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Research Article:

Investigating The Academic Experience of Science Education Students with Virtual Laboratory Classes: A Convergent Parallel Approach

Ymarey Kyle V Amanio[1], Camila O. Legaspino [1], Jhuvan Rhey C. Mondido [1], Ian S Somosot [2]* and Jevannel G Borlio[2]

[1] Bachelor of Secondary Education (Major in Science), Davao del Norte State College, 8M7C+C4P, Panabo, Davao del Norte, Philippines
[2] Institute of Teacher Education, Davao del Norte State College, 8M7C+C4P, Panabo, Davao del Norte, Philippines

*Corresponding author: ian.somosot@dnsc.edu.ph

ABSTRACT

Virtual laboratories are operative platforms utilised by science education students during the pandemic. The study was designed to determine the virtual laboratory experiences of science education students in terms of usability, quality of service, and sense of reality with an exploration of the contributing factors that affect their experiences. The outcomes were supported by John Dewey's Social Constructivist Learning Theory, Dave Kolb's Experiential Learning, and Edgar Dale's Cone of Experience. This study used a convergent parallel design to understand the subject thoroughly. In the quantitative approach, 100 respondents met the inclusion through a purposive sampling technique. In the qualitative approach, six participants are purposely selected by the snowball sampling technique. Quantitative data in the study were analysed through statistical analysis of Frequency, Mean, Independent T-test, and ANOVA. Moreover, qualitative data were analysed using Thematic Analysis performed through Colaizzi's Method. Quantitative and qualitative data were integrated using Joint Display Analysis. In quantitative key findings, virtual laboratories for science education students are helpful. The results also revealed that there is no significant difference in the level of assessment of science education students on their academic experience with virtual laboratories when grouped according to gender and year level. On the other hand, qualitative results revealed that science education students have eight contributing factors affecting their assessment of their academic experience with virtual laboratories. The results of this mixed method research design can be a basis for future researchers to undertake either pure qualitative or quantitative research design.

Keywords: Academic experience, convergent parallel approach, science education, virtual laboratory

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INTRODUCTION

Background of the Study

The current coronavirus pandemic (COVID-19) has produced much uncertainty in research and teaching. During the COVID-19 epidemic, the usage of virtual laboratories in distance education has grown significantly (Dhawan, 2020). Virtual laboratories have been used as a catalyst to help schools and universities worldwide overcome the current problem by implementing multidisciplinary techniques (Soni & Bhola, 2022).

Globally, several institutions and colleges worldwide are utilising virtual laboratories. This includes Middlesex Community College in Massachusetts, the Indian Institute of Technology (IIT) in Mumbai, and others. The Indian Institute of Technology (IIT) Mumbai established a virtual laboratory for engineering and science students to continue the academic year in the face of the COVID-19 epidemic. It is difficult for science students because hands-on practical sessions are critical in addition to online lectures (Almohammed et al., 2021).

As a result of the pandemic, virtual laboratories have been used for educational purposes in biology, chemistry, and other natural sciences since the announcement of the shift in the mode of instruction in the Philippines (Cereno & Borlio, 2021). Students will be able to do studies at home and in the laboratory, despite the COVID-19 pandemic's unexpected circumstances. Despite the COVID-19 epidemic, students can conduct experiments at home, and laboratory sessions will continue as scheduled (Vasiliadou, 2020).

Online labs are now available to students at Malayan Colleges Mindanao (MCM), making it a pioneer in the Philippines. MCM has teamed up with Labster, a leading Danish software company, to create virtual laboratory simulations based on game technology and psychological learning research. The quarantine restricts students from being physically present in the lab only. Students at MCM were able to practice a range of laboratory skills from the comfort of their own homes because of this relationship. Virtual laboratories in online education prohibit students from having hands-on experience with such facilities, despite all the advantages discovered so far in the research (Usman et al., 2021). It is crucial to examine how schools are now delivering lab-based experiments to kids during the pandemic, how they are presented online, and what strategies must be followed to attain learning results (Morgan, 2020). Learning is effective when students can work together in groups.

