



# Effect of Physics Education Technology in the Science Performance of Grade 12 Students.

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**Abstract:** Virtual laboratory has become a trend to students in this generation in which they can easily access, manipulate understands the theory by simple click. There is other institution who are already using this kind of technology in teaching science subject. This quasi-experimental study was conducted to find out if the physics education technology can help improve the Science Performance of Grade 12 Senior High School Students, for the school year 2022-2023. Participants of this study were twenty-six (26) randomly selected Grade 12 students for the experimental group and also twenty-six (26) randomly selected Grade 12 students for the control group. The independent variables were the physics education technology and conventional laboratory. On the other hand, the dependent variable was the Science performance. Data in this study were gathered using a researcher-made Science performance test which had undergone validation and item analysis by the members of the panel. The descriptive statistics used were mean and standard deviation. The inferential statistics used were t-test for independent samples, paired sample t-test, and Cohen's d calculator, to compare the Science performance of grade 12 students using the physics education technology and conventional laboratory. The alpha level of significance was set at 0.05. The major findings of the study revealed that the Science performance of the students during the pretest of the control and experimental group were both interpreted as "low". In the posttest the data revealed that Science performance of control and experimental group "high". There is no significant difference in the pretest scores on the Science performance both for experimental and control groups. However, a significant difference existed on the Science performance of grade 12 students in the pretest and posttest of the control group and experimental group in favor of the used of experimental variable. There is a significant difference in the posttest scores on the Science performance in favor of the experimental group using the physics education technology. Finally, it was found out that physics education technology has a large effect in the Science performance of students.

**Keywords:** Physics Education Technology

## I. INTRODUCTION

Laboratory activities are a set of steps that involve planning, finding facts, gathering data, classifying, drawing conclusions, and interpreting results, with the goal of immersing students in the scientific investigative process. In teaching science, laboratory activities are fundamental to students learning (Putra et al., 2021).

According to Špernjak and Šorgo, 2018, the goal of conventional laboratory research (Traditional Laboratory) can be defined as an active activity of observing objects and their processes using real objects and instruments. When using equipment, virtual laboratories are an alternative for objects that are stand-alone (stand-alone) and cannot be used directly, or for objects that are very far away. Virtual laboratories allow you to use your personal computer as an interactive test simulation.

A virtual laboratory is an interactive learning website or software based on a simulation of a real-life phenomenon. In the virtual lab, students can explore topics by comparing and contrasting different scenarios, interluding, restarting applications, thinking, taking notes, and gaining hands-on experimental experience via the Internet or software.

With the proliferation of online learning in 2020, the need for virtual learning is increasing. As for the practical activities itself, virtual labs are very popular for collecting data on the lab activities of students in physics classes, especially in general physics, school physics labs, and thermodynamics subjects.

During the 2020 pandemic, including CoVid 19, the government has always encouraged and even directed citizens to work from home (SAH), work from home (WFH), and even work from home (SFH). This impacts the teaching and learning process and dramatically changes presentations from face-to-face classrooms to virtual classrooms using smartphones and other means of communication.

One of the alternative solutions for teaching science is the use of virtual lab applications by virtual lab providers such as PhET which is expected to solve problems related to lab courses and provide students with a lab experience with some physics materials that require a practicum.



The Physics Education Technology (PhET) project develops helpful physics simulations and makes them publicly available on the PhET website. Simulators (sims) are animated, interactive, and game-like environments in which students learn by doing. It emphasizes the linkages between real-life phenomena and the underlying science in these simulations, and it strives to make experienced physicists' visual and conceptual models accessible to students. It constructs simulations that improve student engagement with and understanding of physics concepts using a research-based approach, including findings from previous research and own testing.

The effect of using PhET in virtual lab activities is supported by several previous studies by (Rochmah and Madlazim, 2013), (Prihatiningtyas et al., 2013). First, The PhET can explain materials whose concept is abstract and difficult to understand in comparison with the lecture method. Second, compared to integrating a simple KIT, PhET takes less time and is more practical than the KIT that needs to be assembled first. Third, students can understand abstract concepts more effectively.

According to Batuyong et al., 2018 have an incredibly high level of validity in terms of the learning outcomes, instructional qualities, and evaluation. The results of the test indicate that there has been a discernible rise in the overall level of academic achievement of the students in the subject of Physics. The responses given by the students in the informal interview and the feedbacks given by them in the scientific journal revealed that when PhET was used in teaching, they acquired significant learning experiences that can be summed up into three main ideas: learning Physics is fun, learning Physics is real, and learning Physics is simple and easy. As a result, it has been determined that the instructional materials that were designed for PhET are effective in the classroom, particularly when it comes to teaching electromagnetics. Because the stated findings and positive feedback from students only prove that the created PhET are valid, it is advised that they be utilized for classroom instruction for the purpose of helping diverse learners understand ideas related to physics.

Science performance can be defined as the outcome of the process in understanding the Science concepts; it is the degree to which the Science concept was fully understood based on the series of activities, questions, experiments, observation, and assessment. It is usually can be measured with a Summative or formative assessments.

