Performance Evaluation of Grade 9 Students in Science and its Implications for Blended Learning

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INTRODUCTION

Humanity faces an uphill battle to keep pace with rapid scientific and technological advancements, particularly in developing countries like the Philippines. A competitive and scientifically minded society requires access to advanced technology, knowledge, and skills to meet these needs. The quality of science education has a significant impact on these critical issues.

The days of Grade 7 entirely dedicated to General Science, Biology in Grade 8, Chemistry in Grade 9, and Physics in Grade 10 are long gone. Changes were made during the implementation of the K to 12 Curriculum. Republic Act No. 10533, also known as the Enhanced Basic Education Act of 2013, requires private and public schools to use a spiral progression approach to alleviate congestion in the country's basic education system. Thus, students are exposed to a new secondary science curriculum, covering multiple disciplines across different grade levels. Science educators should have a firm grasp of all four areas. Along this line, the country's science education system is constrained by various factors, including a lack of support for scientific culture, as evidenced by curriculum gaps, ineffective teaching-learning processes, teacher training shortage, a scarcity of high-quality textbooks, and insufficient instructional materials. For example, a lack of engaging textbooks and science equipment has harmed Filipino students' ability to conduct scientific investigations and hands-on activities.

In 2018, the Philippines joined the Organization for Economic Cooperation and Development's (OECD) Programme for International Student Assessment (PISA) as part of the Quality Basic Education reform plan and as a first step toward globalizing the quality of Philippine education. The PISA results will aid in policy formulation, planning, and programming with our assessments and studies.

Unfortunately, the Philippines averaged 357 points in scientific literacy compared to the OECD average of 489 points which is significantly lower than all ASEAN countries. Filipino students, according to these findings, continue to face challenges. They have poor conceptual retention, reasoning, analytical abilities, and limited communication skills due to their inability to express ideas or explain events and phenomena in their own words (UP NISMED, 2004). Furthermore, in some schools, a significant proportion of students in Grades 6 to 10 cannot apply concepts to real-world problem-solving situations. Conceptual understanding is a required competency for science education in the Philippines. One method for achieving conceptual understanding in science learning is to use laboratories.

A laboratory is critical for active learning and science instruction because it teaches students to solve real-world problems creatively and critically. The importance of laboratory applications in instruction is readily apparent when considering that some areas are applied branches of Science. This is consistent with experiential learning theory, which advocates for "learning by doing." However, schools frequently lack adequate laboratory space, making it difficult to conduct scientific activities. Inadequate laboratory facilities and science equipment, faulty equipment, defective instructional materials, and a lack of water and

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electricity are common problems. These identified barriers must be overcome to ensure all children receive a high-quality education.

Then, a global pandemic occurs, and these barriers become exponentially more challenging to resolve. The pandemic of COVID-19 has created unprecedented economic, social, and political challenges. Not only has it sparked a health crisis, but also an educational crisis. According to a study presented at the American Educational Research Association's annual conference, COVID -19 has pushed science teachers to become more creative, resourceful, and innovative. However, most science teachers struggled to integrate investigations and hands-on learning for remote students. Virtual laboratories, simulations, websites, and tutorials can assist in alleviating the lack of practical experiences in online education. It brought light to previously unresolved educational issues that had lain dormant for far too long.

A virtual laboratory is a simulated environment in virtual reality that teaches students to learn through experimentation and exploration. Due to time, safety, and cost constraints in the real world, actual experiments and operations can be theoretically evaluated through simulations. It is equally valuable to the learner because it accommodates various learning styles and provides an open-ended environment conducive to inquiry. Students become active learners by seeing, observing and doing. Active participation serves as the foundation for learning.

Thus, this study was conceptualized in light of this concern. The researcher, as a Science teacher, felt the need to conduct a comprehensive study on the competency performance of Grade 9 students in Science and its profound implications for blended learning to have a better grasp on the current state of students' scientific knowledge and skills, particularly in the context of the evolving educational landscape bridging the gaps between theoretical knowledge and practical applications through the use of virtual laboratories. The advantages of online learning modes may rescue us from these trying times. Courses delivered online should be dynamic, engaging, and interactive. Efforts must be made to humanize the educational process as much as possible.

As the Philippines rebuild and reinvent itself in response to COVID-19, an opportunity exists to accelerate progress toward universal access to high-quality education. Every student should have the opportunity to develop their full potential, and our collective responsibility is to ensure that all students have equal opportunities. No student should be left behind.

STATEMENT OF THE PROBLEM

This study aimed to evaluate the science competency performance of Grade 9 students as determined by the Global Resources for Assessment, Curriculum, and Evaluation – Performance Assessment of Standards and Skills (GRACE – PASS) and its implications for blended learning at the University of Saint Anthony, San Miguel, Iriga City, A/Y 2020 – 2021.

It specifically sought answers to the following questions:

1. What is the competency performance of Grade 9 students in Living Things and Their Environment (Biology), Matter (Chemistry), Earth and Space (Earth Science), and Force, Motion and Energy (Physics), as determined by the GRACE – PASS?
2. What are its implications for blended learning?
3. What virtual laboratory activities can be developed in light of the findings of the study?
4. What is the result of the curricular validation as assessed by the experts and teachers in terms of:
5. Content Quality
6. Instructional Quality
7. Technical Quality
8. Other Findings

(i.e., conceptual errors, factual errors, grammatical or typographical errors, computational errors, obsolete information, error in visuals, etc.)

Research Design

The study employed the descriptive-developmental research design to evaluate the competency performance of Grade 9 students in Science as a basis for developing an Integrated Virtual Laboratory Activity and assessed its validity at the curricular level based on the given criteria. The researcher also applied the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) model to achieve the predetermined goals. This model ensured that each step was meticulously planned and carried out in distinct phases.

Descriptive research is a subset of qualitative research that focuses on describing the nature or condition and the degree of detail of the current situation. This technique represents the heart of a problem as it exists in the study and investigates the cause of a specific phenomenon (Fraenkel & Wallen, 2007). Descriptive research aims to develop an accurate portrait of individuals, events, or situations. It is critical for this type of research to clearly understand the phenomena being investigated before beginning the data collection procedure. The researcher used this method to collect data directly from respondents to formulate rational and sound study conclusions and recommendations. The descriptive approach is concise, practical and serves as a foundation for further exploration and analysis. Additionally, the descriptive method is advantageous because it allows for qualitative or quantitative data or a combination of the two, giving the researcher greater flexibility in selecting the instrument for data collection. This method describes, compares, analyzes, and interprets existing data.

On the other hand, a developmental research design is a systematic investigation of designing, developing, and evaluating instructional programs, processes, and products that must meet internal consistency and effectiveness criteria (Richey, 1994). The field of instructional technology places a premium on developmental research. The most common types of developmental research involve analyzing and describing the product development process and evaluating the final product.

In other words, a descriptive developmental research design is a systematic study of designing, developing, and rigorously evaluating instructional programs, processes, and products that must adhere to a standard or set of criteria.

Sources of Data

Selection and utilization of appropriate data sources are crucial in generating reliable and insightful findings. With this, the researcher used two data sources: the result of GRACE's Performance Assessment of Standards and Skills (PASS) and the curricular validation conducted by Science experts.

The GRACE-PASS is a standardized examination designed to evaluate students' competency performance in various academic areas, including Science. Its importance as a data source lies in its ability to provide a comprehensive understanding of students' knowledge and skills. Twenty-two (22) females and ten (10) males from the Grade 9 Special Science Class students of USANT-Junior High School Department Academic Year 2020 – 2021 took this test last April 5, 2021. The examination result enabled the researcher to evaluate the competency performance of students in Science and identify the areas for improvement.

On the other hand, curricular validation involves a comprehensive review and assessment of the developed Integrated Virtual Laboratory Activity. This process ensures that the proposed output is aligned with the educational standards, most essential learning competencies, and needs in science education.

The experts are composed of twenty (20) science teachers from the Basic Education Department of

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University of Saint Anthony and within the Rinconada area that also offer and experience blended learning (online and face-to-face classes) as the learning delivery modality. They are knowledgeable in science, research, and information technology.

Experts evaluated the proposed integrated virtual laboratory activity using the Expert's Evaluation Checklist (EEC), adapted from the Department of Education's Guidelines and Processes for Learning Resource Management and Development Standards (LRMDS). The researcher has adhered to a regular schedule to avoid disrupting classes during validation.

Statistical Tools

The tabulated data was analyzed and interpreted with the application of the following statistical tools:

Frequency Distribution and Percentage. A frequency distribution is an organized tabulation or graphical representation of the number of individuals in each category on the measurement scale. This allows the researcher to have a glance at the entire data conveniently.

On the other hand, a percentage is derived by dividing one quantity by another, with the latter rebased to 100. Percentages are symbolized by 100%. Besides being especially useful when making comparisons, they come in handy for studying a difference compared with a benchmark or initial value.

These tools were used to present the competency performance of Grade 9 students in Science along the four areas based on the result of GRACE's Performance Assessment of Standards and Skills.

Rank Ordering. A rank-ordering is an easy-to-use and easy-to-analyze method of organizing comparative data for judgment. This method can be used in research whenever people's opinions are desired.

