount of time because it is specifically intended to work at its best in a lesson which is good for two to three weeks of discussion and not for a single-day lesson. He further emphasized that employing this inquiry-based approach with the use of the learning cycle in a single-day lesson decreases its effectiveness because a shorter time will be allotted in doing each phase of the cycle. This time-consuming nature of the learning cycle appeared to be the primary culprit why in the study conducted by Gutierez (2015) on the challenges of using inquiry-based teaching, it was revealed that since many competencies are needed to be tackled in a given quarter, teachers opt to use the traditional teaching methods rather than curriculum's prescribed strategy. Furthermore, the findings of the study conducted by Gutierez (2015) and Skamp & Peers (2012) on the use of this strategy in science revealed that most teachers find it difficult to execute and many teachers have a misunderstanding regarding its proper execution; thus, proper training is still needed.

These mentioned challenges are some of the reasons why many teachers become less confident and hesitant in employing inquiry-based strategies, particularly the 5E's learning cycle and end up in teaching the subject in the traditional way where facts are given much focus rather than the development of scientific skills (Gutierez, 2015; Skamp & Peers, 2012); as a result, producing learners with a low level of performance and interest in science (Khalid & Azeem, 2012; Bernardo, Limjap, Prudente & Roleda, 2008). These could also be the reasons why despite the efforts initiated by the DepEd to uplift the quality of science education in the country, still the level of performance of Filipino learners barely improved and remains to be at far behind the international standards as revealed in the result of the recently held international assessment conducted by the Organization for Economic Co-operation and Development (OECD) known as the Programme for International Student Assessment (PISA) in 2018 where the country scored second-lowest in science among all the 79 participating countries worldwide (Philippine DepEd, 2019).

The existing problem demands for another strategy that would also promote 21st-century learners' inquisitiveness; such as the Predict-Observe-Explain Strategy that highly emphasizes the use of students' science process skills and pre-existing knowledge in constructing new knowledge (Hilario, 2015); easy for both learners and teachers to execute (Nurhuda, Lukito & Masriyah, 2018) and also compliant to the goal of the K to 12 curriculum of developing life-long learners with a great interest in science which may serve as another avenue for science teachers especially those who are hesitant to use the 5 E's learning cycle to engage learners in their science classes and create an opportunity for them to promote learners' achievement and interest towards the subject (Gernale, Arañes & Duad, 2015). Predict-Observe-Explain is a learner-centered hands-on strategy developed by White and Gunstone in 1992 which highlights the students' use of their scientific skills particularly predicting, observing, and explaining in generating a conceptual understanding of a certain topic (Yuenyong & Thathong, 2015).

Teerasong, Chantore, Ruenwongsa, & Nacapricha (2010) stated that POE strategy is one of the effective strategies that allow learners to justify their pre-constructed ideas about science and reconstruct them after conducting investigations; thus, correcting their misconceptions about certain topics. In POE strategy, students are first asked to make assumptions or hypothesize the outcome of a certain phenomenon and give reasons for their assumption; secondly, conduct an experiment or demonstration to test their assumptions and evaluate their prediction to check whether there are discrepancies between their prediction and actual observation; and lastly, give an explanation of a certain concept based on their observation and discuss their ideas among other students (Bajar-Sales, Avilla & Camacho, 2015; Hilario, 2015).

Joyce (2006) mentioned that the prediction phase is the most important part of the POE sequence. Therefore, it must be given emphasis by the teachers because if the students are asked to predict or hypothesize the outcome of a certain experiment before the actual observation, it is most expected that the students will observe carefully and there is also a higher chance that they will become more engaged and excited to know the answer on how and why that certain phenomenon happens. He also highlighted the importance of the discussion of the students' prediction phase for the reason that when the students are asked to give reasons for their prediction, they make use of their prior knowledge and the teacher comes to know about these pre-conceptions; thus, it will be easy for him/her to find out students' misconceptions and in due course, plan on how to correct those misconceptions. Moreover, in an article published by the National Science Teachers Association (NSTA) Press, Haysom & Bowen (2010) further stressed that the discussion of the prediction phase gives students a chance to reconsider their predictions and reconstruct their ideas upon knowing the different ideas from their classmates. The teacher's role in this phase is very critical because he/she needs to assure that all the answers of the students will be treated and consolidated fairly.