There are several factors that affect the Science Performance of the students. This may include the teaching strategies used in delivering science concepts, and resources such as laboratories that is crucial in the teaching and learning process to better understand the concept of science. These are the one that needs to consider to improve performance in Science Subject.

This study was anchored from David A. Kolb's Theory of Experiential Learning (1984) which defines learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience. The Experiential Learning Theory (ELT) presents a holistic model of the learning process as well as a multilinear model of adult development. Both of these models are congruent with what we know about how people learn, grow, and develop as they go through life.

Experiential learning theory is differentiated from other learning theories by its emphasis on the essential role that experience plays in the learning process. This emphasis is reflected in the theory's name, which is derived from the phrase "experiential learning." Therefore, the term "experiential" is used to differentiate ELT both from cognitive learning theories, which have a tendency to emphasize cognition over affect, and behavioral learning theories, which deny any role for subjective experience in the learning process. This is done because cognitive learning theories tend to emphasize cognition over affect.

The main objective of this study is to determine effect of Physics Educational Technology to Science Performance of the Grade 12 students.

Figure 1 below shows the variable relationships in this study.

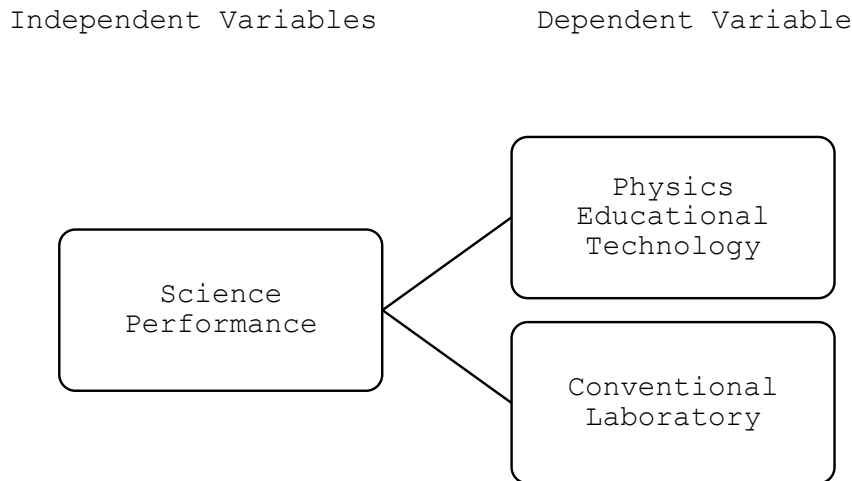


Figure 1. A schematic diagram showing the effect of Physics Educational Technology and Conventional Laboratory to Science performance of students.

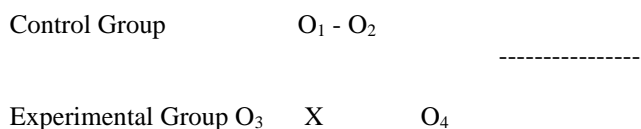
**II. METHODOLOGY**

This study employed quasi-experimental research employed the pretest-posttest non-equivalent control group design conducted to investigate the effectiveness of Physics Educational Technology on the Science performance of Grade 12 students of The University of Perpetual Help System during the school year 2022-2023. Data needed in this study made use of the 50-item Science Performance Test. Two learning materials are tried in this study, the use of Physics Educational Technology and Conventional laboratory.

This study utilized the quasi-experimental method in determining the effectiveness of the teaching materials on the students’ performance in Science using the Pretest-Posttest nonequivalent control group design. According to Best and Khan as cited in Joan (2013), Quasi-experimental design resembled the true experimental design, however, it does not employ random assignment of the participants either in the control or experimental group. This was commonly used in classroom experiments when the experimental and control groups are such naturally assembled groups as intact classes that may have “collective similarity” in characteristics.

Senior high school classes exist as intact groups and teachers do not normally allow the classes to be dismantled and reconstructed for research purposes. This design has the advantage over others since it controls the major threats to internal validity except those associated with interaction and instrumentation (Fraenkel, Wallen & Hyun, 2012).

In this study, the students were assigned to the control and experimental groups to control selections and interaction. The O<sub>1</sub> and O<sub>3</sub> were the pretests; O<sub>2</sub> and O<sub>4</sub> were the posttests; X was the treatment where students were taught using Physics Educational Technology. The dotted line implies the involvement of intact groups. Group I was the control group, which received a pretest followed by the controlled condition and then the posttest. Group II was the experimental group which also received the pretest, the treatment X, and the posttest. This research paradigm is represented in Figure 2.



This diagram shows that  $O_1$  and  $O_3$  were the observation results in the administration of the pretest of both control and experimental groups. This was done before the conduct of the experiment or classroom instruction in the first grading period. It further shows that  $O_2$  and  $O_4$  are the observation results in the post-testing of the two groups. The results were recorded, tabulated, and analyzed using appropriate statistical tools.

### Methods

#### Participants

The participants of the study were 52 students from two (2) section in grade 12 Senior High School students at The University of Perpetual Help System Pdp-Campus for the school year 2022 – 2023. The students were randomly assigned to the group rather they are originally under their respective sections. The number of senior high school students in each group is shown below.

