

Science Majors' Perception of Virtual Laboratory Simulation Learning Towards Academic Performance in Biology.

Princess Bulawan Lagura, Justine Ann Torayno Alfaro, Nickolitte Cathleen Loquinario Cabanilla,
Jamica Estampador Dayag

Major in Science, Bachelor of Secondary Education, Don Carlos Polytechnic College

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ABSTRACT

This study evaluated the science majors' perception of virtual laboratory simulation learning towards academic performance in biology. The study involved a sample size of 60 Bachelor of Secondary Education major in science students who were selected using purposive sampling. Data was gathered through an adapted questionnaire assessing four key domains: Perceived Usefulness, Perceived Ease of Use, Attitude Towards Use, and Behavioral Intention. The instrument demonstrated good internal consistency, yielding a Cronbach's alpha coefficient of 0.812. Descriptive statistics were used to analyze the level of student perception. While the Pearson product-moment correlation coefficient was applied to determine the relationship between virtual simulation perception and academic performance. The results showed that students generally had a positive perception of virtual laboratory simulation learning (overall mean= 2.75). However, statistical analysis revealed no significant relationship between virtual laboratory simulation learning perception and students' academic performance in biology, with a correlation coefficient of $r = -0.088$ and p-value of $p = 0.503$ ($p > 0.05$). Consequently, the null hypothesis was failed to be rejected. These findings suggest that while students appreciate virtual simulations as supplementary tools, perception alone does not directly dictate academic outcomes in biology.

Keywords: Virtual Laboratory Simulations, Academic Performance, Biology Education, Student Perception, Technology-Mediated Learning, Science Education

INTRODUCTION

Background of the Study

Laboratory exercises were considered an essential part of science teaching, through which students were expected to acquire fundamental abilities, science-related skills, practical skills, scientific skills, and general skills (Chan et al., 2020). Laboratory experiments were quite different from other parts of the curriculum because students were placed in complex environments where they had to apply the essential skills introduced (Seery, 2021). Virtual laboratory simulations were considered substitutes for in-person or real-world practical skills training, and they could be completed through online learning (Ramadhan & Irwanto, 2018). These virtual labs emerged as a result of the rapid development of technology and information in society, particularly in the areas of technological and knowledge advancement (Sympas & Kalles, 2018).

The lack of laboratory equipment made it very hard for students to conduct experiments and engage in hands-on learning, which were important for building scientific skills and understanding. Educational crises, such as a lack of laboratory equipment in schools, made it impossible to conduct laboratory experiments that required practical, hands-on engagement. As a result, technology integration became increasingly necessary, with online digital tools needing to be readily available. One of these tools was virtual laboratory simulations (University of the Philippines, 2023). These simulations, commonly used in fields such as Biology, Chemistry, and Physics, provided benefits in terms of safety, efficiency, and cost-effectiveness. However, their adoption in Philippine schools remained limited, and questions persisted regarding their effectiveness in fostering practical skills. As Oclarit (2017) noted, the lack of essential laboratory resources continued to hinder both teachers and students, while Lampi (2013) emphasized that the debate over the educational value of virtual labs was still unresolved.

Consequently, further evaluation of these tools was necessary to determine their true impact on student learning.

Virtual laboratory simulations became particularly evident in educational contexts where physical laboratory equipment was limited, costly, or inaccessible (Bansal, Bhukal, Jain, & Parul, 2024). These simulations provided an innovative alternative that enabled students to engage in experimental procedures, practice scientific inquiry, and develop laboratory skills without the constraints of material resources (Falode, 2018). Research on virtual laboratories has been around for quite some time. Many published reviews compared virtual simulations and remote labs with traditional hands-on laboratory classes. Most of these studies focused on practices in subjects like Earth science, biology, chemistry, and physics. Sypsas and Kalles (2018) reviewed 29 peer-reviewed research articles on virtual laboratory simulations in biology, biotechnology, and chemistry. These studies examined the effectiveness of virtual labs and the teaching methods used when they served as supplementary tools. The findings suggested that virtual simulations often produced results equal to or better than traditional lab activities in high school education. The most commonly highlighted teaching approaches were blended learning and inquiry-based learning. Given these related studies, the present research sought to determine whether similar findings would apply to a local college facing challenges in integrating technological advancements, particularly the use of virtual simulations in complex science subjects.

The limited availability of laboratory equipment significantly affected students' ability to engage in hands-on experiments, particularly in science courses where practical application was essential. At Don Carlos Polytechnic College, this challenge prompted the integration of virtual laboratory simulations to supplement laboratory experiences. These simulations aimed to enhance student learning by providing interactive, technology-driven alternatives to traditional experiments. Research has shown that virtual labs can improve student engagement and conceptual understanding in science subjects (Ramadhan & Irwanto, 2018) and help address resource limitations in schools lacking laboratory facilities (Sypsas & Kalles, 2018). Furthermore, studies have highlighted that virtual laboratories in STEM education offer benefits such as safety, cost-effectiveness, and accessibility, though their effectiveness in developing practical skills remains debated (Lampi, 2013; Academia, 2024). During the COVID-19 pandemic, virtual labs were increasingly integrated into e-learning, demonstrating their potential to sustain science education despite physical restrictions (IJSMS Journal, 2023). In addition, technological tools such as web conferencing software, blogs, wikis, social networking sites, and digital games have been shown to foster student engagement and collaborative learning (Schindler et al., 2017). These findings provided a foundation for examining how undergraduate science majors perceived virtual laboratory simulations and how such tools influenced their academic performance in biology.

This study examined how Undergraduate Science majors perceived virtual laboratory simulations and whether these perceptions were linked to improvements in their academic performance. It emphasized that virtual laboratory simulations yielded results comparable to, or sometimes even better than, those of actual laboratory operations. Beyond simply repeating experiments, these simulations allowed students to actively participate in laboratory operations, engage in scientific inquiry, and enhance critical thinking. Virtual laboratories provided students with relevant learning experiences that enhanced both academic advancement and preparedness for future science jobs by allowing them to participate, explore, and experiment in a flexible digital environment.

Statement of the Problem

The purpose of this study was to examine science students' perceptions of virtual simulation learning and its impact on academic performance in biology.

Specifically, the study sought to answer the following questions:

1. What is the level of science students' perception of virtual simulation learning in terms of:
 - a. perceived usefulness;
 - b. perceived ease of use;
 - c. attitude towards use;

- d. behavioral intention?
2. What is the level of academic performance in biology of science students?
3. Is there a significant relationship between science students' perception of virtual simulation learning and their actual academic performance in biology?

Objectives of the Study

The main goal of this study was to investigate the relationship between science students' perceptions of virtual simulation learning and their actual academic performance in Biology.

Specifically, the study aimed to:

1. determine the perceptions of science students regarding the use of virtual simulation learning in terms of:
 - a. Perceived usefulness;
 - b. Perceived ease of use;
 - c. Attitude towards use; and
 - d. Behavioral intention.
2. assess the level of science students' academic performance in biology.
3. examine whether there is a significant relationship between science students' perceptions of virtual simulation learning and their actual academic performance.

Hypothesis of the Study

The hypothesis was drawn from the given objective and tested at the 0.05 level of significance.

Ha: There is a significant relationship between the perceived level of science students in virtual laboratory simulation learning and academic performance in biology.

Significance of the Study

This study is beneficial to Science students, Instructors, and School institutions because the results help them determine undergraduate science students' perceptions of virtual simulation learning in relation to their academic performance, specifically in Biology.

To Science students, this study benefits them by exploring how they view virtual lab simulations, specifically examining whether these tools are helpful, user-friendly, and effective at improving real biology lab performance. By understanding these findings, students can better weigh the pros and cons of incorporating technology into their learning. Ultimately, these virtual simulations provide a safe, accessible online environment for students to practice and explore concepts, helping bridge gaps in lab access, boost interest, and enhance their overall biology education.