As Muller and Ferreira (2005) explain, online laboratories allow students to collaborate. They can apply all of their knowledge to a problem and evaluate and improve their grasp of the situation. According to the researchers, many soft skills can be honed through interactions with other students, such as the ability to work in teams, achieve goals in collaboration with others, and integrate other people's knowledge to complete a task. Online delivery in an asynchronous way hinders or entirely denies the majority of the capabilities mentioned above.

One country's higher education institution, Davao del Norte State College, which aimed to provide quality graduates (Somosot et al., 2022), has adopted flexible learning. Regarding teaching, the worldwide outbreak has forced a change from face-to-face instruction and traditional classroom methods to more contemporary ones. As a result, students must adapt to the new norms of education. A student's experience in the laboratory has also been made more difficult for scientific education pupils. Because of this widespread concern, adopting virtual laboratories in classrooms became an alternative to learning and participating in experimental activities. Students were using their mobile data to access learning management system and be able to join their synchronous classes (Somosot, 2022).

This study aims to determine the academic experience of science education students and how they deal with problems while doing virtual laboratory activities. Through this study, we could learn about students' different perspectives and academic experiences and how they deal with the new way of learning. This helps the administration, teachers, students, parents and guidance counselors deal with science education students.

Problem statement

This study addresses a knowledge gap, more specifically in methodology, as most of the research conducted with these variables and the phenomenon of experience in virtual laboratory explored mainly quantitative or qualitative approaches, but not the combination of both. The researchers have this proposition that combining both approaches will shed light on understanding this research topic of interest, considering the unit of analysis being chosen include students taking bachelor's degree in secondary education and majoring in science, which can be regarded as an essential and worthy of investigation in the context of science education. In this study, virtual laboratory experiences mean the virtual classes attended by science education students in conducting their laboratory exercises. The measure would be based on usability, quality of service and sense of reality offered by virtual laboratory experiences.

Research objectives

This study aimed to investigate the virtual laboratory experiences of science education students, including the contributing factors related to it. More specifically, this study aimed to address these questions:

1. What is the extent of the virtual laboratory experience of science education students in terms of usability, quality of service, and sense of reality?
2. Is there a significant difference in the extent of virtual laboratory experience of science education students when grouped according to gender and year level?
3. How do science education students describe their experiences in using virtual laboratories?
4. What is the overall academic experience of science education students in their virtual laboratory classes when explored quantitatively and qualitatively?

Null hypothesis

The hypothesis was tested at a 0.05 level of significance stating that there is no significant difference in the level of assessment of science education students on their academic experience with virtual laboratories when grouped according to gender and year level.

Theoretical Framework

This study was anchored on the combination of Social Constructivist Learning Theory by John Dewey, Experiential Learning by Dave Kolb, and Edgar Dale's Cone of Experience. These theories supported the possible outcome of the level of assessment of science education students on their academic experience with virtual laboratories.

Kolb's theory of experiential learning

Kolb's experiential learning theory was founded on the work of John Dewey and others. It is founded on constructivist principles and asserts that learning is a process that evolves in response to changes in people's experiences. The essential concept is that it views the experience as a source of knowledge (Kolb et al., 2014). This theory emphasises concrete experience (feeling), which is the first stage of Kolb's cycle that challenges the possible result of the study on the academic experience of science education students since the theory describes the concrete experience as one that a learner has during a specific class session or laboratory experiment. In using this theory, it is observed why it is essential for students who want to reflect on their experiences and ask questions before deciding to think abstractly about what they have seen and use active experimentation to do so. To do these things, students must experience real laboratories, which is the opposite of virtual laboratories (Healey & Jenkins, 2007).

Social constructivist learning theory

According to the social constructivist learning theory by John Dewey, humans acquire knowledge through participation in a situated task and social negotiation. Constructivist learning theory emphasises that knowledge is built via practical experience. This theory is ideal for laboratory instruction which is the core of science education students during this pandemic, wherein virtual laboratories are helpful in the mastery of the subject as online learning becomes more and more widespread.

