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The Effectiveness of Integrating PhET Interactive Simulation-based Activities in Improving the Student's Academic Performance in Science

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Abstract: ***With the rapid change and development of science and technology of today's world, new methods and techniques are used to meet the interests and demands of the 21st-century learners. There are problems encountered in teaching science that requires exploration in learning. A quasi-experimental design was utilized in the study. The sample consisted of 83 seventh grade students. The standardized test was the instrument used to measure the academic performance of the respondents. Of the groups in the study, the experimental group was taught using PhET Interactive Simulation-Based Activities, while the control group was taught using the traditional teaching method. The results revealed that the academic performance (pre-test) of the control group (M= 13.28) is slightly higher compared with an experimental group (M=14.26), but there is no significant difference between their academic performances (t=1.99, p>.05). After the implementation, the academic performance of the control group increased from (M=14.26 to M=22.65). However, considering the remarkable increase in the academic performance of the experimental group from (M=13.28 to M=26.23). Likewise, statistical results showed that there is a significant difference between the academic performances of the two groups as reflected in their post-test (t=2.0, p<.05). There is a significant improvement in the academic performance of students after using the PhET interactive simulation-based activities. It was also evident that students were very active, highly motivated, and challenged while doing interactive activities in class. It can be concluded and recommended that the integration of PhET interactive simulation-based activities significantly affects the academic performance of Grade 7 students in Science.***

Keywords: PhET Interactive Simulation-based Activities, Academic Performance, Science

I. INTRODUCTION

It is evident in today's society that technology continue to shape our world, especially in the field of education. New methods and techniques should be used to run into the interests and demands of the 21st century learners. The modern cohort of technologies has revolutionized the teaching and learning process. The application of technologies in education has improved the transmission of knowledge to the learners. Imparting knowledge and discussing lessons in an outdated scheme could possibly hinder students' interest and participation.

It is stipulated in the 2002 Basic Education Curriculum that the aim of science education is to help every Filipino learner gain a functional understanding of scientific concepts and principles linked with real-life situations, acquire scientific skills, attitudes, and values necessary to analyze and solve daily problems in the society. Information and Communication Technology (ICT) integration is one of the ways to acquire and to achieve these scientific skills. As described by Bonifacio (2013), ICT-supported education would encourage students to use learning skills in other academic content fields, inspire them to learn more, provide them with opportunities to learn collaboratively with other learners, and help them grow different intelligences. Indeed, ICT integration in the teaching-learning process has become a major concern in the implementation of the K to 12 program of the Enhanced Basic Education Curriculum.

Studies show that students barely understand science concepts because of the lack of models or representations in the invisible concepts. Moreover, empirical survey conducted revealed some problems such as inadequate textbooks, lack of laboratory rooms and apparatus for actual experiments. Rutten (2014) once said that, traditional instruction can be successfully enhanced by using computer simulations. Physics Education Technology (PhET) Interactive Simulation-based activities can be one of the ways to increase picturing of students leading to a deeper understanding of science concepts. For science instruction to be effective, it must be the kind of learning leading to conceptual understanding. Thus, science teachers should teach lessons using inquiry and discovery-based approach, demonstrations and simulations, laboratory-based and other hands-on activities. Although some science concepts are theoretical in nature, actual or visual representations and models are needed in order to understand the concepts.

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Interactive simulations have been studied in recent years to improve the efficacy of science education (Jaakkola, Nurmi, & Veermans, 2011; Rutten, van Joolingen, & Van der Veen, 2012; Rutten, Van der Veen, & van Joolingen, 2015). These interactive simulations are of special status in science teaching and learning as they offer new educational environments which aim to enhance teachers' instructional potentialities and to facilitate students' active engagement (Jimoyiannis & Komis, 2001).

The technological advancements and increasing availability of computers and related equipment such as LCD projectors and LED televisions led to the increase use of simulation-based software physics programs. In a quasi-experimental study conducted by Sari and Guven (2013) examined the effect of inquiry-based learning with the activities (simulations, animations and videos) of interactive whiteboards on students' academic achievements and motivations revealed that students who used interactive whiteboards and activities showed a higher performance than traditional group students with medium effect size. Smetana and Bell (2012) added that computer simulations, which are dynamic, interactive and easily usable programs, support student-centered and inquiry-based teaching models.

Using the data gathered and observed from the school, the insufficiency of laboratory equipment/conditions and students' engagement during the teaching-learning process are the priority problems that needed to be solved in order to improve the academic performance of students in Science. In light of these problems experienced by the teachers and students, Physics Education Technology Colorado developed of an alternative and innovative movement which is the PhET Interactive Simulation-based Activities. This software can be run online or downloaded for free and research-based. These activities/simulations are highly interactive, animated, user-friendly, and creates a game-like environment to the students; and they allow actions that explain and represent concepts which would be impossible in the real-world setup. It supported the enhancement and uplifted the education primarily in science which is in the trends nowadays that most of the students are more technology-oriented.