Predict-Observe-Explain (POE) Strategy stands on the idea of the Constructivist point of view of Jerome Bruner through discovery learning as a bottom-line principle, believing that learners are not just passive receivers of information inside the classroom rather active learners who are capable of generating their learning (Hilario, 2015). The POE as a constructivist strategy recognizes that learners are not blank slates inside the classroom, instead, they have a range of experiences that is why it emphasizes the vital role of students' pre-existing knowledge in learning new ideas (Bajar-Sales et al., 2015; Demirbaş & Pektaş, 2015). The POE strategy leads learners to self-exploration, self-discovery and self-learning through the use of their science process skills such as predicting, observing and explaining, with a high emphasis on the students' ability to make predictions that allows them to make use of their pre-existing ideas as the basis for constructing their conceptual understanding (Mirana, 2017; Hilario, 2015; Akinbobola & Afolabi, 2010). In a constructivist classroom, with the use of the POE strategy, the teacher does not serve as the leading figure who dictates and transmits information rather acts as a facilitator and guide for the learners in constructing their own learning (Tupsai, Yuenyong & Taylor, 2015; Zion & Mendelovici, 2012).

Aina & Philip (2013) stated that students' achievement is directly related to the teaching strategy a teacher utilizes inside the classroom; this means that if the subject-matter will be taught with the use of the most suited strategy, it is most expected that students will also show significant success in the learning area. Joyce (2006) noted POE strategy as one of the most suited strategies in teaching science because of its hands-on nature that requires students to conduct investigations in constructing their own ideas. Moreover, Kearney, Treagust, Yeo, & Zadnik (2001) described this as an appropriate tool in probing students' initial ideas or pre-existing ideas, while the studies conducted by Kibirige, Osodo & Tlala (2014) and Kala, Yaman & Ayas (2013) had proven its effectiveness in minimizing students' misconceptions in chemistry.

Other studies which revealed the effectiveness of POE strategy in raising the students' academic achievement in science include the study conducted by Sreerekha, Raj & Sankaro (2016) which dealt on the effect of POE strategy on the chemistry achievement of secondary school students, the study conducted by Adebayo and Olufunke (2015) which noted POE strategy effective in bringing out students ideas and in encouraging students' discussion of ideas in the classroom; therefore, proving its effectiveness in improving elementary students' practical skills in basic science, and the study conducted by Özdemir, Bağ, & Bilen (2011) which proved the effectiveness of POE strategy in developing pre-service science teachers' performance and interest in performing laboratory activities. In the field of physics, a study conducted by Sliˇsko (2017) revealed that the POE strategy was effective in improving the students' interest and achievement in the subject.

In the local context, the study conducted by Gernale et al. (2015) has shown that the use of this strategy is effective in improving elementary students' academic performance and attitude towards the subject science. Some other studies have also shown its effectiveness in raising students' academic achievement in chemistry, although with some modifications to it. These include the study of Bajar-Sales et al. (2015) which established the effectiveness of Predict-Explain-Observe-Explain Approach (PEOE) as an effective tool in demonstrating the role of metacognition in science achievement and the study conducted by Hilario (2015) which confirmed the effectiveness of Predict-Observe-Explain-Explore Strategy (POEE) in teaching general chemistry.

Although the effectiveness of POE strategy in improving the achievement of students in science had been proven already, most of the studies conducted focused on its effectiveness in the subject chemistry and science in the elementary level while previous studies conducted on its effectiveness in teaching physics were conducted in the foreign setup and no study was conducted in the local setting. For these reasons, this study primarily sought to determine the effect of Predict-Observe-Explain as a learner-centered strategy on students' achievement and attitude towards physics, particularly in the Philippine setup. The effectiveness of Predict-Observe-Explain strategy in teaching physics may serve as another avenue for science teachers especially those who are hesitant to use the 5 E's learning cycle to engage their learners in their science classes and achieve more in the subject, and create an opportunity for them to cultivate their interest and positive attitude towards the subject.

