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Research Article

Improving the Academic Performance Using Virtual Simulation

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Abstract: The context of this study was to determine the effectiveness of a virtual simulation application to improve the performance of science class students in a senior high school in the Schools Division of Bulacan. Among the 40 total participants in each group (control and experimental groups), a quasi-experimental method has made in order to determine the effectiveness of the mediating factor of the variable. To give follow up on the numeric data gathered from the examination, a journaling statement has been made to support and substantiate the results and findings. Based on the findings, the t-test analysis on the difference between the student's performance in the achievement test in Pretest and Posttest using conventional classroom and virtual simulation teaching has a comparable mean difference particularly in terms of virtual simulation teaching from the pretest to the post-test. The data state that there was a highly significant difference between the pretest and posttest scores during the conduct of classes under virtual simulation teaching. The comparison between the difference in scores in the Posttest has also a remarkable level of significance. The data imply that virtual simulation teaching is quite effective in mediating conventional classroom teaching. It is recommended that the utilization of virtual simulation teaching may be implemented all throughout the Science learning area.
Keywords: Virtual simulation, learning science, academic performance.

Introduction

The government has declared a lockdown of Metro Manila, followed by the whole of Luzon, and is ruling on other localized lockdowns due to the strike of the pandemic. In March, the Philippines government proclaimed the country to be in a state of disaster for six months. Several government actions have been done to reduce the danger of disease transmission. Travel restrictions, obligatory quarantines for travelers, social distancing, prohibitions on public gatherings, school, and university closures, company closures, self-isolation, requiring individuals to work from home, curfews, and other measures are among them. The pandemic has impacted all levels of schooling. Globally, educational institutions have either temporarily shuttered or enforced localized closures, affecting billions of students. Many colleges and universities throughout the world postponed or canceled all campus events in order to reduce crowding and consequently viral spread.

Due to the suspension of classroom instruction in many public and private institutions, colleges, and universities, a shift to online instruction for undergraduate and graduate students becomes effective. This method of learning offers an alternate option to reduce contact between students or between students and teachers. The fact that technology utilization is required nowadays, the Department of Education (DepEd) also pays attention to the call to teach 21st-century skills with the implementation of the K to 12 Basic Education Program. It is vital that the principal act as technology leaders and teachers as a channel for the students to gain the skills and knowledge for 21st-century learning (Kohler & Mishra, 2016). Technology evolves much more quickly than other industries. Computer laboratories used to be the sign of a technically advanced school. Students carry much more powerful computers in their pockets. Digital tools offer an instrumental learning and engagement boost, but, especially in the classroom, schools need solutions that are easy to navigate while offering comprehensive classroom management around the world. According to the Arizona Department of Education (2020), providing routine activities and involving students at any level in learning activities is a positive way to provide students in critical situations with a sense of normalcy. Learning activities in the midst of the Covid-19 pandemic are also an effective way to recover from a difficult period. According to the findings of a study conducted by Wibowo *et al.,* (2014) and Zacharo *et al.,* (2020) on students who have completed the online learning, most students prefer online learning because it is more relaxed, fun, flexible, efficient, short, practical, fast, precise, safe, easy, time-saving, and energy-efficient.

Distance education now provides several benefits to all facets of modern learning. Modern DE, primarily in electronic format, now enables schools to give courses to a limitless number of students, which was previously not possible. Schools with smaller enrollments can now offer numerous advanced courses that were previously unavailable. Students in schools that offer a range of DE courses to complement their curriculum may be able to take optional courses that they would not have been able to take otherwise. Several studies have found that students who attend DE courses online perform at least as well as and, in some cases, better than, their colleagues who take classes in a traditional classroom. Some studies even claim that learning possibilities are similar when comparing online courses to those offered in the more conventional, face-to-face style (Dunnick, 2013).

The Office of the Secretary was guided by the following principles while integrating inputs into the BE-LCP: (a) Protect the health, safety, and well-being of learners, teachers, and workers, and prevent disease transmission; (b) Ensure learning continuity through K-12 curriculum changes, alignment of learning materials, deployment of multiple learning delivery modalities, provision of corresponding training for teachers and school leaders, and proper orientation of learners' parents or guardians; (c) Facilitate the safe return of teaching and non-teaching personnel and learners to workplaces and schools, taking into account the scenarios projected by the Department of Health (DOH); (d) Be mindful of equitable issues and concerns, and do our best to address them; and (e) Link and bridge the BE-LCP to DepEd's pivot to quality and into the future of education, using the frameworks of Sulong EduKalidad and Futures Thinking in Education (DepEd LCP, 2020).

