
PhET Simulations as an Instructional Intervention Strategy in Promoting Science Performance and Attitude

HONEY KEITH B. TOLENTINO

honeyborromeo@gmail.com
Saint Anthony College of Technology

SONNY N. DE GUZMAN, EdD

Sirsonnydg726@gmail.com
Saint Anthony College of Technology

Abstract — The primary purpose of this study was to assess the Science Performance and attitude of Grade 8 Students through PhET simulations during the School Year 2024-2025. This study was in San Juan High School, Mexico, Cluster IV, Division of Pampanga, during the School Year 2024-2025. The researcher employed a quantitative, descriptive-quasi-experimental design in this study. The researcher employed statistical treatment of data such as mean, standard deviation, and t-test for independent samples.

Based on the findings, the baseline science performance of the respondents generally performed at a satisfactory level prior to the use of PhET simulations, as evidenced by their composite mean score of 80.92. Correspondingly, the respondents' science performance improved significantly after integrating PhET simulations, reaching a very satisfactory level, as evidenced by an average mean score of 89.23. There was a significant difference between the baseline and posttest science performance of the respondents, as indicated by a paired-samples t-test score of 5.85 ($p = 0.000$). The grade 8 students generally expressed a highly positive attitude toward the use of PhET simulations, as supported by the overall mean score of 4.28. The proposed instructional support plan is designed to support effective implementation of school-based virtual simulations.

Keywords: PhET Simulations, Science Performance, Attitude, Intervention

I. INTRODUCTION

It has been a challenge for the Philippines to enhance the quality of Mathematics and Science education over the years, as evidenced by the country's performance on International School Tests. In PISA 2018, the Philippines consistently achieved an average score of 357 points in Scientific Literacy, which is much lower than the OECD average of 489 points. The average score of pupils from the Philippines falls within the proficiency threshold. This means that an average Filipino 15-year-old student can apply basic scientific knowledge to recognize or identify explanations of scientific phenomena. They can make structured scientific inquiries with at most two variables with additional guidance.

In comparison, a typical 15-year-old student from OECD countries at Proficiency Level 3 can draw upon moderately complex content knowledge to construct explanations of familiar phenomena. Several factors are attributed to this low performance and achievement in Science. One problem a Science Teacher in a public high school must address is inexperience and incompetence in providing appropriate, relevant, and innovative teaching strategies. In addition, most students often perceive Science as a subject that could be more relevant, exciting, and difficult. Consequently, it is the primary reason students perform poorly in this subject.

Moreover, using conventional teaching strategies rather than learner-centered pedagogy emphasizes the use of inquiry-oriented techniques. To improve its performance in Science education, the Philippines initiated a significant curriculum reform, culminating in the implementation of the Enhanced Basic Education Curriculum (K to 12).

In 2013, the Republic Act 10533, Section 5 of the Curriculum Development, stated that the Curriculum should use pedagogical approaches that are constructivist, inquiry-based, reflective, collaborative, and integrative (DepEd, 2013).

To improve students' Science Performance, the Philippine Education System emphasizes inquiry-based instruction to nurture the next generation of scientists, engineers, and medical professionals who will contribute to the country's growth and development (Montebon, 2014).

Aside from using inquiry-based instruction, the Department of Education envisions an ICT-supported quality basic education system, including PhET simulations in teaching Science concepts (Bonifacio, 2013).

Inquiry-Based Instruction

Active learning pedagogy that promotes the Teaching-Learning Process is called inquiry-based education (Abdi, 2014). This type of instruction uses the 5E learning model, which stands for engage, explore, explain, elaborate, and evaluate. An inquiry-based lesson can be constructed using the 5E instructional model. In addition to providing a summary of the five steps or phases that comprise the 5E learning cycle, Bybee (2014) also discussed the ways in which each phase will be utilized: 1) Engagement: This phase is designed to address the prior knowledge of the students and serves as a period of motivation for the student; 2) Exploration: This phase encourages students to investigate on their own and is where the primary inquiry-based lesson is carried out. 3) Explanation: During this phase, students are given the opportunity to describe how well they comprehend the material that they have become familiar with during the exploration phase. Students are required to use the information that they have learned in the explanation phase and apply it to new situations or scenarios during the elaboration phase. 5) Evaluation: Inquiry-based assessments look for continuous progress on a student's learning, understanding of new concepts and skills, as well as evidence on how they have changed their thinking from the previous phase.

