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Effectiveness of Inquiry-Based Approach on Selected Topics in Chemistry

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Abstract: ***This study determined the effectiveness of inquiry-based approach on selected topics in Chemistry among Grade 8 students in San Francisco National High School. This study involved a total of one hundred sixty students (160) as respondents. The students comprise the four sections from regular class. The main instruments used were two sets of lesson plans using 5E learning cycle and 7E learning model and the teacher-made test based on the table of specification as basis in allocating the number of items. This study was carried out using the pre-test-post-test quasi-experimental design utilizing Solomon Four-Groups. Out of the four groups, only experimental group 1 and control group 1 received the pre-test, followed by a treatment to the experimental group 1 and experimental group 2. Finally, all the four groups received post-test, where the effects of the dependent variable of the study were observed and comparison was made of the four groups. The data that was gathered from the pre-test and post-tests were subjected to appropriate statistical treatments such as the mean, frequency count and percentage. The findings are: The level of performance in the pretest of the control group and experimental group are the same. The control group was 67.60% in the pre-test while experimental group was 67.83%. Both ratings are described as Moving Towards Mastery in the five competencies in Chemistry. It also shows that the two groups of respondents have the same relevant knowledge in Chemistry prior to the intervention to be used by the teacher since they were described under the same description equivalent. There is no significant difference between the pretest results of the control group and experimental group. It is revealed at 0.05 level of significance and 78 degrees of freedom, the computed t-value for independent sample is -0.22 that is within the critical value of -1.99. Therefore, the null hypothesis cannot be rejected. The level of performance of the four groups in the posttest was improved. Control group 1 was 84.7% in the post-test while control group 2 was 84.0% which are both described as moving towards mastery. Further, Experimental group 1 was 86.1% in the post-test while experimental group 2 earned 87.2% which are described as Closely Approximating Mastery based on the scale adapted from NETRC (National Education Testing and Research Center. The students learned some competencies and skills along the learning concepts using the inquiry-based approach in teaching since the table revealed improvement in the level of performance of the students in the post-test. The two groups of respondents performed differently in the pre-test and post-test. It reveals that at 0.05 level of significance and 39 degrees of freedom, the computed t-value for correlated sample is 42.43 that is beyond the critical value of 2.023. Therefore, the null hypothesis is rejected. The performance of the students improved with the use of 5 E's and 7 E's. There is a significant difference among the performance of the four groups in the posttest. It is revealed from the computed f-value of 2.58 based from the posttest performances of the four groups is beyond the critical f-value of 2.66 at 5% level of significance with 3 and 156 degrees of freedom hence the null hypothesis is rejected. Either of the 5Es or of 7Es as strategy in teaching Chemistry is equally useful in enhancing the performance of the students in class. The Scheffes' test results confirm these findings. The F'-values of the groups' posttest performance when compared to each other are all not significant. The proposed output based on the results of the study is to create and develop enhanced prototype lesson plans adopting the 5E and 7E learning model to be used as training materials based from the observation of the principal. The conclusions are: The experimental and control group have the same level of performance in pre-test. The two groups of respondents did not perform differently in the pre-test. The level of performance of both groups in the post-test significantly increased using the 5E and 7E Learning model. The respondents' performance has significant difference in the pre-test and post-test. Control groups and experimental groups performed differently in post-test using 5E and 7E model. The study proposes enhanced prototype lesson plans based from the observation of the principal using the 7E and 5E learning model intended to be used as training materials if ever a related training along this method will be conducted. The recommendations are: improve students' performance in Chemistry 8 through the continuous use of the 7E and 5E learning model during the learning process. The 7E and 5E learning models should be used in a flexible time and an activity should be added if it sparks the interest of students or if a concept isn't being understood. Teachers should be encouraged to incorporate either 5E or 7E learning model into their teaching, and to gradually customize it into their own personalized teaching style since this strategy of inquiry teaching considers students' developmental levels and makes them able to use their prior knowledge as they gain new thought processes, develop higher levels of thinking, and became known to their own reasoning. School administrations are encouraged to arrange teachers' seminars and training workshops about these instructional models, where teachers are provided chances to improve their personal skills and use their influential roles to encourage the teachers to attend these programmes. Further studies may be conducted to supplement the findings revealed in this study.***

Keywords: Inquiry-Based Approach

1. Introduction

Science is extremely important in everyday life because there is no aspect of daily living that science has not made easier, faster or safer. Science results in technology that people rely on for health, communication and transportation. Scientific knowledge helps people understand the world from a cellular to a universal level.