To Biology Instructors and Faculty, this research can help them improve their teaching by showing whether virtual simulations truly boost student engagement and performance. These insights allow educators to combine online tools with traditional lab practices more effectively. Additionally, using simulations as prep work can encourage creative teaching, reduce the costs and risks of physical labs, and offer alternatives for students who struggle in standard lab settings. Ultimately, the study empowers teachers to blend technology with hands-on learning to improve overall student outcomes.

To Academic Institutions, the results of this research can help guide curriculum development, resource allocation, and investments in educational technology. By proving the effectiveness of virtual simulations, schools can update their programs to meet modern educational standards and better prepare students with 21st-century skills. It also helps administrators make data-driven decisions to balance traditional lab work with digital tools. In the long run, adopting these simulations can strengthen an institution's reputation by demonstrating a clear commitment to academic excellence, technological progress, and inclusive learning opportunities.

Scope and Delimitation of the Study

The study investigated the relationship between science students' perceptions of virtual laboratory simulation learning and their academic performance in Biology at Don Carlos Polytechnic College. Emphasis is placed on perception because students' beliefs and interpretations of virtual simulations, whether they found them useful, easy to use, engaging, or worth adopting, served as a critical bridge between technology and learning outcomes. Positive perceptions could foster motivation, shape attitudes, and strengthen behavioral intentions, thereby directly influencing academic achievement. Conversely, negative perceptions might have hindered engagement and limited the effectiveness of even well-designed simulations.

The study focused on assessing perceptions across four key dimensions: perceived usefulness, perceived ease of use, attitude towards use, and behavioral intention. Academic performance, the dependent variable, was measured by students' academic achievement, including grades and mastery of scientific concepts in Biology. The investigation was delimited to undergraduate Science major students currently enrolled at Don Carlos Polytechnic College, Purok 2, Poblacion Norte, Don Carlos, Bukidnon. Furthermore, the study utilized a purposive sampling method, specifically targeting a sample of sixty (60) science students who had prior experience with virtual laboratory simulations to ensure relevant insights.

Definition of terms

The following terms were operationally defined for a better understanding of the study:

Academic Performance refers to students' grades, quiz scores, or mastery of scientific concepts following the use of a virtual laboratory simulation.

Attitude Towards Use refers to the student's positive or negative feelings and evaluative affect regarding the use of Virtual Laboratory Simulation Learning in their science curriculum. It determines the student's general favorability toward replacing or aiding traditional methods with digital simulations.

Behavioral intention refers to the student's likelihood or planned desire to continue using Virtual Laboratory Simulation Learning in their future laboratory work. It measured the strength of a student's intention to perform a specified behavior, in this case, utilizing simulation learning for Biology mastery.

Perceived Ease of Use refers to the extent to which the student found the Virtual Laboratory Simulation Learning software easy to navigate, understand, and operate, with minimal physical or mental effort.

Perceived Usefulness refers to the degree to which a science student believes that using Virtual Laboratory Simulation Learning would enhance their learning and performance in Biology laboratory activities.

Self-efficacy refers to students' self-belief in their ability to successfully execute experimental procedures and understand complex biological processes through virtual laboratory simulation learning.

Virtual Laboratory Simulation Learning (VLSL) refers to substitutes for in-person or real-world practical skills training that could be completed online.

THEORETICAL FRAMEWORK

This chapter deals with related literature and studies, the conceptual framework, and the research paradigm.

Review and Related Literature

Virtual Laboratory Simulations Learning (VLS)

Virtual laboratory simulations emerged as innovative tools in science education, offering students opportunities to engage with experimental procedures in a safe and accessible environment. Hanine et al. (2025) conducted a scoping review on STEM education and noted that virtual laboratories could enhance accessibility and reduce costs while fostering creativity in teaching methodologies. Their findings highlighted the perceived usefulness of simulations, as students and educators recognized their potential to supplement traditional laboratory practices, particularly in resource-limited settings.

In biotechnology education, Mercado & Picardal (2023) conducted a systematic review and emphasized that simulations could substitute for costly, resource-intensive physical laboratories. They argued that simulations provide preparatory experiences that build confidence and familiarity with laboratory procedures, especially during periods of restricted access, such as the COVID-19 pandemic. This reflected both perceived ease of use and attitude toward using the simulation, as students gained confidence and developed positive dispositions toward simulation-based learning.

Furthermore, a systematic review of learning analytics in virtual laboratories examined how student engagement and performance data are tracked in simulation environments. The authors suggested that integrating analytics may help educators identify patterns in student learning, thereby refining instructional strategies. This perspective underscored the role of behavioral intention, as data-driven insights could encourage students and institutions to use simulations sustainably and purposefully.

These studies illustrated how virtual laboratory simulations influenced science education not only through their technical features but also through students' perceptions captured in dimensions of usefulness, ease of use, attitude, and intention, which ultimately shaped learning outcomes in Biology.

Perceived Usefulness

The narrative of modern biology education suggests that for a simulation to be effective, students must first see it as a vital tool for their success. Al-Qahtani et al. (2025) demonstrated that when science majors recognized how simulations clarified complex biological processes, their engagement naturally deepened. This sense of utility is echoed by Hanine et al. (2025), who found that both students and instructors increasingly valued virtual labs for their ability to provide high-quality experimental access in resource-limited settings. When this utility was clear, as Venkatesh et al. (2016) argue, students transitioned from seeing the software as a mere requirement to seeing it as a productivity booster. Furthermore, Al-Shammari & Al-Qahtani (2024) highlight that this perceived utility directly translates into a sharper conceptual understanding of lab-based science, while Bansal et al. (2024) emphasize that the usefulness of these tools became undeniable when physical lab access was restricted, proving they are more than just a temporary fix.

Perceived Ease of Use

The platform's technical "friendliness" dictated how much mental energy a student could devote to biology. Mercado & Picardal (2023) suggested that when a simulation was easy to navigate, it built a student's confidence before they even stepped into a real lab. If the interface were intuitive, as Fraenkel et al. (2023) note, students could bypass technical frustrations and focus entirely on the scientific inquiry at hand. However, the process was not always smooth. Hanine et al. (2025) cautioned that poor design can impose a heavy cognitive load that actually hinders learning. To combat this, Makransky & Petersen (2021) pointed out that a sense of "agency" or control within the software, born of ease of use, ultimately allowed a student to acquire knowledge effectively. Syspas & Kalles (2018) reinforced this by stating that the most successful virtual labs are those that feel like a natural, easy-to-use extension of the existing biology curriculum.

Attitude Towards Use

As students found these tools both useful and easy to use, their Attitude Towards Use began to shift toward the

positive. Tsurulnikov et al. (2023) described this as an emotional evolution in which the simulation's immersive and interactive nature made studying biology feel more like an exploration than a chore. This positive disposition was the "bridge" to achievement. Yilmaz (2021) argues that a student's attitude is the primary engine behind their motivation to master difficult biological concepts. Even in challenging times, Mercado & Picardal (2023) observed that regular exposure to simulations helped students develop a favorable outlook on digital learning. This emotional connection is vital because, as Makransky & Petersen (2021) explained, high levels of emotional engagement are what lead to superior academic outcomes. Ultimately, when students enjoy the digital environment, Schindler et al. (2017) found that they became more collaborative and active participants in their own education.

Behavioral Intention

These perceptions and attitudes culminated in Behavioral Intention, the student's conscious plan to continue using these simulations to boost their performance. Al-Qahtani et al. (2025) demonstrated that this intention was the final psychological outcome of a tool perceived as both helpful and easy to use. Fitrianto & Saif (2024) took this further by showing that when simulations were gamified or highly interactive, science majors were far more likely to intend to use them for long-term academic gains. This intention eventually turned into a "habit," a concept Venkatesh et al. (2016) identified as a core predictor of whether a technology would be abandoned or embraced. Recent research in Learning analytics (2025) suggested that as students saw their own progress tracked within these virtual spaces, their intention to stick with the program strengthened. Consequently, as Tsurulnikov et al. (2023) conclude, when science majors intended to integrate these virtual labs into their future studies fully, this paved the way for a measurable and significant improvement in their overall academic performance in biology.