Technology is subject to the same constructivism principles. Technology assists students in comprehending class material and facilitates their education. Students may quickly obtain pertinent information with the assistance of technology, which aids their learning (Hill & Hannafin, 2001). As a result, teachers will be compelled to employ a constructivist approach to instruction (LeBaron & Bragg, 1994). We all know that online learning is not an isolated teaching strategy where students merely interact with their screens. Instead, it is a multifaceted platform that gives students various tools to expand on what they already know and wish to learn. As stated by Duffy and Jonassen (2013), constructivism advocates using authentic studies and tools to avoid misconceptions caused by inappropriate interpretations. In addition, students' modern use of ICT has aided in their comprehension of class materials by making sense of what they have been doing (Torun et al., 2021).

Edgar Dale's cone of experience

According to Edgar Dale, as one progresses further up the Cone, the degree of abstraction steadily increases as one shifts from having direct, purposeful experiences to having experiences represented by word symbols. Consequently, students are reduced to the role of observers rather than participants. This implies the importance of a sense of reality in virtual laboratories to the students as what the base of the Cone represents, "purposeful experience," which was defined as anything that can be seen, handled, tested, touched, felt, and smelled. Virtual laboratories oppose the concept of this Cone because it makes the student a mere spectator instead of an active participant (Amornrit et al., 2022).

Dale elaborated by saying that the wide base of the Cone emphasized the importance of direct experience in demonstrating the importance of effective communication and learning (Nurpratiwi et al., 2022). This study tests Edgar Dale's theory of whether the experiences of students in virtual laboratories give a high level of sense of reality which contradicts the theory, or the results support the idea of Dale that experiences that are real and tangible are essential for having the groundwork for children's long-term learning.

Conceptual Framework

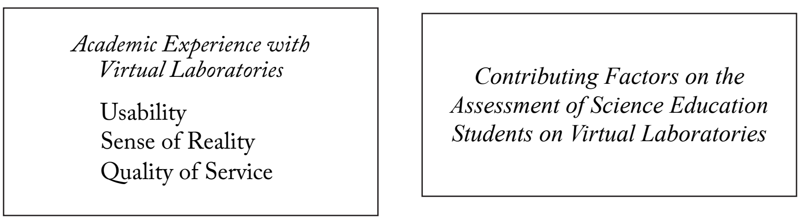

Figure 1. Schematic diagram presenting the variables and phenomenon investigated

METHODOLOGY

Research Design

To gain a thorough understanding of the subject, this study used a convergent parallel design, a mixed-method design. Morse (2021) defined the research method as qualitative and quantitative (QUAL+QUAN). A convergent parallel design requires the researcher to conduct the quantitative and qualitative elements concurrently at the same phase of the research process, weigh the approaches equally, analyse the two components independently, and interpret the results collectively (Dawadi et al., 2021). A convergent-parallel design was used because it is possible that some parts may not be captured only by quantitative data. For the quantitative approach, the researchers determined the level of assessment of science education students on their academic experience with virtual laboratories. For the qualitative approach, the researchers determined the contributing factors that affect their level of assessment. The researcher triangulated the approaches for corroboration and validation by directly comparing quantitative statistical data and qualitative findings. Two datasets were gathered, evaluated individually, and compared during the study process, and the results of the two approaches were presented side-by-side, accompanied by supporting authorities' insights presented in the various literature cited.

Local and Participants

The study was conducted in Davao del Norte State College (DNSC). A state tertiary school located at Panabo City, Davao del Norte, Philippines. The college offers both undergraduate and graduate programs. One of the offerings of the College is Bachelor of Secondary Education major in Science. To set the inclusion criteria, the quantitative approach in this study utilised a purposive sampling technique. The basic criteria for determining the respondents include being enrolled at DNSC, taking up a Bachelor of Science in Secondary Education Major in Science, and having prior experience with virtual laboratory classes. The 2nd (n = 37), 3rd (n = 31), and 4th year (n = 32) science education students met these criteria, giving a total of 100 (Male = 38; Female = 62) respondents. For the exclusion criteria, those students with irregular status, especially those who are not yet enrolled as science education students and have not yet experienced virtual laboratory classes, are not considered research respondents.