This teaching strategy is often perceived as difficult to implement; however, students become more interested in science concepts when they can understand the various forms of scientific inquiry (Nuangchalem & Thannasena, 2019). Various approaches can include inquiry-based instruction, ranging from confirmed inquiry to structured inquiry, guided inquiry, or open inquiry (Banchi & Bell, 2008).

This learning strategy allows the students to discover and construct scientific reasoning and have the ability to transfer knowledge into higher scientific reasoning by themselves, thus

making learning more meaningful and enabling them to retain more information compared to the conventional method (Witt & Ulmer, 2010; Thoron & Myers, 2012; Bybee, 2014).

It places students' queries, thoughts, and observations as the focus of the learning experience. Teachers play an essential role in establishing a learning environment where ideas can be accepted and modified as needed (Cardak et al., 2018).

This learning method can also increase the student's motivation to learn science, as they have the prerogative to choose the projects they are interested in and the opportunity to self-regulate (Zeki et al., 2013).

Teachers are considered the front lines of the education system; they are more engaged in the teaching and learning process. However, the Department of Education needs to improve its use of the inquiry-based approach, as more Filipino teachers need intensive training in handling inquiry-based classes.

On top of that, teachers are also struggling due to the unavailability of inquiry-based materials and the overemphasis on content assessment (Gutierrez, 2015). According to Sanger's (2008) study, teachers with low interest and confidence in inquiry-based instruction tend to teach science subjects conventionally.

On the other hand, teachers with high interest and confidence in inquiry-based instruction let their students explore and construct their knowledge about a specific science concept and gain positive results regarding students' performance.

This teaching strategy requires knowledge about the teaching technique and the teachers to fully embrace it so they can yield positive responses from the students' performance. Meanwhile, students need help to learn science concepts through the inquiry-based approach. One factor that leads to this conception is prior process skills and the student's background, as observed by the University of the Philippines National Institute for Science and Mathematics Education Development (Mejia, 2018).

Despite the challenges encountered in using inquiry-based instruction as a method of teaching in science education in the Philippines, related studies revealed that Filipino students

will be able to exhibit positive performance in an inquiry-based class interaction by integrating the different aspects of chemistry into coherent concepts and displaying deep knowledge using reasoning and planning (Leonor, 2014). The results showed that the students could develop higher-order thinking skills through inquiry-based instruction.

PhET Simulation in Education

PhET simulations have been widely used for education and training over the years. It is a supplemental teaching tool and hands-on learning activities (Eskrootchi & Oskrochi, 2010; Rodrigo, 2010). It significantly improves learners' concentration during science concept learning, especially during laboratory activities.

PhET simulations have enriched the visual presentations of abstract and complex science concepts. It positively affects students' comprehension of the task in the laboratory and their laboratory skills before and during the laboratory activity.

It has enriched the visual presentations of abstract and complex science concepts, allowing students to repeat the activity as a review for examinations without incurring much cost or buying any materials (Tatli & Ayas, 2010; Tuysuz, 2010; Bajpai & Kumar, 2015). PhET simulations allow students to make mistakes and correct themselves, preparing them for real-life and professional settings (Hafner et al., 2013).

A study reveals that students find learning more enjoyable through PhET simulations as they get more involved and are willing to apply knowledge (Chittaro & Ranon, 2017). Tasks guided by questions enable the students to explore the simulation and approach problem-solving and knowledge acquisition like a real expert (Adams et al., 2009), and a well-designed simulation can be self-directed and improve students' inquiry skills (Podolefsky et al., 2010).

In the Philippine context, the PhET simulation did not significantly alter Filipino students' epistemological beliefs about learning science concepts. Significant changes will be observed, focusing only on knowledge, learning, and real-life applicability. Student motivation significantly improved. The students' conceptual understanding increased from low mastery to average

mastery level (Mirana, 2018). PhET simulations are not guaranteed to be attractive most of the time; their difficulty levels should match learners' levels, ages, and genders.

Inquiry-Based Instruction through PhET Simulation

One new way to use inquiry-based instruction is through technology, such as PhET simulations. It enables students to formulate hypotheses through data collection that can be proven or rejected as class discussion progresses (Boychev et al., 2014).

It has promising evidence that can enhance conceptual perception and understanding. However, effectively conveying science concepts requires good design, assessments, and proper scaffolding of the learning experience (Honey & Hilton, 2011).

PhET simulation is at least as effective as a genuine laboratory. It can maximize interactivity, motivating students to be active thinkers through inquiry-based instruction rather than passive observers, thereby creating a meaningful teaching-learning process (Tatli & Ayas, 2021).