▪ METHOD

Research Design

This study employed a quasi-experimental research using the pretest-posttest design. The design was chosen because it allows the researcher to test certain variables such as the performance and attitudes of the control group and experimental group after implementing an intervention (Kibirige et al., 2014). The POE strategy was employed in teaching the experimental group while the inquiry-based approach using the 5E's learning cycle was employed in teaching the control group. Both groups took the pretest and posttest of the Physics Achievement Test (PAT) and Attitudes towards Science Questionnaire (ATSQ). The differences in both groups were compared to determine if the strategy had influenced the performance and attitudes of the students.

Sampling Procedure

Fifty-nine grade seven students coming from two comparable intact classes of one public secondary high school in Mabalacat City served as the participants in this study. The two intact classes were assigned randomly as the control group and the experimental group. To assure the validity of the study, some parameters were taken into consideration by the researcher in selecting the participants: first, both classes were heterogeneous; and second, the mean quarter grades of the two groups were assured to be statistically comparable before the treatment. The time element of the actual teaching was also considered by the researcher and both groups were exposed in the same classroom conditions and taught by one teacher. The only difference was that the experimental group was taught using the POE strategy while the control group was taught using the 5E's learning cycle. Also, the study determined the perceptions of science teachers regarding the use of POE strategy. Three science teachers were purposively chosen to participate as classroom observers and were asked to answer open-ended questions after the observations to explore their perceptions.

Research Instruments

Three questionnaires were used in this study. The first one was a 20-item standardized multiple-choice Physics Achievement Test (PAT) which was used to measure students' achievement in physics. For the posttest, the same set of tests was given to the students but with a rearranged sequence of item numbers. The competencies which were included in the test covered topics on Heat and are all anchored to the competencies prescribed in the curriculum guide for Grade 7 under the K to 12 Basic Education Curriculum. The second questionnaire was the Attitudes towards Science Questionnaire (ATSQ) adopted from Zeidan & Jayosi (2015). It was a 25-item Likert-type questionnaire used in determining the students' attitudes toward science before and after using the two strategies. The third one was a questionnaire containing five open-ended questions developed by the researcher which was used to explore the teachers' perception of the use of the POE strategy. The questionnaire was validated by three science teachers in the Division of Mabalacat City. The POE activity sheets, and semi-detailed lesson plans utilized by the teacher in the actual instruction were also checked and validated.

Data Analysis

The data were analyzed using the Statistical Package for Social Sciences (SPSS). Mean and standard deviation were used to quantify the scores of the participants in the pretest and posttest. The students' responses in the Attitudes towards Science Questionnaire (ATSQ) were tallied and interpreted using descriptive statistical measure, particularly mean. In determining the significant differences and changes between the two groups and within each group in terms of achievement and attitude, the independent-sample t-test and paired-sample t-test were utilized respectively. The teachers' responses in the open-ended questions regarding their perceptions of the use of the POE strategy were analyzed using thematic analysis and were categorized into themes.

▪ RESULT AND DISCUSSION

Table 1 shows the pretest and posttest scores of the participants. For the easy interpretation of data, the mean scores were given corresponding descriptive ratings which were as follows: 0-3 for Did Not Meet Expectation (DNME); 4-7 for Fairly Satisfactory (FS); 8-11 for Satisfactory (S); 12-15 for Very Satisfactory (VS); and 16-20 for Outstanding (O). In the pretest, the control group obtained a mean score of 5.69 while the experimental group obtained a mean score of 6.57. The data revealed that both groups had the same level of understanding about the topic at hand which fell under the category of fairly satisfactory. The data also implied that the students in both groups had limited prior knowledge about the topic. Whereas, the posttest scores showed that the control group obtained a mean score of 8.86 which is satisfactory, while the experimental group obtained a mean score of 11.47 which is also satisfactory. In general, the posttest scores conveyed that the performance of the students in both groups improved after being taught using the two strategies. This affirmed the findings Van Uum et al. (2017) that inquiry-based approaches such as the POE Strategy and the 5E's learning cycle can enhance students' conceptual understanding in science since both strategies let learners to be engaged in the teaching-learning process by allowing them to acquire, analyze and explain data from an investigation.