Table 1  
Distribution of Groupings, Treatment Assignments, and Sample Size

Groupings	Treatment Assignments	Sample Size
Group 1 Experimental Group		26
Group 2 Control Group		26

Therefore, the sample size in this research were 36 Senior High School students. Brysbaert (2019) recommended at least 15-25 students per group, which was supported by Kvale, and Brinkmann (2015), proposing that a small number of cases will facilitate that researcher's close association with the respondents, and enhance the validity of fine-grained, in-depth inquiry of naturalistic settings. Thus, this number is adequate for the study.

#### Research Instruments

*Science Performance Test.* The Science performance of students both in the control and experimental group were measured using a researcher-made Science Performance Test which was prepared by the researcher before the conduct of the study. The researcher prepared and administered two Science Performance Tests. The first test was given as their pretest which identified the student's prior knowledge of the topics covered in the lectures. While the second test was given as their post-test, which measured the knowledge they gained after the conduct of the study. The questions included in this Performance Test were lifted from the researcher's question bank. To ensure that the questions included in the two tests are parallel with each other, especially in terms of the level of difficulty, the researcher asked for help from the research adviser and submitted to the panel for validation. Their suggestions as well as recommendations for the improvement and revision of the instrument were incorporated.

After the validity and reliability of the instrument were established, the pretest is set prior to the implementation of the treatment. Then after the treatment is applied, the same researcher-made test was given during the posttest; however, the items or topics in the test were modified but the same competency was measured.

To interpret the result, the scale of means was arbitrarily used.

Scale	Description
40.01 – 50.00	Very High
30.01 – 40.00	High
20.01 – 30.00	Fair
10.01 – 20.00	Low
0.00 – 10.00	Very Low

#### Data Gathering Procedures

There were three (3) experimental phases conducted by the researcher in this study: the pre-investigation phase, the proper investigation phase, and the post-investigation phase.

*Pre-Experiment Phase.* The researcher prepared the list of topics, lesson plans, test items for the pretest and posttest, and other materials needed in delivering the lesson before the actual experiment were carried out. The topics covered are Scalars, Vectors, and Kinematics. The finished test items were then presented to the panel of experts for face validation. Their suggestions and recommendations for the improvement of the instrument were incorporated into the revision of the



same instrument. After the test items were validated, the researcher then sought permission to conduct the study from the School Director and the School Principal of the University of Perpetual Help System.

Upon approval, the researcher conducted a pilot test of the test instrument to 48 Grade 12 students at St. Anthony College of Roxas City Inc. to determine the discrimination and difficulty index of the instrument. Test items that are too easy or too difficult were eliminated and were not included in the final draft of the test instrument.

After the reliability testing, the final draft of the questionnaire was sent to the target participant, which was the Grade 12 students at the University of Perpetual Help System and was subjected to pretesting for both experimental and control groups, this was done by conducting a synchronous class and answering the Science Performance Test. After the pretest was conducted, the researcher retrieved the instrument, check, and tally the results for analysis using the appropriate statistical tools, more so the test materials were kept being used at the end of the experimental phase.

Thereafter, the researcher did the grouping selection procedure this was done by picking up the rolled paper in a fishbowl with the names of the students written on it. The first student picked was assigned to the experimental group which was taught using a synchronous class and aided with treatment X which was Physics Educational Technology. The second student picked was assigned to the control group taught using the synchronous class and the controlled condition which was the Conventional Laboratory and the same procedure was done for the remaining students.

*Experimental Phase.* The experiment phase started in September 2022 and ended in October 2022. During this phase, the experimental group was taught using synchronous class and aided with Physics Educational Technology while the control group was also exposed to a synchronous class and with the support of a Conventional Laboratory.

During the conduct of the experiment, the two groups consisting of 52 students were exposed to the same classroom condition which was the Face-to-Face discussion. Both groups were taught by the same teacher to eliminate the idea of “teacher factor”. The experimental group which was composed of 26 students was aided with the Physics Educational Technology while the control group consisting of 26 remaining students used the Conventional Laboratory.

Under the experimental group, they used the simulation tool found in the Physics educational tool to explore different concepts of physics through virtual simulation while students in the control group used the conventional method of teaching. They used chalkboard illustrations of physical concepts of science.

The topics covered during the conduct of the study for four (4) weeks are those topics in the first quarter, which were included in the Most Essential Learning Competencies. The topics discussed include Scalar, Vectors, and Kinematics.

On the first week of experiments both control and experimental group was taught the same topic on Physical Quantities, using the same methods of teaching and materials as the topic only requires calculation and conversion of number from one unit to another unit.

On the second week of experiment both groups discussed the topic of Vectors. The control group was taught using the Conventional method of teaching and used graphing paper, a protractor, and a ruler to measure the distance from one point to another point based on the activity given by the teacher. The students used materials such as nylon cords and meter sticks to measure distance as they walked from one place to another and added it up to measure the distance covered. Meanwhile, in the Experimental group the teacher used PhET, a virtual laboratory, to explain the concept of vector quantity. The teacher explained the addition of vectors concept to students using the virtual laboratory, where students put an arrow on the graph shown in the PhET and added another arrow, and automatically the virtual laboratory showed the result of the sum of the two vectors added together.