It is an aspiration for science educators to improve students' engagement in the classroom and facilitate the role of the teachers with more effective instructional strategies. It is for many years that science education researchers are trying to develop student-centered instructional strategies (Mecit, 2006). One way to conduct student-centered classroom is to use learning cycles, which allow teachers to put teaching into a series of planning strategies.

The learning cycle is an inquiry approach originating with the Science Curriculum Improvement Study (Trowbridge and Bybee, 1990).It enables teachers to conduct a series of activities that are meaningful for students and help students to practice for their critical thinking skills (Bevevino et al., 1999).

Inquiry-based approach provides students the opportunity to construct the understanding necessary to produce deeper learning. Such understanding greatly increases the chances that students will be able to apply the concept in new situations. Anderson (2002) defined inquiry-based approach as activities of students in which they develop knowledge and understanding of scientific ideas as well as an understanding of how scientists study the natural world.

According to Keser (2003), some of the models being used in the education-teaching process with different transaction steps are based on constructivist learning theory. One of the most useful of these recent models is the 5E Model, developed by Roger Bybee. The 5E Learning Cycle involves learning something new, or attempting to understand something familiar in greater depth. It is not a linear process. In trying to make sense of things, students use both their prior experience and the first-hand knowledge gained from new Explorations (Newby, 2004).

The 5Es consist of the following phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation. Each phase has a specific function and contributes to the teacher's coherent instruction, as well as the learners' formulation of a better understanding of scientific and technological knowledge, attitudes, and skills (Bybee, 2006).

The first phase, Engagement, is used to motivate students by creating some mental disequilibrium or tapping into familiar real-life situations. The interest generated leads students into the second phase, Exploration, in which they use direct concrete experiences to make observations, collect data, test predictions, and refine hypotheses. This information enables them to begin answering questions initiated in the Engagement phase.

During the Exploration stage, the teacher facilitates safe, guided or open inquiry experiences and questioning so students might uncover their misconceptions about the concept. During the third phase, Explanation, the teacher uses students' observations and data to create a scientific explanation for their results.

The fourth phase, Elaboration, is designed to give students additional problems, which allow them to apply their new knowledge, propose solutions, make decisions and/or draw reasonable conclusions. This is often in the form of another inquiry activity or extension of the Exploration phase.

Finally, the fifth phase, Evaluation, is essential to determine if students obtained a scientifically correct understanding of the concept and if they were able to generalize to other contexts. This may be done formally or informally (Wilder and Shuttleworth, 2004).

The 5E learning cycle has been shown to be an extremely effective approach to learning (Lawson 1995; Guzzetti et al. 1993). However, sometimes a current model must be amended to maintain its value after new information, insights, and knowledge had been gathered. Such is now the case with the highly successful 5E learning cycle and instructional model (Bybee 1997).

Eisenkraft (2003) stated that research on how people learn and the incorporation of that research into lesson plans and curriculum development demands that the 5E model be expanded to a 7E model.7E cycle differs from the 5E in two ways. The engage phase in 5E is expanded into elicit and engage. Thus, more emphasis is placed on prior understanding and tacit knowledge that can be used as a basis for the learning to take place. Similarly, elaborate and evaluate phases are expanded into elaborate, evaluate and extend phases. Moreover, the addition of the extend phase to the elaborate phase is intended to explicitly remind teachers of the importance for students to practice the transfer of learning.

The primary aim of the 7E learning cycle is to highlight the increasing importance of provoking previous understandings and transferring the concepts to new contexts. Adopting a 7E model ensures that eliciting prior understandings and opportunities for transfer of learning are not omitted. With this new model, teachers should no longer overlook these essential requirements for student learning.

To keep pace with the rapidly changing world, Philippines enhanced its curriculum by implementing the K-12 program in basic education under Aquino Administration which focuses on the core subjects Mathematics, Science and English. In line with this, Section 5 Curriculum Development of the Republic Act no. 10533 stated that the curriculum shall use pedagogical approaches that are constructivist, inquiry-based, reflective, collaborative and integrative. One of the approaches suited to be used in Science is Inquiry-based Approach. It is to improve students' performance and learning outcomes.