Academic Performance

Academic performance has long been recognized as a critical component of science education, directly influencing students' mastery of concepts and overall academic achievement. Hands-on laboratory activities provided learners with opportunities to apply theoretical knowledge, develop practical skills, and engage in scientific inquiry. Sasapan et al. (2023) investigated the effect of laboratory activities on the science performance of STEM students at Mindanao State University-Sulu. Their study revealed that active participation in laboratory tasks significantly enhanced students' understanding of scientific concepts and improved their academic performance, underscoring the importance of experiential learning in science education.

Similarly, Ugwuoti & Ugochukwu (2022) examined the effectiveness of laboratory facilities on students' achievement in Biology in secondary schools in Imo State, Nigeria. Using a quasi-experimental design, they found that well-equipped laboratories positively influenced students' achievement, demonstrating that access to adequate facilities was a key determinant of academic performance.

In addition, Timbasal (2022) examined the adequacy and utilization of laboratory equipment in relation to science teachers' performance in Malapatan Municipality. Although the study focused on teachers, the findings highlighted that insufficient training and limited resources hindered effective laboratory instruction, which, in turn, affected student performance. This suggested that academic performance was shaped not only by student engagement but also by the availability of resources and educators' competency in facilitating laboratory-based learning.

These studies emphasized that academic performance is a multifaceted construct influenced by student participation, facility adequacy, and instructional quality. Strong academic performance was closely tied to improved academic achievement, making it a vital area of focus in science education research.

Virtual Laboratory Simulations Learning (VLS) and Academic Performance in BiologyRecent studies have emphasized the role of immersive technologies in enhancing student engagement and performance in science education.

Tsurulnikov et al. (2023) investigated the use of immersive virtual reality in biology education and found that

such simulations significantly improved student motivation and performance. Their findings suggested that immersive environments could foster deeper conceptual understanding and active participation, making them valuable complements to traditional laboratory instruction.

This study aligned with broader research on virtual laboratories, reinforcing the idea that technology-mediated learning environments could positively influence both perceptions and outcomes. By demonstrating the motivational and performance benefits of immersive simulations, Tsirulnikov et al. (2023) provided evidence supporting the integration of virtual laboratory tools into biology curricula, particularly for undergraduate science majors.

The collective body of research from 2016 to 2026 underscored that the success of digital tools in science education was built upon four psychological pillars: the perceived usefulness of the tool in mastering complex biological concepts, the ease with which a student could navigate the interface, the resulting emotional attitude toward the technology, and the final behavioral intention to adopt these tools long-term. While global studies by Al-Qahtani et al. (2025) provided a robust theoretical framework for understanding how these variables interacted, a critical "localization gap" remained in the existing literature. Most data were derived from high-resource international settings or large-scale urban universities, leaving the specific experiences of science majors in local community colleges largely unexplored.

Specifically, there was a lack of empirical evidence focused on students at Don Carlos Polytechnic College. As science majors at DCPC navigated a curriculum that balanced traditional laboratory rigor with modern virtual simulations, it was not yet clear how their unique local perceptions, shaped by specific institutional resources and the regional academic environment, were directly related to their academic performance in Biology. This study aimed to fill this gap by providing localized insights into the DCPC context. By moving beyond general trends and focusing on the science majors at Don Carlos Polytechnic College, this research will determine whether the global successes of virtual laboratory simulation learning (VLSL) hold for local learners, ultimately offering a foundation for context-specific improvements in the college's science department.

CONCEPTUAL FRAMEWORK

The present study was primarily anchored in the Cognitive Affective Model of Immersive Learning (CAMIL) developed by Makransky and Petersen (2021). CAMIL provided a modern psychological basis for understanding how immersive technologies, such as virtual reality and simulations, impacted learning. The model emphasized two critical constructs: presence (the sense of being in the simulated environment) and agency (the feeling of control within that environment). These factors influenced a learner's cognitive load and emotional engagement, which were essential precursors to effective knowledge acquisition and academic performance. In the context of Biology education, CAMIL suggested that when students perceived a virtual laboratory as realistic and controllable, their conceptual understanding of complex biological processes was enhanced, leading to stronger academic performance.

Complementing CAMIL was the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), which Venkatesh et al. (2012, 2016) refined for educational contexts. UTAUT2 expanded beyond traditional measures of ease of use and usefulness by incorporating additional dimensions such as hedonic motivation (the enjoyment or intrinsic satisfaction derived from using the technology) and habit (the tendency to continue using the tool over time). These constructs were particularly relevant for understanding undergraduate students' perceptions of digital learning tools, as they captured both the affective and behavioral aspects of technology adoption.

Together, CAMIL and UTAUT2 provided a comprehensive framework for this study. CAMIL explained how immersive experiences shaped cognitive and emotional processes, while UTAUT2 highlighted the role of perceptions, attitudes, and behavioral intentions in technology use. Applied to the research, these theories suggested that the technical quality of virtual simulations did not solely determine students' academic performance in Biology. Instead, it was deeply influenced by students' perceptions of the simulation's usefulness, ease of use, level of immersion, and ability to satisfy psychological needs for competence, autonomy, and enjoyment. Thus, the conceptual framework positioned perception as the central variable linking virtual

laboratory simulation learning to actual academic performance.

Research Paradigm

Independent Variable

Dependent Variable

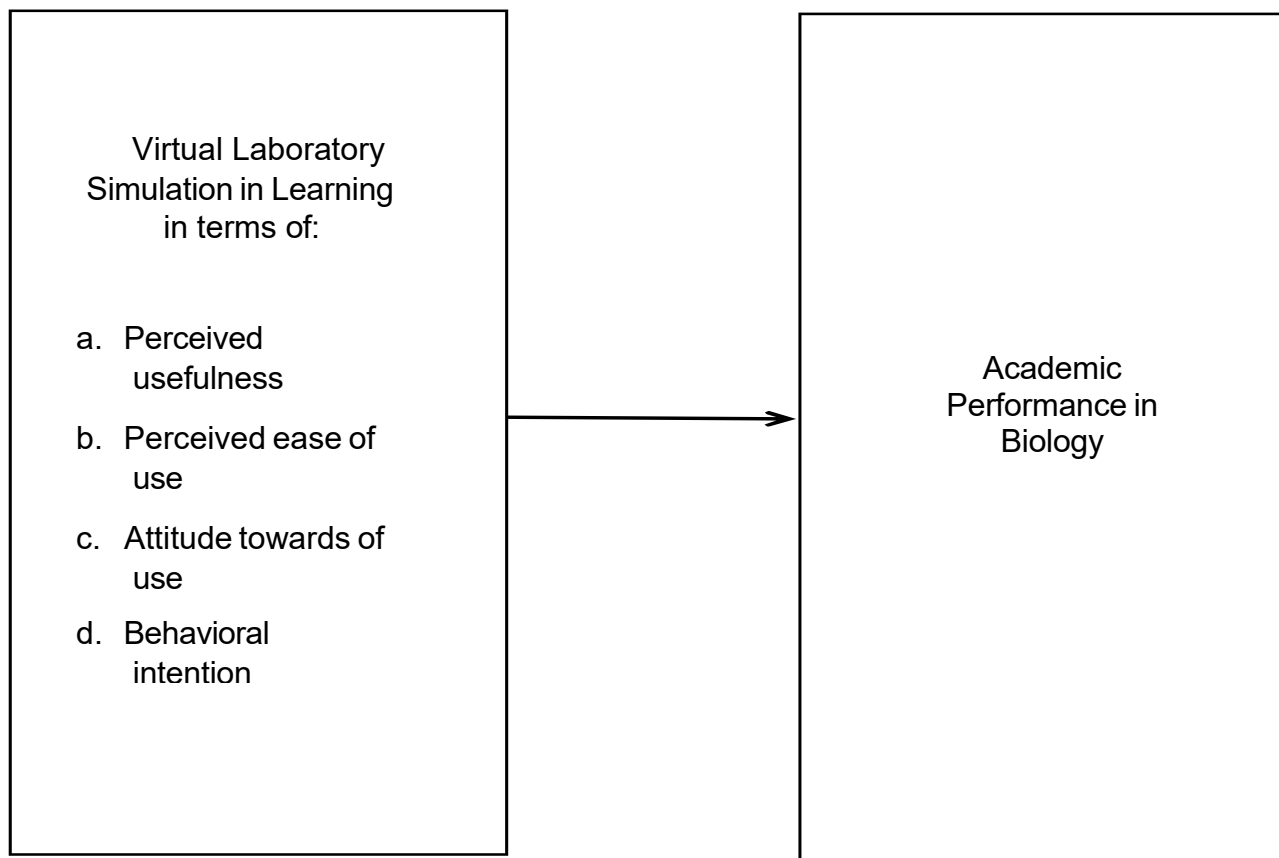


Figure 1. Schematic diagram showing the relationship between independent and dependent variable

METHODOLOGY

This section deals with the methods and procedures used in the study. It includes the research design, the research locale, the respondents of the study, the instrument, the administration and collection of the questionnaire, the scoring procedures, and the statistical treatment of the data gathered.