Inquiry-based learning allows the learners to control what they are learning in a hands-on activity. Incorporating this philosophy into a computer simulation can further enhance learning (Roseman & Jones, 2013; Wilson, 2018).

Through PhET simulation in an inquiry-based class discussion, students and teachers become highly engaged, improving student attendance. Disruptive behavior decreases, and students build 21st-century skills through PhET communication and expression. Most importantly, using this technology in the classroom can facilitate good inquiry teaching (Ketelhut et al., 2020).

Although PhET educational environments can support highly interactive inquiry activities and are increasingly used to deliver inquiry-based science curricula, some factors should be addressed to maximize their effectiveness. This includes the totality of the students, whether they

can benefit from the experience, and access to classroom resources to conduct scientific PhET inquiry-based classes (Nelson & Ketelhut, 2017).

A PhET simulation in an inquiry-based discussion does not confine attention or attention attraction and is used as an alternative to the actual apparatus. This should also be utilized in a truthful reasoning process during class discussions. Its function should explain natural phenomena (Chen, 2020).

During the simulation, the learner will interact as the test subject in a lab experiment. This strategy fits well with the principle of inquiry-based instruction and is also an effective way to help students understand the nuances of a concept or condition (Shamsudin et al., 2013)

Challenges and Attitudes of Students in Science

Over the past years, the Philippine government has struggled to uplift the quality of Science education in the country. However, still, its level of performance, which is already accounted for in both national and international assessments of Science education, remains to be at far behind the international standards based on the results of the National Achievement Tests (NAT) and the Trends in Math and Science Study (TIMSS) in 2003 where the Philippines placed 42nd out of 45 participating countries (Dela Cruz, 2017).

Currently, based on the Global Competitiveness Report for the year 2018-2017 of the World Economic Forum, the Philippines ranked 79th out of 138 countries in the world in terms of the quality of Math and Science Education, ranked 72nd in terms of the quality of scientific research institutions and ranked 78th when it comes to the availability of scientists and engineers which are clear indicators that Science education in the country had been deteriorating (Schwab, 2018).

Furthermore, the results of the National Career Assessment Examination (NCAE) in the year 2012-2013 showed that students garnered the lowest score in scientific ability among all other areas, such as reading comprehension, verbal, mathematical, clerical, and logical reasoning,

and the lowest percentage in terms of the occupational interest of the examinees which are enough indicators that students' interest in the subject is deteriorating (Bajar-Sales et al., 2015).

In the study by Bernardo et al. (2008) on students' perceptions of Science classes in the Philippines, this low level of performance is linked to teachers' reliance on conventional teaching strategies rather than learner-centered pedagogies that emphasize hands-on, inquiry-oriented approaches. These issues faced by the country's science education and education system as a whole prompted a significant curriculum reform from the old framework of education to a new system known as K to 12 Basic Education Curriculum under the Republic Act 10533, with high optimism of bringing the educational system of the country in a greater height for the benefit of every Filipino citizen (Department of Education, 2012; SIE-DOST & UP-NISMED, 2011).

The K to 12 curriculum highly recommends the use of constructivist, learner-centered, and inquiry-based teaching approaches because 21st-century learners are no longer interested in a kind of learning situation where the teacher becomes the predominant figure in the teaching-learning process, turning out students to be passive learners or passive receivers of the information, which are merely memorizing and reproducing the concepts without much retention (Sezgin et al., 2013; Zion et al., 2012).

The inquiry approach, which is strongly emphasized in the curriculum, can be implemented using several methods, including structured inquiry, guided inquiry, open inquiry, and a learning cycle such as the 5 E's (Abraham, 2017).

According to Van Uum et al. (2017), if properly executed, it would be very effective in helping learners acquire, analyze, and explain data from an investigation, leading them to a conceptual understanding.

Factors Affecting Students' Performance in Science

Most Filipino students perceive science as an abstract and complex subject. Other factors contributing to Filipino students' poor performance in the subject include limited instructional

and laboratory materials and the unpopularity of professional mentoring in innovative pedagogy (Orleans, 2007).

In the study by Mudau, Mundalamo, and Sedumedi (2014), most science teachers used a conventional teaching approach that involved demonstration lectures and question-and-answer strategies, without considering students' interactivity or involvement in discussing science concepts. Other factors that affect the performance of Filipino students are the manner of unrealistic assessments (Alimen, 2019).

As shown in Baran's (2018) study, students' engagement in science subjects would be more meaningful if the subject were more closely tied to real-life situations. As a result, students' perceptions of science differed from those of teachers. Teachers must be able to tailor their approach to the students' understanding of the subject (Ornek et al., 2018).