In the gradual resumption of classes, the Department of Education identified learning losses in literacy, numeracy, and science skills (Mateo, 2022). It is quite alarming that schools in the Philippines today are focusing on various ways and interventions in addressing learning gaps through a strategic learning recovery. UNICEF also aims to recover the learning losses to avoid long-term damage to learners' well-being.

Virtual Simulation

Computers are increasingly being used in dental education (Schleyer *et al.,* 2012). Because of increased internet speed, accessibility, and connectivity, electronic education has shifted from a hard medium to an online environment (Pahinis *et al.,* 2017). According to a survey, medical students prefer web tutorials to traditional lecture-based classes. Among the reasons given for their preference are accessibility, ease of use, freedom of navigation, high-quality medical images, and the possibility of repeat practice. Because it is constantly being developed and updated, web-based learning is an important tool in evidence-based medicine (Potomkova *et al.,* 2016). One of the interventions of the Department of Education to support the teaching and learning process during the community quarantine is to strengthen the integration of ICT in the delivery of education. Moreover, the science subject opens more opportunities for the teachers in enhancing classroom activities using simulation.

Tsihouridis *et al.,* (2013) examined the efficacy of virtual laboratories with real school labs in teaching electric circuits in Upper High School. The data analysis revealed that there was no significant difference between the two groups in their conceptual comprehension of the fundamental principles of electric circuits. However, modest non-significant individual differences in favor of the real-lab group were detected in three of the twelve instructional goals. These findings led to the conclusion that the two teaching styles would significantly assist students in developing an exploratory attitude toward all things scientific, collaboration skills, and the capacity to communicate crucial questions with clarity and accuracy.

Aside from the stated claims above, there are other studies showing that virtual simulation has a positive effect on learners. Shegog *et al.,* (2012) used the HEADS UP Virtual Molecular Biology Lab as an instructional tool to conduct a randomized clinical control design study on a sample of 44 students from two high schools to assess student’s skills and knowledge about molecular lab processes, as well as their attitudes toward science and computers. The Virtual Lab was found to result in a considerable increase in students' knowledge over time; nevertheless, the researcher discovered no significant improvements in science attitude ratings. Tsihouridis *et al.,* (2014) discovered similar findings in research in which students were permitted to use both actual and virtual labs based on their educational requirements. The findings revealed that using the virtual lab as a mobile School-Lab during instruction significantly improved students' conceptual knowledge of specific physics subjects.

Brinson (2015) has provided a study of 56 publications published in and after 2005 that focused on comparing learning outcomes by employing conventional and non-traditional lab participants as experimental groups. According to the findings, the majority of the examined studies (n=50, 89 percent) demonstrated that student learning results were equivalent or greater in the Non-traditional Lab when compared to the Traditional Lab across all learning outcome types (knowledge and understanding, practical skills, inquiry skills, perception, analytical skills, as well as social and scientific communication).

Using virtual simulation as a teaching tool can be beneficial. The usefulness of a tool in teaching pupils desired learning outcomes is critical for any instructor. Virtual labs have been investigated as an alternative to or supplement to in-person labs in order to establish whether students will benefit from the virtual lab experience (Davenport *et al.,* 2018). Virtual laboratories have been found in several studies to be as beneficial, if not more successful, for student learning across a wide range of student groups. As a result, measuring the particular learning effects of using virtual laboratory experiences with students was not the goal of this study. Instead, the emphasis was on how the incorporation of the virtual lab into the teaching techniques influenced the attitudes of students (Miller *et al.,* 2018).

Conventional Classroom Teaching

Traditionally, the learning process takes place face-to-face in the classroom between teachers and students. Teachers play a critical role in determining the scope and quality of the implementation study. As a result, teachers must carefully consider and plan in order to improve learning opportunities for students and teaching quality. Today, technology is an essential component of the learning process, serving as both a medium of instruction and a learning resource. On a mobile device, it is marked with a number of functions. This marked the beginning of the evolution of mobile devices, which was characterized in this case by the emergence of smartphone technology. Smartphone technology is a new type of mobile device that can help with data access and processing feature (Villamor, 2021). Because of the rapid advancement of mobile technology and communication, the learning process can now take place outside of classrooms during school hours. Teaching and learning can be done anywhere and at any time thanks to mobile technology and communication (Wirawan & Darmawiguna, 2017).

In traditional classroom teaching, learning necessitates effective collaboration between students and instructors. Students complete their learning tasks as a group, not as individuals. Instructors, on the other hand, are interconnected in such a way that learning in the classroom context is efficiently coordinated. To put it another way, classroom education uses a collaborative project-based curriculum to improve communication and thinking among various stakeholders. The second key characteristic of traditional education is that instructors create the learning environment and facilitate the learning process. Furthermore, many stakeholders, including teachers, administrators, and parents, share responsibility for student learning. Third, students in traditional education learn through a hands-on approach, gaining thumb-of-rule experience. In general, traditional education uses the face-to-face method in almost all learning processes.

