Physics Education Technology (PhET) Interactive Simulation in Student's Learning Skills in Biology

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Abstract— **The study aimed to determine the impact of integration of PhET interactive simulation in students' learning skills in Biology 2. The respondents were the 70 grade 12 Science and Technology, Engineering and Mathematics (STEM) students from Aliaga National High School and San Ricardo National High both in the context of blended learning modality and they were selected using purposive sampling in order to satisfy the objectives of the study. The researcher used descriptive correlational research to describe the relationship of PhET interactive simulation and students' skills. The findings results that students are allotted one to hours in their online learning using their smartphone and they can access online learning using data internet connections. The students had a very good performance in the subject. The integration of PhET interactive simulation in students' learning skills concluded that it helps develop students' flexibility, inquiry and discovery process, creativity, exploration and analytical and critical thinking skills. The findings concluded that those students with smart phone and laptop, DSL connection and always attended online class have better level of PhET interactive simulation.**

***Index Terms*— Biology 2, Interactive, Learning Skills, Science, PhET, Simulation**

I. INTRODUCTION

The integration of interactive or online simulation in Science plays a vital role especially in today's trying times in helping learners to improve learning development and progress. Teachers always find ways to deliver instructions in more convenient, effective and simpler ways.

PhET interactive simulations, activity design guidelines and strategies aims to help students and teachers to create a student-centered classroom by hearing and valuing students ideas, promoting student agency-actively driving their learning, encouraging and guiding students inquiry, being a co-participants in the inquiry process, building on students' prior knowledge, valuing and addressing multiple goals, adapting activities to their environment and the students, implementing checks for understanding in order to assess students learning and drive instruction, being responsive by flexibly adapting to emergent student ideas and being experience, professionalism, and knowledge of their students to designing, implementing and improving activities, implementation and sim design (PhET, Colorado, 2019).

In this challenging times of pandemic, teachers and learners need to be prepared in a more advanced technology interactive simulation in teaching and learning process in Science to meet the learning goals and competencies in achieving quality education in full satisfaction.

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In the study of Salagubang (2020), PhET simulation in Science class was a very effective tool in the teaching-learning process. The study also revealed that PhET simulation in Science instruction was an effective tool in improving students' academic performance. The gadget used at home and the time allotment in the study were found significantly related to the subjects profile and academic performance in Science.

PhET Simulations is a substantial in teaching and learning biology, math, physics and other sciences. Considerable research has investigated the used of PhET sims in a variety of educational settings. Real world substance, situations and scenarios are used so that students understand well the phenomena, theories and concepts of the subject matter (Refuerzo, 2019).

According to Radnai et al. (2019), the effectiveness of the use of PhET simulation in learning physics is also in accordance and with the assisted of simulation of media or game like PhET in learning science especially mathematics and physics, the learning activities or explanation is more effective than other media and student learning outcomes are also better.

In addition, Batuyong and Antonio (2018), revealed that PhET Interactive Simulation-Based Activities (ISBA) had a significant improvement on the Physics academic performance of the students. The answer in the informal interview and feedbacks in the scientific journal of the students revealed that when PhET ISBA was used in teaching, students acquired significant learning experiences which were synthesized into three big themes: learning Physics is fun, learning Physics is real and learning Physics is simple and easy. Hence, PhET ISBA was found to be effective as an instructional material in teaching Physics, particularly in Electromagnetism.

By integration of PhET interactive simulation in Science learning, it is like a blended learning approach with complete package of online discussion and activities, virtual laboratories and experiments, lectures, real life scenarios, exercises and discussions with the use of models or representations of the invisible and risky for better understanding.

The researcher aims to conduct this study to determine the impact of integration of PhET interactive simulation in students' learning skills in Earth and Life Science, learning in terms of inquiry and discovery processes, exploration, developing higher order thinking skills, flexibility and professionalism.

II. OBJECTIVES OF THE STUDY

This study aims to determine the impact of integration of PhET interactive simulation in students' learning skills in Biology.

Generally, it will seek to answer to the following questions:

1. How may the online learning of the respondents be described in terms of:
   1.1 time allocation in Study (biology 2);
   1.2 availability of gadgets;
   1.3 internet connection; and
   1.4 online class attendance?
2. How may the academic achievement of the students be described with their first quarter grade in Biology?
3. What is the level of integration of PhET interactive simulation in students' learning skills in Biology 2 in terms of:
   3.1 inquiry and discovery processes;
   3.2 exploration;
   3.3 creativity;
   3.4 analytical and critical thinking; and
   3.5 flexibility?
4. Is there a significant relationship between online learning and in integration of PhET Simulation of the students in Biology 2?
5. Is there a significant relationship between academic achievement and of integration of PhET interactive simulation in students' learning skills in biology?
6. What are the challenges encountered by the students during PhET interactive simulation in students' learning skills in biology 2 in terms of:
   6.1. connectivity;
   6.2 schedule of online learning; and
   6.3. learning activity tasks?
7. What is the output of the study that the researcher may recommend?