On the third week of the experiment, both groups were taught the topics of displacement, time, average velocity, and instantaneous velocity. In the control group the students used materials such as a timer and meter stick. The students were tasked to do an activity where the two students walked on the same direction, one walk in a normal speed, and the other walked faster than the normal speed, then the time of travel was recorded using the stopwatch. Meanwhile, in the experimental group, the students are tasked to open the link for PhET Velocity and input different velocities and change the position of the man, then start and observe his acceleration as the man moves. After the activity the students were asked of the difference between velocity and acceleration, and the topic was discussed.

On the fourth week of experiments, both groups were taught about the topic of average and instantaneous acceleration in 1-dimensional motion. In the control group, students used a ruler and protractor to measure distance and direction. The

teacher reviewed the last lesson and did the same activity where students are asked to walk at different speeds and measure the time and determine the direction. On the experimental group, the same activity, “The Moving Man” to discuss the topic. The students were tasked to change the details on the virtual laboratory to determine the difference between average acceleration and instantaneous acceleration.

*The Post-Experiment Period.* The researcher conducted the posttest for the control and experimental groups; this was done by answering the examination using their individual Learning Management System account.

After conducting the post test, the instruments were retrieved, checked, and recorded. These were submitted to the statistician to be computed and analyzed. Both the pretest and posttest results were used for processing using the Statistical Package for the Social Science (SPSS) software. The differences in the pretest and posttest results were determined by submitting the data to statistical analyses using inferential statistical tools to answer the statement of the problem and the hypotheses advanced in this study. The analyses of the data were placed in tabular form and textual presentation of the analysis and interpretation.

The researcher conducted the study bearing in mind the data privacy act and ethical considerations especially in observing confidentiality, quality, and human subject protection. The researcher explained to the participants their right to voluntarily withdraw from the study at any time, the central purpose of the study, the procedures used in the data collection, comments about protecting confidentiality, a statement about known risks associated with it, and the expected benefits to accrue by participating in the study.

#### *Statistical Data Analysis Procedure*

The data gathered from the study were analyzed using the appropriate statistical procedures.

*Mean.* This was used to describe the level of science performance both in the pretest and posttest of the experimental and control group.

*Standard Deviation.* This test was used to determine homogeneity as well as the heterogeneity of the scores obtained by the senior high school students in the Science performance test.

*T-test for dependent samples.* This test was used to determine the effect of the pretest on the posttest of the experimental group and control group.

*t-test for independent samples.* This test set at .05 alpha level was used to determine the significant difference between the two compared groups, the pretest results of the control and experimental groups, and the posttest of the two groups.

*Cohen’s d calculator.* This was used to determine the effect size of the Physics Educational Technology and Conventional Laboratory in the Science performance.

### **III. RESULTS AND DISCUSSION**

#### *Descriptive Data Analyses*

##### *Science Performance in the Pretest and Posttest of the Control and Experimental Group Design*

Table 2 presents the Science performance in the pretest and posttest of the experimental group using the physics education technology and the traditional laboratory in the control group.

The pretest in the experimental group using the physics education technology ( $M = 12.96$ ,  $SD = 4.20$ ) is low while the pretest in the control group using the traditional laboratory ( $M = 14.50$ ,  $SD = 3.71$ ) is fair. Moreover, in the posttest of the experimental group, the result is fair ( $M = 25.62$ ,  $SD = 3.90$ ), whereas in the posttest of the control group the result is also fair ( $M = 20.62$ ,  $SD = 4.80$ ). This simply shows that there is an increase in the Science performance of the students using both approaches in teaching.

Table 2  
 Mean and Standard Deviation of Science Performance in the Pretest and Posttest of the Control and Experimental Groups

Group	Pretest			Posttest		
	Mean	Description	SD	Mean	Description	SD
Control	14.50	Low	3.71	20.62	Fair	4.80
Experimental	12.96	Low	4.20	25.62	Fair	3.90

Scale	Description
40.01 – 50.00	Very High
30.01 – 40.00	High
20.01 – 30.00	Fair
10.01 – 20.00	Low
0.00 – 10.00	Very Low

The “low” Science performance of the students on the pretests of the experimental and control groups indicated that they lacked prior knowledge or skills about science; this also implies that they have not yet learned the specific content that was covered on the test, or that they may not fully comprehend the concepts and ideas being tested, which resulted in low scores. The data also shows that in order to improve student performance in science; it is essential to identify the specific factors that contribute to low scores and implement strategies to address these problems. This could involve providing additional support and resources for struggling students, creating a more positive and engaging learning environment, or discovering ways to improve student motivation and engagement with science.

The result of the pretest signifies collective similarity between students. This means that both control and experimental group have same level of knowledge.

The results of the posttest demonstrated that both groups had gained knowledge. The experimental group's science performance improved from “low” to “fair” and the control group's science performance improved from “low” to “fair.” Students in the experimental group who utilized Physics Education Technology had a greater mean gain than those in the control group who utilized a conventional laboratory. This suggests that students favor Physics Education Technology over traditional laboratory setup.