According to the 2003 Trends in Mathematics and Science Survey, the Philippines was 34th out of 38 countries in high school math; 43rd out of 46 countries in high school science and 23rd out of 25countries in both grade school math and science. In 2008, even with only the science high schools participating in Advanced Mathematics category, the Philippines ranked lowest among 10 countries. (Manila Times, 2014).

This performance has not improved at all based on the results of 2012 National Achievement Test. In the science part of the exam only 58.42% examinees scored below the average which is lower than 75% that shows a sad reflection of the overall state of the country's basic education program.

Further, Sorsogon got an over-all MPS of 42.12% in the National Achievement Test, SY 2012-2013 and 49.52% in SY 2014-2015 (Science Sorsogon (ASEP), 2014).It shows that the performance of the students in Science had been increased.

In San Francisco National High School, the Science teachers use varied teaching strategies like traditional method, explicit instruction, cooperative approach and others. The researcher observed that despite several strategies utilized by the teachers in teaching Science, students' level of performance need to be improved to achieve the desired mastery level. It is showed in the NAT results that the students level of performance in Science increased from

38.04% SY 2012-2013 to 40.76% MPS during the NAT SY 2014-2015, and ranked 67 out of 99 secondary schools with over-all MPS of 48.86%. However, the results of the National test cited above indicate that there was a failure to reach the target of at least 75.00 MPS. This is why the researcher conducts this study to help improve the MPS of the students in Science.

The researcher hopes to contribute to the improvement of Science instruction in San Francisco National High School. She thought of using inquiry-based approach with the new proposed 7E learning model as intervention in teaching Science that can motivate and arouse the interest of the students that could improve their academic performance and lead to a better performance in NAT.

2. Statement of the Problem

This study determined the effectiveness of inquiry-based approach on selected topics in Chemistry among Grade 8 students of San Francisco National High School, Bulan, Sorsogon, SY 2016-2017.

Specifically, it answered the following questions:

1) What is the level of performance of the control group and experimental group in the Pre-test?
2) Is there a significant difference between pre-test results in control group and experimental group?
3) What is the level of performance of the four groups in the post-test?
4) Is there a significant difference between the pre-test and post-test results of the two groups of respondents?
5) Is there a significant difference among the performance of the four groups in the post-test?
6) What could be proposed as a result of the study?

3. Methodology

Research Design

This study determined the effectiveness of inquiry-based approach on selected topics in Chemistry among grade 8 students in San Francisco National High School, Bulan, Sorsogon, SY 2016-2017. This study was carried out using the pre-test-post-test quasi-experimental design utilizing Solomon Four-Groups. According to Shuttleworth (2016) the Solomon four group design is a way of avoiding some of the difficulties associated with the pretest-posttest design.It is a standard pretest-posttest two-group design and the post-test only control design. The various combinations of tested and untested groups with treatment ensured that confounding variables and extraneous factors do not influence the results.This design type also combats many of the internal validity issues that can plague research.

The respondents were 160 grade 8 students of San Francisco National High School. There were 40 students per group. Two succeeding sections, except the first section, were utilized as the experimental groups. Experimental groups received the lessons in Chemistry using Inquiry-based approach with 7E model. The fourth and last section were utilized as control groups whose lessons were discussed using inquiry-based approach employing the 5E Learning cycle. The methodology used in this study was the test administration using 60-item pre-test and post-test. Statistical tools like percentage, mean, t-test, ANOVA and Scheffe's Test were used to analyze the data.

The Sample

The samples of this study were 4 sections coming from the five sections of San Francisco National High School Grade 8 students who were officially enrolled for the school year 2016-2017. Since the first section students were grouped homogeneously, it was not included in the sample. The second and the third sections served as the experimental groups respectively and the fourth and last section were utilized as control group. Table 1 reflects the sample of the study.

Table 1: The Respondents

Group	Frequency	Percentage
Control Group 1	40	25%
Control Group 2	40	25%
Experimental Group 1	40	25%
Experimental Group 2	40	25%
Total	160	100%

The researcher utilized the purposive sampling since each grade 8 section is composed of more than forty students. She gave a 50-item teacher-made test to the students and ranked the results of the test. Those who belong to top 40 from the class were chosen as the sample. This was being done to determine the members of the control groups and experimental groups.