The qualitative approach in this study involved two non-probability sampling techniques, namely: purposive sampling and snowball sampling. The primary criteria for participants were science education students who have prior experience with virtual laboratory classes and have good internet connections that can readily access virtual laboratory activities. For the exclusion criteria, those science education students who experience virtual laboratory classes but with a poor internet connection are not considered research participants. The participants are purposely selected based on referrals. The instructors teaching Science subjects who used virtual laboratories were asked to suggest two representatives who met the inclusion criteria, gaining their cooperation in the open-ended individual interviews. During the conduct of the survey, the respondents were notified that by participating in this research study, they were not surrendering any legal claims, rights, or remedies.

Research Instrument

Two (2) sets of survey instruments were utilised for qualitative and quantitative approaches. For the qualitative phase, a set of Interview Guide Questions was utilised to find out the contributing factors that affected the level of assessment of science education students on their academic experience with virtual laboratories. Before the usage of the tool, it was forwarded for validation to three experts in the field. Moreover, a survey questionnaire was adapted from a study, "Transforming Computer Engineering Laboratory Courses for Distance Learning and Collaboration," by Saniie et al. (2015) for the quantitative phase. The questionnaire consists of 14 questions that are separated into three categories. The first category, Usability of Virtual Laboratories, has five questions, the second, Sense of Reality, contains four questions, and the third, Quality of Service of Virtual Laboratories, contains five questions. A validation protocol of the research instrument was done also with three (3) experts and pilot testing with the non-target respondents was employed, consisting of those students who are not Science Education majors but also experienced virtual laboratory classes with their minor Science subjects. Cronbach's alpha is used as a measure of reliability, with values of 0.7 or above considered satisfactory indicators of reliability. According to the result, Cronbach's Alpha value is 0.944, which implies that the instrument has an excellent level of Internal Consistency.

Data Analysis

Quantitative data were subjected to statistical treatment. Analysis and interpretation of the quantitative data in the study were obtained by the following: *Mean* was used to determine the level of assessment of science education students on their experience with virtual laboratories in terms of Usability of Virtual Laboratories, Sense of Reality, and Quality of Service of Virtual Laboratories (Objective No. 1), *Independent t-test* was employed to determine if there is a significant difference in the level of assessment of science education students on their academic experience with virtual laboratories when grouped according to gender, and *ANOVA* was employed to determine if there is a significant difference in the level of assessment of Science education students on their academic experience with virtual laboratories when grouped according to year level (Objective No. 2).

Qualitative data from the in-depth interviews conducted captured the narrated experiences of the students in virtual laboratories and were analysed using *thematic analysis*. In this type of analysis, the codes were allocated to the data, and then patterns were found by determining the frequency of the idea and classifying it into themes (Savin-Baden & MacKenzie, 2022). Colaizzi's method is one way of conducting thematic analysis. The approach followed a seven-step procedure to analyse the qualitative data acquired through open-ended individual interviews (Objective No. 3).

Quantitative and qualitative results were integrated using *joint display analysis*. Joint display analysis is an effective method of integrating because it requires the researcher to consider both types of data for linked constructs at the same time. This can provide you with new ideas that go beyond what you could learn from quantitative and qualitative results separately (Fàbregues et al., 2021; Guetterman et al., 2021).

Ethical Considerations

Several ethical considerations were taken into account by the researchers while conducting this study. In this study, the identity of the respondents and participants were kept confidential. This is done to protect their privacy and provide them with a sense of security. Furthermore, all of the information was carefully gathered and tallied by the researchers. Opinions, results, methodologies, and processes were all acquired and implemented in a non-manipulative way. The researchers were granted permission to conduct this study by the school administration. This was accomplished through the submission of a letter of authorisation. The researchers used simple terms while explaining the research to the respondents and participants. This made them aware of the research and learning objectives.

Additionally, no one was coerced or compelled to participate in this study. They willingly took part in and contributed to the research.

The researchers assured the respondents and participants that any information they shared in the survey would be kept private and confidential. The researchers safeguard the personal information of the respondents and participants as well as the collected data and ensure that it was only utilised for the purposes of the study. Furthermore, this study followed Republic Act No. 10173, often known as the Data Privacy Act, a law that attempts to protect all types of information, whether private, personal, or sensitive. It is intended to apply to both natural and juridical individuals involved in the processing of personal data. A state policy aimed at protecting the basic human right to privacy and communication while allowing the free flow of information to promote innovation and growth. The State acknowledges the critical significance of information and communications technology in nation-building and its inherent commitment to maintaining the security and protection of personal information in government and private sector information and communications networks. The researchers required informed consent from the respondents and participants mailed on the day of the procedure. The researchers further discussed the details of the study and the consent form through virtual platforms and online surveys. The Informed Consent Form was used in this study since it served as a guide for the respondents and participants throughout the investigation. This aided respondents and participants in being educated about the activities that they would participate in during the research. This also notified them of their rights and benefits as research participants. After conducting the study, they were informed of the results to express transparency.