Research Design

This study used a correlational research design and quantitative methods to examine Science students' perceptions of Virtual Laboratory Simulation Learning and its relationship to Academic Performance in Biology at Don Carlos Polytechnic College. Students' perceptions were assessed for perceived usefulness, perceived ease of use, attitude towards use, and behavioral intention, while Academic Performance was measured by their Biology grades.

Locale of the Study

The study was conducted at Don Carlos Polytechnic College (DCPC), located at Purok 2, Poblacion Norte, Don Carlos, Bukidnon, during the school year 2025–2026. Its location and strong focus on community-based education made it a suitable setting for examining how virtual laboratory simulation learning influenced science students' academic performance in Biology.

Don Carlos Polytechnic College was selected as the study site because its science students experienced virtual laboratory simulations as an alternative to traditional laboratory activities. This was primarily due to insufficient

laboratory equipment, which had led to the adoption of simulation-based learning. By situating the research in this institution, the study provided valuable insights into how perceptions of virtual laboratory simulations related to actual academic performance in Biology within a resource-limited educational environment.

Map of the locale of the Study



Figure 2. Map of Don Carlos Polytechnic College

Respondents of the Study

The respondents of this study consisted of 60 Science major students enrolled at Don Carlos Polytechnic College during the school year 2025–2026. These students were chosen because they represented the population most directly engaged with Biology laboratory activities and virtual laboratory simulations. A total of sixty (60) students were purposively selected to ensure that the sample included individuals who had prior experience with virtual laboratory simulation learning.

On the day the questionnaire was administered, all identified respondents were invited to participate. Instructions for completing the questionnaire were presented in clear, simple language to avoid confusion. Additional time was allotted to explain the procedures, including how responses would be scored and interpreted, so that participants would fully understand the process. This approach helped ensure that the collected data were accurate, reliable, and reflective of students' perceptions and academic performance.

Sampling Procedure

This study employed a purposive sampling method to select participants from the total population of 297 Science major students at Don Carlos Polytechnic College. Purposive sampling was used because the study focused on students who had already completed a biology course that involved virtual laboratory simulation learning, making them the most relevant respondents for the research. The researchers used inclusion and exclusion criteria to ensure the statistics were reliable.

Specifically, the inclusion criteria required that participants were officially enrolled students within the Bachelor of Secondary Education major in Science program during the 2025–2026 academic year. Most importantly, these respondents had to have direct experience with Virtual Laboratory Simulation Learning (VLSL) as part of their Biology laboratory coursework to ensure that their perceptions of usefulness, ease of use, attitude, and behavioral intention were based on actual use rather than speculation. Conversely, the exclusion criteria filtered out students from other departments or those majoring in different fields who did not use these specific biological simulations.

Additionally, any science major who had not yet participated in laboratory activities involving virtual simulations, such as first-year students, was excluded from the sample to maintain the integrity of the purposive sampling design and to focus solely on those whose academic performance was directly tied to the use of these digital tools.

Research Instrument

The study used an online survey questionnaire as its primary data source. The instrument was adapted from established research tools developed by Babbie et al. (2016), ensuring that the items were grounded in recognized educational research practices. The questionnaire was structured to measure students' perceptions of virtual laboratory simulation learning across four dimensions: perceived usefulness, perceived ease of use, attitude toward use, and behavioral intention.

Originally, the instrument was designed using a five-point Likert scale (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree). However, for this study, the scale was modified into a four-point Likert scale to eliminate the neutral option and encourage respondents to express a clear stance. The revised scale consisted of: 4 = Strongly Agree, 3 = Agree, 2 = Disagree, and 1 = Strongly Disagree.

This modification allowed the researchers to capture more decisive responses, thereby reducing ambiguity in data interpretation. The Likert scale enabled participants to indicate their level of agreement or disagreement with each statement, providing quantifiable measures of perception that were analyzed in relation to academic performance.

The adapted questionnaire included items specifically tailored to the context of Biology laboratory simulations at Don Carlos Polytechnic College. Each item was reviewed for clarity and relevance to ensure that respondents fully understood the questions. Prior to administration, the instrument was validated by experts in science education and pilot-tested with a small group of students to confirm reliability and appropriateness for the target

population.

Administration of the Research Instrument

The researchers asked for permission, and a formal written letter was sent to the school administrators to obtain respondents from the secondary level of the Bachelor of Secondary Education Major in General Science program at Don Carlos Polytechnic College. Copies were also provided to the respondents and their adviser. The researchers gathered the data with assistance from all the group members. Since this research design was descriptive-correlational, the researchers developed the survey questionnaire and distributed it to the respondents. The students' anonymity and confidentiality were safeguarded throughout the data collection process. While their names and identities were required to ensure the accuracy and validity of the responses, this information remained strictly confidential. It was not disclosed at any point in the study. Copies of all respondents' responses were securely stored and used only when necessary for matters directly related to this research.

Scoring Procedure

The research provided a scoring procedure and grading system, with quantitative descriptions and interpretations below, to determine and analyze science students' perceptions of virtual laboratory simulation learning in relation to academic performance in Biology at Don Carlos Polytechnic College.

The following was a 4-point Likert scale that measured the level of science students' perception of virtual laboratory simulation learning.

Scale	Range	Descriptive Rating	Qualitative Interpretation
4	3.50-4.00	Strongly Agree	Very positive perception
3	2.50-3.49	Agree	Positive perception
2	1.50-2.49	Disagree	Negative perception
1	1.00-1.49	Strongly Disagree	Very negative perception

This information pertained to academic performance through a raw scoring system aligned with standard scoring criteria in biology.

Grade Range	Percentage	Qualitative Interpretation
1.00-1.50	100% - 84%	Excellent
1.51-2.00	83% - 72%	Very Good
2.01-2.50	71% - 60%	Good
2.51-3.00	59% - 50%	Satisfactory
3.01-4.00	49% - 40%	Needs Improvement
5.00	Below 40%	Failed

Ethical Consideration

In conducting the study on science majors' perceptions of virtual laboratory simulation learning and its relation to academic performance in Biology at Don Carlos Polytechnic College, several ethical considerations were observed. First, informed consent was obtained from all participants, ensuring they were fully aware of the study's purpose, procedures, and potential risks and benefits before deciding to participate. Confidentiality and anonymity were maintained throughout the research process, with all data and personal information kept secure and accessible only to authorized researchers. Participants retained the right to withdraw from the study at any time without facing any consequences. The research adhered to ethical guidelines and regulations established by relevant governing bodies to ensure that the well-being and rights of the participants were protected. Finally, the study's findings were reported accurately and objectively, with proper acknowledgment of the respondents' contributions and full respect for their privacy.

Data Gathering Procedure

Prior to administering the survey questionnaire, a letter of request was submitted to the Vice President for Academic Affairs (VPAA) of Don Carlos Polytechnic College (DCPC), seeking permission to administer the questionnaire and use the data for study purposes only. The researchers then asked the thesis adviser for permission to conduct the study. After doing so, the researchers selected the respondents through purposive sampling. After identifying the target respondents, a letter, as noted by the adviser, along with the survey questionnaire, was given to them. The researchers then obtained the respondents' consent to participate in the study.