Table 1. Pretest and posttest scores of the participants

Group	Measure	Mean	SD	Interpretation
Control (5E's)	Pretest	5.69	2.36	FS
	Posttest	8.86	2.77	S
Experimental (POE)	Pretest	6.57	2.05	FS

	Posttest	11.47	1.72	S

Table 2 unveils the difference in the pretest and posttest scores of the students within each group. The control group obtained a t-value of 5.20 and a p-value of 0.00 at a 1% level of significance which meant that there was a significant difference between the students' pretest and posttest scores. Whereas, the experimental group obtained a t-value of 10.63, and a p-value of 0.00 at a 1% level of significance which also showed a significant difference between the students' pretest and posttest scores. Since the p-values of both groups were less than 0.01, the null hypothesis that there is no significant difference between the pretest and posttest scores of the two groups was rejected. The data further revealed that both groups performed better in the posttest after being taught using the two strategies. These results supported the findings of Hilario (2015) that the use of POE has a great impact on students' academic performance in science and the findings of Abdi (2014) that inquiry-based strategy using the 5E's learning cycle also has the potential to positively influence the students' academic achievement in the subject. This is since these two strategies are learner-centered that match the needs and interests of the learners, and promote learning through inquiry, hands-on learning, meaningful exploration, and discovery.

Table 2. Difference in the pretest and posttest of the two groups

Group	**Measure**	**Mean**	**SD**	**t-value**	**p-value**	**Remarks**
Control (5E's)	Pretest	5.69	2.36	5.20	0.00	Significant at 1 %
	Posttest	8.86	2.77			
Experimental (POE)	Pretest	6.57	2.05	10.63	0.00	Significant at 1 %
	Posttest	11.47	1.72			

Table 3 presents the difference between the performances of the two groups in the pretest and posttest. In comparing their pretest scores, a t-value of 1.52 and a p-value of 0.13 were obtained. Since the computed p-value was greater than 0.01, the null hypothesis that there is no significant difference in the performance of the two groups during the pretest was accepted. This implied that both groups were statistically comparable and had the same level of knowledge in the subject content prior to the intervention. In comparing the performance of the two groups in the posttest, a t-value of 4.32 and a p-value of 0.00 were obtained. Since the computed p-value was less than 0.01, the null hypothesis that there is no significant difference in the performance of the two groups in the posttest was rejected. This meant that there was a significant difference in the performance of the two groups in the posttest. The results suggested that the students in the POE group were able to acquire the necessary competencies and performed better than the students in the inquiry-based group using the 5E's learning cycle. The results affirmed the finding of Gernale et al. (2015) that the POE strategy has a great effect on enhancing the academic performance of the students in science. It can be deduced from the results that the students who were taught using the POE strategy performed better since the strategy enabled them to engage in more meaningful explorations. Also, it can be inferred that the students performed better since the strategy allowed for a thorough exploration of their pre-existing ideas during the prediction phase and explanation of the prediction phase which are the most important parts of the POE sequence. This confirms the finding of Kibirige et al. (2014) that prior knowledge can greatly influence students' learning.

Table 3. Difference in the performances of the participants

Group	Measure	Mean	SD	t-value	p-value	Remarks
Control (5E's)	Pretest	5.69	2.36	1.52	0.13	Not Significant at 1 %
Experimental (POE)	Pretest	6.57	2.05			
Control (5E's)	Posttest	8.86	2.77	4.32	0.00	Significant at 1 %
Experimental (POE)	Posttest	11.47	1.72			

Detail of students' attitudes towards science before and after employing the 5E's learning cycle and the POE strategy can be observed in Appendix-1. For the easy interpretation of data, the mean scores in each statement were given corresponding descriptive ratings which were as follows: 1.00-2.32, Negative Attitude; 2.33-3.67, Neutral Attitude; and 3.68-5.00, Positive Attitude. Also, the negative statements were reversely scaled. In the control group, based on the results before the experiment, the statements: "I like practical work in science because I can use equipment and scientific tools" got a mean score of 4.24, "Practical work in science is exciting" got a mean score of 4.03, "Practical work in science is boring" got a mean score of 3.93 and "Practical work is useless" got a mean score of 4.07 which all indicated a positive attitude towards practical works in science. These revealed that before the intervention; the students in this group viewed practical works in science positively, supporting the findings of Kibirige & Hodi (2013). However, after employing the strategy, the first three statements got the mean scores 4.10, 3.79, and 3.83 respectively which are slightly lower than the previous scores although still indicated a positive attitude and only the fourth statement had an increase in the mean score from 4.07 to 4.17. The slight decrease in the mean scores supported the findings of Demirbaş & Pektaş (2015) that although students view science positively and look forward to performing investigation using the inquiry-based strategy through 5E's learning cycle, still there are students who encounter hindrances in performing science experiments.