The Instrument

The main instruments used in this study were two sets of lesson plans using 5E learning cycle and 7E learning model and the 60-item teacher-made test (Appendix D) based on the table of specification (TOS) (Appendix E) as basis in allocating the number of items. The researcher also observed the guidelines in proper test constructions to improve the test questions. The topics included for the third grading period in Chemistry 8 were based from the K-12 Science Curriculum Guide. To validate the instruments, these were checked by the Master Teacher II of Bulan National High School. Before the final draft of the test is made, the researcher consulted her adviser and panel members for some comments and suggestions. After the finalization, the test is subject for dry run to determine its validity.

A dry run of the study was conducted on November 21, 2016 to 30 grade 8 students from Beguin National High School and 30 students of grade 8 students of San Francisco National High School who were not respondents of the study on the same day. After the dry run, the researcher conducted an item analysis for the refinement of the test items for its final draft. This was done to validate the test. The 85-item test on Chemistry 8 was administered to find out the number of items that need to be discarded and revised. These items were the most difficult and too easy questions. Twenty five items were removed from the test questions resulting to the final 60-item test. The competencies included in the test were: a) explain the properties of solids, liquids and gases based on the particle nature of matter; b) Explain physical changes in terms of arrangement and motion of atoms and

molecules; c) determine the number of protons, neutrons and electrons in particular atom; d) trace the development of the Periodic table based n similarities in properties of elements; and e) use the periodic table to predict the behaviour of an element.

Data Gathering Procedures

Before the study was being conducted, the researcher prepared a letter of request addressed to the principal of San Francisco National High School dated November 7, 2016 to allow her to conduct a study on the target respondents and to administer the test. Upon the approval, the researcher conducted the pre-test on November 22, 2016 to the two groups (control group 1 and experimental group 1). The students were properly instructed on how to answer the test questions. They were given one hour to answer it. The test papers were retrieved by the researcher right after the examination and the results were recorded and made available for statistical interpretation.

The classes were held at 7:30-8:30 and 8:30 – 9:30 AM for the experimental groups and 1:00 -2:00 and 3:00-4:00 for the control groups. The 60 minute lessons everyday stipulated in the lesson plan were followed from November 23, 2016 to January 12, 2017. The teacher used inquiry-based approach to the respondents. The control group received the lessons utilizing the 5E Learning cycle while the experimental groups received the lessons using the expanded form, the 7E model. The students were also asked to make a science journal for them to express what they learned from the given activities of the day.

The 7E model that was used in experimental groups is an expansion of the 5E Learning Cycle that was used in the control groups. That is the reason why the two groups performed almost the same activities. The only difference was that 7E has elicit before engage and it has extend instead of assignment is 5E learning model. The goal of the 7E learning model is to emphasize the increasing importance of eliciting prior understandings and the extending, or transfer, of concepts.

Finally, the post-test was administered to the four groups of respondents on January 13, 2017 when all the topics in Chemistry 8 for the third quarter were taught. The students were oriented about the nature of the test. They were given enough time to answer the test questions. The test papers were collected right after the time has finished and subjected for checking purposes. The data gathered were tallied, analyzed and interpreted with the use of statistical tools. The effects of dependent variable of the study were also observed and the comparison was made to assess the effect of the independent variable on the dependent variable.

The entire duration of the activity lasted for 30 school days starting from the pre-test to the post-test. Within this period, the researcher did not entertain class interruptions to ensure continuity of the lessons according to the planned activities.

The principal conducted classroom observations during the actual demonstration of the researcher on her study. After the demonstration, the researcher had the post-conference with the principal for necessary feedbacks using the Instructional Monitoring Tool (Appendix G). The researcher requested the principal to have more observations to collect the data needed for the study.

Data Analysis Procedures

The data gathered from the pre-test and post-tests were treated by getting the mastery level. The mean, frequency count and percentage were used to determine the level of performance in the pre-test and post-tests of control and experimental groups.

The following scale from the Department of Education's National Education Testing and Research Center (NETRC) was used.

Percentage	Descriptive Equivalent
96% -100%	Mastered
86%-95%	Closely Approximating Mastery
66%-85%	Moving Towards Mastery
35%-65%	Average Mastery
16%-34%	Low Mastery
5%-15%	Very Low Mastery
0%-4%	Absolutely No Mastery

To test the difference between the pre-test results of the control and experimental group, the t-test for independent samples was used.
On the other hand, the t-test for correlated samples was used to test the difference between the pre-test and post-test results of the two groups of respondents.