Scientific Relevance

The issue and argument of improving the delivery of education in the Science subject have been emanating even before. Since the late 1800s, scientific educators have thought that a laboratory is a vital tool for teaching science. In the 1880s, laboratory activities were employed in high school chemistry (Fay, 1931). Harvard University issued a list of physics experiments that should be included in high school physics curricula for students interested in attending Harvard in 1886 (Moyer, 1976). Laboratory education was deemed necessary since it offered observation training, and precise information, and piqued students' attention. It is clearly evident that since the early 19th century, up to this present age, the same arguments are still valid almost a century later.

For support of the requests for materials and equipment for laboratory activities, science teachers commonly consult academic researches. Many variables, such as achievement, attitudes, critical thinking, cognitive style, understanding of science, the development of science process skills, manipulative skills, interests, retention in science courses, and the ability to do independent work, have been investigated by science education researchers. These reasons alarmed science scholars to perform studies about the use of online delivery of laboratory science (Gamage *et al.,* 2020). Several studies such as Mezzacappa (2020) explain the importance of using virtual learning experiences in teaching laboratory science during the pandemic and lockdown period. With these arguments, the research of the current study came up with and formulated the following research questions.

Research Problem

This study aims to determine the effectiveness of a virtual simulation application to improve the performance of science class students in the senior high school of San Miguel National High School. Specifically, this study seeks answers to the following questions.

1) What is the student's level of understanding in the pretest of science prior to exposure to conventional classroom teaching and virtual simulation teaching?
2) What is the student's level of understanding in the posttest of science prior to exposure to conventional classroom teaching and virtual simulation teaching?
3) Is there a significant difference in the performance of the students in science after the implementation of regular classroom teaching and visual simulation application?
4) What are the insights and perceptions of students during the use of virtual simulation applications in science?
5) What sample lesson may be crafted based on the findings of the study?
6) What plan of action may be proposed from the results of the study?

Hypotheses

From the formulated research questions, the following research hypotheses are formulated:

1) There is no significant difference in the performance of the students in science after the implementation of regular classroom teaching and visual simulation application.

Conceptual Framework

This study is anchored on the Cognitive Theory of multimedia learning by Mayer (1997). A cognitive theory of multimedia learning is based on three main assumptions: there are two separate channels for processing information (auditory and visual); there is limited channel capacity; and learning is an active process of filtering, selecting, organizing, and integrating information. The basic premise of the cognitive theory of multimedia learning is that the learner can learn more deeply by combining words and pictures than by just words alone. This basic premise may explain why so many people can learn new hobbies or skills from videos. When learning to knit, a novice can understand and learn by watching a video of an expert knitter creating a scarf and listening to their verbal explanation. The basic principle appears to be so simple and obvious that we automatically select textbooks with charts, diagrams, maps, and pictures, and it is also the reason learners use it.

When an educator is attempting to impart new knowledge to big groups, traditional techniques of lecture-based or teacher-led training perform effectively. There is minimal consideration for learners' specific needs or particular learning styles, and it is assumed that some children will not retain the information provided. This initiative offered research and examples of alternative educational approaches that lead to a more successful learning experience for children in grades K 12, ensuring each student's maximum learning potential. Experiential learning employs tried-and-true approaches to convey pertinent knowledge in a way that enhances learners' intellectual capacity and retention (Rapaport, 2013). Rochman (2021) suggests that experiential learning is an excellent strategy for increasing learners' vocabulary knowledge.

It is common knowledge that learning by doing is the foundation of experiential learning theory. Experiential learning is based on the premise that having experiences is the best way to learn. Those encounters get imprinted in your memory, assisting you to retain knowledge and recall facts. According to one study, experiential learning has a favorable impact on student performance (Abu-Assab, 2015). From the point of experiential learning, this study argues the positive effect of learning by doing through a virtual simulation application for the Science subject. Understanding the distinction between observation and inference is critical to comprehending how scientific knowledge advances. Observations are statements involving the senses. Inferences are conclusions reached after considering one or more observations. In contrast to observations, inferences transcend beyond the senses and begin to make conclusions (Kim, 2020).

For example, students may deduce that South America and Africa were formerly connected based on the fact that their coastlines overlap. Inferences reveal a connection that extends beyond the senses and begins to explain our findings. Scientific knowledge is also subjective and/or based on theories. Beliefs and past knowledge impact scientists, as they do all individuals. It is unrealistic to claim that science is objective. Current views and knowledge influence how nine scientists conduct their research and interpret their discoveries. Theories give a framework for observations that enables meaningful interpretation. As a result, a person who is gaining scientific literacy will progressively comprehend the link between theory and observations- without theory, man has no idea what to observe (Kim, 2020).