RESULTS

The presentation of the results follows the sequence of presenting first the outcomes of quantitative analysis, followed by the presentation of essential themes. Presented in Table 1 is the assessment of science education students on their academic experience with virtual laboratories in terms of usability of virtual laboratories, sense of the reality of virtual laboratories, and quality of service of virtual laboratories. The overall mean is 3.49 with a descriptive equivalent of high. This means that the Virtual Laboratories provide a fair academic experience as perceived by Science Education Students. In addition, among the indicators Usability of Virtual Laboratories got the high mean of 3.57 and Sense of Reality of Virtual Laboratories got a mean of 3.24 with a descriptive equivalent of moderate.

Table 1. Level of assessment of science education students on their academic experience with virtual laboratories (*n* = 100)

Indicators	$\bar{x}$	Description
Usability of virtual laboratories	3.57	High
• Virtual lab help in the subject: concepts, practical exercises,	3.87	
projects.	3.80	
• It is a good idea to extend this virtual lab to all students.	3.61	
• I would like to use the virtual lab in other subjects.	3.20	
• I am satisfied with the virtual lab.	3.35	
• I have been motivated by the virtual lab to learn more about the		
subject.		
Sense of reality of virtual laboratories	3.24	Moderate
• Virtual lab feels real to me, as if I am there.	3.11	
• Web cameras enhance reality.I feel in control of the lab	3.30	
experiment, even though I am not there.	3.19	
• Virtual and local students are equal participants in the	3.35	
experiments.		
Quality of service of virtual laboratory		
• I have enjoyed using a virtual lab.	3.51	High
• Virtual lab is easy to use and access.	3.48	
• Assigned lab time was sufficient.	3.56	
• Guidelines and instructions for the virtual lab are clear.	3.33	
• Teamwork between virtual and local students is practical and	3.63	
intuitive.	3.60	
Total	3.49	High

Presented in Table 2 is the significant difference in the level of assessment of science education students on their academic experience with virtual laboratories when grouped according to gender and year level.

Table 2. Significant difference in the level of assessment of science education students on their academic experience with virtual laboratories when grouped according to gender and year level (*n* = 100)

Test variables	F	Sig.	Decision
Gender	0.866	0.673	Accept Ho
Year Level	0.888	0.651	Accept Ho

Since the *p*-values for Gender and Year Level in Table 2 are 0.673 and 0.651 > 0.05, respectively, then we do not reject the null hypothesis. There is no significant difference in the level of assessment of science education students on their academic experience with virtual laboratories when grouped according to gender and year level.

Integration of Quantitative and Qualitative Data Through Joint Display Analysis

The essential themes of "Seeking help from teachers and classmates", "Stable internet connection", "Intermittence, and video glitches", "Time and task management", and "Prior knowledge about the laboratory equipment" do not have parallel results with the quantitative mean scores. Table 3 shows the joint display analysis for "Virtual laboratories are accessible and easy to explore".

Table 3. Joint display analysis (convergence of the two methods)

Qualitative results (Significant themes)	Quantitative results (Significant numerical results)	Interpretation
Virtual laboratories are accessible and easy to explore	Usability of virtual laboratories **3.57 (High)** Quality of service of virtual laboratory **3.67 (High)**	The theme of virtual laboratories is accessible and easy to use, correlated to the evident usability and quality of service of the virtual laboratory.