Whereas, prior to the experiment, the statements: "I learn science quickly" got a mean score of 3.07, "I feel helpless when doing science" got a mean score of 3.31, "In my science class, I understand everything" got a mean score of 3.21, and "I find science difficult" got a mean score of 3.10. All the mean scores obtained indicated a neutral attitude. After the experiment, the same statements obtained the mean scores 3.41, 3.62, 3.41, and 3.38 respectively which still indicated a neutral attitude. These suggested that the students in this group maintained neither positive nor negative self-concept in science which according to Sahranavard (2014) could be a factor in the students' success in the subject. It can be also noticed from the results that after being taught using the 5E's learning cycle, the students drew a positive attitude on the statements pertaining to students' interest in learning science in school. These statements include: "It is exciting to learn about new things happening in science" with a mean score of 4.17, "I like science because it helps me to develop the skills of thinking" with a mean score of 3.97, "I would like to do more science activities in science lessons" with a mean score of 3.83 and "science lessons are interesting" with a mean score of 3.69.

In general, the control group before and after the intervention obtained the mean scores of 3.57 and 3.61 respectively which indicated a neutral attitude and statistically showed no significant difference. It suggested that the students in this group neither had a positive nor negative attitude towards science. The results affirmed the finding of Zeidan & Jayosi (2015) that most students have a neutral attitude towards science and parallel to the findings of Sen & Oskay (2017) that inquiry-based strategy using the 5E's learning cycle has no significant effect on the attitude of the students.

In the experimental group, based on the results prior to the experiment, the statements about students' attitude towards practical work obtained the following mean scores: "I like practical work in science because I can use equipment and scientific tools" got a mean score of 4.20, "Practical work in science is exciting" got a mean score of 4.10, and "Practical work is useless" got a mean score of 3.90 which all indicated a positive attitude towards science. In addition, the statement "Practical work in science is boring" got a mean score of 3.63 which indicated a neutral attitude. After employing the strategy, the same statements got the mean scores 4.47, 4.20, 4.40, and 4.03 respectively which are higher than the previous scores indicating a positive attitude. These meant that the students in this group viewed practical works in science positively. The findings were aligned in the findings of Kibirige & Hodi (2013) that students who experience practical works or experiments in science yield a more positive attitude towards science than those who are not engaged in practical works.

Furthermore, prior to the experiment, the statements regarding students' self-concept in science: "I learn science quickly" got a mean score of 3.07, "I find science difficult" got a mean score of 3.17, "In my science class, I understand everything" got a mean score of 2.83, and "I feel helpless when doing science" got a mean score of 2.97 which all indicated a neutral attitude. After the experiment, the first three statements obtained the mean scores 3.53, 3.60, and 3.57 respectively which still all indicated a neutral attitude while the last statement obtained a mean score of 3.77 which indicated a positive attitude. It can be noticed that after the intervention, the mean scores of the students on the statements regarding their self-concept in science slightly increased. This suggests that after the intervention, the students' self-concept in science somehow improved. It can be also gleaned from the results that after the intervention, the students in the experimental group drew a positive attitude in the statements related to students' interest in learning science school and obtained mean scores which were significantly higher than the mean scores obtained by the control group. These statements include: "It is exciting to learn about new things happening in science" with a mean score of 4.30, "I like science because it helps me to develop the skills of thinking" with a mean score of 4.37, "I would like to do more science activities in science lessons" with a mean score of 4.23 and "science lessons are interesting" with a mean score of 4.03.