This also implies that students improved their science test scores from low on the pre-test to fair on the post-test, indicating that they have made progress in their understanding and mastery of the concepts and ideas being tested. This may be the result of a variety of factors, including increased motivation, enhanced learning strategies, additional support or resources, or a more conducive learning environment.

Based on the statement of Rutten (2014), the use of computer simulations is a viable method for enhancing the effectiveness of conventional teaching methods. One method to enhance students' capacity for visualization, which would result in a greater understanding of scientific ideas, is to use activities based on interactive simulations.

The result substantiates the findings Hamed and Aljanazrah (2020), the utilization of face-to-face theoretical preparation in the general physics laboratory is at least just as effective as the utilization of virtual experiments. Students who had access to virtual tools gained a deeper understanding of physics concepts and were more ready to carry out real experiments.

*Inferential Data Analysis*

*Differences in the Science Performance in the Pretest of the Control and Experimental Group*

Table 3 presents the differences in the pretest scores of the experimental and control groups.

Data shows statistically that there is no significant difference  $t(1.40^{ns}) = .168, p > .05$  in the pretest scores on the Science performance both for experimental and control groups. This indicates that the experimental and control groups are comparable in their science performance.

Table 3

Independent t-test Result of Science Performance Between the Pretests of the Control and the Experimental Groups

Group	Mean	SD	t	df	Sig
Control	14.50	3.71	1.40 <sup>ns</sup>	50	0.17
Experimental	12.96	4.20			

\*  $p < 0.05$  significant 5% alpha level

ns  $p > 0.05$  not significant 5% alpha level

No significant difference in the pretest scores of the students in the Science Performance test revealed that the students who use treatment X, which is the Physics Education Technology and controlled condition have almost the same performance in science. This implies that the experimental and control groups are similar and comparable to each other. The results also indicate and validate the grouping selection procedure that the participants were equally matched to one another.

According to the research posted in NASA-ADS (2013) in the study conduction comparing hands-on and virtual laboratories, it shows that there is no significant difference in short-term learning between hands-on and virtual laboratories.

Thus, the hypothesis which states no significant differences in the pretest scores of the experimental and control groups is accepted.

*Differences in the Science Performance between the Pretest and Posttest of the Control and Experimental Groups*

Table 4 presents the differences in the pretest and posttest scores of the control and experimental groups.

Data show that there is a significant differences  $t(5.42^*) = 0.000, p < 0.05$  in the pretest and posttest scores in the control group and  $t(13.35^*) = 0.000, p < 0.05$  in the pretest and posttest scores in the experimental group on the Science performance. This means that both physics education technology and conventional laboratories are effective tools in teaching science especially in this time of pandemic.

Table 4

Paired t-test Results of Science Performance Between the Pretests and Posttests of the Control and the Experimental Groups

Group	Test	Mean	SD	t	df	Sig
Control	Pretest	14.50	3.71	5.42*	25	0.000
	Posttest	20.62	4.80			
Experimental	Pretest	12.96	4.20	13.35*	25	0.000
	Posttest	25.62	3.90			

\*  $p < 0.05$  significant 5% alpha level

ns  $p > 0.05$  not significant 5% alpha level

The significant difference that exists in the pretest and posttest scores of the experimental group using the experimental treatment, which is the Physics Education Technology, suggests that utilization of treatment X is an effective tool for improving students' Science performance. The result shows significant gain in knowledge of students' performance in science. Comparably, its counterpart, which is the Conventional laboratory setup also helps to improve the Science

performance of the students since the result shows that there is a significant difference in the pretest and posttest results of the participants.

Moreover, the studies illustrate that the use of Physics Education Technology and Conventional Laboratory setup are effective strategies for enhancing student learning and interest in physics; this is because both strategies improve student comprehension of difficult concepts and promote active learning, since the students are the ones actively performing the Physics task, whether using the software Physics Education Technology or performing the experiment manually using conventional methods.

However, it is also important to recognize that the scores of the experimental and control groups are relatively not that high and that there is still room for improvement; this means that there is a need to effectively integrate the learning resource into teacher's instruction in order to realize its full benefits.

In conjunction to David A. Kolb's Theory of Experiential Learning (1984) which defines learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience. The Experiential Learning Theory (ELT) presents a holistic model of the learning process as well as a multilinear model of adult development. Both of these models are congruent with what we know about how people learn, grow, and develop as they go through life.

Therefore, the null hypothesis which states no significant differences in the pretest and posttest scores on the Science performance in the control and experimental group is rejected.

#### *Differences in the Posttest Scores of the Control and Experimental Groups*

Table 5 presents the differences in the posttest scores of the control and experimental groups.

Data shows that there is a significant difference  $t(4.12^*) = 0.000, p < 0.05$  in the posttest scores on the Science performance in favor of the experimental group ( $M = 25.62; SD = 3.90$ ) using the physics education technology.