Below are the significant statements from the interview conducted which paved way to the emergence of the theme "Virtual Laboratories are Accessible and Easy to Explore":

> The impact of virtual laboratories for me is that it made me study much easier than the actual, however, the experience is really different. Though actual and virtual are similar when it comes to the step-by-step process which you can learn, however, actual is different wherein you can touch, see, and you yourself could see the materials being used, whereas, in virtual laboratories you'll just manipulate the keys, and you cannot identify the real result of your experiment. (Student 3, Female)

> When it comes to the ease of utilising virtual laboratories, we can access them anytime and anywhere. So, when it comes to learning, we can go at our own pace. It was easy to navigate since the tool can be just found in one line and the feature of the software is accessible. (Student 5, Female)

Table 4. Joint display analysis (convergence of the two methods)

Qualitative results (Significant themes)	Quantitative results (Significant numerical results)	Interpretation
No tactile senses involved in using virtual laboratories Students relied on other videos and references	Sense of reality 3.24 (Moderate)	This joint result from the two combined methods entails that the sense of reality of a virtual laboratory is only moderate since no concrete senses engage in utilising the tool resulted in students relying on other videos and references.

Table 4 shows the joint display analysis for "No tactile senses involved in using virtual laboratories" and "Students relied on other videos and references". The significant statements from the interview conducted which paved way to the emergence of the themes "No tactile senses involved in using virtual laboratories" and "Students relied on other videos and references" are as follows:

> I think that the traditional laboratory is more effective when compared to the virtual laboratory. I really believe that authorisation instills effective learning in every student. So, I think that if the students can manipulate laboratory equipment and observe it in a real-life situation or circumstance, they can appreciate and effectively digest what the topic is all about. (Student 1, Male)

> Actual class is different wherein you can touch, see, and you, yourself, could see the materials being used, whereas, in virtual laboratories, you'll just manipulate the keys, and you cannot identify the real result of your experiment. (Student 2, Female)

> You can also search on other websites like YouTube to watch other videos, which is where you can base your laboratory. Sometimes, when I don't understand the virtual laboratory activity, I would not really attempt to use or watch other videos, I wouldn't try the simulator or watch a video, I would directly answer the activity, or sometimes I would look for similar activity on the internet. (Student 4, Female)

DISCUSSION

Key Findings of the Study

With great desire, the researchers hope to gather the contributing factors that affected the level of assessment of science education students on their academic experience with virtual laboratories.

Level of assessment on virtual laboratories

Based on the result, in measuring the assessment of science education students on their academic experience with virtual laboratories, it was found out of three indicators, two have high description levels, while one got moderate description levels. According to Tatli and Ayas (2013), the results of the COVID pandemic reveal the virtual chemistry laboratory program was at least as effective since students could connect the experiment to their daily lives and investigate the macro and molecular and symbolic levels of every experiment.

Moreover, virtual laboratories for science education students in terms of usability are useful. This was supported by Smith et al., (2019) in their study entitled Evaluating the Benefits of Virtual Training for Bioscience Students, which shows that the virtual laboratory simulation improved student understanding and was still perceived to have been useful one year after completion, providing evidence of a longer-term impact of the simulation on student learning. However, virtual laboratories for science education students in Sense of Reality are somewhat useful. This result is true to the statement of Usman et al. (2021) that despite all its advantages, virtual laboratories prevent students from getting hands-on experience with such facilities.

Meanwhile, virtual laboratories for science education students in terms of Quality of Service are useful. This connotes a high quality of service of the tool. This claim is backed by a result from a study in 2020; 370 students took part in the event. At least 77% of students found that virtual lab simulations helped them understand course ideas across all four courses. At least 74% of students could traverse the virtual labs without difficulty, and 58% thought the simulations were high quality (Papaconstantinou et al., 2020).

Test of significant difference

The results revealed no significant difference in the level of assessment of science education students on their academic experience with virtual laboratories when grouped according to gender and year level. Similarly, when Szopiński and Bachnik (2022) looked at the effect of factors on how much students liked virtual learning, they found that gender was not a significant factor in how much students liked virtual learning during the COVID-19 outbreak. Also, in their study, the level of study and the type of study material did not make a big difference in how students chose to learn. With a whole dedication to achieving the objectives of this research, the qualitative element of this mixed-method design provided the possibility to gather contributing factors that affected the level of assessment of science education students on their academic experiences with virtual laboratories. This study is what Ekka and Singh (2022) described as one of the factors in the perceiver that affect perception is experience wherein past occurrences affect the focus of attention, and individuals tend to perceive those objects or events to which they can relate. In this idea, the past experiences of science education students about using virtual laboratories influenced their level of assessment of the tool.