This research intended to analyze the effectiveness of integrating PhET Interactive Simulation-Based Activities in improving the Academic Performance of Students in Science at the end of the grading period. Specifically, the research questions addressed in this study are as follows:

A. How may the academic performance of the control and experimental group be described in their pre-test?
B. Is there a significant difference in the academic performance of the control and experimental group in their pre-test?
C. How may the academic performance of the control and experimental group be described in their post-test?
D. Is there a significant difference in the academic performance of the control and experimental group in their post-test?

II. METHODS

A quasi-experimental design was used by the researchers to come up with a comprehensive study. Quasi-experimental design involves the creation of a comparison group (control and experimental). It is also used to the measure the effectiveness or impact evaluation of something. Of the groups in the study, the experimental group was taught using PhET Interactive Simulation-Based Activities, while the control group was taught using traditional teaching method.

The respondents of the study were the Grade 7 students who were purposively selected based on their academic performance provided in the School Form 5 and equally distributed heterogeneously to the control and experimental group as high performing, average performing, and low performing.

Table 1 shows the Distribution of the Respondents.

CONTROL GROUP			EXPERIMENTAL GROUP		
Male	Female	Total	Male	Female	Total
20	22	42	18	23	41

This study utilized two research instruments which are PhET Colorado software and a standardized (SDO-made) test paper. Before the conduct of the study, the researches asked permission from the school principal and schools' division office. After the approval, they conducted the study based on the formulated work plan. They had prepared and set the control and experimental group. Also, they have administered the pretest at the start of the third grading period on both groups and then integrated PhET Interactive Simulation-Based Activities with the experimental group while applied traditional (lab/hands-on) approach to the control group for the entire grading period. At the end of the grading period, students took the same standardized test that will corresponded to their post-test scores. The scores in the pretest and post-test served as data for interpretation.

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The data collected in this study was treated and analyzed using the Stata 11 Program which is a statistical software designed for easy tabulation. In analyzing the collected data, appropriate statistical treatment was used; Arithmetic Mean to find out the average of a set of numerical values, computed by adding them together and dividing by the number of terms and to determine the level of academic performance in science of the two groups and independent T-test to measure whether there is any significant differences between the pre-test and post-test (academic performance) of the two groups before and after using the PhET interactive simulation-based activities.

III. RESULTS AND DISCUSSION

This study focused on determining the effect of PhET interactive simulation-based activities on the academic performance of Grade 7 students in Science of Sta. Maria High School for School Year 2018-2019. The researcher collected the data from the experimental and control group. The experimental group was exposed to PhET interactive simulation-based activities as part of the classroom discussion and assessment, while the control group was taught using the traditional method. The findings of the study were presented in tables together with verbal description and interpretations.

A. Academic Performance of the Two Groups before the Treatment

Prior to the exposure to PhET interactive simulation-based activities, the control and experimental group had their pretest using the standardized test from the Division of Pampanga in order to determine their baseline level and comparability. It was done to measure a starting point or the amount of pre-existing knowledge of the respondents on the subject.

It is evident on the table 2, that the academic performance of the control group is a slightly higher compare with experimental group. Control group accumulated a mean of 14.26, while the experimental group has a mean of 13.28.

Group	Mean
Control	14. 26
Experimental	13.28

Table 2. Academic Performance before the Treatment

After calculating the pretest of the two groups, the scores were treated using t-test with .05 level of significance to determine the comparability of the two groups. It is manifested from the table that p value (0.51) accepts the first null hypothesis, indicating that there is no significant difference between the academic performances of the two groups in their pretest, which makes the two groups to be applicable pair as respondents of the study. The comparability of the two groups made sure that no group is better than the other one.

Indicator	Value
t-Critical	1.99
P	0.16

Table 3. Difference between pretest

B. Academic Performance of the Two Groups after the Treatment

After the pretest, PhET interactive simulation-based activities was integrated and used for the experimental group. The group was taught using the different simulations in physics. Ten weeks of interaction to PhET interactive simulation-based activities to the experimental group as part of the treatment, while the control group was taught using the traditional method for 10 weeks also. After ten weeks of implementation, both of the two groups took the periodic test from standardized test of the Division of Pampanga. Raw scores were collected to compare their academic performance after the treatment.

It is reflected from the table 4 that even using the traditional method, the academic performance of the control group increased from 14.26 to 22.65 indicating that there is an improvement in the control group. However, considering the remarkable increase in the academic performance of the experimental group from 13.28 to 26.23 which shows that the academic performance of the experimental group who was exposed to PhET interactive simulation-based activities is greater than the control group, which specifies that there is an enormous improvement on the part of the experimental group.

Group	Pretest Mean	Posttest Mean
Control	14. 26	22.65
Experimental	13.28	26.23

Table 4. Academic Performance before and after the Treatment

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Even though the result of the mean that shows the gap on their scores, the researcher treated the raw scores of the two groups using t-test with .05 level of significance. It is evident from the table that the p value (0.01) rejects the second null hypothesis, which means that there is a significant difference between the academic performances of the two groups in their posttest, which makes the use of the PhET interactive simulation-based activities effective for the experimental group.