Table 5

Independent t-test Result of Science Performance Between the Posttests of the Control and the Experimental Groups

Group	Mean	SD	t	df	Sig
Control	20.62	4.80	4.12*	50	0.000
Experimental	25.62	3.90			

\*  $p < 0.05$  significant 5% alpha level

ns  $p > 0.05$  not significant 5% alpha level

The significant difference in the posttest scores of the experimental and control groups implies that the students who use the Physics Education Technology have a better score than the students who use the conventional laboratory; this also means that the intervention that the experimental group received can lead to a better Science performance than the controlled treatment.

The significant difference in posttest scores is attributed to the fact that Physics Education Technology is an interactive simulation tool that is effective at enhancing student understanding of confusing physics concepts, allowing students to grasp the concepts more easily and be more interested in learning compared to the conventional laboratory. Visualization provided by Physics Education Technology enables students to interact with complex concepts and phenomena in a sense that is difficult to achieve with a conventional laboratory. In addition, it facilitates students to work at their own pace and tailor their learning experience according to their individual needs and preferences, and it is more accessible to students regardless of their location or access to physical resources.

The study supports the findings of Rutten (2014) where he stated that the use of computer simulations is a viable method for enhancing the effectiveness of conventional teaching methods. Activities that are based on interactive simulations

that are provided by Physics Education Technology (PhET) could be one technique to improve students' ability to visualize, which would lead to a deeper comprehension of scientific principles.

*Effect Size of Physics Education  
Technology on Science  
Performance*

The effect of physics education technology on the Science performance is shown in Table 6.

Data show that statistically physics education technology has a large effect (25.62%) in the Science performance of students (*Cohen's d* = 1.14). This means that using physics education technology can help improve the Science performance of students.

Table 6  
Cohens' d on the Effect of physics education technology on the Science performance

Group	Mean	SD	Cohen's d	Remark
Control	20.62	4.80	1.14	Large
Experimental	25.62	3.90		

Scale	Description
0.2	Small
0.5	Medium
0.8	Large

The results show that the physics education technology has a “Large” effect on the Science performance of students. This is due to the fact that the use of this interactive simulation tool enhanced the students' understanding of the topic because it promotes active learning, which is the most effective way for students to learn best. Physics education technology was also integrated into the classroom activities, allowing the teacher to anticipate what resources would be required for the activity, resulting a significant positive effect. In addition, this virtual laboratory was also useful for enhancing student learning and interest in physics because it is highly useful for students with different learning styles or those who may require additional support or challenge.

The result of the study is similar with the findings of Bao & Koenig (2019), which states that students who use physics education technology score higher on assessments of physics knowledge and problem-solving skills than those who do not.

The result is also in line with the results of Pritchard et al. (2019), who found that students who used interactive simulations to learn about mechanics had significantly higher test scores than those who did not, as well as greater confidence in their grasp of the material.

#### IV. CONCLUSION

The following conclusions were drawn based on the study's major findings as indicated above.

1. Given that both groups have “low” Science performance in the pretests it is reasonable to think that both groups have a collective similarity. It also indicates that students have low understanding of the subject. Moreover, since the Physics subject builds heavily on mathematical concepts, there are some students who struggle with math so as a result they also struggle with physics.

In addition, the low performance of grade 12 students on the science performance test may be due to the fact that students did not have a relevant or positive experience with the physics subject in earlier grade levels. As a result, they may not be motivated to continue studying this subject in senior high school because they believe the materials are not presented in a clear and engaging manner, which resulted to not fully comprehend the concepts.

Students may also have a limited exposure to real-world applications of the physics subject in which some students may not understand the relevance of this subject to their lives and may be less motivated to learn the subject matter.



It is crucial to also consider the students' personal factor. Some students may have learning difficulties, a lack of interest or motivation, and a lack of family and peer support, all of which may contribute to a negative physics experience.

The improvement in students' Science performance from “low” to “Fair” in the control group and from “Low” to “Fair” in the experimental group reveals that there is an effective transfer of learning among students using both learning resources.

It is reasonable to conclude that the improvement of students in both groups using Physics Education Technology and traditional laboratory setups was due to the fact that both provide students with opportunities for hands-on learning. The Physics Education Technology (PHET) and traditional laboratory setups enable students to engage in hands-on learning and experimentation, allowing them to better understand and apply the concepts to solve problems. Also, Physics Education Technology and traditional laboratory setups provides students an immediate feedback on their performance, which can help them understand where they went wrong and make adjustments to improve their understanding and performance.

Though both data show that the students' Science performance has improved, it is apparent that the experimental group, which used Physics Education Technology (PHET), has shown a greater improvement. It is possible to conclude that using this learning tool will improve students' Science performance more effectively than the traditional laboratory setup.

2. The Science pre-test performance of grade 12 students using either Physics Education Technology (PhET) or a Traditional Laboratory setup does not differ significantly. This result indicates that the experimental group and the control group have the same performance, and has a verbal description of “low”, which indicates that the participants' prior knowledge of the test topics and questions was insufficient, necessitating the teaching and learning of additional concepts.

The pretest scores serve as a benchmark for measuring the students' comprehension and performance in physics. Since the student have a low performance on the pretest, they are likely to perform poorly on the posttest as well. This is due to the fact that the pre- and post-tests assess the same topic, and without adequate support and resources, the student may not be able to fully comprehend the topic and improve their comprehension. It would be like attempting to construct something without a solid foundation; the structure would be weak and unstable. Therefore, it is essential to use the student's low pretest score as an opportunity to provide additional support, resources, and strategies to help them improve their comprehension and performance on the posttest.