III. RESEARCH METHOD

The researcher used descriptive correlation design to describe the profile of the students' and impact of PhET interactive simulation to students' learning skills in Biology. In the study of Viernes (2016), stated that descriptive correlation research design involves analysis of an extremely range of phenomena that results in comprehensive presentation and interpretation of statistical tabulations of data yielded by survey.

The study was conducted at the two public secondary schools in Division of Nueva Ecija, namely Aliaga National High School and San Ricardo National High School. They are selected The participants are the 70 grade 12 students at the two mentioned school above and chosen using purposive sampling method in order to satisfy the needs of the objectives.

The scope of this study was based on the biology 2 subject area for grade 12 students. And it will be delimited to three video lessons/topics based on aligned MELCs in the integration of PhET simulation covering for the period of First Quarter, Second Semester for S.Y. 2020-2021 to determine the impact of integration of PhET interactive simulation in students' learning skills in terms of students' inquiry and discovery processes; exploration; creativity analytical and critical thinking; and flexibility.

Furthermore, the main instrument used in this study was a survey questions based on the use of PhET interactive simulation of the students in biology wherein the students can determine the impact of PhET in their learning skills. A range of references are the basis of the development.

Rating Scale	Weights Assigned	Description	Interpretation Impact of PhET interactive Simulation
4	3.25 – 4.00	At all times	Very High
3	2.50 – 3.24	Most of the Times	High
2	1.75 – 2.49	Sometimes	Average
1	1.00 – 1.74	Never	Low

Moreover, the researcher will use the following data analysis tool to tabulate and analyze data in line with the objectives of the study:

1. To describe the demographic profile of the student-respondents, the frequency count and percentage will be used.
2. To described the academic achievements in biology, frequency and percentage will be utilized.
3. To described the impact of the PhET interactive simulation in learning skills in biology of the students, weighted mean will be used.
4. To determine the relationship of PhET interactive simulation, Pearson Product Moment Correlation and Spearmans' rho will be used.
5. To determine the impact of PhET interactive simulation, Chi- Square will be used.
6. To identify the challenges encountered by the students in integration of PhET interactive simulation in biology, frequency and ranking will be utilize

IV. RESULTS AND DISCUSSION

Online Class Attendance	**Frequency**	**Percent**
Always	34	48.57
Most of the times	21	30.00
Sometimes	15	21.43
Total	**70**	**100**

Table 1.*Online Learning of the Student-Respondents as to Internet Connection*

1) Online learning of the Student-Respondents

Table 1 shows the data on the online learning of the students in term of internet connection. As shown less than half 29 (41.43%) of the respondents used data internet connection, followed by 26 (37.14%) have DSL internet connection and only one (1.43%) use Piso Net during online learning.

The findings meant that most of the students now a days were using data internet connection. The findings also revealed that data internet connections was considered the cheapest and affordable internet connectivity for the students to have easy access used for their online learning.

Availability of Gadgets

Availability of Gadgets	Frequency	Percent
Smart phone	45	64.29
Non smart phone	4	5.71
Smart phone/laptop	20	28.57
Others	1	1.43
Total	70	100

Table 2. Online Learning of the Student-Respondents as to Availability of Gadgets

Table 2 presents the data on the online learning of the students in terms of availability of gadgets. Almost half 45 (64.29%) have smart phone and 20 (28%) have smart phone and laptop. There are few 4 (5.71%) students only have non smart phone and only one (1.43%) had other available gadgets used in online learning.

This means that smart phone are the most commonly used and available gadgets used on online learning may be because it is compact and handy for the students to have easy access on online learning anytime and anywhere.

Internet Connection

Internet Connection	Frequency	Percent
DSL(Converge, PLDT, etc...)	26	37.14
Wifi	14	20.00
Data	29	41.43
Piso Net	1	1.43
Total	70	100

Table 3. Online Learning of the Student-Respondents as to Internet Connection

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The findings meant that most of the students now a days were using data internet connection. The findings also revealed that data internet connections was considered the cheapest and affordable internet connectivity for the students to have easy access used for their online learning.

Online Class Attendance in Biology 2

Online Class Attendance	Frequency	Percent
Always	34	48.57
Most of the times	21	30.00
Sometimes	15	21.43
Total	70	100

Table 4. Online Learning of the Student-Respondents as to Online Class Attendance in Biology 2

Table 4 projected the data on the students' online class attendance in Biology 2. Less than half 34 (48.57%) of the students always attended Biology 2 online class, whereas 21 (30%) attend most of the times and 15 (21.43%) are sometime attended.