In Ramos et al.'s (2013) study, Filipino students need help developing higher-order thinking skills because the subject is taught through a lecture-demonstration method. The students tend to perform the same way their teacher taught the science concept. On the other hand, students become active constructors of science learning if exposed to a more personalized and inquiry-based environment (Ebora, 2018).

Learners need help acquiring science concepts, as it is considered an intellectually challenging subject that is most often taught in a conventional manner, without considering interactivity during class (Gosling, 2018).

Although misconceptions about science concepts have been thoroughly studied, and the effectiveness of inquiry-based instruction and PhET simulations has been proven, the possible effect on students' performance of combining the inquiry-based approach and PhET simulations in a single instruction has not been specifically studied in a Philippine setting. Considering the following concerns, this study proved that students' science performance would improve through inquiry-based instruction using PhET simulations in learning science concepts.

Conceptual Framework

In this study, the researcher determined the effect of PhET simulations on students' science performance and attitudes in the Biology subject. This research adopts the IV-DV model (independent-dependent variable model). This model will be used in most experimental-based research (Cristobal & Cristobal, 2017).

The researcher utilized two (2) groups of respondents in this study. The first group comprised the control group, which used the lecture and conventional board-chalk methods. In contrast, the second group was the experimental group that used the PhET simulation to teach biology concepts. The arrow in the middle of the two variables indicates the independent variable's effect on the dependent variable. The dependent variables included the science performance and the student's attitude towards the use of PhET simulations. Table 1 presents the study's paradigm.

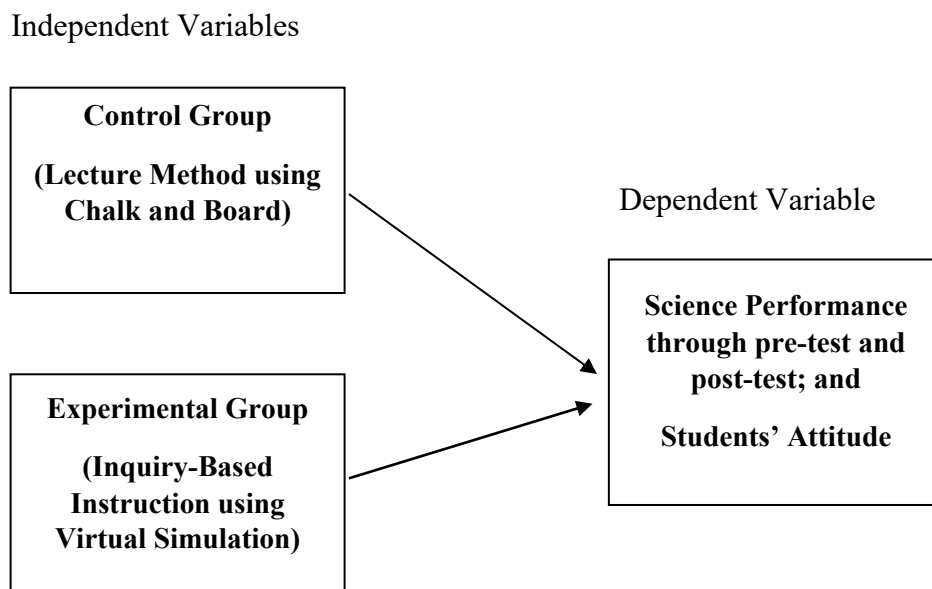


FIGURE 1
PARADIGM OF THE STUDY

Statement of the Problem

The primary purpose of this study was to assess the Science Performance and attitude of Grade 8 students through PhET simulations during the School Year 2024-2025.

Specifically, the study answered the following questions:

1. How may the level of Science Performance of Grade 8 students be described before and after integrating PhET simulations?
2. Is there a significant difference in their Science performance before and after integrating the PhET simulations?
3. How may the respondents describe their attitude towards PhET simulation?
4. What proposed instructional support plan can be made based on the study's findings?

Hypothesis

After conducting the research, this study will affirm that Science performance significantly differs before and after integrating PhET simulations.

Significance of the Study

The study results would be valuable to the following individuals:

School. The PhET simulation would serve as an alternative teaching aid without an actual laboratory apparatus and without jeopardizing the target competencies, as stated in the science curriculum guide.

School Administrators. The results of this study can be utilized by the school administrators as a basis for formulating a possible scheme for developing strategies for

teaching Biology concepts. Further, they can encourage teachers to use Inquiry-Based Instruction through Phet simulation as a technique or strategy for teaching science concepts.