This tool was used as the researcher sought the opinion of experts as to the curricular validity of the developed integrated virtual laboratory activity.

Weighted Mean. This tool was used to quantify the data and make the interpretation more objective, particularly in the curricular validation of the integrated virtual laboratory activity.

Four – Point Likert Scale. A Likert scale is a rating scale used to evaluate individuals' opinions, attitudes, and behaviors. Likert scales are frequently used in survey research because they make operationalizing personality traits or perceptions simple. This scale was used to quantify and interpret the average points for each factor: content quality, instructional quality, and technical quality. It also consists of the following interpretations:

Scale	Interval	Verbal Interpretations
4	3.25 – 4.00	Very Satisfactory (VS)
3	2.50 – 3.24	Satisfactory (S)
2	1.75 – 2.49	Poor (P)
1	1.00 – 1.74	Not Satisfactory (NS)

The scale and verbal interpretation below are used for Factor D. Other Findings include conceptual, factual, grammatical, or typographical errors, computational errors, obsolete information, and visual errors.

Scale	Interval	Verbal Interpretations
4	3.25 – 4.00	Not Present (NP)

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3	2.50 – 3.24	Present but very minor & must be fixed (PM)
2	1.75 – 2.49	Present and requires major redevelopment (PR)
1	1.00 – 1.74	Do not evaluate further (DE)

RESULTS AND DISCUSSION

This presents and discusses the results and findings of this study. The data were tabulated, computed, and statistically analyzed to answer the research questions presented in the statement of the problem.

Competency Performance of Grade 9 Students in Science

A basic understanding of Science is vital because Science and Technology have become relevant in the fast-paced, changing world and the challenges that continue to transform the educational landscape today. However, the struggling ranking of Science in the large-scale assessments conducted by TIMSS 2019 and PISA 2018 shows that despite the many types of research aiming to uplift and boost the country's present rank in international education, Science still sags as a significant learning area.

Similarly, to TIMSS and PISA, the Grade 9 students of the University of Saint Anthony of A/Y 2019 – 2020 took the Performance Assessment of Standards and Skills (PASS) in Science administered by the Global Resources for Assessment Curriculum and Evaluation (GRACE) to comprehensively evaluate and determine students' competency performance as defined by the Department of Education.

Table 1 summarizes the competency performance of Grade 9 students in the four areas of Science. Based on the result of the Performance Assessment of Standards and Skills, it can be noticed that Living Things and Their Environment (Biology), Matter (Chemistry), and Force, Motion, and Energy (Physics) all obtained a performance rating of 53% verbally interpreted as "Approaching Proficiency." In comparison, Earth and Space (Earth Science) obtained a performance rating of 63%, verbally interpreted as "Proficient.

Table 1. Summary of Competency Performance of Grade 9 Students in Science

Most Essential Learning Competencies	Code	Performance Rating	Level of Proficiency
A. Living Things and Their Environment (Biology)		53%	AP
1. Explain how the respiratory and circulatory systems work together to transport nutrients, gases, and other molecules to and from the different parts of the body.	**S9LT-la-b-26**	72%	P
2. Describe the location of genes in chromosomes.	**S9LT-ld-29**	32%	D
3. Relate species extinction to the failure of populations of organisms to adapt to abrupt changes in the environment.	**S9LT-le-f-30**	45%	AP
4. Differentiate basic features and importance of photosynthesis and respiration.	**S9LT-lg-j-31**	60%	P
B. Matter (Chemistry)		53%	AP
1. Explain the formation of ionic and covalent bonds.	**S9MT-llb-14**	28%	D

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2. Recognize the different types of compounds (ionic or covalent) based on their properties such as melting point, hardness, polarity, and electrical and thermal conductivity.	**S9MT-lle-f-16**	97%	A
3. Explain how the structure of the carbon atom affects the types of bonds it forms.	**S9MT-llg-17**	55%	AP
4. Recognize the general classes and uses of organic compounds.	**S9MT-llh-18**	52%	AP
5. Use the mole concept to express mass of substances.	**S9MT-lli-19**	47%	AP
6. Determine the percentage composition of a compound given its chemical formula and vice versa.	**S9MT-llj-20**	80%	A
C. Earth and Space (Earth Science)		63%	
1. Explain what happens when volcanoes erupt.	**S9ES-llIb-28**	52%	AP
2. Explain how different factors affect the climate of an area.	**S9ES-llle-30**	67%	P
3. Describe certain climatic phenomena that occur in a global level.	**S9ES-lllf-31**	56%	AP
4. Identify which constellations may be observed at different times of the year using models.	**S9ES-lllj-35**	78%	P
5. Infer the characteristics of stars based on the characteristics of the sun.	**S9ES-lllk-36**	53%	AP
D. Force, Motion and Energy (Physics)		53%	AP
1. Investigate the relationship between the angle of release and the height and range of the projectile.	**S9FE-Iva-35**	69%	P
2. Describe the horizontal and vertical motions of a projectile.	**S9FE-lva-34**	44%	AP
3. Relate impulse and momentum to collision of objects (e.g., vehicular collision).	**S9FE-IVb-36**	30%	D
4. Explain energy transformation in various activities/events (e.g., waterfalls, archery, amusement rides).	**S9Fe-IVb-37**	54%	AP
5. Identify activities that demonstrate conservation of mechanical energy.	**S9FE-IVe-42**	81%	A
6. Demonstrate that heat can do work.	**S9FE-IVe-42**	64%	P
7. Infer that heat transfer can be used to do work, and that work involves the release of heat.	**S9FE-IVe-45**	28%	D
OVERALL PERFORMANCE		**55%**	**Approaching Proficiency (AP)**

The overall performance rating was registered at 55% and was verbally interpreted as "Approaching Proficiency." This proficiency level means that students have already developed the fundamental knowledge,

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skills, and core understandings in Science; however, they need more to understand how these concepts can be applied and transferred through performance tasks.

According to Gabriel et al., (2022), some of the most essential learning competencies were compromised because of the lack of resources. When students lack access to essential resources, such as textbooks, laboratory equipment, or hands-on materials, they may miss out on critical content or skills, resulting in educational disparities. This can worsen the gaps between the competencies, weakening the foundations of learning. Muller et al., (2008) suggest that a deeper understanding of Science may be achieved by increasing the visualization of students as the lack of models or representations of the invisible concepts is one of the reasons why students hardly understand science concepts. This implies that through visualizations, students can see structures and processes that are typically invisible and abstract. Research suggests one way to address these learning gaps is by integrating computer simulations and virtual laboratories into student activities.

Below is the comprehensive representation of the performance rating of the most essential learning competencies in the four major areas of Science.

- **Living Things and Their Environment (Biology)**

The scientific study of living organisms, including their structure, function, growth, evolution, and taxonomy, is known as Biology. It aims to unlock life's mysteries and comprehend the complex interactions between organisms and the world around them. It includes various disciplines such as ecology, genetics, physiology, evolution, and many others, each shedding light on the different aspects of the intricate tapestry of life. Biology provides students with a comprehensive understanding of the diversity of life and the natural world around them. It allows students to develop scientific literacy and critical thinking skills, appreciate life's wonders that foster a lifelong love for learning, promotes a sustainable future, become responsible stewards of the environment, and make environmentally conscious choices.

Figure 3 displays the competency performance of the Grade 9 students in Living Things and Their Environment (Biology). This area of science got an overall performance rating of 53%, interpreted as Approaching Proficiency. The proficiency level of the most essential learning competencies in this area ranges from 32% to 72%. Explain how the respiratory and circulatory systems work together to transport nutrients, gases, and other molecules to and from the different parts of the body got the highest level of proficiency of 72%, interpreted as Proficient while describe the location of genes in chromosomes got the lowest proficiency level of 32% interpreted as Developing.

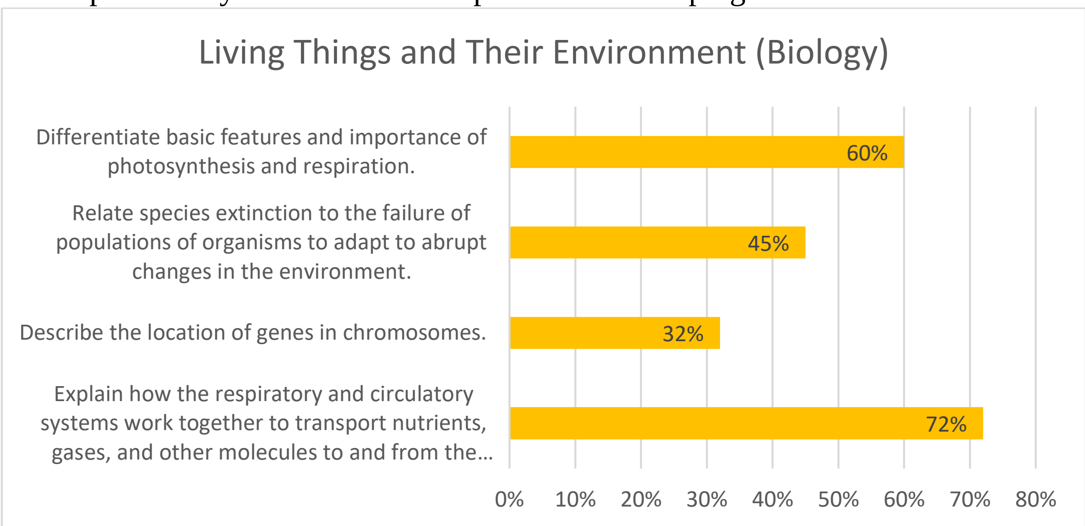

Figure 3. Competency Performance of Grade 9 Students in Living Things and Their Environment (Biology)

This result explains that one common problem science teachers and students face is their low mastery of science content knowledge, specifically in biology. This is supported by the study of Grobschedl et al., (2014), which stated that the most challenging part for educators is to assist learners in developing their knowledge in subject matter such as Biology. Cimer, in 2004, also argued that high school students could see many Biology concepts as challenging.