The result meant that majority of the students are regularly attended their online class specifically in Biology 2. The students show eagerness and enthusiasm to learn.

2) Students' Academic Performance in Biology 2

Academic Performance in Biology 2	Frequency	Percentage
below 75 Did not meet expectation	0	0.00
80 -84-Fairly Satisfactory	0	0.00
85-89-Satisfcatory	17	24.29
90-94-Very Satisfactory	35	50.00
95-100-Outstanding	18	25.71
Total	70	100.00

Table 5. Academic Performance in Biology 2 (Final Grade)

Table 5 presented the data on the academic performance of the students in Biology 2 based on their final grade. Half 35 (50%) of the student got academic grade performance ratings of 90 to 94, followed by 18 (25.71%) got ratings of 95 to 100 and 17 (24.29%) got ratings ranges from 85 to 89.

The findings meant that students shows a very good academic performance in Biology 2. They performed better in the subjects by showing their eagerness and enthusiasm to get a good grades.

3) PhET Interactive Simulation in Students' Learning Skills in Biology

PhET Interactive Simulation	WM	Verbal Interpretation
Inquiry and Discovery Process	3.20	Most of the Time
Exploration	3.18	Most of the Time
Creativity	3.20	Most of the Time
Analytical and Critical Thinking	3.15	Most of the Time
Flexibility	3.67	Most of the Time
Overall Weighted Mean	3.28	Most of the Time

Legend:
3.25 - 4.00 At All Times (High) | 1.75 – 2.49 – Sometimes (Average)
2.50 - 3.24 Most of the Time (High) | 1.00 – 1.74- Never (Low)

Table 6. Summary of PhET Interactive Simulation in Students' Learning Skills in Biology

Table 6 presents the data on the summary of the findings on integration of PhET interactive simulation in students' learning skills in Biology 2. As shown, the overall weighted mean got 3.28 and interpreted as "Most of the Times". Flexibility was found the highest weighted mean of 3.67 while analytical and critical thinking skills was found the lowest mean of 3.15 but still both interpreted as "Most of the Time".

The findings meant that the integration of PhET interactive simulation in Biology had high influential factor on students' learning skills for the students to keep on learning dealing with the lessons. The students are motivated to perform all the tasks assigned them, the reason why they can submit complete requirements on time in a well organize and orderly manner. By the integration of PhET, they do things more productive, creative and would be more flexible to explore new ideas and knowledge through inquiry and discovery process resulting to manage all task and activities needed to accomplish.

4) Relationship between online learning and in integration of PhET Simulation of the students in Biology 2

Based on the findings of the study the relationship between online learning and in integration of PhET Simulation of the students in Biology 2. Availability of gadgets was positively correlated with integration of Phet interactive simulation in terms of inquiry and discovery process (r=.418), exploration (r=.244), creativity (r=.268), analytical and critical thinking (r=.323) and flexibility (r=.291). This meant that those respondents with smartphone and laptop have better level of PhET interactive simulation.

However, internet connection was negatively correlated but significant with integration of Phet interactive simulation in terms of exploration (r=-.280), creativity (r=-.325), and flexibility (r=-.439). This meant that those respondents with DSL connection have better level of Phet interactive simulation.

On the other hand, Online Class Attendance in Biology was negatively correlated but significant with integration of Phet interactive simulation in terms of inquiry and discovery process (r=-.440), exploration (r=-.340), creativity (r=-.270), analytical and critical thinking (r=-.301) and flexibility (r=-.368). This meant that those respondents always attended classes have better level of Phet interactive simulation.

Therefore the hypothesis of no significant relationship is rejected. The findings implies that those students who had both smart phone and laptop with DSL internet connection can regularly attend online classes in Biology 2 that would be considered to have a better level of PhET interactive simulation. The findings concluded that online learning in terms of availability of gadgets, internet connects and online class attendance found to have significant correlation to student's learning skills in term of inquiry and discovery process, exploration, creativity, analytical and critical thinking and flexibility in the integration of PhET interactive simulation in Biology 2. The findings also concluded that those respondents with smart phone and laptop, DSL connection and always attended online class have better level of PhEt interactive simulation.

The findings of the study was similar to the findings of Wardani et al (2017) proved that gadgets with adroid-base physics games can improved students learning outcomes and critical thinking skills.

5) Relationship between academic achievement and of integration of PhET interactive simulation in students' learning skills in Biology

Table 14 shows the data on the relationship between academic achievement and of integration of PhET interactive simulation in students' learning in Biology. As shown, academic achievement of students do not significantly influence the integration of PhET interactive simulation in terms of inquiry and discovery process. The hypothesis of no significant relationship is accepted.