Indicator	Value
t-Critical	2.00
P	0.01

Table 4. Difference between posttest

In the study conducted by Antonio et. al (2018), it also implies that there is a significant improvement on the academic performance of students after using the PhET interactive simulation-based activities (PhET-ISbA). It was evident that during the conduct of the study, students were very active, highly motivated, had fun and challenged while doing the activities in class.

IV. CONCLUSION

Based on the results of the study, the following conclusions were drawn;

A. The integration of PhET interactive simulation-based activities significantly improves the academic performance of Grade 7 students in Science.
B. PhET interactive simulation-based activities as ICT-based instruction engages student to participate during classroom discussion and hands-on activities.
C. The utilization of PhET interactive simulation-based activities saves time for the teacher and the students in terms of laboratory experiments.

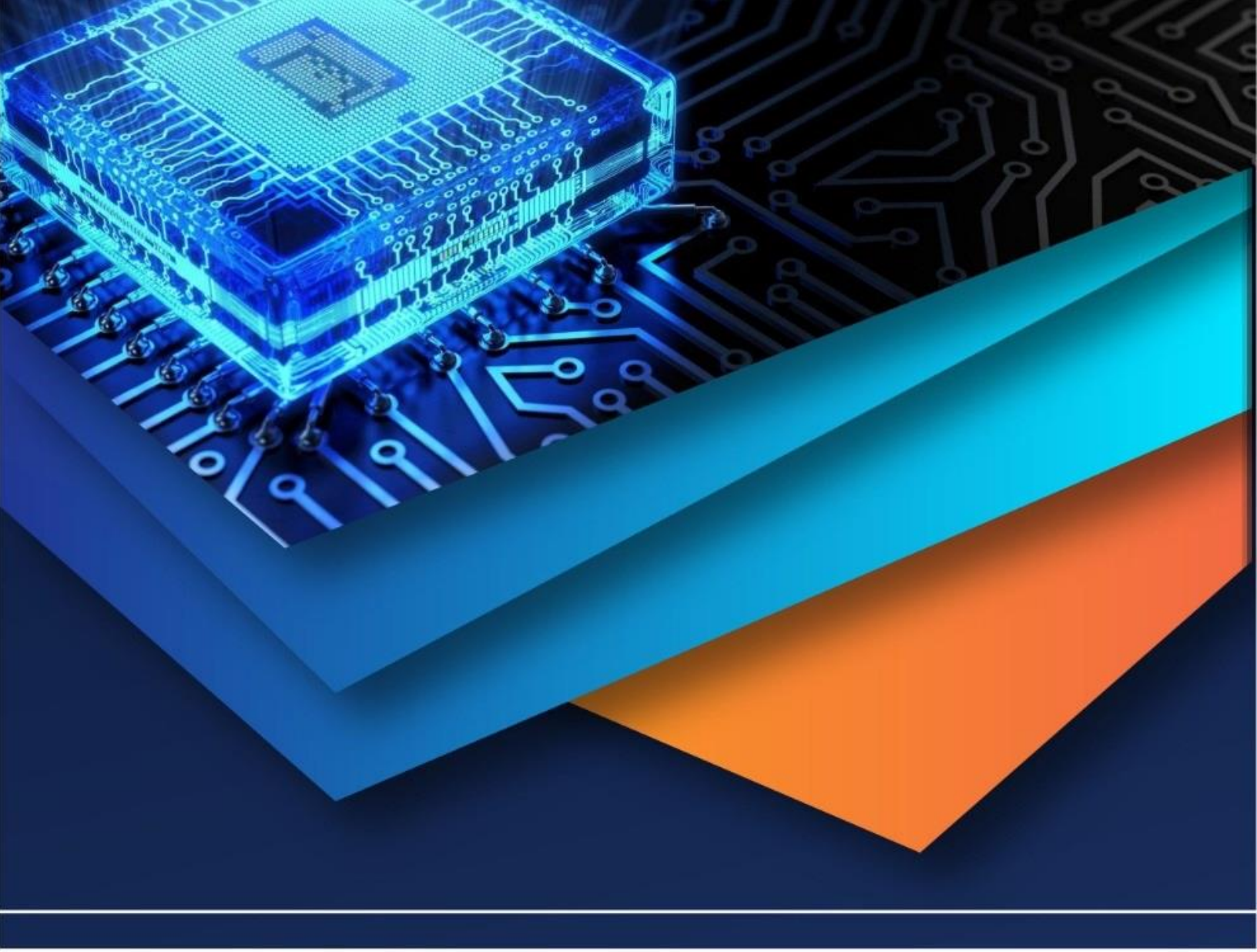
V. RECOMMENDATIONS

A. PhET interactive simulation-based activities should be applied as one of the ICT-based approach to improve the academic performance of students, particularly in Science.
B. Science teachers are encouraged to use PhET interactive simulation-based activities to save time for laboratory experiments and discussion procedure.
C. Schools should devote more effort or ways in providing access to students to technology (working computers) for academic purposes.

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