Most classroom experiences are designed to hinder innovation. If students are allowed to be imaginative and creative, it is usually just in the creation of hypotheses. In the explanation of data and evidence, creativity is rarely fostered. In most classroom investigations students are working towards a known explanation in which creativity and imagination are not necessary. K-12 pupils frequently lose sight of the provisional nature of scientific knowledge. Many classes teach scientific information as absolute (Kim, 2020). In a normal scientific classroom experiment, students follow a series of processes to arrive at a conclusion that the teacher knows in advance. If students collect data and evidence that contradicts the known conclusion, they may be offered the option to redo the experiment, but more frequently than not, they are simply told that they did the experiment improperly (Melville, 2011).

According to Hughes *et al.,* (2017), explicit teaching is a combination of research-supported instructional practices used to design and deliver instruction that offers critical support for successful learning through clarity of language and purpose, as well as cognitive load reduction. It encourages active student participation by requiring frequent and diverse replies followed by appropriate affirmative and critical feedback, and it aids with long-term memory by utilizing purposeful practice tactics.

Figure 1 describes the schematic diagram of the constructs of the study. The diagram shows how the mediating variable is more likely to intervene with the relationship between the key variables of this study such as the teaching of Science and Technology subject and the achievement of the students. To be specific, teaching Science and Technology as a subject in the senior high school using regular classroom teaching and teaching with a virtual simulation application approach is expected to have a significant difference as regards the academic achievements of the students. This significant difference is expected through a positive outcome where the academic achievements in the Science subject are more likely high if there will be an integration of virtual simulation in classroom teaching. It is given that once the teacher teaches the lesson, there will be an acquisition of knowledge from the teacher. However, a comparative note is more likely evident between the two approaches.

Another theory that was found relevant to this research is the Multimedia Learning Theory (Mayer, 1997). This idea is based on cognitive load and information processing theories. When extraneous information exceeds the processing capability of working memory, cognitive load arises, interfering with the learning process. Richard Mayer created the Multimedia Learning Theory in 1997. It is part of the big theory of Cognitivism. Mayer defines multimodal learning theory as three components that help students learn more successfully. The first is that there are two channels for information processing, namely auditory and visual; this is also known as the multimedia principle. According to this theory, kids may learn more effectively through visuals and words than through words alone. The second element is that each channel has a limited capacity for information processing. In other words, humans can only digest a finite quantity of information and attempt to interpret it by forming mental representations from information sources.

Ercan (2014) has shown that multimedia has a significant effect on student achievement. The researcher investigated the impact of multimedia learning material on the academic success and attitudes toward science courses of 62 5^{th}-grade pupils. McTigue (2019) did another research that demonstrates the importance of multimedia learning theory to assess the significance of multimedia presentations in students' reading. The experimental group read a science text with an image or diagram, whereas the control group read simple text. According to the study, kids gained more from reading with diagrams or drawings. These findings highlight concerns regarding the application of multimedia uses in classroom practice; the key worry that educators must address in classroom settings is the limited usage of multimedia. To improve student’s learning experiences, teachers could offer their content in more appealing ways, such as by employing more media.

The relevant theories discussed above support the study through the integration of technology into regular classroom teaching. This idea emphasizes the context of the study in which the students are expected to have a high level of academic achievement in the sense that the teacher utilizes the regular classroom teaching approach. However, the mediating factor of the virtual simulation application is also expected to improve the academic achievement of the students of senior high school at a higher level.

Virtual simulation application is the outlet of experiential learning through learning by doing. It is interesting to note that if the teacher teaches the learners in a regular classroom setup with the mediation of a virtual simulation application, the learners have more likely to have higher academic achievement than in a regular classroom with no application of virtual simulation. To summarize the constructs of this paper, this study describes that the mediation of virtual simulation applications is more likely to have better academic achievement in Science subjects among senior high school students.

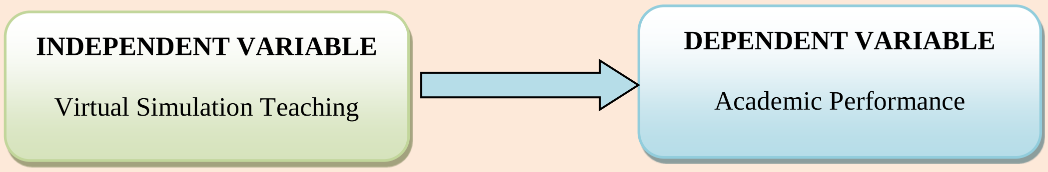

Figure 1. Paradigm of the study

The paradigm of the study illustrates the framework (Figure 1) where classroom teaching with an arrow pointing to academic achievements is mediated by the virtual simulation application.