Teachers. The findings of this study help them choose a method they can use for an enjoyable and effective way to deliver their lessons through this innovative teaching strategy.

Students. The results of this study would help the students improve their performance and attitude through innovative strategies such as PhET simulations. This may also address the need for more learning resources in the school.

Future Researchers. The study's findings may be used as additional literature relative to exploring various strategies to enhance quality instruction through this innovative initiative.

Scope and Delimitation

The primary purpose of this study was to assess the Science Performance and attitude of Grade 8 students using PhET simulations. This study was in San Juan High School, Mexico, Cluster IV, Division of Pampanga, during the School Year 2024-2025.

Moreover, the study's respondents were purposively selected Grade 8 students. It was further delimited to the following: the level of science performance of Grade 8 students before and after integrating Phet simulations, the significant difference in their science performance before and after using inquiry-based instruction through Phet simulations, the respondents' descriptions of their attitude towards inquiry-based instruction through Phet simulation and lastly, the proposed instructional support plan based on the findings of the study.

Definition of Terms

Some variables used in this study were defined conceptually and operationally to guide the readers in understanding the concepts.

Attitude. It is a settled way of thinking or feeling about someone or something, typically reflected in a person's behavior (Macmillan Dictionary). This pertains to the student's way of thinking regarding the Phet simulation activity.

Phet Simulation. The Healthcare Simulation Dictionary defines Phet simulation as "the recreation of reality depicted on a computer screen. This study will focus on teaching biology concepts among Grade 8 students.

Science Performance. It is the measurement of student achievement in the science learning area. This refers to the pre-test and post-test scores of the Grade 8 students in biology subject.

II. METHODOLOGY

This part explains how the study were conceived and carried out. This study is part of the research design, study participants, research instruments, data collecting, ethical considerations, and data analysis.

Research Design

The researcher utilized a quantitative method using a descriptive-quasi-experimental design in this study. This type of research is an empirical interventional study used to estimate the causal impact of an intervention on a target population without random assignment (Levy & Ellis, 2011). Specifically, a One-Group Pre-test-post-test design was employed because the dependent variable was measured before and after the implementation of the PhET simulation

strategy. The pre-test and post-test scores were compared to determine the effectiveness of PhET simulations.

Respondents

The study's respondents were the selected Grade 8 students in San Juan High School, Mexico, Cluster IV of the Division of Pampanga. Initially, the researcher selected the respondents using nonprobability sampling techniques, such as purposive sampling. This is the primary consideration in determining the number of cases, especially in a quasi-experimental design, to eliminate biases throughout the investigation, since the number of observations is predetermined. As such, the qualifications included in the pool of respondents were as follows: a) must be a Grade 8 pupil in San Juan High School, Mexico, b) must have a final grade of 75-79 in Science 8 during the 1st quarter, and c) must have no academic awards received.

After determining the number of respondents, the researcher divided them into two (2) groups, with at least thirty (30) members for each group. One group was the control group, and the other was the experimental group. Table 1 presents the distribution of the respondents.

TABLE 1
RESPONDENTS OF THE STUDY

School	Control Group	Experimental Group
Section A	5	5
Section B	5	5
Section C	5	5
Section D	5	5
Section E	5	5
Section F	5	5
Total	30	30

Research Instrument

The researcher used a standard test in the science learners' module in Grade 8. The pre-test consists of 50 multiple-choice questions of picture and table analysis computations. In comparison, the post-test consists of 50 multiple-choice questions, including picture analysis, computations, and table analysis.

The competencies were based on the Science 8 Curriculum Guide. The questions covered the topics about Genetics (Biology) (The pre-test and post-test from the Teacher's Guide Grade 8 Science were subjected to content validation, explicitly using a Table of Specifications. Initially, it was presented to Science Teachers and one Head Teacher in Science. They were asked to assess the clarity, specificity, and sufficiency of the items. After that, their suggestions were incorporated into the final draft of the instrument.

Second, an adapted version of the Science Attitudes Scale (Espinosa et al., 2012) was used to describe students' attitudes toward using the PhET simulation. The questionnaire items were coded numerically (4 = Strongly agree, 3 = Agree, 2=Disagree, and 1 = Strongly Disagree; these were reversed for negatively worded items). The values for any attitude towards science measures for the group could range from 1 (most pessimistic) to 5 (most optimistic).

Data Collection

The researcher requested permission through a letter addressed to the Office of the Schools Division Superintendent in the Division of Pampanga as part of the initial data-collection process. After obtaining official approval, the researcher prepared and presented the plan of activities for the actual data-gathering phase to the School Head of the participating school to comply with ethical standards.