Essential themes

Based on the results, science education students come up with many contributing factors, which comprise the themes when asked about the factors that affected their level of assessment of their academic experience with virtual laboratories. There were No Tactile Senses Involved in Using Virtual Laboratories. Virtual laboratories do not provide a full sensory experience for the student. Virtual laboratories rely heavily on images and some sounds that the programmer picks out. Verawati et al. (2022) agreed, and in a study done in Zambia, they said that the problem with virtual laboratories is that they don't seem to help people learn psychomotor skills. It is said that hands-on laboratories give students sensory and situational awareness that can't be duplicated in a virtual environment.

When science education students are concerned about using virtual laboratories, they Seek Help from Teachers and Classmates. They often asked how to manipulate the virtual laboratories to get the desired result in an experiment. In the same way, a study showed that using virtual labs alone does not guarantee that students will learn about science. Virtual labs often help students see how things work, but they may not change how students think about the processes (Akaygun & Adadan, 2019). It is emphasized that students have trouble doing virtual experiments in a thoughtful and useful way (McElhaney et al., 2015). So, teaching guidance is needed to help students learn how to use virtual labs to do scientific experiments (Efstathiou et al., 2018; Thoms & Girwidz, 2017). Some science education students stated that Virtual Laboratories are Accessible and Easy to Explore. They can easily do different experiments no matter where they are or what time. They can easily learn about ideas and theories without going to a physical science lab. A study at Yogyakarta State University shows this idea is also true. It shows that learning is more interesting, more effective, can be shortened, can improve the quality of learning, and can be done anywhere and at any time by using virtual labs and E-Reference in the learning process and chemistry research.

Students Relied on Other Videos and References when given the lesson and the instruction on how to conduct the virtual laboratory. They still relied on other references like videos and other sources due to a lack of understanding of the lesson or even manipulating the tool. According to Beazer and Cummins (2020), students are more likely to recall specific details and, as a result, can more easily compare those details with new information as they examine additional sources. She discussed that as students develop a set of sources, they think about how the information provided supports and/or extends the information in the other sources.

Science educators firmly attested to the impact of a Stable Internet Connection in using virtual laboratories (Duping et al., 2021). Especially when using a virtual microscope in microbiology and parasitology, a good internet connection is required to display clearer images of the results. If not, students won't be able to see the specimen under the microscope. This will result in inaccurate results and incorrect data that might affect students' performance. According to a new study that was conducted by Bauer et al. (2020), it was found that students living in rural areas with sluggish internet connections or limited access from their homes were more likely to fall behind in their academic pursuits. A student's ability to succeed academically, gain admission to college, and find work after high school can all be negatively impacted by difficulties encountered in the classroom.

As a result of poor internet connection, Intermittence and Video Glitching are being experienced by students. Freezing the screen and glitching can be a common problem, especially when you have a poor internet connection resulting in inconsistency when observing the simulator and when the screen freezes, the text on the screen is already altered. As a result of this challenge, a blog post in March 2020 by UNICEF Young Reporters Milosievski et al. (2020) suggested that students should not be assessed with numerical grades but rather descriptively to improve online learning. Time and Task management are crucial for science education students to perform all the assigned virtual laboratory activities. Students should set goals, decide on the most important event, and organise around it to accomplish tasks and activities. According to Cyril (2015), the ability to effectively manage one's time may prove useful in a student's hectic schedule. It assures that students will be appropriately prepared, well-organised, and focused in order for them to successfully manage their day-to-day life and finish their academic work on time.

Having Prior Knowledge About Laboratory Equipment would greatly help science education students conduct virtual laboratory activities. They apply what they know to handle the actual laboratory equipment in the virtual laboratory activities and tasks. Lindgren et al. (2016) are proponents of employing various pieces of laboratory equipment in a teaching capacity. Students have a deeper comprehension of the material that is being taught to them in school because of the apparatus found in laboratories. It has been discovered that students are more likely to remember information if the topics being covered in class or the activities, they are participating in are relevant to their personal life, and Somosot (2018) states that when students are taught relevant educational experiences, they will likely get satisfied in their learning. Because of this, one of the most important aspects of teaching is recognising students' prior experience with laboratory equipment, which might also be referred to as prior knowledge. This is one of the most important aspects of teaching.