Furthermore, the researchers personally administered the survey questionnaire and collected the data to ensure the confidentiality of the responses. Following data collection, the researchers analyzed and interpreted the data using specific statistical tools and techniques. Finally, the results were presented in both tabular and textual forms.

Statistical Treatment

The researchers gathered the data using the adapted 4-point scale questionnaire. The survey was conducted among the selected sixty (60) students who served as respondents representing the Science student population.

For Problem No. 1, which sought to determine the level of science students' perception of Virtual Laboratory Simulation Learning (VLSL) in terms of perceived usefulness, perceived ease of use, attitude towards use, and behavioral intention, the Weighted Mean and Standard Deviation were utilized. The resulting mean scores were interpreted using a 4-point scale to categorize the students' perceptions according to the following ranges:

For Problem No. 2, the Weighted Mean was used to assess the overall level of performance in biology. Descriptive statistics were used to summarize, compute, and present the collected data clearly and accurately based on the respondents' responses.

For Problem No. 3, which investigated the significant relationship between VLSL perceptions and Academic Performance, the Pearson Product-Moment Correlation Coefficient (Pearson r) and t-test were used to determine whether there was a statistically significant relationship between undergraduate science majors' perceptions and their academic performance in Biology. The level of significance was set at 0.05.

Presentation, Analysis, And Interpretation Of Data

This chapter presents the representation, analysis, and interpretation of data on science majors' perceptions of virtual laboratory simulation learning and its impact on academic performance in biology. The order of presentation is based on the objectives of the study.

Science Students' Perception of Virtual Simulation Learning

Perceived Usefulness

Table 1 presents data on science majors' perceptions of the perceived usefulness of virtual laboratory simulation learning. The table includes the weighted means for each indicator and the resulting overall mean. Overall, the data show a mean of 2.82, which is qualitatively interpreted as a Positive Perception.

Table 1. Level of perception in terms of perceived usefulness.

Table: Students' Perception of Virtual Laboratory Simulations (N = 60)

Statement	Mean (N=60)	Qualitative Interpretation
Virtual laboratory simulations limit the development of manual laboratory skills (e.g., handling tools and instruments).	1.75	Negative Perception

Virtual laboratory simulations may cause students to miss the hands-on experience of a real laboratory.	1.82	Negative Perception
Virtual laboratory simulations may increase the likelihood of plagiarism in laboratory activities.	1.88	Negative Perception
Virtual laboratory simulations limit direct interaction with classmates.	1.95	Negative Perception
Virtual laboratory simulations reduce opportunities for teamwork.	2.00	Negative Perception
Virtual laboratory simulations limit direct interaction with the teacher.	2.00	Negative Perception
Virtual laboratory simulations make data analysis easier.	3.25	Positive Perception
Virtual laboratory simulations provide immediate feedback to students.	3.30	Positive Perception
Virtual laboratory simulations help students answer questions that challenge them.	3.33	Positive Perception
Virtual laboratory simulations increase student engagement in the learning process.	3.33	Positive Perception
Virtual laboratory simulations enhance students' understanding of science concepts.	3.38	Positive Perception
Virtual laboratory simulations offers a safe environment for conducting experiments.	3.40	Positive Perception
Virtual laboratory simulations helps Improve student performance.	3.40	Positive Perception
Virtual laboratory simulations supports individualized learning.	3.42	Positive Perception
Virtual laboratory simulations help in visualizing and modeling abstract concepts.	3.42	Positive Perception
Virtual laboratory simulations provides effective integration of technology.	3.53	Very Positive Perception
Overall Mean	2.82	Positive Perception

Legend

Scale	Range	Descriptive Rating	Qualitative Interpretation
4	3.50–4.00	Strongly Agree	Very positive perception
3	2.50–3.49	Agree	Positive perception
2	1.50–2.49	Disagree	Negative perception
1	1.00–1.49	Strongly Disagree	Very negative perception

Table 1 presents the level of science majors' perception of virtual laboratory simulation learning in terms of perceived usefulness. The data indicates that the statement "Virtual laboratory simulations provide effective integration of technology" had the highest mean of 3.53, which falls under the Very Positive Perception category. Conversely, the statement "Virtual laboratory simulations limit the development of manual laboratory skills" received the lowest mean of 1.75, falling within the Negative Perception range.

The data show strong recognition of the tool's structural and cognitive benefits. The highest mean was recorded for the "effective integration of technology" (3.53), followed by "visualizing abstract concepts" and "supporting individualized learning," both at 3.42. Students also highly valued the "safe and secure environment" for experiments (3.40). However, critical gaps were identified in practical areas. The "limitation of manual laboratory skills" received the lowest score of 1.75, while the "loss of direct interaction with classmates" scored 1.95, both indicating a negative perception. This demonstrates that while students see the tool as a conceptual "productivity booster," they do not believe it can replace the tactile and social experience of a physical lab.

This high rating suggests that in a resource-limited environment like Don Carlos Polytechnic College, students view Virtual Laboratory Simulation Learning as an indispensable "productivity booster" and a vital bridge for conceptual mastery. The positive perception of safety and performance enhancement implies that students feel more confident exploring complex science topics digitally, where physical equipment may be lacking. However, the perceived deficiency in building practical skills remains a critical concern, implying that while simulations

are valued for theory, they cannot yet replace the social and physical dimensions of a traditional lab.

These results are deeply anchored in the Technology Acceptance Model (TAM) by Davis (1989), which posits that "perceived usefulness" is a primary driver of a user's intent to adopt new technology. Specifically, the high scores for concept visualization align with Al-Qahtani et al. (2025), who argued that digital tools provide a "cognitive bridge" that physical labs often lack. Furthermore, the identified gap in manual skills directly supports Lampi's (2013) Localization Theory, which warns that overreliance on virtual tools in developing regions can lead to a "tactile deficit," in which students master the theory but struggle with the physical application of science.

Perceived Ease of Use

Table 2 presents the perceived ease of use of virtual laboratory simulations among science majors. The findings reflect an overall mean of 2.03, which carries a qualitative interpretation of Negative Perception.

Table 2. Level of perception in terms of perceived ease of use.

Table: Students' Perception of Virtual Laboratory Simulations (N = 60)

Statement	Mean (N = 60)	Qualitative Interpretation
Virtual Laboratory Simulation requires access to specific platforms or programs (e.g., LabXchange, Labster).	1.58	Negative perception
Preparing for experiments become more difficult in online labs.	1.80	Negative perception
Assessing laboratory work becomes more challenging in online environments.	1.83	Negative perception
Virtual Laboratory Simulations require extensive technical training.	1.83	Negative perception
It is difficult to obtain accurate measurements in online laboratory activities.	1.93	Negative perception
Preparing for experiments becomes more difficult in online labs.	2.00	Negative perception
Virtual Laboratory Simulations provides flexibility in choosing when and where to work.	3.23	Positive perception
Overall Mean	2.03	Negative perception

Legend

Scale	Range	Descriptive Rating	Qualitative Interpretation
4	3.50–4.00	Strongly Agree	Very positive perception
3	2.50–3.49	Agree	Positive perception
2	1.50–2.49	Disagree	Negative perception
1	1.00–1.49	Strongly Disagree	Very negative perception

Table 2 illustrates science majors' perceptions of the ease of use of virtual laboratory simulations. The data show that the statement "Virtual Laboratory Simulations provide flexibility in choosing when and where to work" received a high mean score, indicating a positive view of the software's accessibility. However, critical technical items such as the requirement for extensive technical training and the interference of technical issues during lab work received significantly lower mean scores. The overall grand mean for this dimension is 2.03, which is qualitatively interpreted as a Negative Perception.