Research Design

This study was basically utilizing a quasi-experimental research design. Two groups of science class were the participating students and be categorized as the control group (without treatment), and the experimental group (with treatment). Quasi-experimental research is a kind of experimentation that is characterized by the two groups of participants that are compared before and after the treatment. The participating students in this research are the General Academic Strand (GAS) students in the Senior High School of San Miguel National High School. The data analysis used is descriptive statistics to determine the achievements of the students before and after the treatment. More so, t-test analysis was used to determine the significant differences in the achievements between groups. Aside from the quantitative research design, this study was conducted using a document analysis from the journals of the participant, which was qualitative in nature.

Before the distribution and administration of the pretest and posttest, the researcher followed the usual procedures for conducting research. The researcher sought permission from the Schools Division Superintendent of Bulacan the conduct and administer a pretest and posttest to the GAS students of San Miguel National High School. The researcher also sought permission from the School Principal of San Miguel National High School for the conduct and administration of the pretest and post-test for the GAS students of San Miguel National High School. The researcher conducted a survey first on the availability of senior high school students, in particular the GAS students. From there, the researcher extracted the student respondents for the experimental and control group.

After this, the researcher mediated the classes for the experimental group with the Virtual Simulation application in the Weekly Learning Plan/Daily Lesson Log while the control group was treated to usual traditional class sessions. The conduct of the classes using virtual simulation in the computer laboratory of the school was being sought permission also from the School ICT Coordinator and the School Principal. Together with this, the researcher guided the students with the modules that were distributed. The instrument–pretest and posttest were validated by experts in the Science curriculum. For furnishing the pre and post-test use, item analysis was first conducted by the researcher before the distribution of the questions so that the questions should easily be understood by the respondents. The researcher conducted orientation for the students for the conduct of the study. Student ratings were collected as baseline data for the study. A pretest was given to the participants.

Lastly, a post-test was given to the group and recorded for research and academic purposes. A journal of the participants' experiences from using the application was done after the posttest to support numeric data from the test administration. For the journaling, 10 students from the experimental were gathered. The results gathered were treated statistically to analyze the performances of the experimental and control group. In gathering the data relative to the insights and perceptions of students during the use of the virtual simulation application, the researcher employed journaling by the participants to record their experiences of using the application. The researcher also considered the protocol for the collection of the needed data by informing the participants through the orientation.

The participants had the freedom to choose whether the data collection would be done through journaling with their names or not. In addition, to comply with ethical considerations in conducting this research, all participants were asked to read and sign a written consent (if they agree) to participate in the study. Then, the purpose of the research was explained to the participants and with that, they have the right to withdraw at any point during the experimentation. Permission to record the process at some point that is necessary was also obtained from the participants. The participants were treated with the utmost respect as their answers had been recorded for proper data analysis and interpretation. To protect the identity of the participants, names, addresses, and other personal information were not included in the study. Data that were collected from the participants who chose to participate were stored only in the temporary folder located on the personal laptop of the researcher. This study also ensured that only the researcher had the access to the data collected from the participants for security purposes. All the data were handled carefully such that only the researcher was able to analyze them to avoid the unauthorized transfer of data. After finalizing the paper, the researcher waited until the full completion of the study, after which the researcher deleted all files in the personal laptop and google drive and the researcher did not keep any copy of the respondents' data.

Sampling Procedure

The study used purposive sampling across the class sections of GAS students in San Miguel National High School. The researcher pre-identified the participants with the same classification. There was a total of 80 participants across two groups of students. The participants were selected considering a heterogeneous classification. Two sections of 40 students with the same classification had been selected for the study.

Table 1. Number of Control and Experimental Group Respondents

Group of Participants	Girls	Boys	Total
Control Group			40
Experimental Group			40
Total			**80**

Data Analysis Scheme

Quantitative data gathered through pre and post-assessment/test were presented and tallied using a statistics application. To ensure accuracy and reliability in the analysis and interpretation of data, consultation from the expertise of a statistician or data analyst was also considered. First, the Mean was used in describing the performance of the students in the pretest and posttest. Secondly, Standard deviation determined the variability and homogeneity of the student's scores. The Standard Deviation is the measure of variability. It is the most used indicator of the degree of dispersion and is also the most dependable measure to estimate the variability in a total population. Furthermore, a T-test was used to compare two averages (means) and tells if they are different from each other. Also, this tells how significant the differences are.