As a whole, prior to the intervention, the experimental group obtained a mean score of 3.38 which showed a neutral attitude while a mean score of 3.76 which indicated a positive attitude was obtained by the group after the intervention. These revealed that before receiving the intervention, the students have neither positive nor negative attitude towards science which was similar to the findings of Zeidan & Jayosi (2015) that most students have a neutral attitude towards science. However, after being taught using the Predict-Observe-Explain strategy, the students showed a positive attitude towards the subject. This affirmed the findings of Gernale et al. (2015) and Hilario (2015) that the POE strategy positively influences the attitude of the students towards science. It could be speculated that the students' interest and motivation in learning science improved, they were actively engaged in the learning process and they had meaningful learning experiences with the use of the POE strategy. According to Guido (2013) & Bahtaji (2016), students' attitudes, motivation, and academic achievement were directly interrelated. This suggests that the use of POE strategy in teaching can improve students’ attitudes towards science and may lead to giving students’ a higher chance of attaining success in the subject.

Table 4 reveals the difference in the attitude within each group before and after employing the two strategies. In the control group, a t-value of 0.42 and a p-value of 0.68 was calculated which showed no significant difference in the attitude of the students before and after they were taught using the strategy, thus, accepting the null hypothesis. This conveyed that the use of inquiry-based strategy using the 5E’s learning cycle did not significantly affect the attitude of the students towards science. This was similar to the finding of Sen & Oskay (2017) that the use of 5E’s learning cycle in teaching does not significantly influence the attitude of the students due to the negative perceptions that the students have concerning the strategy. Another reason for this could be the fact that although students look forward to performing experiments with the use of the 5E’s learning cycle, Demirbaş & Pektaş (2015) asserted that there still students who encounter difficulty in performing investigations.

Whereas, in the experimental group, a t-value of 6.24 and a p-value of 0.00 was obtained which meant that there was a significant difference in the attitude of the students before and after using the strategy, thus, rejecting the null hypothesis. This finding suggested that the use of POE strategy inside the classroom enhanced the attitude of the students towards the subject which is similar to the finding of Gernale et al. (2015) and Hilario (2015) that POE strategy positively influences the attitude of the students because it engages students whenever they perform experiments and they become excited to find out whether or not their predictions and pre-conceptions on the topic are correct. Another reason for this could be the fact that the strategy is easy for the learners to execute (Nurhuda et al. 2018).

Table 4. Difference in the attitude of the of the participants before and after

Group	Measure	Mean	t-value	p-value	Remarks
Control (5E’s)	Pre-Attitude	3.57	0.42	0.68	Not Significant at 1 %
	Post-Attitude	3.61			
Experimental (POE)	Pre-Attitude	3.38	6.24	0.00	Significant at 1 %
	Post-Attitude	3.76			

Table 5 shows the teachers’ perceptions of the use of Predict-Observe-Explain strategy in teaching physics in terms of its strengths and weaknesses. Based on the teachers’ responses, it can be inferred that the teachers viewed the POE strategy as one of the strategies that are compliant to the requirements and goals of science education of developing life-long learners with a great interest and motivation in science. Furthermore, it was viewed by the teachers to be effective in providing learners an opportunity to have a firsthand access to learning, make use of their process skills, develop their 21st-century skills and higher-order thinking skills, construct their own learning through the use of their pre-existing knowledge and learn through self-discovery. This is because POE strategy is a constructivist strategy, learner-centered, and inquiry-based.

Furthermore, the teachers viewed the strategy to be effective in enhancing the teachers' pedagogical skills such as their ability to facilitate constructivist teaching-learning process and resourcefulness in improvising instructional materials. These identified strengths regarding the utilization of POE strategy were all parallel to what was stipulated in the implementing guidelines of the Enhanced Basic Education Act of 2013 (Philippine DepEd, 2013) and to what was stated in the Framework for Philippine Science Teacher Education published by the University of the Philippines National Institute for Science and Mathematics Education Development and Department of Science and Technology-Science Education Institute (UP-NISMED & DOST-SEI, 2011). These findings were also supported by several research studies regarding the use of POE strategy in teaching science which were cited in the literature review of this study.