Tekkaya et al., (2001) found challenging ideas considering the secondary students' Mendelian genetics, nervous system, hormones, chromosomes, mitosis, genes, and meiosis. This is parallel with the findings of Bahar et al., (1999) that water transportation in plants and genetics were the two scientific aspects that proved to be most troublesome.

- **Matter (Chemistry)**

As a fundamental concept in Chemistry, matter is anything that occupies space and has mass. It is the fundamental unit of our physical universe and encompasses everything we can see, touch, or interact with. From cooking to cleaning, from understanding the impact of pollutants on the environment to choosing appropriate construction materials, knowledge of matter guides us to make safe, sustainable, and efficient decisions.

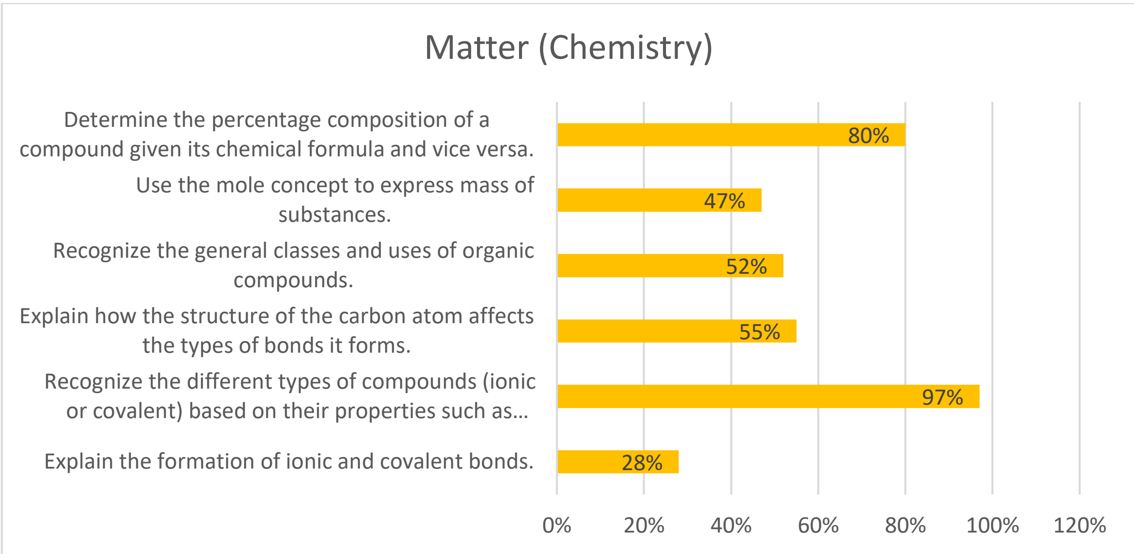

Figure 4. Competency Performance of Grade 9 Students in Matter (Chemistry)

It can be viewed in Figure 4 the competency performance of Grade 9 students in Matter (Chemistry). This area of science got an overall performance of 53%, interpreted as Approaching Proficiency. At this level, a student has developed a core understanding of the fundamental knowledge and skills in Chemistry. In connection with its most essential learning competencies, recognizing different types of compounds (ionic or covalent) based on their properties, such as melting point, hardness, polarity, and electrical and thermal conductivity, got the highest level of proficiency which is 97% interpreted as Advanced consequently, explaining the formation of ionic and covalent compounds got the lowest performance rating which is 28% interpreted as Developing. The result implies that students can effectively identify whether compounds are ionic or covalent based on their properties and characteristics; however, students also need help in tracing the formation of ionic and covalent compounds.

Parallel to this result, a research article by Ely (2019) concluded that through the Chemistry Achievement Test (CAT), the level of mastery in chemistry competencies is generally average. The ninth-grade students who have a lesson in chemical bonding, mole concept, and carbon compound achieve the lowest score as the subject integrates many abstract concepts, which is essential to learning since it is the basis for further knowledge in other fields of science. Based also on the literature by Ely (2019), it was noted that chemical bonding is one of the most challenging concepts in General Chemistry. Chemical bonding requires intellectual thought since it needs a broad understanding of abstract concepts. Understanding chemical bonding is fundamental to learning the nature of chemistry, like chemical reactions, thermodynamics, molecular structure, chemical equilibrium, and physical properties. Knowledge of chemical bonding theories can also be obtained by learning about reactivity, spectroscopy, and organic chemistry (Pabuccu et al.,2012).

- **Earth and Space (Earth Science)**

Earth, our home planet, is a dynamic and complex system that has supported life for billions of years and continues to evolve in fascinating ways. Studying Earth and space sciences enable students to gain insights into the processes that continue to shape our planet's history and future. By unraveling the mysteries of Earth and space, one can gain a deeper understanding of our place in the universe and the interconnectedness of all things. It inspires us to protect our planet, explore new frontiers and pursue knowledge that expands the boundaries of human understanding. Based on Figure 5, the level of proficiency of Grade 9 students in Earth and Space is Proficient as it obtained an overall performance of 63%. This is the only area of science with no competencies that fall on the developing level.

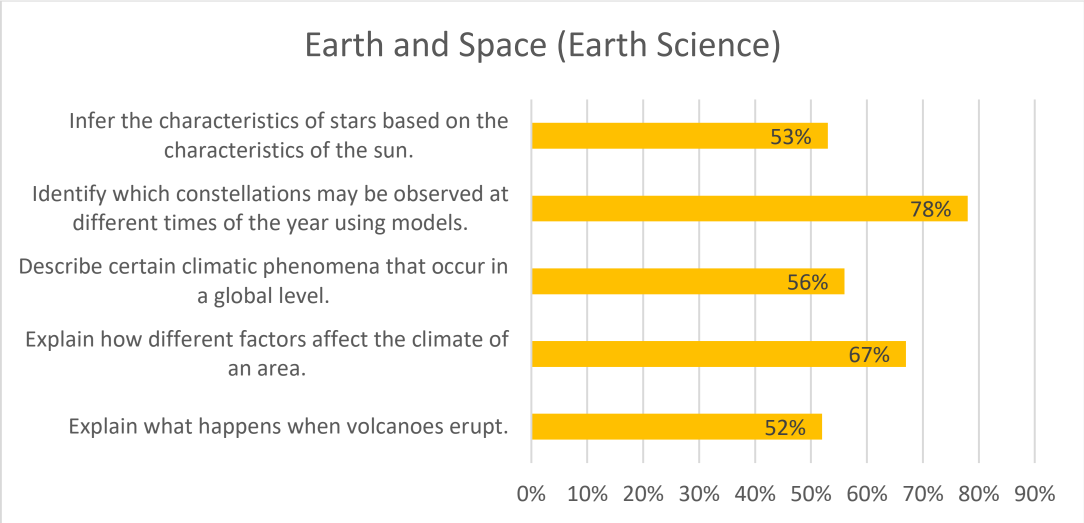

Figure 5. Competency Performance of Grade 9 Students in Earth and Space (Earth Science)

The most essential learning competency that obtained the highest rating of 78%, interpreted as Proficient, is identifying which constellations may be observed at different times of the year using models while explaining what happens when volcanoes erupt got the lowest rating of 52%, interpreted as Approaching Proficiency.

To sustain and continuously improve the competencies of students in this area of science, several studies on Earth Science (ES) focus on the use of ICT as ES is characterized by geological phenomena whose space parameters, time, and physicochemical conditions we do not control as in the case of convection currents, metamorphism, plate tectonics, orogenesis, and magmatism, which require the use of analog models or simulations.

In this case, information and communication technologies (ICT) constitute a relevant didactic tool to address complex concepts and phenomena that are difficult to acquire. For example, the possibilities offered by ICTs in certain learning situations include: watching reduced or accelerated model events that are not accessible to direct observation for reasons of time (e.g., prolonged speeds of some geological phenomena) or space (gigantic or microscopic dimensions of particular geological objects). The study of Chakour et al., has shown that using simulations can improve learning outcomes.[13] In fact, the integration of a computer simulation in a learning situation concerning relative chronology had a positive effect on student

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achievement.