Results and Discussions

Students' Level of Understanding in Pretest using a Conventional Classroom Teaching

The level of understanding of students is one of the considerations in this study. It is quite important to determine and compare the difference between the data of and post assessments, and between the data whether with and without intervention. Table 2 shows the performance of students in science subjected to conventional classroom teaching. The data in Table 2 show the descriptive statistics of the pretest and posttest. The data in the table show that the most frequent scores were in the range of 11-20. Among 40 students as the total number of participants, there are 30 students (75%) who fell in this range of scores (11-20). There were only 2 participants out of the total number of cases (40) who fell in the range of 1-10 scores. More so, the average of the scores has a value of 17.30 in the range of 9-26. The mean value of 17.30 has a verbal interpretation of "fairly satisfactory".

Table 2. Students' Performance in Science in Pretests Using Conventional Classroom Teaching

Score	Conventional			Virtual Simulation		
	f	%	Verbal Interpretation	f	%	Verbal Interpretation
41-50	0	0.0	Outstanding	0	0.0	Outstanding
31-40	0	0.0	Very Satisfactory	0	0.0	Very Satisfactory
21-30	8	20.0	Satisfactory	3	7.5	Satisfactory
11-20	30	75.0	Fairly Satisfactory	34	85.0	Fairly Satisfactory
0-10	2	5.0	Did Not Meet Expectations	3	7.5	Did Not Meet Expectations
Range	9-26			10-26		
Mean	17.30			16.00		
Verbal Interpretation	Fairly Satisfactory			Satisfactory		
Standard Deviation	3.639			3.530		

The data in Table 2 show the descriptive comparison between the pretest scores in Science with and without the mediation of virtual simulation teaching. The data in Table 2 show that the scores with the highest frequency were in the range of 11-20. The highest frequency value is 34 out of 40 or 85% of the total participants-that is the score from 11-20 has a verbal interpretation of Fairly Satisfactory. On the other hand, the scores from 0 to 10, and 21 to 30, have both 7.5% of the total participants.

The data suggest that conventional classroom teaching in Science is still effective at some point. The increase in mean value from the pretest to the posttest is considerable. In addition, the verbal interpretation has been changed one step higher from Fairly Satisfactory to Satisfactory. This means that conventional teaching is effective in improving the learning achievements of students to some extent where the teachers are the primary source of learning (Cielo *et al.,* 2019).

Students' Level of Understanding in Posttest using Virtual Simulation Teaching

The highlight of this study is the virtually simulated teaching in the Science subject. Mediating the lesson in Science using virtual simulation teaching and its effectiveness is the primary highlight of this study. Table 3 describes the performance of the students in the Science subject.

Table 3. Students' Performance in Science in Posttest Using Virtual Simulation Teaching

Score	Conventional			Virtual Simulation		
	f	%	Verbal Interpretation	f	%	Verbal Interpretation
41-50	0	0.0	Outstanding	4	13.3	Outstanding
31-40	2	5.0	Very Satisfactory	22	73.4	Very Satisfactory
21-30	19	47.5	Satisfactory	4	13.33	Satisfactory
11-20	19	47.5	Fairly Satisfactory	0	0.0	Fairly Satisfactory
0-10	0	0.0	Did Not Meet Expectations	0	0.0	Did Not Meet Expectations
Range	17-34			20-48		
Mean	22.70			32.13		
Verbal Interpretation	Satisfactory			Very Satisfactory		
Standard Deviation	4.686			9.428		

On the other hand, the data on the posttest in the same table (Table 3) has shown changes in the frequency distribution. The table shows that from 8 in the pretest, there are 19 students, out of 40 cases who are in the range of scores from 21-30. The same number of students (19 out of 40) are in the range of scores of 11-20. Moreover, 2 students have scores between 31-40. The mean score for the posttest has a value of 22.70 with a verbal interpretation of Satisfactory. The posttest on the same table describes remarkable data that is comparable with the posttest in conventional classroom teaching. To most frequent scores in the posttest is in the range scores of 31-40. This is an indication that classroom teaching has a great contribution to the learning of the students. 73.4% of the total sample has a Very Satisfactory verbal interpretation. The overall mean value of 32.13 from the posttest is remarkably high compared to the overall mean value of 16.00 from the pretest. The data suggest that learning has also been acquired through the mediation of virtual simulation teaching in the Science subject. The data imply that learning is also possible even if there is a mediation of virtual simulation in the teaching episode. It is similar to the claims of Bonifacio (2022) stating that virtual simulations were found effective in improving the achievements of students in Physics.

Comparative Analysis of the Students' Performance

The comparative analysis of the two groups is presented and discussed in the following tables. Table 4 presents the data on the t-test analysis within the paired sample. The conventional classroom teaching attained a mean difference of -5.400 with a t-value of -6.583 and a p-value of 0.000. The data state that there was a highly significant difference between the pretest and posttest scores during the conduct of classes under conventional classroom teaching.