The findings reveal that while students appreciate the "flexibility in choosing when and where to work" (3.23), they struggle with nearly every other operational aspect. The indicators regarding "technical issues interfering with laboratory work," "dependence on specific platforms," and "preparation difficulties" all received low mean scores ranging from 1.58 to 2.00. This indicates that the software is not viewed as user-friendly and that navigating complex interfaces and technical malfunctions creates a significant barrier to their science inquiry.

This study suggests that technical "friendliness" is a major hurdle in the local context. For students at DCPC, the frustration of navigating complex platforms or dealing with slow internet connectivity likely leads to a heavy "cognitive load". The implication is that without proper orientation or more intuitive software, simulation remains a source of stress rather than a simple tool for learning. This suggests that while students are willing to use the technology, they feel unprepared for its technical demands, which could eventually lead to academic burnout. This is a critical need for a structured institutional response from Don Carlos Polytechnic College. The negative perception of ease of use suggests that simply providing access to software is insufficient; the institution must provide comprehensive technical orientation and reliable infrastructure to mitigate these hurdles. If the college intends to continue using virtual labs, these findings suggest that the school should invest in IT support specifically for the Science Department and consider transitioning to more user-friendly, low-bandwidth platforms that accommodate students' local connectivity challenges.

The technical friction observed in the data validates the Cognitive Load Theory discussed by Hanine et al. (2025), which states that when a digital interface is complex, the "extraneous load" prevents the "germane load" (actual learning) from occurring. This is further supported by Mercado and Picardal (2023), who found that, in the Philippine context, technical "friendliness" is not just a convenience but a prerequisite for student confidence. The results also mirror those of Fraenkel et al. (2023), who noted that for technology to be "easy to use," the institution must first remove the "infrastructure anxiety" caused by platform dependence and connectivity issues.

Attitudes Towards Use

Table 3 presents data on science majors' attitudes toward using virtual laboratory simulations in their academic curriculum. This section measures the students' evaluative effect and general favorability toward the digital learning environment. The statistical results reveal an overall mean of 2.91, which corresponds to a qualitative interpretation of Positive Perception.

Table 3. level of perception in terms of attitudes towards use.

Table: Students' Perception of Virtual Laboratory Simulations (N = 60)

Statement	Mean (N = 60)	Qualitative Interpretation
My participation feels limited to observing rather than performing tasks in online labs.	2.12	Negative perception
I feel frustrated during online laboratory activities.	2.20	Negative perception
I can complete experiment task more quickly in an online laboratory	3.07	Positive perception
I will use Virtual Laboratory Simulations more often if I have regular access to them.	3.08	Positive perception
Virtual Laboratory offer simulations comparable to real Laboratory experience.	3.15	Positive perception
Virtual Laboratory Simulation proved an interactive and motivation learning environment.	3.18	Positive perception
Virtual Laboratory Simulations provide opportunities for creative research work.	3.20	Positive perception
Virtual Laboratory Simulations increase students' motivation to learn science.	3.27	Positive perception
Overall Mean	2.91	Positive perception

Legend

Scale	Range	Descriptive Rating	Qualitative Interpretation
4	3.50–4.00	Strongly Agree	Very positive perception
3	2.50–3.49	Agree	Positive perception
2	1.50–2.49	Disagree	Negative perception
1	1.00–1.49	Strongly Disagree	Very negative perception

Table 3 presents data on science majors' attitudes toward using virtual laboratory simulations. The data shows that the indicator "Virtual Laboratory Simulations increase students' motivation to learn science" received the highest weighted mean of 3.27, which is qualitatively interpreted as Positive perception.

On the other hand, the statement "My participation feels limited to observing rather than performing tasks in online labs." garnered the lowest weighted mean of 2.12, with a qualitative interpretation of Negative perception.

The specific indicators reveals that students highly value the motivational and interactive aspects of the tool. The highest mean score was recorded for the statement that "Virtual Laboratory Simulations increase students' motivation to learn science" (3.27), followed closely by the belief that they "provide opportunities for creative research work" (3.20) and offer an "interactive and motivating learning environment" (3.18). Students also had positive perceptions of simulations, describing them as "comparable to real laboratory experiences" (3.15) and noting they would use them more often with "regular access" (3.08) and that they could "complete experimental tasks more quickly" (3.07). However, significant emotional and pedagogical barriers remain, the statement "I feel frustrated during online laboratory activities" received a mean of 2.20, and the perception that "participation feels limited to observing rather than performing tasks in online labs" recorded the lowest mean of 2.12. This detailed breakdown shows that while the technology is conceptually engaging and efficient, students feel a lack of manual agency and experience frustration during its execution.

This means that while the students at Don Carlos Polytechnic College (DCPC) are intrinsically motivated by the interactive nature of simulations, their positive attitude is weighed down by the "observer-only" nature of the current digital experience. For the institution, this implies that the current use of simulations may be too focused on demonstration. To maintain high student morale, the college should investigate ways to make these virtual labs more hands-on and reduce the technical stressors that lead to student frustration.

The emotional duality found in the results high motivation paired with frustration supports the Affective Domain Theory in science education. This reflects Tsirulnikov et al. (2023), who described the "emotional evolution" of students, in which the "gamified" nature of simulations creates an initial high. However, poor usability leads to a sharp decline in attitude. This deep linkage suggests that, as Yilmaz (2021) argued, the "attitude engine" is the most volatile part of the learning process; if the institution doesn't stabilize the tech, students' motivation for "creative research" will be overshadowed by the frustration of technical failure.

Behavioral Intention

Table 4 illustrates the behavioral intention of science majors to continue utilizing virtual laboratory simulations in their future studies. This dimension measures the strength of the students' conscious plans to integrate simulation learning into their long-term academic habits. The findings show a grand mean of 3.25, qualitatively interpreted as a Positive Perception.

Table 4. level of perception in terms of behavioral intention.

Table: Students' Future Intentions Toward Virtual Laboratory Simulations (N = 60)

Statement	Mean (N = 60)	Qualitative Interpretation
I do not plan to use Virtual Laboratory Simulations in the future.	2.60	Positive Interpretation
I prefer to use Virtual Laboratory Simulations together with real laboratory activities in the future.	3.15	Positive Interpretation
I am interested in participating in forums or conferences related to online laboratories.	3.23	Positive Interpretation
I look forward to learning more about online science laboratories.	3.32	Positive Interpretation
I am willing to suggest improvements for Virtual Laboratory Simulations for future use.	3.32	Positive Interpretation
Overall Mean	3.25	Positive Interpretation

Legend

Scale	Range	Descriptive Rating	Qualitative Interpretation
4	3.50–4.00	Strongly Agree	Very positive perception
3	2.50–3.49	Agree	Positive perception
2	1.50–2.49	Disagree	Negative perception
1	1.00–1.49	Strongly Disagree	Very negative perception

Table 4 illustrates the behavioral intention of science majors to continue utilizing virtual laboratory simulations. The data show that the indicators "looking forward to learning more about online science laboratories" and "willing to suggest improvements for Virtual Laboratory Simulations for future use" tied for the highest weighted mean of 3.32, which is qualitatively interpreted as Positive Perception. Conversely, the statement "I do not plan to use Virtual Laboratory Simulations in the future" received the lowest weighted mean of 2.60. It is important to note that this item is reverse-scored. Therefore, a mean of 2.60 indicates that the majority of students disagree with the negative sentiment and do intend to use the simulations in their future academic performance in biology.

This indicates a strong, proactive commitment to technological integration among the respondents. The high mean of 3.32 for "suggesting improvements" indicates that students are transitioning from passive users to active stakeholders invested in the software's refinement. This is further supported by their interest in participating in professional forums and conferences (3.23). Most importantly, the score of 2.60 on the reverse-coded item (Item 32) confirms a rejection of the idea of abandoning these tools. When combined with the high preference for a hybrid model (3.15), the data show that students intend to maintain a long-term relationship with virtual labs, provided they are used to complement, not replace, physical experimentation.

