EFFECTIVENESS OF INTERACTIVE SIMULATION IN IMPROVING THE PERFORMANCE IN SCIENCE OF THE GRADE 8 STUDENTS OF OCCIDENTAL MINDORO STATE COLLEGE

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ABSTRACT

This study evaluates the effectiveness of interactive simulations, specifically Physics Education Technology (PhET) simulations, in teaching science. PhET simulations are offline applications designed to provide dynamic and engaging representations to enhance student learning.

A quasi-experimental design was employed, utilizing a pre-test and post-test approach with the DepEd Science 8 self-learning module (SLM) in the Caraga Region. The study involved 50 Grade 8 students from Occidental Mindoro State College during the 2022-2023 academic year. Students were divided into two groups: one experienced conventional teaching methods, while the other used interactive simulations. Both groups participated in two learning sessions and then completed a test on the particle nature of matter.

The test results indicated that the performance of students in both the conventional and interactive simulation groups was comparable. Statistical analysis showed no significant difference between the two groups' scores, suggesting that both teaching methods were equally effective in helping students understand the subject matter.

The study finds that interactive simulations and conventional teaching methods yield similar outcomes in terms of student understanding. Despite the engaging nature of interactive simulations, they did not demonstrate a significant advantage over conventional methods. This suggests that both approaches are effective and may be used interchangeably or in combination to support science education.

Keywords*: Physics education technology (PhET) simulation, conventional teaching strategy, interactive simulation teaching strategy*

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INTRODUCTION

In today's era, science stands as a central element, as emphasized by Shana and Abulibdeh (2020), whose primary objective in education is to equip every Filipino student with a pragmatic grasp of scientific principles and their relevance to daily life. This approach aims to foster the essential scientific knowledge, skills, attitudes, and values vital for comprehending and tackling societal issues routinely.

However, according to Mullis et al. (2020), the trends in International Mathematics and Science Study (TIMSS) reports that the Philippines only scored 249 in science which is significantly lower than other participating countries in science assessments in the year 2019. Only 13% of all the Filipino students who joined were on the low benchmark which means they had a limited understanding of scientific concepts and foundational science facts, while 87% of the population participating did not even reach the low benchmark.

Hannel and Cuevas (2018) pointed to an outdated approach to information transfer and course discussion that may affect the students' interest and engagement. To improve on this, Bonifacio (2013) suggested that ICT-assisted education encourages students to learn more, provides them with opportunities to work cooperatively with other students, and supports the growth of different intelligences. In the latest study on grade 10 students at Occidental Mindoro State College basic education laboratory found that synchronous modality yields higher improvement in terms of scores than asynchronous mode of learning. Thus, based on the outcomes of the post-test the difference is not noticeable as the mean is interpreted as satisfactory in both modalities. Whereas, they recommend that teaching may involve intervention on one of the groups to measure if the performance of students alleviate, intervention such as simulations and gamifications (Smiderle et al., 2020).

With all the primary issue in Philippine science education is apparent in the notably low TIMSS score, lagging significantly behind global averages. Mullis et al. (2020) highlights the problem is due to an outdated teaching approach, prompting suggestions for remedies. Overall, the problem underscores the necessity for a comprehensive revaluation and innovative measures to bring about meaningful improvement in science education in the Philippines.

Considering these problems experienced by the teachers and students, computer simulations can successfully enhance conventional teaching (Rutten et al., 2012; Nickl et al., 2022). The utilization of interactive simulation-based activities from Physics Education Technology (PhET) can help students better understand science ideas. PhET provides free interactive math and science simulations to enhance learning (Smart,2014). These exercises and simulations allow students to participate in acts that would be impractical in a real-world setting (Bowen & DeLuca, 2015).

The purpose of this study was to examine the effectiveness of PhET Interactive Simulation in improving students' academic performance in science, taking into account the conceptual challenges students have with abstract chemistry concepts and the issues stated by the researchers above (Jones & Roseman, 2013).The introduction of your research paper should explain what the research problem is all about which includes a very brief discussion of what has been done from previous research in relation to your problem and the gap you are

trying to address. Likewise, the purpose of why you have conducted your research must be highlighted in this section including the contribution of the article.