- **Force, Motion, and Energy (Physics)**

Physics is the scientific study of the fundamental principles that govern the behavior of matter and energy. One of the key areas of physics is the study of force, motion, and energy. Understanding these concepts is crucial to explaining and predicting how objects interact with each other and the world around us. They explain phenomena ranging from the movement of celestial bodies in space to the behavior of atoms and particles at the quantum level. Through this, scientists and engineers have developed technologies and innovations that have shaped the modern world.

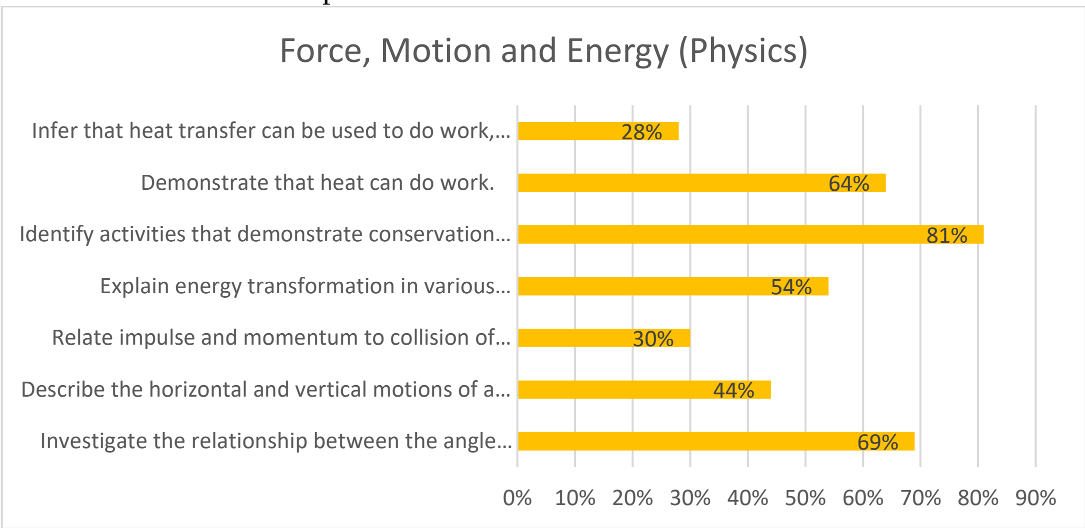

Figure 6. Competency Performance of Grade 9 Students in Force, Motion and Energy (Physics)

Figure 6 displays the competency performance of Grade 9 students in Force, Motion, and Energy (Physics). This area of science also obtained an overall performance of 53%, interpreted as Approaching Proficiency. Moreover, two of the most essential learning competencies in this area fall under the Developing category. These are relate impulse and momentum to the collision of objects like vehicular collision and infer that heat transfer can be used to do work and that work involves heat release. The competency performance in these areas was only of 30% and 28%, respectively.

This was supported by the study of Pullicino & Bonello (2020) that compared to other lessons, although there are many relationships between the subject and the number of subjects to be learned, more than knowing the definition of Physics is needed to learn the subject. There are also theories and numerical expressions that make also tricky to understand Physics. Although, Ebora stated in 2016 that Physics opens new opportunities to many career options, teaching the subject effectively and learning it on the part of the students is a common challenge encountered by every classroom physics teacher. There are key important factors to consider for the teaching-learning process like the teachers facilitating the learning process, the students who receive information, instructions, learning resources, and the learning environment.

In order to address these challenges, there is a need to teach Physics using different student-centered education methods. According to Abubakar (2020), for students to comprehend Physics which is hard to understand, using visuality like films, shapes, schemas, graphics, pictures, and animations is needed to motivate students and attract their attention. At the same time, Ahmed & Hasegawa (2019) also claimed that physics could be learned best virtually inside a computer. Experiments in Physics can be executed using simple-to-use and learn computer programs. These studies reveal that instructional learning materials have a significant impact on students' performance and achievement, especially in science subjects. Selecting appropriate instructional learning materials for a particular topic will result in positive student performance (Choppin et al., 2020). Furthermore, effective use of instructional learning material can promote meaningful classroom discussion.

IMPLICATIONS FOR BLENDED LEARNING

The educational setting had been disrupted by the COVID-19 pandemic, which paved the way for the country to shift from face-to-face learning to alternative learning modalities. The new normal education was implemented after planning and piloting different learning modalities to sustain and provide quality education despite the ongoing pandemic crisis. Teachers and students were forced to adapt to the new way of accessing knowledge as they mainly relied on online resources (Chavez et al., 2021). Teaching materials played an essential role in the learning process as these learning resources were able to supplement, sustain, and enrich the learning process.

The findings from the analysis respond to the study's research questions and help to achieve its goal, which is to evaluate the competency performance of Grade 9 students in the four areas of Science and consequently articulate its implications for blended learning in order to develop an integrated virtual laboratory activity to be used by the students and teachers.

The abrupt shift to distance learning and teaching posed several difficulties for students and teachers, which may have impacted the student's competency performance in Science. Here are some key implications of this situation.

First is limited access to technology. Not all students have equal access to reliable internet connections, computers, or smartphones necessary for online learning. Access to technology is needed to improve students' ability to engage effectively with online Science resources, participate in virtual experiments or demonstrations and collaborate with their peers. Although many studies have implied the growing development of electronic references that are extremely useful and have significantly contributed to the advancement of digital literacy, barriers to the effective use of these materials still exist. Rotas and Cahapay (2020) revealed the following categories of difficulties in distance learning: unstable internet connectivity, insufficient learning resources, power outages, ambiguous learning contents, overloaded lesson activities, limited teacher scaffolds, poor peer communication, conflict with home responsibilities, poor learning environment; financial issues, physical health compromises, and mental health struggles.

Since blended learning allows for a combination of online and face-to-face instruction when students have limited access to technology, the face-to-face component can provide them with necessary resources, materials, and technology access within the classroom. This empowers and ensures that students can participate in learning activities even if they do not have consistent access to technology outside of the classroom.

The second is insufficient teacher training. Many teachers were not adequately prepared to conduct online classes or deliver science lessons through digital platforms like Zoom or Google Meet. They may need assistance with online teaching tools, developing interactive science activities, or adapting traditional teaching methods for an online environment. This lack of training can hinder the delivery of quality science education and impede students' understanding of complex scientific concepts. Despite these difficulties experienced by teachers, the implementation of the K to 12 curriculum and the occurrence of COVID – 19 pandemic in the Philippines pushes teachers to always look for ways and means to accomplish things and to make activities, especially in science, more meaningful and lifelong. Teachers are challenged to create relevant, research-based, and responsive instructional materials (Rogayan & Dollete, 2019).

Teachers need both technological proficiency and pedagogical skills to integrate online components into blended learning effectively. Professional development and training opportunities can enhance their teaching skills, help them navigate the blended learning environment, and gain expertise in utilizing

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technology. This can address the challenge of insufficient teacher training and ensure they are well-prepared to facilitate blended learning experiences.

Third is limited student engagement and motivation. The remote learning environment may reduce student engagement and motivation, particularly in science subjects requiring hands-on experimentation and practical application. Students may find maintaining their interest and enthusiasm challenging without the in-person interaction, laboratory experiments, and group activities typically associated with science learning. This implication is consistent with the findings of Fortus et al., (2021), who assert that motivation is crucial. Motivation is the key to learning because it leads to engagement, without which learning is unlikely. It suggests that interest in science, as well as the value and understanding of science, influence current and future participation in science learning and that enjoyment is a crucial mediator in this process.

However, integrating blended learning as a modality offers diverse instructional strategies, combining online and face-to-face activities. It provides opportunities for interactive and engaging learning experiences through online multimedia resources, gamification, virtual simulations, or collaborative projects. By integrating these elements, blended learning can help enhance student engagement and motivation, overcoming the limitations of online learning.

Fourth is the social and emotional impact on learners. Prolonged isolation and limited social interaction due to online learning can harm students' mental well-being and academic performance. The absence of face-to-face interactions with teachers and peers may lead to feelings of detachment, loneliness, and reduced support systems, which can further affect students' motivation to excel in science. Several researches conducted during the COVID-19 pandemic have shown that social isolation can result in negative emotional experiences that can significantly impact students' overall well-being and hinder their ability to perform academically. For example, Xiong et al., (2020) observed increased anxiety and stress among students participating in online learning during the pandemic compared to traditional classroom settings wherein students can interact with their teachers and peers, seek clarification and receive emotional support. This is often the problem of online learning as it lacks the same level of personal connection and immediate feedback. Without the presence of teachers and peers for guidance and support, students may fell less motivated to excel in their studies.

Blended learning allows face-to-face interactions, fostering social connections and emotional support. In face-to-face components, students have opportunities for direct interaction with their peers and teachers, promoting social interaction, collaboration, and emotional support. This can help mitigate the social and emotional impact that may arise from a solely online learning environment.