This implies that the Science Department at Don Carlos Polytechnic College must pivot from a "delivery-only" model to a "co-design" partnership with its students. Since students are explicitly willing to suggest improvements, the institution should formally integrate student feedback into the annual IT and curriculum review process. Specifically, the college should establish a Student-Faculty Tech Committee to pilot these suggested improvements. This ensures that digital tools evolve based on the actual user experience of science majors, moving away from broad implementation toward a localized, student-led refinement of the laboratory curriculum.

The students' intention to act as co-designers is a practical application of Venkatesh et al.'s (2012) Unified Theory of Acceptance and Use of Technology (UTAUT2), specifically the "Habit" and "Price Value" constructs. When students are willing to suggest improvements, it shows they see a "long-term value" that outweighs the current technical costs. This aligns with Al-Qahtani et al. (2025), who noted that behavioral intention is the "ultimate psychological determinant" of success. Their desire for a hybrid model also aligns with Fitrianto and Saif (2024), who argued that science majors in the modern era view technology not as a replacement but as a "permanent enhancement" to their professional identity.

Summary of Science Majors' Perception on Virtual Laboratory Simulation Learning

Table 5 presents a consolidated summary of science majors' perceptions of Virtual Laboratory Simulation Learning across all four investigated dimensions. This table provides a holistic view of students' psychological and operational responses by averaging the scores for perceived usefulness, perceived ease of use, attitude toward use, and behavioral intention. The composite findings reveal a total overall grand mean of 2.75, which is qualitatively interpreted as a Positive Perception.

Table 5. Summary of science majors' Perception

Perception Variable	Mean (N=60)	Qualitative Perception
Perceived Usefulness	2.82	Positive Perception
Perceived ease of use	2.03	Negative Perception
Attitude Towards Use	2.91	Positive Perception

Behavioral Intention	3.25	Positive Perception
Total overall Mean	2.75	Positive Perception
Legend:		
Scale	Range	Descriptive Rating
4	3.50-4.00	Strongly Agree
3	2.50-3.49	Agree
2	1.50-2.49	Disagree
1	1.00-1.49	Strongly Disagree

Table 5 summarizes the overall perception of sixty (60) science major respondents toward Virtual Laboratory Simulation Learning (VLSL) across four core sub-variables. Behavioral intention yielded the highest mean score of 3.25, followed by attitude toward use (2.91) and perceived usefulness (2.82), while perceived ease of use registered the lowest mean score at 2.03. Ultimately, combining these scores yields a grand mean of 2.75, indicating a positive overall perception.

The data reveals that while students highly value the educational utility of virtual labs and intend to use them, they struggle noticeably with software operations. The low mean of 2.03 highlights clear procedural roadblocks and interface complexities within the digital simulation environment. However, this friction did not undermine their motivation, as the overall mean of 2.75 indicates that students' appreciation for the software's learning benefits outweighs their technical frustrations.

These findings imply that virtual simulations are a highly viable solution to institutional laboratory resource gaps, provided that user accessibility is actively managed. Instructors must recognize that complex software setups can cause operational drag and hinder student learning. To prevent user frustration from eclipsing academic benefits, the college should provide structured onboarding orientations and select user-friendly simulation designs.

This pattern is strongly supported by the literature, which confirms that technological friction frequently coexists with high tool acceptance. Hanine et al. (2025) observed that while virtual tools overcome physical scarcity, complex interfaces increase cognitive load and cause operational difficulties. However, the students' high drive aligns with Tsirulnikov et al. (2023), who found that interactive simulations transform science learning into an engaging experience, and Venkatesh et al. (2016), who demonstrated that recognized utility drives long-term usage intent despite procedural hurdles.

Academic Performance in Biology

Table 6 illustrates the academic performance of the science majors at Don Carlos Polytechnic College based on their General Weighted Average (GWA). The data reveals that the students achieved a mean GWA of 1.68. According to the institution's grading scale, this numerical value falls within the qualitative interpretation of Very Good academic performance.

Table 6. Frequencies of the General Weighted Average (GWA) of BSED Science 3A, Science 4A and 4B students.

GWA	Counts	Interpretation
1.00-1.50	15	Excellent
1.51-2.00	30	Very Good
2.01-2.50	10	Good
2.51-3.00	5	Satisfactory
3.01-4.00	0	Need Improvement
5.0	0	Failed
Mean = 1.68	60	Very Good

Table 6 illustrates the academic performance of the science majors at Don Carlos Polytechnic College based on

their General Weighted Average (GWA). The data reveals that the students achieved a mean GWA of 1.68. According to the institution's grading scale, this numerical value falls within the range of 1.51 to 2.00, which is qualitatively interpreted as Very Good academic performance.

The data show that, despite technical challenges and mixed perceptions of the ease of use of virtual simulations, students have maintained a high level of scholarship. A mean of 1.68 indicates that most science majors are performing at a superior level, suggesting that they possess strong foundational knowledge and a high degree of academic resilience. This performance suggests that the current instructional methods, supplemented by digital tools, are effectively supporting the students' mastery of complex scientific concepts.

This states a significant responsibility for Don Carlos Polytechnic College to sustain and maintain this standard of excellence. The "Very Good" performance suggests that students are academically capable. However, to prevent future burnout or performance plateaus, the institution must ensure that the transition to more digital-heavy learning remains stable. The implication for the college is to implement a continuous academic monitoring system and to provide advanced enrichment activities that align with students' performance levels. Sustaining this requires the school to proactively upgrade laboratory resources, both virtual and physical, to ensure that students' academic growth is not hindered by outdated technology or a lack of support.

The "Very Good" performance recorded here aligns with Bandura's Self-Efficacy Theory, as cited by Mercado and Picardal (2023), which suggests that high-performing students often overcome technical barriers through sheer academic grit. This is supported by Timbasal (2022), who argued that in rural polytechnic settings, academic success is more closely tied to the "instructor's pedagogical competence" than the quality of the software used. This linkage confirms that students' grades reflect their foundational resilience, aligning with Al-Qahtani's (2025) observation that superior students remain high-achieving even when "learning tools" are still in transition.

Correlation between science majors' perception of Virtual Laboratory Simulation Learning and Academic Performance in Biology

Table 7 presents the correlation results between science majors' perceptions of virtual laboratory simulation learning and their actual academic performance in biology, as measured by their GWA. To determine the relationship between these variables, a correlation analysis was conducted using Pearson's r to assess the strength and direction of the link between the students' perceived level of simulation learning and their academic performance.

Table 7. Correlation between science majors' perception of virtual laboratory simulation learning and their actual academic performance in biology.

Academic Performance in Biology	r-value	p-value	Remarks	Decision
Perception of Virtual Laboratory Simulation Learning	-0.088	0.503	Not Significant	Reject the alternative hypothesis

Table 7 The Pearson correlation analysis revealed no statistically significant relationship between BSED Science student's perception of virtual laboratory simulations and their academic performance in biology ($r = -0.088$, $p = 0.503$). While these findings indicate that positive students perception did not directly correspond to higher academic grades within this specific cohort, this result should be interpreted within the scope of the present study. Academic achievement in biology is multifaceted and influenced by numerous cognitive and contextual factors beyond perceptual attitudes.

This reveals that the student's academic performance is statistically independent of their perception of virtual laboratory simulations. Even though students expressed varied perceptions ranging from high motivation in Table 3 to technical frustration in Table 2, these internal views did not dictate their General Weighted Average (GWA). Specifically, the very low Pearson r -value -0.088 suggests a negligible correlation, meaning that a student's positive or negative outlook on the software does not translate into higher or lower grades. The

respondents "Very Good" academic standing remains consistent regardless of the technical hurdles or benefits they perceive in the virtual environment.

This states that the "Very Good" academic performance of science majors at DCPC is primarily driven by internal factors, such as individual study habits, student discipline, and the quality of faculty instruction, rather than the technology itself. The lack of a significant relationship implies that virtual simulations serve only as a supplementary tool and not a foundational driver of academic success. For the institution, this means that while technology is a valuable addition to the classroom, the "human element" specifically teacher-student interaction and personal effort remain the core reason for academic excellence in biology in the Science Department.