Nonetheless, despite the advantages that the strategy offers to science teachers, the use of the strategy also has limitations. As revealed in the responses of the teachers, they viewed that this strategy when utilized inside the classroom may face a problem on time management, especially when the activities to be undertaken inside the classroom are not carefully planned by the teacher. Since the strategy aims to develop the learners' use of their science process skills like any other inquiry-based strategies, it was also viewed by the teachers that the lack of standardized instructional materials and laboratory apparatus may hinder the successful implementation of the strategy which was parallel to the findings of Gutierez (2015).The idea that this strategy may not apply to all science lessons, language barrier, learners' self-confidence and misconceptions that may arise when not facilitated properly along all the other limitations regarding the use of Predict-Observe-Explain Strategy as identified by the teachers were already noted by Joyce (2006) as the limitations of this strategy as cited in the literature review of this study. Nonetheless, according to Gernale et al. (2015) and Hilario (2015) that its success still largely depends on the competence of the teacher as well as on their creativity and innovative ability; and if further training will be given to teachers, this strategy can be very effective in enhancing the students' academic performance in science.

Table 6. Teachers' perceptions on the use of Predict-Observe-Explain strategy

Theme	Subtheme	Code
Strengths of the POE strategy	Maximizes students' prior knowledge	The role of the learners' pre-existing knowledge is maximized
		It allows learners to connect with their pre-existing ideas and new ideas
	Develops students' interest and motivation in the subject	It promotes active participation and engagement
		It makes learning science fun for the learners
		It may develop learners' positive attitude towards science
	Enhances students' science process skills	It gives learners a chance to experience the work of a scientist

	and 21st century skills	It may encourage students to get involved in many scientific investigations
		It may boost students' confidence in expressing themselves
		It allows learners to practice and enhance their science process skills such as making a prediction
		It excites ideas and opinions from the learners through collaboration
		It helps to develop HOTS and 21st century skills to the learners
	Promotes learner-centered approach in teaching	There is a higher chance of making learning long-lasting to the learners
		It allows learners to construct their own learning
		It makes learning more authentic to the learners
		It gives access firsthand learning to learners
	Enhances teachers' pedagogical skills	It may further develop teachers' creativity and resourcefulness in terms of improvising instructional materials
		The teacher becomes a facilitator of learning
Theme	**Subtheme**	**Code**
Weaknesses of the POE strategy	Teachers' readiness and competence to facilitate learner-centered classroom	Lessons which are not carefully planned may result to a waste of time
		It becomes more challenging on the part of the teacher in terms of leading the learners to the correct concept
		Unexplored learners' schema about the topic at hand may hinder learners' learning
		Misconceptions may arise if the teaching-learning process is not facilitated properly
		The teachers' art of questioning may hinder the successful use of the strategy
	Students' readiness and ability to participate in a learner-centered classroom	The learners' inability to express themselves may hinder their participation
		The learners' inability to analyze, interpret and draw a conclusion from observation
		The language barrier may hinder the successful use of this strategy
		The learners' self-confidence may hinder them from participating
	Nature of the strategy	Since the flow of the lesson is not direct, it can be quite time-consuming
		The availability of standardized laboratory apparatus and other instructional materials
		It may not be applicable to all lessons

▪ CONCLUSION

Based on the findings of the study, the following conclusions were drawn: The Inquiry-based strategy using the 5E's learning cycle and Predict-Observe-Explain strategy were both potential in enhancing the students' academic achievement in science which is evident in their posttest scores. However, the students who were taught using the POE strategy performed better and registered a more positive attitude towards the subject after the intervention than the students who were taught using the 5E's learning cycle. Furthermore, the study revealed that the POE strategy is perceived by the science teachers to be compliant with the goals of the K to 12 curriculum of developing learners' interest and motivation, enhancing learners' science process skills and 21st-century skills, promoting learner-centered approach in teaching, maximizing learners' prior knowledge and enhancing teachers' pedagogical skills; however, the strategy has also limitations when employed inside the classroom. These limitations include the teachers' readiness and competence to facilitate learner-centered approach classroom, learners' readiness and ability to participate in a learner-centered classroom, the time-consuming nature of the strategy, its applicability to other science lessons, and the availability of standardized laboratory equipment. Based on the findings, it is suggested that science teachers must employ inquiry-based teaching strategies inside their classrooms to engage their learners in an active teaching-learning process. Science teachers who wish to engage their learners in inquiry but hesitant to use the inquiry-based strategy using the 5E's learning cycle may use Predict-Observe-Explain strategy as an option. Furthermore, since both strategies demand the use of laboratory apparatus and other instructional materials which can be a major challenge in its implementation, science teachers must consider improvisation of materials to address this problem.