MATERIALS AND METHODS

Research Design

This study adopted a quasi-experimental research design. According to Maciejewski (2018), quasi-experimental is the most useful design in situations where conducting a true experiment would be unethical or impractical. In this case, a quasi-experiment allows researchers to investigate the same causal relationship without having to deal with ethical concerns. Although quasi-experiments have lower internal validity than true experiments, they frequently have higher external validity because they can use real-world interventions rather than artificial laboratory settings.

It is considered as an appropriate means in achieving the main objective of the study whereas, control groups are not randomized; the non-equivalence dependent variable in study is more regulated, efficient and targeted. It aids to determine if there is a significant difference in improving students' performance in the particle nature of matter using traditional teaching strategy and interactive simulation.

Research Site

This study was conducted at Occidental Mindoro State College – San Jose Campus, Quirino St, San Jose, Occidental Mindoro during the Academic Year 2022-2023.

Respondents of the Study

The respondents of this study were the Grade 8 students of Occidental Mindoro State College – San Jose Campus for the Academic Year 2022-2023. The researchers chose them for the study because they studied the particle nature of the matter in the third quarter of the mentioned academic year. The researchers used purposive sampling technique in the selection of the respondents.

There were 25 respondents who participated in each setup, with a total of 50 participants selected by the researchers using random sampling.

Research Instrument

The researchers adopted a pre-test and post-test in DepEd Science 8 Self-Learning Module (SLM) of Caraga Region, as the study's primary instrument. The researchers cited three different test types: pre-test, quizzes, and post-test. To identify the students' prior knowledge in relation to the subject that is taught, 15 items for the pre-test were given to Grade 8 students that include test items regarding the particle nature of matter. Addition to that, in order to evaluate their understanding about the particle nature of matter, the Grade 8 students took 15 items for the post-test.

To help students understand the topics better, two quizzes were added after discussing each theme. The first quiz looked at the properties of matter with 15 questions, and the second quiz covered the physical changes of matter, also with 15 questions. This careful approach not

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only assessed the students thoroughly but also got them actively thinking about what they learned.

A key part of the study's method was using the Physics Educational Technology (PhET), an interactive simulation made by the University of Colorado Boulder (Wieman et al. 2010). This tool, made for teaching physics and chemistry in high school and college, uses visual aids, demonstrations, and drawings to enhance the learning experience.

Data Collection

To assess the students' prior knowledge, a pre-test was administered before the intervention. This pre-test was designed to determine whether both groups possessed similar competency levels regarding the topic. Following the pre-test, the instructional intervention was implemented, with one group receiving conventional teaching and the other being taught using interactive simulations. Both groups were instructed by the same researcher to maintain consistency in the delivery of content.

The topic of study, "The Particle Nature of Matter," was covered uniformly in both groups over two learning sessions. These sessions were conducted sequentially for Grade 8 students at Occidental Mindoro State College-San Jose Campus during the third grading period of the academic year 2022-2023.

After the first learning session, a quiz was administered to both the conventional and interactive simulation groups to evaluate their understanding of the material. The same process was repeated following the second session, with an identical set of tests given to both groups to ensure a fair comparison between the teaching strategies.

Ethical Consideration

Before commencing the study, ethical approval was obtained from the relevant authorities at Occidental Mindoro State College-San Jose Campus. A formal communication letter was signed by the school principal, granting permission to conduct the research on-site. This letter also ensured that the study adhered to all institutional and ethical guidelines.

To protect the rights and welfare of the participants, strict measures were implemented to maintain confidentiality and anonymity. All student data was anonymized, and no identifying information was recorded or disclosed at any stage of the research. Participants and their guardians were informed about the study's purpose, procedures, and potential risks, and informed consent was obtained from both students and their guardians before participation.

Furthermore, the study was designed to minimize any potential harm or disruption to the students' regular educational activities. The researchers ensured that all data collection processes, including pre-tests, interventions, and post-tests, were conducted with respect for the students' time and well-being. Data was securely stored and accessible only to the researchers involved in the study.

Data Analysis

The researchers employed several statistical tools to evaluate the students' performance. Frequency, percentage, mean, and standard deviation were calculated to describe the overall level of student performance. To assess the improvement in scores, the dependent sample t-test was utilized, using the pre-test scores as the baseline for comparison. The paired t-test was conducted to examine the homogeneity of the groups by comparing the pre-test and post-test scores within each group. Additionally, the independent sample t-test was applied to determine any significant differences in performance levels between students taught using the interactive simulation and those taught through conventional teaching methods.