Table 4. T-test Analysis on the Difference between the Students' Performance in the Achievement Test in Pretest and Posttest Using Conventional Classroom and Virtual Simulation Teaching

Teaching Methods	Test	Mean	SD	Mean Difference	t-value	p-value
Conventional classroom teaching	Pretest	17.30	3.639	-5.400	-6.583**	0.000
	Posttest	22.70	4.686			
Virtual simulation teaching	Pretest	16.00	3.530	-16.125	-10.174**	0.000
	Posttest	32.13	9.428			
Legend: ** highly significant difference p ≤ 0.01; * significant difference p ≤ 0.05						

The data also show the comparative analysis of results from the virtual simulation teaching. It is interesting to note that like in conventional classroom teaching, virtual simulation teaching has a notable increase from the pretest to the posttest. The mean difference of virtual simulation teaching from the pretest to the posttest is -16.125 with a t-value of -10.174 and a p-value of 0.000. The data state that there was a highly significant difference between the pretest and posttest scores during the conduct of classes under virtual simulation teaching. However, the mean comparison of the two pretests is closely the same (3.639–Conventional and 3.530–Virtual simulation) and was found insignificant. This signifies the findings of several studies (e.g., Acaso *et al.*, 2019; Azadon *et al.*, 2019; & Cayas *et al.*, 2019) where the comparison of pretests to two or more different teaching approaches has found no significant difference.

Comparative Analysis between the Posttest Scores

In order to determine the effectiveness of the virtual simulation teaching, the mean of the post-test results is compared through a t-test analysis.

Table 5. Comparison between the difference of Scores in the Posttest

Teaching Methods	Posttest Mean	Mean Difference	t-value	p-value
Conventional classroom teaching	22.70	-9.425	-5.662**	0.000
Virtual simulation teaching	32.13			
Legend: ** highly significant difference p ≤ 0.01				

The comparative analysis between the two posttests determines the significant value of whether virtual simulation teaching is an effective mediating factor to improve the performance of the students. The data show a mean difference of -9.425 between the posttest mean value of 22.70 from the conventional classroom teaching and the posttest mean value of 32.13 from the virtual simulation teaching. The t-value is -5.662 with a p-value of 0.000 which is highly significant. The data imply that virtual simulation teaching is quite effective in mediating conventional classroom teaching. It is noticeable that technology-driven teaching is still proven effective, especially in teaching Science subjects. The same findings and conclusion found by Bantolo (2019) were using the Gain Score statistical treatment, the effectiveness of the teaching technique was determined by the Gain Score of both groups for the posttest and pretest.

To assess the students' conceptual change, item analysis was performed on the pretest and posttest. The nature of their answers during the pretest and posttest was used to categorize conceptual change. There are four types of answers: wrong to wrong (negative conceptual change), wrong to correct (positive conceptual change), correct to correct (no conceptual change), and correct to the wrong (no conceptual change) (negative conceptual change).

Insights and Perceptions of the Students

The traditional educational setting of education, according to learners somehow no longer meets the needs of their generation today who strive to design their own learning experience. The use of the virtual simulation is quite a big help for them to do the lesson.

> "As a user of this virtual simulation, I find it very useful and helpful especially for me a grade 11 student"
> "It helps me to faster understand the lesson"

Moreover, based on the statements of the students, the change from a teacher-centered learning environment to a student-centered learning environment with the integration of technology creates interest and creates opportunities for the learners.

> "I think this virtual simulation application is easy to use because the instructions are clearly explained by our teacher using the students' exploration sheet"
> "This helps me to visualize the lesson even more and motivates us during science classes."

Learners recognize the benefits of integrating technology into their classrooms, especially the virtual simulation, which includes advantages over traditional teaching and additional opportunities for improving student learning. As described in the summary of answers from the respondents in Table 6, the use of virtual simulation improves the process of learning delivery as well.

Table 6. Summary of Insights from the Respondents

Question	Significant Responses	Frequency
As the end user of the virtual simulation, how do you find the functionalities of the application in terms of ease of use?	• The application is easy to use. The instructions in the students' exploration sheet help me a lot to understand how to manipulate the virtual simulation application.	2
	• At first, I find it hard to use but with the help of my teacher, I understand the functionalities of the application and it helps me a lot in a difficult lesson in Biology	6
	• I think the functionalities for me are not easy nor hard, it's just right as an aid for students who have some difficult issues in visualizing the	2