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APPENDIX-1

Attitudes of the Participants Before and After the Intervention

Statements	Control (5E's)				Experimental (POE)			
	Pre-Attitude		Post-Attitude		Pre-Attitude		Post-Attitude	
	Mean	Description	Mean	Description	Mean	Description	Mean	Description
1. I like practical work in science because I can use equipment and scientific tools.	**4.24**	Positive	**4.1**	Positive	**4.20**	Positive	**4.47**	Positive
2. It is exciting to learn about new things happening in science.	**4.55**	Positive	**4.17**	Positive	**4.27**	Positive	**4.30**	Positive
3. I like science because it helps me to develop the skills of thinking.	**3.83**	Positive	**3.97**	Positive	**4.00**	Positive	**4.37**	Positive
4. I would like to do more science activities in science lessons.	**3.66**	Neutral	**3.83**	Positive	**3.87**	Positive	**4.23**	Positive
5. Science lessons are interesting.	**3.52**	Neutral	**3.69**	Positive	**3.67**	Neutral	**4.03**	Positive
6. Science excites questions, opinions and ideas.	**3.69**	Positive	**3.34**	Neutral	**3.73**	Positive	**3.77**	Positive
7*. Science is not important for society.	**4.21**	Positive	**4.07**	Positive	**3.73**	Positive	**4.40**	Positive
8. I like reading science magazines and books.	**3.72**	Positive	**3.38**	Neutral	**3.17**	Neutral	**3.13**	Neutral
9. Practical work in science is exciting.	**4.03**	Positive	**3.79**	Positive	**4.10**	Positive	**4.20**	Positive
10. I would like to discuss scientific topics with my classmates.	**3.66**	Neutral	**3.28**	Neutral	**3.23**	Neutral	**3.33**	Neutral
11. I like watching science programs on TV.	**3.90**	Positive	**3.9**	Positive	**3.30**	Neutral	**3.63**	Neutral
12. I would like to do more science activities outside of school.	**3.21**	Neutral	**3.55**	Neutral	**3.70**	Positive	**3.87**	Positive

13*. Practical work in science is useless.	**4.07**	Positive	**4.17**	Positive	**3.90**	Positive	**4.40**	Positive
14*. Practical work in science is boring.	**3.93**	Positive	**3.83**	Positive	**3.63**	Neutral	**4.03**	Positive
15. I like science lessons more than most other subject lessons.	**2.97**	Neutral	**3.34**	Neutral	**2.87**	Neutral	**3.10**	Neutral
16. I look forward to my science lessons.	**3.59**	Neutral	**3.45**	Neutral	**3.37**	Neutral	**3.83**	Positive
17*. Science lesson is boring.	**3.79**	Positive	**3.72**	Positive	**3.17**	Neutral	**4.20**	Positive
18. I would like to do more science in school.	**3.41**	Neutral	**3.69**	Positive	**3.17**	Neutral	**3.73**	Positive
19. I learn science quickly.	**3.07**	Neutral	**3.41**	Neutral	**3.07**	Neutral	**3.53**	Neutral
20. I would like to study science at university.	**2.83**	Neutral	**3.03**	Neutral	**2.67**	Neutral	**2.97**	Neutral
21*. I feel helpless when doing science.	**3.31**	Neutral	**3.62**	Neutral	**2.97**	Neutral	**3.77**	Positive
22. I would like to do science posters in school.	**3.00**	Neutral	**3.21**	Neutral	**2.57**	Neutral	**3.10**	Neutral
23. In my science class, I understand everything.	**3.21**	Neutral	**3.41**	Neutral	**2.83**	Neutral	**3.57**	Neutral
24*. I find science difficult	**3.10**	Neutral	**3.38**	Neutral	**3.17**	Neutral	**3.60**	Neutral
25. I would like to become a science teacher.	**2.66**	Neutral	**2.9**	Neutral	**2.07**	Negative	**2.50**	Neutral
Overall Mean	3.57	**Neutral**	3.61	**Neutral**	3.38	**Neutral**	3.76	**Positive**