These statistical analyses were integral to determining whether the interactive simulation method led to a significant improvement in student scores compared to conventional teaching strategies.

RESULTS

Students' performance levels before the conventional and interactive simulation teaching interventions

The results indicate that both the conventional method (7.36±2.35) and the interactive simulation (7.96±1.47) largely did not meet expectations. However, the interactive simulation performed slightly better, showing a higher percentage of satisfactory scores (36%) compared to the conventional method (4%). Overall, neither method achieved very satisfactory or outstanding results (Table 1).

Table 1. Students' performance levels before the conventional and interactive simulation teaching interventions.

SCORE	CONVENTIONAL		INTERACTIVE SIMULATION	
	f	%	f	%
0 – 7	13	52.00	12	48.00
8 – 9	11	44.00	4	16.00
10 – 11	1	4.00	9	36.00
12 – 13	0	0.00	0	0.00
14 – 15	0	0.00	0	0.00
Total	25	100.00	25	100.00
Conventional (Mean Score±SD)			7.36±2.35	
Interactive Simulation (Mean Score±SD)			7.96±1.47	

Legend:0-7=Did not Meet Expectations; 8-9=Fairly Satisfactory; 9-10=Satisfactory; 11-12=Very Satisfactory; 13-15=Outstanding

Significant differences in student performance before the conventional and interactive simulation teaching interventions

The t-test results suggest that there is a statistically significant difference between the mean scores of the conventional method (7.36 ± 2.35) and the interactive simulation (7.96 ±

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1.47), with a t-statistic of 1.087 and a p-value of 0.001. This indicates that there is a significant difference between the two groups.

Table 2. Significant differences in student performance before the conventional and interactive simulation teaching interventions.

VARIABLE	MEAN±SD	T- STATISTIC	P- VALUE
Conventional	7.36±2.35	1.087	0.001
Interactive simulation	7.96±1.47		

Legend: p-value < 0.05 = Significant

Students' performance levels after the conventional teaching strategy and interactive simulation intervention

The results show that the interactive simulation method performed better overall compared to the conventional method. The mean score for the interactive simulation (9.16±1.37) was satisfactory, while the conventional method (8.64±2.13) is fairly satisfactory performance. A higher percentage of participants in the interactive simulation achieved satisfactory or very satisfactory scores compared to those in the conventional method.

Table 3. Students' performance levels after the conventional teaching strategy and interactive simulation intervention.

SCORE	CONVENTIONAL		INTERACTIVE SIMULATION	
	f	%	f	%
0 – 7	6	24.00	5	20.00
8 – 9	13	52.00	9	36.00
10 – 11	4	16.00	7	28.00
12 – 13	2	8.00	4	16.00
14 – 15	0	0.00	0	0.00
Total	25	100.00	25	100.00
Conventional (Mean Score±SD)			8.64±2.13	
Interactive Simulation (Mean Score±SD)			9.16±1.37	

Legend:0-7=Did not Meet Expectations; 8-9=Fairly Satisfactory; 9-10=Satisfactory; 11-12=Very Satisfactory; 13-15=Outstanding

Comparison of pre-test and post-test scores for conventional and interactive simulation methods

The t-test results show a significant improvement in scores from pre-test to post-test for both methods. The conventional method improved from a mean score of 7.36 ± 2.35 to 8.64 ± 2.13, with a t-statistic of 3.669 and a p-value of 0.001, indicating a significant improvement. The interactive simulation also showed a significant improvement with a t-statistic of 3.928 and a p-value of 0.001, though the exact pre-test and post-test means for this method aren't provided. Both methods demonstrated effective outcomes with significant changes in performance.

Table 4. Comparison of pre-test and post-test scores for conventional and interactive simulation methods.

VARIABLE	MEAN±SD	T- STATISTIC	P- VALUE
Conventional			
Pre-test	7.36±2.35	3.669	0.001
Post-test	8.64±2.13		
Interactive simulation			
Pre-test	7.96±1.47	3.928	0.001
Post-test	9.16±1.37		

Legend: p- value < 0.05 = Significant

Significant differences in student performance between conventional and interactive simulation teaching methods

Given the t-statistic of 0.917 and a p-value of 0.364 for the comparison between the conventional teaching strategy and the interactive simulation, the results indicate that there is no statistically significant difference between the two methods.