The lack of a significant relationship ($p=0.503$) aligns with the "No Significant Difference" Phenomenon in educational technology, as explored by Fraenkel et al. (2023). This theory suggests that technology acts as a "medium" but not the "cause" of learning. The findings also validate Lampi's (2013) assertion that student discipline is a "confounding variable" that can maintain high performance regardless of how a student "perceives" a tool. Finally, this mirrors Mercado and Picardal (2023), who concluded that while virtual labs improve the "experience" of learning, the "result" of learning (the GWA) remains anchored in traditional study habits and faculty-led instruction.

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This chapter contains the summary of the findings, conclusions, and recommendations of the study.

Summary of Findings

The study reveals that science majors at Don Carlos Polytechnic College maintain an overall mean of 2.75 in their perception of virtual laboratory simulation learning, which is qualitatively interpreted as a "Positive Perception". Among the four specific dimensions analyzed, behavioral intention had the highest mean (3.25). In contrast, perceived ease of use had the lowest (2.03), indicating that although students intend to use the tools, they find technical navigation challenging.

Regarding academic achievement, the respondents demonstrated a very good level of academic performance in Biology, as evidenced by a mean General Weighted Average (GWA) of 1.68. The data showed that 75% of the students achieved grades ranging from "Very Good" to "Excellent," suggesting they possess a strong foundational understanding of scientific concepts despite any technical hurdles encountered with digital tools.

The Pearson correlation analysis resulted in a non-significant r-value of -

0.088 and a p-value of 0.503. These statistical results indicate no significant relationship between science students' perceptions of virtual simulations and their actual academic grades in Biology.

Conclusions

Based on the findings of the study, the following conclusions were drawn: The results indicate that science majors have a positive perception of

Virtual Laboratory Simulation Learning.

The findings also conclude that science majors have a very good academic performance in Biology.

The findings show no significant relationship between students' perceptions of Virtual Laboratory Simulation Learning and their actual academic performance in Biology. Therefore, the study failed to accept the alternative hypothesis that there is a significant relationship between the perceived level of science students in Virtual Laboratory Simulation Learning and their academic performance in Biology.

Recommendations

From the enumerated findings and conclusions, the researchers present the following recommendations:

For school administrators and science instructors, it is recommended to invest in more user-friendly software licenses and repurpose virtual laboratories primarily as pre-lab preparation tools. This approach ensures that digital simulations supplement rather than replace hands-on activities, allowing students to bridge the gap between theoretical knowledge and practical application without being overwhelmed by technical hurdles.

For students, it is recommended that they participate in dedicated orientation workshops or technical walk-throughs to reduce the cognitive load of navigating complex simulation platforms. Reducing these technical frustrations can improve their overall attitude towards the technology, allowing them to focus more on the scientific inquiry at hand rather than on software operation.

For future researchers, it is recommended that this study be expanded to other academic majors or institutions to determine if these trends persist across different scientific disciplines. Additionally, conducting qualitative interviews is advised to gain a deeper, more descriptive understanding of the specific manual and technical hurdles students face, which could inform the development of better localized digital learning strategies.

Republic of the Philippines Province Of Bukidnon

Municipality of Don Carlos

DON CARLOS POLYTECHNIC COLLEGE

Purok-2, Poblacion Norte, Don Carlos, Bukidnon

APPROVAL SHEET

This research entitled “SCIENCE MAJORS’ PERCEPTION OF VIRTUAL LABORATORY SIMULATION LEARNING TOWARDS ACADEMIC

PERFORMANCE IN BIOLOGY” was prepared and submitted by the following students: CABANILLA, NICKOLITTE CATHLEEN L., ALFARO, JUSTINE ANN T.,

LAGURA, PRINCESS B., DAYAG, JAMICA E., in partial fulfillment of the requirements for the degree, Bachelor of Secondary Education Major in Science is hereby accepted.

NICKOLITTE CATHLEEN LOQUINARIO CABANILLA JUSTINE ANN TORAYNO ALFARO

PRINCESS BULAWAN LAGURA JAMICA ESTAMPADOR DAYAG

REYZAMAE D. SAGANDILAN, MS

Research Adviser Date Signed

LEAH MAE P. JADRAQUE, MS

Member

Date Signed

ARIEL M. BERICO, MS

Member

Date Signed

RUBYLEN D. GRANADEROS, PhD

Examiner

Date Signed

Accepted in partial fulfillment of the requirements for the degree, Bachelor of Secondary Education Major in Science.

RUBYLEN D. GRANADEROS, PhD

Dean, College of Teacher Education

Date Signed _____

RYAN T. CAMAÑERO, MAEd

Research Director

Date Signed _____

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APPENDICES

Appendix F. Research Instrument



Republic of the Philippines
DON CARLOS POLYTECHNIC COLLEGE
Purok 2, Norte Poblacion, Don Carlos, Bukidnon
COLLEGE OF EDUCATION



Name (Mandatory): _____

Year and Section: _____ Gender: _____

Instruction: Using the four (4) point scale shown below. Rate the following questions by placing a check in the box. Please answer the questions honestly. Do not leave each item unanswered.

4- Strongly Agree 3- Agree 2- Disagree 1- Strongly Disagree

No.	Item	4	3	2	1
I agree that online science lab:					
1	Virtual Laboratory Simulations provides effective integration of technology.				
2	Virtual Laboratory Simulations offers a safe environment for conducting experiments.				
3	Virtual Laboratory Simulations help in visualizing and modeling abstract concepts.				
4	Virtual Laboratory Simulations supports individualized learning.				
5	Virtual Laboratory Simulations provides immediate feedback to students.				
6	Virtual Laboratory Simulations help improve student performance.				
7	Virtual Laboratory Simulations enhance students' understanding of science concepts.				
8	Virtual Laboratory Simulations increase student engagement in the learning process.				
9	Virtual Laboratory Simulations make data analysis easier.				
10	Virtual Laboratory Simulations help students answer questions that challenge them.				
11	Virtual Laboratory Simulations may cause students to miss the hands-on experience of a real laboratory.				
12	Virtual Laboratory Simulations may increase the likelihood of plagiarism in laboratory activities.				
13	Virtual Laboratory Simulations limit direct interaction with the teacher.				
14	Virtual Laboratory Simulations limit direct interaction with classmates.				
15	Virtual Laboratory Simulations limit the development of manual laboratory skills (e.g., handling tools and instruments).				
16	Virtual Laboratory Simulations reduces opportunities for teamwork.				

Perceived Ease of Use (PEOU)

No.	Item	4	3	2	1
17	Virtual Laboratory Simulations provides flexibility in choosing when and where to work.				
18	Virtual Laboratory Simulations require extensive technical training.				
19	Virtual Laboratory Simulations require access to specific platforms or programs (e.g., LabXchange, Labster).				
20	It is difficult to obtain accurate measurements in online laboratory activities.				
21	Technical issues often interfere with laboratory work in online labs.				
22	Assessing laboratory work becomes more challenging in online environments.				
23	Preparing for experiments becomes more difficult in online labs.				

Attitudes Toward Use (ATU)

No.	Item	4	3	2	1
24	Virtual Laboratory Simulations provide an interactive and motivating learning environment.				
25	Virtual Laboratory Simulations offer simulations comparable to real laboratory experiences.				
26	Virtual Laboratory Simulations provide opportunities for creative research work.				
27	Virtual Laboratory Simulations increase students' motivation to learn science.				
28	I can complete experimental tasks more quickly in an online laboratory.				
29	I will use Virtual Laboratory Simulations more often if I have regular access to them.				
30	I feel frustrated during online laboratory activities.				
31	My participation feels limited to observing rather than performing tasks in online labs.				

Behavioral Intention (BI)

No.	Item	4	3	2	1
32	I do not plan to use Virtual Laboratory Simulations in the future.				
33	I prefer to use Virtual Laboratory Simulations together with real laboratory activities in the future.				
34	I am willing to suggest improvements for Virtual Laboratory Simulations for future use.				
35	I look forward to learning more about online science laboratories.				
36	I am interested in participating in forums or conferences related to online laboratories.				