Fifth is the decreased opportunities for practical application. Science education heavily relies on practical application and laboratory work to reinforce theoretical concepts. The transition to distance learning has significantly limited students' opportunities for hands-on experiments, data collection, and analysis. These experiences are necessary for students to fully grasp scientific principles and develop critical thinking skills. A study conducted by Barbour et al., (2020) during the COVID-19 pandemic examined science educators' challenges in adapting laboratory-based courses to online environments. The findings highlighted that the lack of access to physical laboratories and equipment was a significant hurdle for teachers and students. Furthermore, practical application in science education fosters critical thinking and problem-solving skills. These skills are essential for scientific inquiry and can significantly contribute to students' scientific literacy.

Blended learning can provide a balance between theoretical knowledge and practical applications. Face-to-face components allow for hands-on activities, experiments, group discussions, or fieldwork, facilitating practical learning experiences that may be limited in an online distance learning setup. By incorporating these practical applications into the learning process, blended learning addresses the challenge of reduced opportunities for hands-on learning.

Educators have explored alternative approaches to address the challenges of limited practical application in distance learning. Virtual laboratories and simulations have been used as substitutes for hands-on experiments. Some studies have found that well-designed online practical activities can still contribute to students' learning outcomes. For example, a study by Huang et al., (2020) examined the effectiveness of virtual experiments in enhancing students' conceptual understanding and scientific inquiry skills. The findings suggested that virtual experiments can be valuable for promoting scientific learning and critical thinking when appropriately designed and integrated into the curriculum.

By combining the benefits of online and face-to-face instruction, blended learning offers a flexible and versatile approach to address the challenges associated with online distance learning. It provides opportunities for personalization, engagement, practical application, social interaction, and support, enhancing the overall learning experience and helping students overcome the limitations of a purely online environment.

In this regard, the researcher humbly proposes to adapt the integrated virtual laboratory activity as the output of this study. The researcher firmly believes that learners should be exposed to learning resources such as virtual laboratories, simulations, video presentations and gamifications since these are effective in learning and acquiring science process skills. Furthermore, this is the researcher's way of contributing to advancing science education in the context of distance learning by offering students meaningful and engaging learning experiences. This approach will make a positive impact on science education and empower learners to succeed.

The Science Bridge: Bridging the Gaps in Blended Learning

With the perceived challenges by the teachers and students in teaching and learning science concepts and processes, the researcher developed an integrated virtual laboratory-based activity entitled "The Science Bridge: Bridging the Gaps in Blended Learning." Similar to how a physical bridge ensures a smooth transition between two points, the output aims to integrate practical applications into the blended learning environment seamlessly. This approach aims to leverage the benefits of both modalities, providing students with flexibility, personalized learning experiences, and opportunities for collaboration.

The output also emphasizes "bridging the gaps" in blended learning. It acknowledges the challenges when practical application opportunities are limited in online environments and seeks to fill that gap by providing an effective and engaging alternative. Addressing the need for practical application enhances the overall learning experience for students. It ensures they receive a well-rounded science education combining theoretical knowledge, hands-on experiences, critical thinking, and problem-solving skills.

Moreover, the output of this study is based on the competency performance as a result of the Performance Assessment of Standards and Skills (PASS) administered by the Global Resources for Assessment Curriculum and Evaluation last April 5, 2021, to Grade 9 Special Science Class students of University of Saint Anthony. The test primarily aims to obtain a comprehensive evaluation of students' proficiency in science as set by the Department of Education.

The different tasks and activities included by the researcher are believed to be the best to motivate, encourage and provide meaningful and lifelong learning to the students. All the activities address the students' difficulty in learning science concepts, and teachers facilitate classroom discussions. This objective in mind was supported by Carneiro (2007), who stated that instructional aids are defined as small units of digital educational materials that can be used flexibly and in a variety of formats. It can be through videos, interactive games, tutorials, worksheets, and simulations. These materials are commonly used to

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enhance online discussions.

Furthermore, The Science Bridge: Bridging the Gaps in Blended Learning is an online tool for discussing science concepts using Rise Articulate 360 and Canva as the leading platform. Phet simulations developed by the University of Colorado Boulder, live worksheets, videos, MS Office, and other software will also be used in structuring the lesson and laboratory activities.

The template design of the integrated virtual laboratory activities followed the Atkin-Karplus 5E Learning Cycle. This model allows students to comprehend a concept over time by following predefined steps: Engage, Explore, Explain, Elaborate, and Evaluate.

On the Parts of the Science Bridge: Bridging the Gaps in Blended Learning

Figure 7 highlights the overview of The Science Bridge: Bridging the Gaps in Blended Learning using different platforms. The material can be viewed and accessed using a desktop, tablet, iPad, or mobile device in both portrait and landscape mode. It ensures learners can engage with the educational content according to their preferences and technological capabilities. Whether students prefer the larger screen real estate of a desktop computer or the mobility and convenience of a handheld device, they can seamlessly connect to the material. The inclusion of desktop computers enables learners to delve into rich multimedia content and interact with the learning materials more effectively.

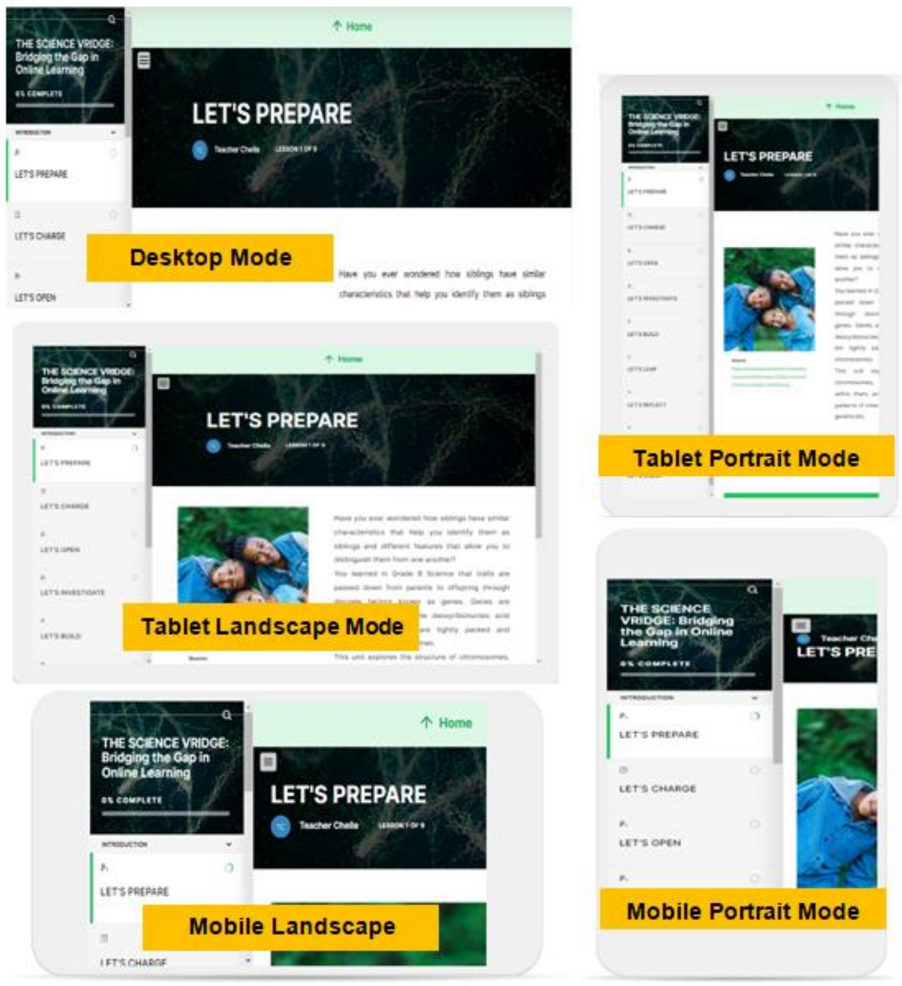

Figure 7. Overview of The Science Bridge: Bridging the Gaps in Blended Learning Using Different Platforms

By accommodating these orientations, the platform caters to different viewing preferences and allows learners to optimize their experience based on the content. Whether the material features lengthy texts,

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graphics, videos, or a combination thereof, users can choose the orientation that best suits their needs, maximizing readability and comprehension.

Moreover, Figure 8 displays the interactive parts of The Science Bridge: Bridging the Gaps in Blended Learning. These components aim to enhance the learning experience by incorporating engaging and dynamic elements.

It begins with a concise and informative overview of each lesson. This section highlights the key concepts, objectives, and topics covered throughout the lesson, offering students a clear roadmap of what to expect. The interactive quizzes assess students' understanding and reinforce their learning. These quizzes can be accessed online and are designed to test comprehension, recall, and critical thinking skills. Through this, students can actively participate in the learning process and receive immediate feedback on their progress.

The researcher recognizes the importance of visual aids in facilitating learning. Hence, it provides downloadable PowerPoint presentations (PPTs) for each lesson. These PPTs are packed with engaging visuals, diagrams, and illustrations that complement the lesson content. Students can download and review these at their convenience, strengthening their understanding of the topic.