In conjunction with the grouping selection procedure, the researcher ensured that the participants were directly analogous to one another prior to introducing the intervention to the two groups, so that there would be no bias in the selection process. As a result, the data indicates that both groups were comparable.

Taking into account the similar backgrounds of the students, such as strand, age level, and year level, suggests that their science performance is comparable. Consequently, it is plausible that both experimental and control group students will have an equal opportunity to improve their science performance.

3. There is a significant difference in the Science performance of grade 12 students in the pretest and posttest of the control and experimental group. The result signifies that both of the treatments were effective in improving the Science performance of the grade 12 students.

The significant difference in the pretest and posttest scores of the experimental group reveals that Physics Education Technology (PhET) simulations provide an interactive and engaging learning experience for students, which drastically increased their motivation and understanding of the material. Additionally, Physics Education Technology simulations provided grade 12 students with a virtual laboratory environment that allows them to experiment and explore physics concepts in a safe and controlled way. This helped students to develop a deeper understanding of physics concepts and improve their problem-solving skills.

On the other hand, the significant difference in the pretest and posttest scores of the control group indicates that traditional laboratory setup provided the students with the opportunity to conduct hands-on experiments and data gathering. This enabled the students to develop important laboratory skills such as data collection, measurement, and analysis. Additionally, the traditional laboratory setups provided grade 12 students with a deeper understanding of experimental techniques and the limitations of various measurements.

Thus, it is plausible to conclude that when these two approaches are combined, they can create a more effective and comprehensive learning environment for students, given that Physics Education Technology (PhET) simulations can help students develop an intuitive understanding of physics concepts, and traditional laboratory setups can help students develop practical skills. This can result in students gaining a deeper understanding of the subject, problem-solving skills, and the nature of physics.

In winding up, Physics Education Technology simulations and traditional laboratory setups can be utilized in alongside to complement and strengthen one another. For instance, students can use simulations to investigate a physics concept, and then confirm their understanding through experimentation in a traditional laboratory setting. This can strengthen students' comprehension and enhance their retention of the material.

4. The significant difference in the posttest scores of the control and experimental groups signifies that the use of Physics Education Technology (PhET) is more effective in improving the Science performance of the students, thus, is advisable to utilize this learning resource to aid the class.

The Physics Education Technology (PhET) has been shown to be more effective than traditional laboratory setups in improving student performance in physics, this is likely due to its ability to provide individualized instruction, interactive simulations and visualizations, immediate feedback, and remote access to students. As such, it is worth considering the implementation of Physics Education Technology in physics class to enhance student learning and understanding of the subject.

In addition to the aforementioned benefit which resulted a significant difference in the posttest scores of the students, The Physics Education Technology (PhET) was able to provide several advantages over traditional laboratory setups. For example, with Physics Education Technology, students had the ability to repeat their experiments and simulations as many times as they need, allowing them to explore different variables and gain a deeper understanding of the concepts. Physics Education Technology also allowed their teachers to monitor the students' progress and understanding in real-time and provide support where needed. Furthermore, other studies have shown that Physics Education Technology is proven to be cost-effective in the long run as it eliminates the need for expensive equipment, chemicals, and maintenance.

5. The result indicates that Physics Education Technology has a large effect on the Science performance of students; This points out that the use of this advance learning tool is an efficient means of enhancing the students' Science performance. This is due to the fact that Physics Education Technology provided students with interactive and engaging learning experiences that enhanced their comprehension and retention of the lesson. In addition to providing real-time feedback and data on student progress, Physics Education Technology enabled teachers to modify their instruction to better meet students' needs. In addition, Physics Education Technology gave students access to simulations and virtual laboratories, which helped them develop problem-solving skills and apply their knowledge in a practical setting. Consequently, the use of Physics Education Technology led to a large positive effect in the physics performance of students.

#### Recommendations

In view of the aforementioned conclusions that have been formulated, the researcher offers the following recommendations:

1. Students ought to make use of all the features of Physics Education Technology so they will be able to maximize their learning potential. Students are recommended to make use of the simulation tools that is available in Physics Education Technology and use it as a supplement to their traditional classroom learning.

Students may also use the simulation tools in Physics Education Technology (PhET) before their class to preview the concepts that will be covered in their class. This can help them to better understand and engage with the material, and can help them to have a better context to follow the class.

It is also recommended to students to use the Physics Education Technology (PhET) after class to review the concepts that were covered in the class. This can help them to solidify their understanding of the material, and can also help them to identify areas where they need additional practice or instruction.

Students are also recommended to investigate the available scenarios, variables, and parameters in Physics Education Technology, as they are able to adjust parameters and observe their effects on the modeled system. This can aid in the development of students' ability to make predictions and comprehend cause-and-effect relationships.