The results meant that the integration of PhET interactive simulation had no significant relationship to the academic achievement of students in Biology specifically in inquiry and discovery process. The students can still perform well even without integration of PhET .

6) Challenges encountered by the students during PhET interactive simulation in students' learning skills in biology in terms of connectivity, schedule of online learning and learning activity tasks

Based on the responses of the respondents on their challenges during the PhET interactive simulation, the following are revealed:

In terms of connectivity, almost all of the student-respondents were challenged to the low internet connection because one of their reason they only used data connections with limited internet accessibility based on the number of bytes are loading to their smartphone and also considering the type and specifications of smartphone they have.

With regards to the schedule of classes, one of the challenging and difficulties they experienced and encountered are the unexpected power interruption in the respective areas. The students experienced hard time to connect and access to the online classes they might be missed some of the discussions scheduled for the period of time.

And on the learning activity tasks, some of the students were challenged and facing difficulties to finish more and complex activities for each lesson/topic. And there were also experienced difficulties in the availability of learning resources and materials needed to perform activity experiment.

7) Proposed output of the study

The output of the study was the compilation of video lessons of PhET interactive simulation in Biology 2.

V. CONCLUSION AND RECOMMENDATIONS

The study aims to determine the impact of integration of PhET interactive simulation in students' learning skills in Biology.

CONCLUSION

On the findings of the study, the following conclusions are drawn.

1. Students are allotted one to two hours in their online learning using their smartphone and they can access online learning through the use of data internet connections the reason why they can regularly attended online classes in Biology. This can be concluded that students particularly in online class shows eagerness and enthusiasm to learn.
2. Students in online learning shows a very good performance in the subject Biology 2. They can excellently performed on online learning as they eagerly and enthusiastically performed all the assigned given to them.
3. The integration of PhET interactive simulation in students' learning skills in Biology, as assessed by the students, it is concluded that it helps develop students' flexibility, inquiry and discovery process, creativity, exploration and analytical and critical thinking skills. The students are always fell motivated, eager and enthusiastically to learn and perform all task/activities with the integration of PhET towards development of their learning skills.
4. The integration of PhET interactive simulation was found a significant relationships on online learning wherein availability of gadgets had positive

correlation with all learning skills in terms of inquiry and discovery process, exploration, creativity, analytical and critical thinking, and flexibility. However, internet connectivity was negatively correlated with integration of PhET simulation in terms of exploration, creativity and flexibility and online class attendance also found negative correlations with the integration of PhET simulation in all terms. The findings concluded that those respondents with smart phone and laptop, DSL connection and always attended online class have better level of PhEt interactive simulation.

5. Academic achievement of students do not significantly influence the integration of PhET interactive simulation in terms of inquiry and discovery process. Therefore, The students can still perform well in Biology 2 even without integration of PhET interactive simulation.
6. The students were challenged to low internet connections, unexpectedly loss of power supply or power interruption and to the complex of learning activities to accomplish in limited resource and materials available.
7. The output of the study are the compiled video lessons in Biology related to Most Essential Learning Competencies, that help learners to develop their learning skills.
8. All findings regarding to the integration of PhET intergration of simulation in teaching, this study would be beneficial to the students, teachers, educators, researchers, future researchers

RECOMMENDATION

On the findings and conclusion of the study, the following are recommended:

1. 1.Students should always attend classes even in online or face-to-face learning that could help them to learn and gain more knowledge, ideas and skills towards better academic performance. Maintain eagerness and enthusiasm to learn and may allot extra time and effort to study the lessons even an off-line learning.
2. Students may maintain good academic performance not only in Biology but also in all learning areas. May continue to actively participated and perform all learning activities and tasks in orderly and organized manner.
3. School and teachers as partners for the learning development and progress of the students may continue to integrate interactive simulation in teaching in all learning areas that could help learning improve learning skills towards better academic performance.
4. Parent may support the learning needs of their children especially this online learning by providing online learning needs of their children like gadgets used for online learning, and strong internet connections. Always guide and monitor their children especially during online learning classes that lead them to a better learning performance.
5. Student may explore the other benefits of PhET interactive simulation to other learning areas even. May continue to explore and discover the benefits PhET sim tools in more fun and enjoyable learning.
6. Teachers and parent may work hand in hand to addressed challenges and difficulties of students in online learning. Teachers may conduct interventions and alternative activities in simplest and easiest way. And parent may provide learning needs of their children. And also the school may ask for help from the LGU in providing free wifi internet connections and free online learning gadgets program especially for the economically disadvantage or less fortunate but deserving students.
7. The compiled videos may use for the students to have deeper understanding on the lesson/stopic in Biology 2.
8. Continue the study related to integration of interactive simulation using other variables.

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