In order to simulate real-world scientific experimentation and practical learning, the material incorporates virtual laboratories

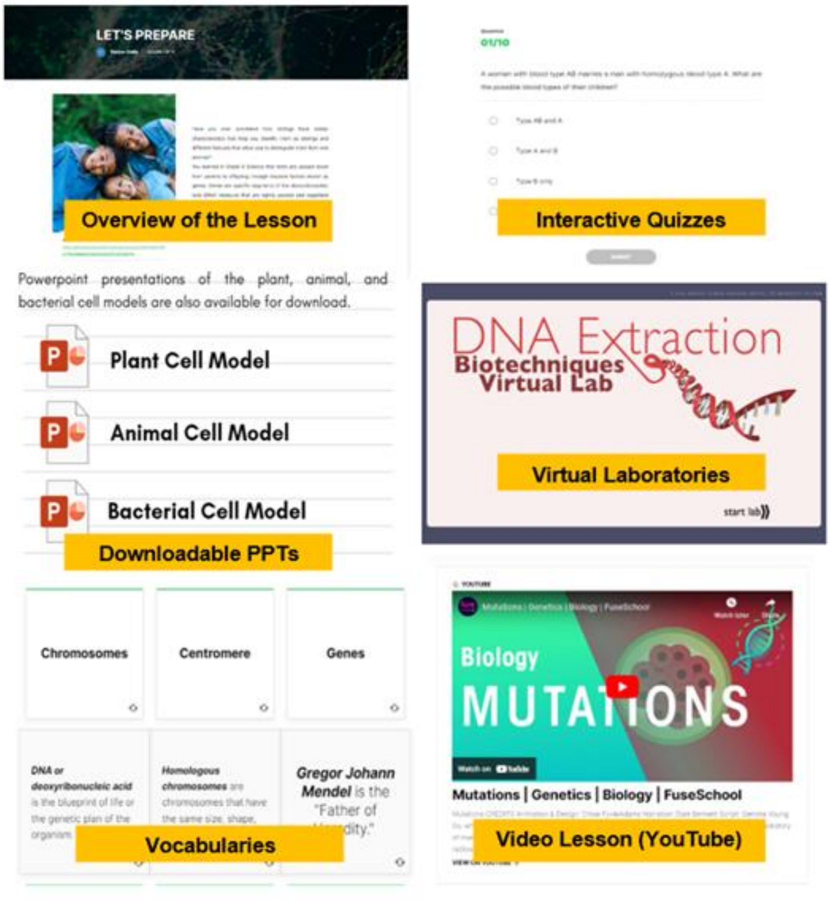

Figure 8. Interactive Parts of The Science Bridge: Bridging the Gaps in Blended Learning

These virtual laboratories and simulations provide hands-on experiences in a digital environment, allowing students to conduct experiments, make observations, and analyze data. Through these, students can develop essential laboratory skills and gain a deeper understanding of scientific concepts.

Science education often involves a multitude of technical terms and specialized vocabulary, and the

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instructional material, The Science Bridge: Bridging the Gaps in Blended Learning, acknowledges the importance of building a strong scientific vocabulary therefore, it offers dedicated vocabulary resources to help students expand their understanding and comprehension of key terms. These resources include glossaries, word lists, flashcards, and interactive exercises on scientific terms and terminology.

Leveraging the power of multimedia, the output also incorporates video lessons delivered through YouTube. These videos are a helpful addition to Science lessons as they provide dynamic and engaging content that complements the written materials. Through visual demonstrations, animations, and explanations, students can grasp complex scientific concepts more effectively. The YouTube platform enables easy access and flexibility, allowing students to view the lessons at their own pace and revisit them as needed.

The Science Bridge: Bridging the Gaps in Blended Learning provides numerous opportunities to facilitate students' acquisition of a more enjoyable understanding of science through the following features:

1. **Let's Prepare.** This presents the introduction of each unit. This includes the content standard, performance standards, and the Most Essential Learning Competencies, Key Understanding, which presents the big idea to be learned in each unit, and Essential Questions which help to unlock each lesson can also be viewed in this part. This section sets the stage for the upcoming lessons, providing students and teachers clear framework and direction.
2. **Let's Charge.** This is a diagnostic test to assess students' prior knowledge and gauge their understanding of the new topic. The test consists of a 10-item multiple-choice test with rationalization provided for each question. The purpose is to identify any knowledge gaps or misconceptions students may have before diving into the lesson.
3. **Let's Open.** This mind-on activity elicits students' understanding of the pre-requisite topics. This serves as a review of the needed concepts to understand the lesson better. By reviewing and revisiting the necessary concepts, students can refresh their memory, establish connections and build a solid foundation for the upcoming lesson. This helps students approach the material with a better grasp of the context.
4. **Let's Build.** This component provides a discussion of the topic using illustrations, examples, games, and simulations with step-by-step solutions and explanations of critical concepts. By using different instructional materials, it caters the various learning styles of the students and encourage active engagement.
5. **Let's Investigate.** This is a hands-on activity to engage students in active science learning. It prompts students to investigate science concepts and principles through virtual laboratory activities and simulations. fostering curiosity and critical thinking. It fosters curiosity and critical thinking skills as students explore and experiment with scientific phenomena.
6. **Let's Leap.** This enriches and deepens the knowledge and skills attained in the lesson. This part also integrates the lesson to good moral development and a positive attitude in life. This section aims to develop well-rounded individuals who can apply their scientific knowledge in meaningful ways.
7. **Let's Sum It Up.** This provides a summary of the essential concepts and principles discussed. It serves as a quick reference for important information and acts as a reminder of the core concepts covered.
8. **Let's Check.** It provides an assessment that tests students' understanding of concepts or ability to make meaning. This allows students to assess their own learning and identify areas that may require further review or clarification.

CURRICULAR VALIDATION OF THE SCIENCE BRIDGE: BRIDGING THE GAPS IN BLENDED LEARNING

The integrated virtual laboratory activity entitled The Science Bridge: Bridging the Gaps in Blended

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Learning was evaluated independently by twenty (20) science teachers using the Expert's Evaluation Checklist (EEC) adapted from the Department of Education's Guidelines and Process for Learning Resource Management and Development Standards (LRDMS). The evaluators utilized the Evaluation Rating Sheet for Non-Print Materials and its associated descriptors for Factors A to D for non-print materials. The rating sheet includes criteria on the following: a. Content Quality, b. Instructional Quality, c. Technical Quality, and d. Other Findings include conceptual, factual, grammatical, typographical, computational, and obsolete information and visual errors.

Aside from the evaluation rating sheet, the researcher also utilizes the four-point Likert scale, with the following ranges and verbal interpretation; 3.25 – 4.00 as very satisfactory (VS), 2.50 – 3.24 as satisfactory (S), 1.75 – 3.49 as poor (P) and 1.00 – 1.74 as not satisfactory (NS). Factor D, which pertains to other findings, also has four response options, namely; (4) not present (NP), (3) present but very minor and must be fixed (PM), (2) present and require major redevelopment (PR) and (1) do not evaluate further (DE).

- **Validation as to Content Quality – Factor A**

Table 2. Validation as to Content Quality – Factor A

Factor A. Content Quality	**Average Points**	**Verbal Interpretation**	**Rank**
1. Content is consistent with topics/skills found in the DepEd Learning Competencies for the subject and grade/year level it was intended.	3.95	VS	1.5
2. Concepts developed contribute to enrichment, reinforcement or mastery of the identified learning objectives.	3.90	VS	4
3. Content is accurate.	3.85	VS	7
4. Content is up-to-date.	3.90	VS	4
5. Content is logically developed and organized.	3.85	VS	7
6. Content is free from cultural, gender, racial or ethnic bias.	3.80	VS	9.5
7. Content stimulates and promotes critical thinking.	3.90	VS	4
8. Content is relevant to real life situations.	3.85	VS	7
9. Language (including vocabulary) is appropriate to the target user level.	3.80	VS	9.5
10. Content promotes positive values that support formative growth.	3.95	VS	1.5
TOTAL POINTS	**38.75**	**Passed**	

Legend:

3.25 – 4.00 as Very Satisfactory (VS),

2.50 – 3.24 as Satisfactory (S),

1.75 – 2.49 as Poor (P)

1.00 – 1.74 as Not Satisfactory (NS).

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Note: Learning resource must score at least 30 points out of a maximum of 40 points to pass this criterion.

Table 2 presents the validation result on each criterion of Factor A. Content Quality of the integrated virtual laboratory activity. It shows that each statement got a verbal interpretation of Very Satisfactory (VS), which resulted in a total of 38.75 points out of a maximum of 40 points. It indicates that the integrated virtual laboratory activity passed the criterion.

According to Memebrebe & Anadia (2015), it is suggested that the contents of learning materials and resources must be carefully assessed following the content criterion provided by the Department of Education so it can be used to improve science teaching, facilitate the learning process and most importantly to improve student academic achievement of the least mastered competency performance. This criterion likely includes guidelines and standards that ensure the content's accuracy, relevance, and appropriateness. Similarly, Maliga (2018) emphasizes the significance of having valid and acceptable content in learning materials. Validity ensures that the content accurately represents the scientific concepts and principles being taught. In contrast, acceptability ensures that the content aligns with educational standards and meets the needs of the learners. Criterion 1. Content is consistent with topics/skills found in the DepEd Learning Competencies for the subject and grade/year level it was intended for and Criterion 10. Content promotes positive values that support formative growth got the highest average point of 3.95, verbally interpreted as Very Satisfactory (VS). This means that the integrated virtual laboratory activity is related to and supports the development of skills related to the learning competencies and the inclusion of positive values is evident and is properly discussed in the material.