Students are also advised to seek assistance from their teachers, parents, or guardians if they are unable to use their computers effectively, particularly if they are unfamiliar with this type of technology or are unable to use their computers effectively. Courses in basic computer literacy will improve students' computer skills; having this fundamental knowledge of computer hardware and software will enable them to use the application without difficulty.

Students are also recommended that they should have internet connection to use the virtual laboratory.

2. Teachers are recommended to make the most of by incorporating these interactive simulations and visualizations into their lesson plans, because it can be used to supplement traditional lectures and textbook readings, and can help students to better understand and engage with the material. For example, teachers can use interactive simulations to demonstrate difficult concepts such as electric circuits, or to show the motion of objects in different types of forces.

Also, teachers are recommended to evaluate the quality of the Physics Education Technology resources they are using, because not all resources are created equal, so it's important to use well-established and reputable resources available in Physics Education Technology to ensure that the content is accurate and aligns with the curriculum standards.

It is recommended that teachers may thoroughly investigate Physics Education Technology in order to effectively integrate it into their instruction and maximize its potential benefits. Once teachers have mastered this learning resource, they will have a thorough understanding of the available tools and resources and how they can be used to support student learning. Additionally, this can assist them in selecting and utilizing the appropriate technology for their particular lesson. In addition, by investigating the features and capabilities of Physics Education Technology, teachers can discover how to employ this technology to provide interactive and engaging learning experiences, real-time feedback, and data-driven instruction.

It is recommended that Science Teachers may have a refresher training in the use of Physics Education Technology. Newly hired science teachers would benefit greatly from annual training on how to use the Physics Education Technology, as they would be able to comprehend its various features. It would also serve as a review for tenured teachers, allowing them to go over Physics Education Technology again or learn something new about it.

Teachers may also provide guidance and support to students when using Physics Education Technology, as it may not be familiar to all students. Teachers are recommended to make themselves available to answer questions, provide help, and give feedback on the students' work.

3. The school administrators may consider investing in technology specifically designed for physics education, such as interactive simulations and virtual laboratories. These tools can enhance students' engagement and understanding of complex physics concepts, and can be used in both in-person and online learning environments.

Additionally, school administrators may provide teachers with professional development opportunities to learn how to effectively integrate this technology into their instruction can help ensure that it is used to its fullest potential.

The school administrators may also consider implementing an inquiry-based learning strategies in their physics curriculum. This approach allows students to actively engage in the learning process by asking questions, designing experiments, and analyzing data, rather than simply memorizing facts and formulas. This can help students develop critical thinking skills, which are essential for success in physics and other STEM fields.

The school administrators are also recommended to develop a comprehensive plan about the implementation of physics education technology. This plan must discuss the instructional methods for integrating the technology into the classroom, as well as the resources required for implementation, such as funding, personnel, and equipment. A timeline for implementation and a maintenance and support schedule may be included. It is essential that the plan aligns with the school's overall educational goals and objectives and has the support of the administration and faculty. This plan will serve as a guide for the implementation process and ensure that technology is used to enhance student learning.

It is also recommended for the administrator to conduct a monitoring and evaluation of the progress of the technology implementation on a regular basis, because it is essential for determining its effectiveness and make any necessary adjustments. Administrators of schools may implement a system for collecting and analyzing data on student performance and engagement, as well as teacher satisfaction and efficacy. This data can be used to identify areas where the technology has a positive impact and areas where adjustments are necessary.

4. Parents are advised to support their child's education by being actively involved in their child's learning process. This may include providing some time to assist their child for studying, staying informed about what is being taught in school, and communicating with the child's teachers to stay informed about their progress. Additionally, creating a positive and supportive learning environment at home can help the child feel motivated and engaged in their education.

Parents are recommended to work with teachers. It is important to involve the teacher in the process of using Physics Education Technology (PhET) resources at home. Teachers can provide guidance and recommendations on which resources are most appropriate for your child's level and learning style. They can also provide insight on how the resources are being used in the classroom. By working with the teacher, parents can ensure that the resources being used at home are complementary to what is being taught in the classroom.

For working parents, it is recommended for them to encourage their child a self-directed learning since some of the resources provided are self-paced learning, this allows the child to take ownership of their learning by using the resources on their own and exploring different topics. Thus, they may encourage their child to explore the resources, experiment with different simulations and activities, and develop their own questions and hypotheses. By doing so, they will be able to learn at their own pace and level of understanding and will be more motivated to engage with the material.

For working parents, it is recommended for them to encourage their child to engage in self-directed learning since some of the provided resources are self-paced. So, this trains the child to take ownership of their learning by using the resources independently and exploring different topics alone. So as a result, they may be able to encourage their child to explore the resources, experiment with various simulations and activities, and formulate their own questions and hypotheses.

5. Future researchers may conduct studies to determine the impact of Physics Education Technology on grade levels below or above senior high school, as well as the integration of this application with other subject areas.

The future researchers are also recommended to have an in-depth study on the Mobile-based apps and games related to physics and how are this technology can be used to support and enhance that learning of students.

As a final point, this can be used as a literature review by future researchers to assist them to validate their findings. Future researchers will be able to utilize the findings of this study as a foundation for undertaking other related studies. It's also big assistance when it comes to writing a comprehensive literature review.

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