The researcher administered the pre-test to the control and experimental groups to measure their science performance, which was facilitated within the day. After obtaining the pre-test score, the researcher provided an intervention strategy to the experimental group. This activity was

administered within a week. After implementing the strategy, a post-test was executed for the respondents.

Also, the respondents completed a Students Perception Survey (SPS) to measure their attitude toward the Phet simulation. The last part of the data processing was collecting, analyzing, and interpreting the gathered data.

Ethical Considerations

The researcher adhered to ethical norms during the study. Initially, respondents' consent was obtained to respect their decision to participate in the study. Also, the respondents' anonymity was protected, and their responses remained confidential. Finally, the study results were treated with complete objectivity and evidence of professional respect for the gathered data.

Statistical Treatment

The gathered data were analyzed using appropriate statistical methods to generate the study's findings.

1. Frequency and Percentage. This tool described the level of science performance of the learners in their pre-test and post-test scores adopting the Policy on Classroom Assessment (D.O. no. 8, s. 2018). The following scales were used to describe the learners' performance levels.

Raw Scores	Grading Scale	Interpretation
43–50	90–100	Outstanding
33–45	85–89	Very Satisfactory
23–30	80–84	Satisfactory
13–20	75–79	Fairly Satisfactory
0–10	Below 75	Did Not Meet Expectations

2. T-test for dependent samples. This determined the significant difference in learners' science performance between pre-test and post-test scores, assuming the data are normally distributed.

3. Weighted Mean. This tool described the respondents' attitudes regarding inquiry-based instruction through PhET simulation. The following scales will be used as a guide for interpretation:

Scale	Descriptive Equivalent	Interpretation
4.21-5.00	Strongly agree	Very High
3.41-4.20	Agree	High
2.61-3.40	Undecided	Neutral
1.81-2.60	Disagree	Low

III. RESULTS AND DISCUSSION

This chapter presents, analyzes, and interprets the data gathered from the survey questionnaires to answer the specific objectives in Chapter 1.

1. Descriptions of Science Performance Levels of Grade 8 Students Before and After Using PhET Simulations

Table 2 presents the baseline science performance levels of the respondents prior to using the PhET simulations. Out of the 30 participants, the data showed that no student achieved an Outstanding performance. Meanwhile, almost half, or 33.33% of them, were rated “very satisfactory” performance, 26.67% obtained “satisfactory performance”, and 23.33% achieved “fairly satisfactory” performance. Notably, only 16.67% of the respondents “did not meet the expectations”, having scores of below 75.

On average, the grade 8 students' science performance falls under the "satisfactory" level, as evidenced by their composite score of 80.92 with a standard deviation of 5.32. The results suggest that some learners demonstrated relatively strong science performance; however, a considerable number of them performed near or even below the minimum proficiency level.

This highlights the gap in their science conceptual understanding since their performance was generally adequate but not optimal. This means that the conventional type of teaching alone does not support a deeper understanding of the science concepts. This also provides a strong justification for integrating innovative teaching strategies, such as PhET simulations, as instructional interventions. This finding is consistent with the results of Banda and Nzabahimana (2023), who noted that most students often struggle with complex science concepts when instruction relies heavily on lectures and textbooks. Students often develop a shallow understanding, which can lead to underperformance (Diab et al., 2024).

TABLE 2
SCIENCE PERFORMANCE LEVELS OF GRADE 8 STUDENTS BEFORE USING
PHET SIMULATIONS

Scores	Frequency	Percentage	Descriptive
	(f)	(%)	Rating
90-100	0	0	Outstanding
85-89	10	33.33	Very Satisfactory
80-84	8	26.67	Satisfactory
75-79	7	23.33	Fairly Satisfactory
Below 75	5	16.67	Did not meet the expectation
N=30 Composite Mean= 80.92 Sd=5.30			

Table 3 displays the science performance of the respondents after integrating PhET simulations. Out of 30 respondents, the results reveal that almost half, or 46.67% of respondents, were categorized as “outstanding level”, while 30% rated “very satisfactory” performance. In addition, 16.67% of respondents were identified as “fairly satisfactory.” Most essentially, no students scored below the minimum performance threshold. This indicates that all learners have met the desired learning standards after the instructional intervention. The overall science performance of the learners reached a “very satisfactory” level, as supported by the composite mean of 89.23 with a standard deviation of 5.98. These findings align with the study by Muilwijk and Lazonder (2023), which investigated virtual and physical learning approaches and reported that virtual learning methods, such as PhET, are more effective in certain contexts than traditional laboratory setups due to their ability to promote conceptual understanding.