	hard lesson in Biology	
How fast do you understand the lesson using the virtual simulation application?	• I learned the lesson faster than I could imagine because I can visualize the difficult topic in Biology • I think a little faster than usual because of the visual application I appreciate the lesson even more • Just the same, I think my knowledge in lessons remains the same	7 2 1
What are the learning experiences you can share on how hard or easy to use the virtual application during the lesson?	• I think this virtual simulation application is easy to use because the instructions are clearly explained by our teacher using the students' exploration sheet. • At first, it is hard to use because I don't know how to explore the virtual simulation but with the help of my teacher explaining how to manipulate and explore the application, I manage to finish the task and understand the lesson • It's easy to use as long as the internet connection is stable	6 1 3
What are the difficult learning experiences you can share about learning science using a virtual simulation application?	• I think a stable internet connection is one of the most difficult learning experiences that I can share because a slow internet connection can interrupt our learning session • I don't encounter any difficult learning experiences because the application is easy to use and my teacher explained the application very well. • I encounter some difficulties in learning because of the limited time in our session	4 3 3
How do you describe the virtual simulation application as you use it during science classes?	• It is easy to use, student-friendly application, and I learned a lot in Biology after using the application. • The virtual simulation application helps me a lot to understand the difficult lesson in Biology. This helps me to visualize the lesson even more and motivates us during science classes. • This serves as a helping tool for students who experience difficulties in looking for materials needed in science classes.	2 6 2

Learners also consider benefits such as the availability of equipment, ease of use, and the interest the technology may spark motivation and learning interests. The process of identifying and implementing instructional technology requires different levels of support. The data imply that the insights and perceptions of the students expressed that the transition from a traditional learning environment to a learning environment integrating technology requires a certain amount of self-education on the part of the learners, and the change process may take years. Nicol *et al.*, (2018) stated that some learners find the process of providing the devices and loading materials into virtually simulated course shells frustrating, and others find professional development activities do not fulfill their needs.

Proposed Plan of Action

The proposed program based on the findings of the study falls under two parts. These are the capacitating of teachers on virtual simulation and the other one is on the implementation of the program to improve the academic achievements of students in Science subjects. Table 7 presents the proposed program of activities in teaching Science subjects with the mediation of virtual simulation. The program aims to capacitate the teaching initially to develop trained teachers to use the virtual simulation along the way of teaching the lessons in Science.

Table 7. Proposed Plan of Action

Objectives	Activities	Time Frame	Persons Involved	Expected Output
Coach and train Science teaching in using virtual simulation teaching	LAC session	Every Quarter	School Principal Department Head Science Teachers	Highly equipped Science teaching in teaching using virtual simulation.
Improve lesson delivery through virtual simulation teaching.	Quarterly Mediation Program in Science	Every Quarter	Science Teachers, Department Head, School Principal	High level of academic achievement among STE students in all grade level
Create localized learning materials for Science subjects	Development of Localized Learning Materials	Every Quarter	Science Teachers, Department Head, School Principal	A pool of localized learning materials

The program is only intended but not limited to the students under the special program for science, technology, and engineering.

Conclusions

From the aforementioned summary of findings, the following conclusions were drawn:

1) Students' performance in science subjected to conventional classroom teaching becomes high as measured in the pretest and posttest of the control group. Students' performance in science subjected to virtual simulation teaching also becomes high after the experimentation and is measured through pretest and posttest.
2) Comparison between the difference of scores in the Posttest has been found in favor of the virtual simulation mediation. The findings found that there is a significant difference between the posttests of the two groups were found with a significant difference. This study concludes that the second hypothesis is rejected.
3) Insights and perceptions of the students create congruence with the result of the experimentation. There are positive insights and perceptions among students who used and underwent virtual simulation teaching from their teachers.

Recommendations

Based on the conclusions, the research offered the following recommendations:

1) It is advised that schools with specialized programs in science, technology, and engineering try using virtual simulation to raise their students' academic performance in science-related courses.
2) It is recommended that the school prepare alternative offline learning resources for virtual simulation for the students and teachers to access in case the learning module is not yet or no longer available for the students to consume, given that the arising challenge emerged from the aspect of learning resource production.
3) The creation of a virtual simulation application may also be very helpful in addressing the accessibility and sufficiency of learning resources as well as internet connectivity. The school

heads may amplify the mediation of virtual simulation applications to have a concrete framework in terms of technology management to prevent issues and challenges during uncertainties in education and school operation. Contingency plans may be incorporated into the annual implementation plan or even in the six-year school improvement plan.

4) The schools, or even the schools division offices may craft and implement a series of training and seminars for both school heads and teachers on school virtual simulation teaching to mitigate the undesirable impact of crises such as the pandemic on education leaders and frontliners. The schools-school heads and teachers, may develop supplemental materials and activities suitable for offline or online distance learning fit to the needs of the learners and the capacity of the parents to guide their children. Together with the supplemental materials and activities, an effective assessment may also be developed to measure the progress of the learners.

Conflicts of interest

The author declares no conflicts of interest.

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