Furthermore, Criterion 2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives, Criterion 4. Content is up-to-date, and Criterion 7. Content stimulates and promotes critical thinking obtained an average point of 3.90 verbally interpreted as Very Satisfactory (VS). This shows that the material supports and complements the achievement of learning objectives of the subject area and grade/year level for which it is intended. There is also no outdated information, improper use of figures, inaccurate graphs, and oversimplified models or diagrams. It also promotes higher order thinking skills (HOTS) as it requires cognitive effort, not just a chance selection of responses.

On the other hand, Criterion 3. Content is accurate, Criterion 5. Content is logically developed and organized and Criterion 8. Content is relevant to real-life situations attained an average point of 3.85, verbally interpreted as Very Satisfactory (VS). This denotes that the presentation of factual content is accurate and presented in a well-organized, consistent and logical manner, allowing students to follow through with the content effectively. The content of the simulation is coherent and authentic as seen in the metaphors and scenarios to enhance understanding of real-life situations.

Lastly, Criterion 6. Content is free from cultural, gender, racial, or ethnic bias and Criterion 9. Language (including vocabulary) is appropriate to the target user level earned an average point of 3.80 verbally interpreted as Very Satisfactory (VS). This reflects that there are no ideological, cultural, religious, racial and gender biases/prejudices found in the material. All social content is fairly presented and does not violate the Social Content Guidelines. The new and complex words and terms are also clearly and consistently explained and defined to make them suitable and appropriate to the target user's level.

These findings suggests that the Science Bridge: Bridging the Gaps in Blended Learning has been evaluated by the experts positively in terms of Factor A – Content quality. This implies that content and topics' scope, range, and depth are appropriate to the target audience's learning needs. Material reinforces, enriches, or leads to mastery of specific learning competencies. The learning activities require cognitive effort, not just a chance selection of responses. The presentation of social content, including values and perspectives, is fairly represented. The presentation of controversial social content is balanced and structured to promote an

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educated understanding of differing points of view. The material is presented to connect with the target reader's knowledge and experience. The inclusion of adequate warning / cautionary notes (where needed) is evident in the material.

- **Validation as to Instructional Quality – Factor B**

Table 3 displays the validation result on each criterion about Factor B. Instructional Quality of the integrated virtual laboratory activity. It shows that each statement got a verbal interpretation of Very Satisfactory (VS), which resulted in a total of 38.60 points out of a maximum of 40 points. According to Espinosa (2018), instructional materials should emphasize embedding skills and knowledge in holistic and realistic contexts. Anchored contexts support complex and ill-structured problems in which learners generate new knowledge and sub-problems while determining how and when to apply their knowledge.

Table 3. Validation as to Instructional Quality – Factor B

Factor B. Instructional Quality	**Average Points**	**Verbal Interpretation**	**Rank**
1. Purpose of the material is well – defined.	3.95	VS	1.5
2. Material achieves its defined purpose.	3.85	VS	6
3. Learning objectives are clearly stated and measurable.	3.85	VS	6
4. Level of difficulty is appropriate for the intended target user.	3.85	VS	6
5. Graphics/colors/sounds are used for appropriate instructional reasons.	3.80	VS	8.5
6. Material is enjoyable, stimulating, challenging and engaging.	3.95	VS	1.5
7. Material effectively stimulates creativity of target user.	3.90	VS	3.5
8. Feedback on target user's responses is effectively employed.	3.75	VS	10
9. Target user can control the rate and sequence of presentation and review.	3.80	VS	8.5
10. Instruction is integrated with target user's previous experience.	3.90	VS	3.5
TOTAL POINTS	**38.60**	**Passed**	

Note: Learning resource must score at least 30 points out of a maximum of 40 points to pass this criterion.

Among the criteria evaluated, Criterion 1. Purpose of the material is well defined and Criterion 6. Material is enjoyable, stimulating, challenging and engaging got the highest average points of 3.95, verbally interpreted as Very Satisfactory (VS). This suggests that the educational purpose of the material is stated or is evident within the overall design of the material. Furthermore, in terms of pedagogy, the proposed

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material is innovative. It scaffolds and challenges students' level of understanding through its design and presentation.

Furthermore, Criterion 7. Material effectively stimulates creativity of target user and Criterion 10.Instruction is integrated with target user's previous experience obtained an average point of 3.90, verbally interpreted as Very Satisfactory (VS).

This shows that the material promotes user engagement and encourages creativity. Instructional prerequisites are also stated or easily inferred as it encourages users to review prior knowledge.

On the other hand, Criterion 2. Material achieves its defined purpose, Criterion 3. Learning objectives are clearly stated and measurable, and Criterion 4. Level of difficulty is appropriate for the intended target user attained an average point of 3.85, also verbally interpreted as Very Satisfactory (VS). This denotes that the material is well-designed and is likely to achieve its defined purpose, and does not contain gratuitous information or graphics. What the user will know and be able to do is also clearly stated. There are also opportunities provided for different levels of instruction based on content chunking and sequencing.

Criterion 5. Graphics/colors/ sounds are used for appropriate instructional reasons and Criterion 9. Target user can control the rate and sequence of presentation and review earned an average point of 3.80, verbally interpreted as Very Satisfactory (VS). This reflects that the illustrations/visuals are effective and appropriate. It makes balanced use of graphics, sound, and color to augment the content. In terms of control, the user can revisit, replay active content and decide when to progress to the next step.

Lastly, Criterion 8. Feedback on target user's responses is effectively employed gained an average point of 3.75 verbally interpreted as Very Satisfactory (VS). This indicates that the feedback is non-threatening, immediate, positive, motivational, and user-sensitive.

The result only shows that continuous development of the educational system becomes necessary as time goes by. It is always true that there is no educational system and teaching methods that suit all types of learners. Luckily, teachers have realized that the existing instructional methods can no longer meet the demands of modern technology. Thus, there is a need to adapt educational innovations. Hence, educational objectives were set, and supporting guiding policies were promulgated. These educational policies were designed to improve teaching methodologies and techniques to attain the optimum potential learner.

- **Validation as to Technical Quality – Factor C**

Table 4 highlights the validation result on each criterion about Factor C. Technical Quality of the integrated virtual laboratory activity. It shows that each statement got a verbal interpretation of Very Satisfactory (VS), resulting in a total of 49.20 points out of 52 points. This indicates that the instructional material successfully met the criterion. This is parallel to the study of Aquino in 2018 in which he stated that illustrations could be effective in attracting attention, aiding retention, enhancing understanding, and creating context. The positive result from the validation suggests that the use of illustrations is a must.

As technology evolves, the importance of technology in education will grow too. Teachers need training on how to take their students into the future with the next technological invention and stay abreast and use this technology in their own lives to use it in the classroom at different learning modalities effectively. The validators emphasized that the supplementary learning material is appropriate for learners as it provides comprehensive information using illustrations, audiovisual, and digital resources. It can stimulate learners' hearing and visual skills. Barrot (2018) said that electronic devices could perform many functions of a personal computer while taking up less space and cost. Students can interact with the subjects by using a computer or mobile-based applications.

Table 4. Validation as to Technical Quality – Factor C

Factor C. Technical Quality	**Average Points**	**Verbal Interpretation**	**Rank**
1. Audio enhances understanding of the concept.	3.70	VS	11.5
2. Speech and narration (correct pacing, intonation and pronunciation) is clear and can be easily understood.	3.65	VS	13
3. There is complete synchronization of audio with the visuals, if any.	3.80	VS	6.5
4. Music and sound effects are appropriate and effective for instructional purposes.	3.80	VS	6.5
5. Screen display (text) are uncluttered, easy to read and aesthetically pleasing.	3.75	VS	9.5
6. Visual presentation (non-text) is clear and easy to interpret.	3.85	VS	3
7. Visuals sustain interest and do not distract user's attention.	3.80	VS	6.5
8. Visuals provide accurate representation of the concept discussed.	3.90	VS	1
9. The user support materials (if any) are effective.	3.85	VS	3
10. The design allows the target user to navigate freely through the material.	3.75	VS	9.5
11. The material can easily and independently used.	3.70	VS	11.5
12. The material will run using minimum system requirements.	3.85	VS	3
13. The program is free from technical problems.	3.80	VS	6.5
TOTAL POINTS	**49.20**	**Passed**	

Note: Learning resource must score at least 39 points out of a maximum of 52 points to pass this criterion.

Criterion 8. Visuals provide accurate representation of the concept discussed got the highest average point of 3.90, verbally interpreted as Very Satisfactory (VS). This means that the visuals are accurate, and interpretation of visuals will not result in misconceptions.