TABLE 3
SCIENCE PERFORMANCE LEVELS OF GRADE 8 STUDENTS AFTER USING PHET SIMULATIONS

Scores	Frequency	Percentage	Verbal Description
	(f)	(%)	
90-100	14	46.67	Outstanding
85-89	9	30.00	Very Satisfactory
80-84	5	16.67	Satisfactory
75-79	2	6.67	Fairly Satisfactory
Below 75	0	0.00	Did not meet expectation
N=30	Composite Mean= 89.23	Sd=5.98	

2. Significant Difference in their Science Performance Before and After Implementing PhET Simulations

Table 4 presents the results of the paired sample t-test conducted to determine the significant differences in science performance between grade 8 students before and after using the PhET simulations, as measured by the pretest and posttest scores. As appeared in the table, there is a significant increase in the mean scores of the respondents from their pretest score of 80.92 to a posttest score of 89.23. This yielded a computed t-value of 5.85.

Also, the corresponding probability value of 0.000 is below the significance level at 0.005. This signifies that there is a difference in the science performance of the learners before and after the integration of the PhET simulations. That is, the use of PhET simulations has resulted in meaningful improvement in learners' science performance. This further suggests that students can gain a deeper conceptual understanding when teachers use interactive and learner-centered instructional strategies.

The use of PhET simulations provides learners with opportunities to manipulate variables and proactively engage in the teaching and learning process. Confirming this, Pranata (2024) underscored that virtual simulation activities promote a deeper understanding of science concepts. Thus, this reinforces their scientific inquiry processes.

TABLE 4
T-TEST RESULTS ON THE DIFFERENCE BETWEEN THE PRE-TEST AND POST-TEST SCORES OF THE RESPONDENTS

Group	t-value	Mean	p-value	Remarks
Pre-test	5.85	80.92	0.0000**	Significant
Posttest		89.23		

Sig. at 5%

3. Descriptions of Learners' Attitude towards PhET Simulations as an Instructional Intervention

Table 5 outlines the grade 8 students' attitude toward the use of PhET simulations as an instructional intervention. As reflected in the table, the respondents generally expressed a highly positive attitude toward the use of PhET simulations, as evidenced by their composite mean score of 4.28, with a verbal description of strongly agree. The favorable attitude of the learners signifies that PhET simulations make a significant contribution to addressing one of the common challenges in teaching Biology lessons, particularly in conceptualizing microscopic and abstract concepts. This supports a deeper understanding of the scientific phenomena and helps learners to sustain their interest and engagement.

In addition, among the indicators, "PhET simulations make learning Biology more interactive and fun", and I am satisfied with the use of PhET simulations in my Biology Class equally received the highest weighted mean score 4.47 with a verbal description of strongly agree. This manifests a strong approval and satisfaction among the learners. Moreover, students strongly agreed on the indicators related to engagement, motivation, and perceived value of PhET simulations, which received high ratings, ranging from 4.27 to 4.33.

On the other hand, students scored "agree" on the following statements addressing conceptual understanding and confidence, such as understanding complex biology topics and confidence in answering biology-related questions, with a mean score of 4.20 and 4.13, respectively. This entails that learners generally perceive PhET simulations as beneficial for conceptual understanding and building their self-confidence, although there are slight variations in perceptions due to individual differences.

TABLE 5
DESCRIPTIONS OF LEARNERS' ATTITUDE TOWARDS PHET SIMULATIONS

Statement	Mean	Sd	DR
1. PhET simulations make learning Biology concepts more engaging and interesting.	4.33	0.66	Strongly agree
2. I find it easier to understand complex Biology topics when using PhET simulations.	4.13	1.01	Agree
3. PhET simulations help me visualize abstract biological processes effectively.	4.17	0.70	Agree
4. I prefer learning Biology through PhET simulations rather than conventional lectures.	4.10	0.88	Agree
5. Using PhET simulations improves my confidence in answering Biology-related questions.	4.20	0.66	Agree
6. PhET simulations encourage me to explore Biology topics beyond what is covered in class.	4.27	0.69	Strongly agree
7. I believe that PhET simulations are a valuable tool in enhancing my Biology learning experience.	4.33	0.66	Strongly agree
8. PhET simulations make learning Biology more interactive and fun.	4.47	0.73	Strongly agree
9. I feel more motivated to study Biology when PhET simulations are used in class.	4.30	0.65	Strongly agree
10. I am satisfied with the use of PhET simulations in my Biology class.	4.47	0.73	Strongly agree
Overall Mean	4.28	0.55	Strongly agree

4. Proposed Instructional Support Plan for Science Teachers

I. Rationale

The Simulation-Enhanced Science Instructional Plan is designed to support the effective use of PhET simulations. This aims to solidify the scientific literacy skills of the grade 8 students and deepen their conceptual understanding and self-confidence in learning scientific concepts through sustained integration of PhET simulations in Biology lessons.