The F-test one-way ANOVA was used to determine the difference among the performance of the four groups in the post-test. The Scheffe's test was used to compare the post-test performance of the four groups of samples.

4. Results and Discussions

Findings

Based on the analysis and interpretation of the data, the following findings were revealed:

1) The level of performance in the pretest of the control group and experimental group are the same. The control group was 67.60% in the pre-test while experimental group was 67.83%. Both ratings are described as *Moving Towards Mastery* on selected topics in Chemistry 8.
2) There is no significant difference between the pre-test results of the control group and experimental group. It was revealed at 0.05 level of significance and 78 degrees of freedom, the computed t-value for independent sample is -0.22 that is within the critical value of -1.99. Therefore, the null hypothesis cannot be rejected.
3) Control group 1 was 84.7% in the post-test while control group 2 was 84.0% which are both described as m*oving towards mastery*. Further, Experimental group 1 was 86.1% in the post-test while experimental group 2 earned 87.2% which are described as *Closely Approximating Mastery* based on the scale adopted from NETRC (National Education Testing and Research Center). The students learned some competencies and

skills along the learning concepts using the inquiry-based approach in teaching since the table revealed improvement in the level of performance of the students in the post-test.

4) The two groups of respondents performed differently in the pre-test and post-test. It was revealed that at 0.05 level of significance and 39 degrees of freedom, the computed t-value for correlated sample is 42.43 that is beyond the critical value of 2.023. Therefore, the null hypothesis is rejected.
5) There is no significant difference among the performances of the four groups in the post-test. It was revealed that the computed f-value of 2.58 based from the posttest performances of the four groups is within the critical f-value of 2.66 at 5% level of significance with 3 and 156 degrees of freedom hence the null hypothesis is accepted.
6) Either of the 5Es or of 7Es as strategy in teaching Chemistry is equally useful in enhancing the performance of the students in class. The Scheffes' test results confirm these findings. The F'-values of the groups' posttest performance when compared to each other are all not significant. The four groups of respondents have similar performances regardless of the teaching approach used. The use of the 5Es and 7Es as approaches of inquiry both showed that they are equally effective to improve students' performance.
7) The proposed output based on the results of the study is to create and develop Lesson Plans on selected topics in Chemistry 8 using the 7E and 5E learning models to be used as training materials.

5. Conclusions

Based on findings of the study the following conclusions were drawn:

1) The level of performance of control group and experimental group in pre-test is equal. Hence, it reveals that they have similar skills to be developed on selected topics in Chemistry 8. It also shows that the two groups of respondents have the same relevant knowledge in the subject matter prior to the intervention used by the teacher.
2) The performances of the two groups of respondents in pre-test are almost the same.
3) The experimental groups showed a higher performance in the post-test than the control groups.
4) The two groups of respondents performed differently in the pre-test and post-test.
5) The use of 5E and 7E learning models to control groups and experimental groups are equally effective in enhancing the performance of students on selected topics in Chemistry 8.
6) The study proposes Lesson Plans on selected topics in Chemistry 8 using the 7E and 5E learning models intended to be used as training materials if ever a related training along this method will be conducted.

6. Recommendations

From the conclusions drawn, the following are recommended:

1) Teachers should be continuously updated with the learning strategies that can motivate and arouse the interest of the learners to learn something new in the Science concepts.
2) The performance of the students may improve through the continuous use of either 7E or 5E learning model during the learning process.
3) To continuously improve the performance of the students, the Learning Cycle should be used in a flexible time and an activity should be added to spark the interest of students for better understanding of the concepts.
4) The teachers should use positive rewards that can be given to the students who got high scores along with the application of inquiry-based approach in teaching and conduct a remediation or give any enrichment activities for the students who got low scores.
5) School administrations are encouraged to arrange teachers' seminars and training workshops about these instructional models, where teachers are provided chances to improve their personal skills and use their influential roles to encourage the teachers to attend these programmes.
6) Teachers could adopt the proposed lesson plan in Chemistry 8 that may enhance the academic performance of the students.
7) Further studies may be conducted to supplement the findings revealed in this study.

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