Table 5. Significant differences in student performance between conventional and interactive simulation teaching methods.

VARIABLE	MEAN±SD	T- STATISTIC	P- VALUE
Conventional	8.64±2.13	0.917	0.364
Interactive simulation	9.16±1.37		

Legend: p-value < 0.05 = Significant

DISCUSSION

The study evaluates the effectiveness of conventional teaching methods versus interactive simulation-based activities in enhancing students' performance in science, specifically focusing on the Particle Nature of Matter. Data from both experimental and control groups were analyzed, with the experimental group using PhET interactive simulations and the control group receiving conventional teaching.

The pre-test results showed that neither teaching method met the expected performance standards. However, students displayed a basic understanding of the topic, likely due to prior exposure to fundamental scientific concepts. This highlights the challenge of assessing students' knowledge and underscores the importance of considering the broader educational context (Cole et al., 2020; Dunton & Co, 2019; Singer et al., 20023).

Initial comparisons of mean scores revealed no significant difference between the two teaching methods, suggesting similar effectiveness in facilitating initial comprehension. This finding aligns with previous research by Raymond et al. (2016), which emphasizes the need for careful group comparison to ensure study validity.

In the post-test, both groups showed improvements, with the interactive simulation group achieving a slightly higher mean score. Despite this difference, the overall performance levels between the two groups were not significantly different. This indicates that while

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interactive simulations may enhance student engagement, their effectiveness in terms of overall learning outcomes is comparable to that of conventional teaching methods (Hannel & Cuevas, 2018).

The study's findings resonate with previous research on the potential of interactive simulations to deepen conceptual understanding (Banda & Nzabahimana, 2021). However, it is essential to acknowledge that both teaching methods have their strengths and limitations, and their effectiveness may vary depending on factors such as subject matter, student demographics, and instructional context.

While interactive simulations offer promising opportunities for enhancing science education, their integration into teaching practices should be considered alongside conventional methods. By leveraging the strengths of both approaches, educators can create engaging and effective learning environments that cater to the diverse needs of students and promote meaningful learning experiences. Thus, teachers remain a crucial source of knowledge in instructing students and communicating information (Murray, 2021).

This study employed learning sessions, pre-tests, and post-tests as its primary data collection methods to assess student performance, utilizing both conventional teaching and interactive simulation strategies to explore their impact on science learning. As a quasi-experimental study, it examined causal relationships between variables, though it lacked random assignment of participants to different groups, making comparisons challenging due to potential confounding variables such as gender or socioeconomic status. Consequently, while the study sheds light on the effectiveness of teaching strategies, caution is warranted in attributing observed differences solely to the treatments administered.

This study, as a quasi-experimental design, faced limitations including the lack of random assignment to different groups, which introduces potential confounding variables such as gender or socioeconomic status. Additionally, the study's reliance on pre-tests and post-tests may not fully capture the exact effects of the teaching methods on long-term learning and retention. The findings should be interpreted with caution, as the observed differences may be influenced by factors beyond the teaching methods alone.

CONCLUSION

In conclusion, the study found that neither conventional teaching methods nor interactive simulations initially met the expected performance standards. However, both approaches demonstrated comparable effectiveness in improving students' science performance, as evidenced by the t-test results. Both methods resulted in relatively satisfactory performance levels, with the conventional teaching approach showing notable improvement. Although interactive simulations facilitated deeper engagement and enhanced conceptual understanding, they did not produce statistically significant differences compared to conventional methods. Therefore, integrating both strategies thoughtfully is crucial for developing effective learning environments tailored to students' needs.

To optimize educational outcomes, educators should consider blending conventional teaching with interactive simulations to leverage the strengths of both methods. Additionally,

further research should explore long-term impacts of these teaching strategies on student retention and conceptual mastery to provide more comprehensive insights.