II. Objectives

1. To improve mastery of abstract lessons in Biology lessons;
2. To increase learners' confidence in participation during discussions; and
3. To sustain high level of engagement and motivation of the learners

III. Work Plan

Phase	Activities	Persons Involved	Time Frame	Expected Output
Preparation	Orientation on PhET simulations	School Head, Science Teachers	1st Month	Teachers oriented on simulation-based inquiry
	Selection of Biology topics suitable for PhET integration	Science Teachers	1st Month	Identified target lessons

Implementation	Integration of PhET simulations in Biology lessons (guided inquiry activities)	Science Teachers, Learners	2nd–4th Month	Improved conceptual understanding
	Use of structured worksheets and inquiry guides during simulations	Science Teachers	2nd–4th Month	Enhanced inquiry skills
Support & Enrichment	Small-group remediation using PhET simulations for struggling learners	Science Teachers	3rd–4th Month	Reduced learning gaps
	Enrichment tasks (exploration challenges, virtual investigations)	Science Teachers, Learners	3rd–4th Month	Increased confidence and mastery
Monitoring & Evaluation	Periodic formative assessments (quizzes, reflection journals)	Science Teachers	Throughout implementation	Monitored learning progress
	Posttest and attitude survey	Science Teachers	End of implementation	Measured learning gains

Sustainability	Sharing of best practices through LAC sessions	Science Teachers	End of SY	Sustained implementation
	Integration of PhET simulations in science lesson exemplars	Teachers, School Head	Next SY	Institutionalized strategy

IV. Monitoring and Evaluation

Indicators	Tool	Responsible Persons	Frequency
Improvement in test scores	Pretest–Posttest	Science Teachers	Quarterly
Learner engagement and participation	Observation checklist	Science Teachers	Monthly
Learner confidence and attitude	Attitude survey	Science Teachers	End of quarter
Teacher implementation fidelity	Lesson plan review	School Head / Department Head	Quarterly

IV. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of findings, conclusions drawn, and recommendations offered.

Summary of Findings

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

1. The baseline science performance of the respondents generally performed at a satisfactory level prior to the use of PhET simulations, as evidenced by their composite mean score of 80.92. Correspondingly, the science performance of the respondents improved significantly after integrating PhET simulations to a very satisfactory level, as supported by an average mean score of 89.23.
2. There was a significant difference between the baseline and posttest science performance of the respondents as indicated by their paired sample t-test score of 5.85, with a p-value of 0.000.
3. The grade 8 students generally expressed a highly positive attitude toward the use of PhET simulations, as supported by the overall mean score of 4.28.
4. The proposed instructional support plan is designed to support effective implementation of school-based virtual simulations.

Conclusions

Based on the summary of findings, the following conclusions were drawn:

1. The Grade 8 Science Performance was generally adequate but not optimal prior to the use of PhET simulations. After the integration of PhET simulations, the science performance of the respondents significantly elevated, resulting in the elimination of low-performing outcomes.
2. PhET simulations are an effective instructional intervention strategy in promoting deeper understanding of scientific concepts.
3. The innovative instructional intervention strategy, such as PhET simulations, fosters not only academic success but also engagement and confidence in learning Biology lessons.
4. The Simulation-Enhanced Science Instructional Support Plan aims to solidify the scientific literacy skills of the grade 8 students and deepen their conceptual understanding and self-confidence in learning scientific concepts through sustained integration of PhET simulations in Biology lessons.

Recommendations

Given the preceding conclusions, the following recommendations are offered:

1. School Heads may lead and initiate professional development activities, such as learning action cells to support the implementation of school-based virtual learning approaches.
2. Science Teachers are urged to adopt PhET simulations into their instructional practices, especially in teaching abstract scientific concepts.
3. Students are encouraged to be actively involved with PhET simulations as additional learning support resources to further enrich their deeper understanding of concepts.
4. The Simulation-Enhanced Science Instructional Support Plan is recommended to be implemented and adopted at the school level to ensure its effectiveness and sustainability.

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5. Future researchers may examine the relationship between learners' attitudes and academic performance using larger sample sizes and mixed-method research designs.

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