Furthermore, Criterion 6. Visual presentation (non-text) is clear and easy to interpret, Criterion 9. The user support materials (if any) are effective and Criterion 12. The material will run using minimum system requirements obtained an average point of 3.85, verbally interpreted as Very Satisfactory (VS). This shows that the images, diagrams, animations, and videos are clear and easy to interpret. There is a dynamic content that can be revisited and replayed by the user if required. In terms of user support, The Science Bridge: Bridging the Gaps in Blended Learning provides adequate and clear instructions for using the material. It is also user-friendly, as it can run on all platforms.

On the other hand, Criterion 3. There is a complete synchronization of audio with the visuals, Criterion 4. Music and sound effects are appropriate and effective for instructional purposes, Criterion 7. Visuals sustain interest and do not distract user's attention and Criterion 13. The program is free from technical problems attained an average point of 3.80 also verbally interpreted as Very Satisfactory (VS). This denotes that the audio and visuals are synchronized while the music and sound effects are appropriate and effective for

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instructional purposes. The visuals are also used effectively to complement textual information, as their primary purpose is to attract attention, aid retention, enhance understanding or create context. Criterion 5. Screen display (text) is uncluttered, easy to read and aesthetically pleasing and Criterion 10. The design allows the target user to navigate freely through the earned an average point of 3.75, verbally interpreted as Very Satisfactory (VS). This reflects that the amount of text on the screen is limited to the screen area rather than requiring continuous scrolling. In terms of navigating the material, there is a clear link to the instructional purpose and learning design. It does not also interfere with user's engagement in the content.

Lastly, Criterion 1. Audio enhances understanding of the concept and Criterion 11. Material can easily and independently used gained an average point of 3.70, verbally interpreted as Very Satisfactory (VS). This indicates that the audio is used to enhance understanding and comprehension which can support vocabulary development. Moreover, the material also allows and encourages students to work independently. This is possible since the user can replay, stop and start audio. The audio includes voice-over/speech that is clear and can be easily understood. This implies that Science teachers found the material with sound technical characteristics.

The visuals, audio, and videos had complete synchronization, which helped to enhance understanding of the concept. Screen displays are not cluttered, easy to read, and aesthetically pleasing to sustain users' interest.

Consequently, Criterion 2. Speech and narration (correct pacing, intonation and pronunciation) is clear and can easily be understood received the lowest average point of 3.65 verbally interpreted as Very Satisfactory). While this rating is still positive, it indicates that there may be some room for improvement in terms of clarity and ease of understanding of the audio narration.

- **Validation as to Other Findings – Factor D**

Table 5 shows the validation result on each criterion about Factor D. Other Findings include conceptual, factual, grammatical, and typographical errors, computational errors, obsolete information, and visual errors of the integrated virtual laboratory activity. It shows that each statement got an average point of 4.00 verbally interpreted as Not Present (NP) which resulted in a total of 16.00 points out of a maximum of 16 points.

Table 5. Validation as to Other Findings – Factor D

Factor D. Other Findings	**Average Points**	**Verbal Interpretation**	**Rank**
1. Conceptual errors	4.00	NP	2.5
2. Factual errors	4.00	NP	2.5
3. Grammatical and/or typographical errors.	4.00	NP	2.5
4. Other errors (i.e., computational errors, obsolete information, errors in visuals, etc.)	4.00	NP	2.5
TOTAL POINTS	**16.00**	**Passed**	

Legend:

3.25 – 4.00 Not present (NP)

2.50 – 3.24 Present but very minor & must be fixed (PM)

1.75 – 2.49 Present & requires major redevelopment (PR)

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– 1.74 Do not evaluate further (DE)

Note: Learning resource must score at least 16 points out of a maximum of 16 points to pass this criterion.

According to the validators, the integrated virtual laboratory activity fulfilled the criteria and was marked "Passed." It suggests that there were no conceptual, factual, grammatical, typographical, computational, obsolete information, or visual errors found in the activity during the validation process.

This implies the need for error-free materials to facilitate better understanding and comprehension among learners. Whether conceptual, factual, grammatical or typographical errors can create confusion, misconception, misinterpretation or misinformation. With this, eliminating errors is a must so learners can focus on the intended content leading to a more accurate and meaningful learning experiences. This can be done through intensive review and validation of the content for accuracy, relevance and appropriateness by subject matter experts, educators and instructional designers.

Table 6. Result of Validation Based on the Criteria for Non-Print Materials Provided by the Department of Education (DepEd)

Criteria	**Points Obtained**	**Required Points**	**Remarks**
Factor A. Content Quality	37.98	40	Passed
Factor B. Instructional Quality	37.66	40	Passed
Factor C. Technical Quality	48.16	52	Passed
Factor D. Other Findings (i.e., conceptual errors, factual errors, grammatical and/or typographical errors, computational errors, obsolete information, errors in visuals, etc.)	16.00	16	Passed

Legend:

Content Quality (Resource must score at least 30 points out of 40 points)

Instructional Quality (Resource must score at least 30 points out of 40 points)

Technical Quality (Resource must score at least 39 points out of 52 points)

Other Findings (Resource must score at least 16 points out of 16 points)

On the other hand, Table 6 shows that The Science Bridge: Bridging the Gaps in Blended Learning is valid and accepted based on the criteria for non-print materials provided by the Department of Education. All factors were marked "Passed" on the evaluations of the Science experts and teachers. This means that the digital material scored at least 30 points out of 40 points in the "Content Quality;" at least 30 points out of 40 points in the "Instructional Quality," at least 39 points out of 52 points in the "Technical Quality;" and 16 points out of the 16 points in the "Other Findings" (conceptual, factual, grammatical, and other errors) factor and obtained a valid result for every criterion during its evaluation phase. It is also recommended for public use, provided that the corrections and revisions included in the comments/suggestions the validators give are made. It is essential to address the corrections and revisions suggested by the validators to enhance its quality and effectiveness further.

This implies that The Science Bridge: Bridging the Gaps in Blended Learning has performed well in each category, scoring the minimum required points or higher in content quality, instructional quality, technical quality, and other findings. This positive evaluation indicates that the digital material meets the necessary standards and requirements. The validation results are congruent with the study conducted by Manalastas & De Leon (2021), where software was also used to develop interactive learning material in science. It includes examples that are relevant and realistic so that learners can understand. It is also supported by Mayen that instructional materials provide learner competencies and opportunities for mastery because well-planned instructional material teaches concepts logically.

With all these findings collected, analyzed, and interpreted, "The Science Bridge: Bridging the Gaps in Blended Learning" is, therefore, valid and accepted as assessed by experts and teachers in terms of content quality, instructional quality, technical quality, and other findings such as conceptual errors, factual errors, computational errors, obsolete information, error in visuals, etc. Furthermore, this is designed to meet the objectives of the Department of Education (DepEd) to continue the excellent quality of education despite COVID-19 threats. This adaptability makes it valuable, especially in the context of challenges posed by the pandemic, where blended learning approaches are becoming increasingly important. It is an innovation that can be a potential tool for online distance learning and face-to face-learning.

CONCLUSIONS

In view of the research findings, the following conclusions were drawn:

1. The Grade 9 students have a mixed level of competency performance in Science. While they demonstrate a relatively higher proficiency in Earth and Space (Earth Science), they exhibit a lower proficiency in Living Things and Their Environment (Biology), Matter (Chemistry), and Force, Motion, and Energy (Physics). The overall performance indicates that the students are approaching proficiency in Science.
2. The result of Global Resources for Assessment, Curriculum, and Evaluation – Performance Assessment of Standards and Skills (GRACE – PASS) becomes an avenue to identify learning gaps and learning losses and provide solutions to address them.
3. The Science Bridge: Bridging the Gaps in Blended Learning aims to effectively address the challenge of bridging the gaps between physical and virtual learning spaces, offering students a practical and interactive learning experience.
4. The proposed instructional material in Science 9, "The Science Bridge: Bridging the Gaps in Blended Learning," is valid and accepted as assessed by experts in terms of the four factors, namely: Content Quality, Instructional Quality, Technical Quality and Other Findings (i.e., conceptual errors, factual errors, grammatical or typographical errors, computational errors, error in visuals, etc.). The validators also recommend the possible use of the learning material, provided that the suggestions and recommendations are integrated.

RECOMMENDATIONS

Based on the findings and conclusions, the following recommendations were formulated:

1. The Junior High School Department of the University of Saint Anthony should revisit its academic policies and programs to find out what is lacking and what can be done to improve the quality of instruction. Teachers may also undergo continuing professional development (CPD). This lifelong learning process enhances teachers' competence by upgrading and updating knowledge and skills brought by modernization and technology advancements. On the other hand, students should take an active role in their learning process and seek support when needed to make significant progress in the subject and beyond.
2. The school should craft a Learning Recovery Plan to address learning gaps and learning losses

brought about by the changes in the educational landscape and its implication for teaching and learning processes.
3. Technology is always changing. Therefore, there is a need for ongoing retooling of best practices in online education. Teachers may use and adapt the proposed learning material to make learning in science more meaningful and eventually get better learning outcomes.
4. There is a need to continuously refine and validate the learning material in terms of content, instructional, technical quality and other findings. Checking the quality of the proposed learning material when integrated into online learning platforms like Learning Management System (Schoology, Edmodo and Google Classroom) or when the material is exported as a web, mobile, or desktop app is also a must.

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