REFERENCES

Banda, H. J., & Nzabahimana, J. (2021). Effect of integrating physics education technology simulations on students' conceptual understanding in physics: A review of literature. *Physical Review Physics Education Research*, *17*(2). https://doi.org/10.1103/physrevphyseducres.17.023108

Bonifacio, A. (2013). *Developing Information Communication Technology (ICT) curriculum standards for K-12 schools in the Philippines*. https://www.semanticscholar.org/paper/Developing-Information-Communication-Technology-(-)-Bonifacio/7164ae5e942f0bd45a8f1296677abd8714299d87

Bowen, B., & Deluca, W. (2015). *Comparing traditional versus alternative sequencing of instruction when using simulation modeling* (16th ed.). Institute for STEM Education and Research. https://eric.ed.gov/?id=EJ1065409

Cole, M., Wilhelm, J., Vaught, B. M., Fish, C., & Fish, H. (2020). The Relationship between Spatial Ability and the Conservation of Matter in Middle School. Education Sciences, 11(1), 4. https://doi.org/10.3390/educsci11010004

Dunton, J. B., & Co, W. S. (2019). "Spiral Progression Approach in Teaching Science and the Performance of Learners in District I, Capiz." *Journal of Physics Conference Series*, *1254*(1), 012045. https://doi.org/10.1088/1742-6596/1254/1/012045

Hannel, S. L., & Cuevas, J. (2018). A study on science achievement and motivation using computer-based simulations compared to traditional hands-on manipulation. *Georgia Educational Researcher*, *15*(1). https://doi.org/10.20429/ger.2018.15103

Jones, D. L., & Roseman, R. B. (2013). Comparing physics and math problems. *AIP Conference Proceedings*. https://doi.org/10.1063/1.4789688

Maciejewski, M. L. (2018). Quasi-experimental design. *Biostatistics & Epidemiology*, *4*(1), 38–47. https://doi.org/10.1080/24709360.2018.1477468

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). *TIMSS 2019 International Results in Mathematics and Science.* Retrieved from Boston College, TIMSS & PIRLS International Study Center website: https://timssandpirls.bc.edu/timss2019/international-results/

Murray, J. (2021). Good teachers are always learning. *International Journal of Early Years Education,* 29(3), 229–235. https://doi.org/10.1080/09669760.2021.1955478

Nickl, M., Huber, S. A., Sommerhoff, D., Codreanu, E., Ufer, S., & Seidel, T. (2022). Video-based simulations in teacher education: the role of learner characteristics as capacities for positive learning experiences and high performance. *International Journal of Educational Technology in Higher Education*, *19*(1). https://doi.org/10.1186/s41239-022-00351-9

Raymond, E., Atsumbe, B., Okwori, R., & Jebba, A. M. (2016). Comparative effects of the synchronous and the asynchronous Instructional approaches concerning the students' achievements and interests in electrical engineering at the Niger State College of

Education. *International Journal of Engineering Pedagogy (iJEP)*, *6*(3), 4. https://doi.org/10.3991/ijep.v6i3.5302

Rutten, N., Van Joolingen, W. R., & Van Der Veen, J. T. (2012). The learning effects of computer simulations in science education. *Computers & Education*, *58*(1), 136–153. https://doi.org/10.1016/j.compedu.2011.07.017

Shana, Z., & Abulibdeh, E. S. (2020). Science practical work and its impact on students' science achievement. *Journal of Technology and Science Education*, *10*(2), 199. https://doi.org/10.3926/jotse.888

Singer, J. E., Tal, R., & Wu, H. (2003). Students' understanding of the particulate nature of matter. *School Science and Mathematics*, *103*(1), 28–44. https://doi.org/10.1111/j.1949-8594.2003.tb18111.x

Smart, J. B. (2014). A Mixed Methods Study of the Relationship between Student Perceptions of Teacher-Student Interactions and Motivation in Middle Level Science. *RMLE Online*, *38*(4), 1–19. https://doi.org/10.1080/19404476.2014.11462117

Smiderle, R., Rigo, S. J., Marques, L. B., De Miranda Coelho, J. a. P., & Jaques, P. A. (2020). The impact of gamification on students' learning, engagement and behavior based on their personality traits. *Smart Learning Environments*, *7*(1). https://doi.org/10.1186/s40561-019-0098-x

Wieman, C., Adams, W., Loeblein, P., & Perkins, K. (2010). Teaching physics using PhET simulations. *The Physics Teacher, 48*(4), 225–227. https://doi.org/10.1119/1.3361987