Theory Base

This showed that Kolb's theory about how people learn from experience was right. The most important idea is that it sees the experience as learning. The theory is about how people learn by doing things and describes how knowledge is gained through experience. Because of this, students need to work in real laboratories where they can use their senses. The convergence of the two methods implies that virtual laboratories help students in their conceptual and experiential learning. This was supported by the *Social Constructivist Learning Theory*, where Mann and MacLeod (2015) stated that students might easily obtain pertinent information with the assistance of technology, which aids their learning. Virtual laboratories are a vital ICT tool for teaching practical skills related to real laboratory experiments. Another result of the two combined methods entails that virtual laboratories do not provide a full sensory experience for students. Dale supported this in his famous *Theory on the Cone of Experience*, that the wide base of the Cone stressed the importance of direct experience in demonstrating the importance of effective communication and learning. Real and tangible experiences are essential for laying the groundwork for children's long-term learning.

CONCLUSION

Quantitative results showed that females had the greatest number of science education students than males, most of whom were in their 2nd year. In measuring the assessment of science education students on their academic experience with virtual laboratories, it was found out of three indicators, two have high description levels, while one got moderate description levels. Virtual laboratories for science education students are useful in terms of Usability and Quality of Service and somewhat useful in Sense of Reality.

In testing the hypothesis of the relationship, as shown in the generated results, it can be said that there is no significant difference in the level of assessment of science education students on their academic experience with virtual laboratories when grouped according to gender and year level. Thus, the null hypothesis cannot be rejected.

On the other hand, qualitative results revealed that science education students have many contributing factors affecting their level of assessment on their academic experience with virtual laboratories. There were eight themes emerged along with their core ideas generated from the IGQs, which are No Tactile Senses Involved in Using Virtual Laboratories, Seeking Help from Teachers and Classmates, Virtual Laboratories are Accessible and Easy to Explore, Students Relied on Other Videos and References, Stable Internet Connection, Intermittence, and Video Glitches, Time and Task Management, and Prior Knowledge About the Laboratory Equipment.

When the quantitative and qualitative data of the research are evaluated together, it is seen that the virtual laboratories for science education students are useful, accessible, and easy to explore. Virtual laboratories are a great way for students to practice in a safe, online environment. Through virtual laboratories, students can complete laboratory experiments online and explore abstract concepts and complex theories without stepping into a physical science lab. However, virtual laboratories do not provide a full sensory experience for some science education students. Virtual laboratories heavily rely on visual images and some audio sounds that are selected by programmers. Science education students can learn something useful from a full sensory experience in a real lab, like weird noise and smell, random errors, faulty machinery, etc.

RECOMMENDATIONS

Since the findings of the study revealed virtual laboratories for science education students are useful, accessible, and easy to explore, it is strongly suggested that using virtual laboratories have to be maintained accessible and used in schools and colleges. The prevalence of the pandemic prompted how operational virtual laboratories are. Thus, maintaining it as a means of learning tool for students to continuously engage in science-related experiments and laboratories is a must. Results found that in Davao del Norte State College, science education students have been supported with the effective use of virtual laboratories despite distance learning. The study evokes that virtual laboratories must be introduced and operated in other learning institutions to aid and accompany the students in their virtual laboratory activities.

As there is no actual hands-on experience in virtual laboratories for some science education students, it is recommended that traditional laboratories must also be integrated to fully satisfy and achieve an effective learning experience. There should be a combination of virtual and traditional laboratories, especially during the times of COVID-19. The combination of virtual and traditional laboratories will give better outcomes than using virtual laboratories alone.

Since this study investigated the academic experience of science education students with virtual laboratory classes, this opens up several avenues for future research to unveil related matters and concerns of the topic. Since this study is limited to the science education students of Davao del Norte State College in Panabo City, with the same method of investigation, there could be theory development and concept validation to be conducted on a wider scope of participants from different colleges in various locations.

Researchers can go beyond the responses of the participants by exploring their actual situations and scenarios as they engage in virtual laboratory classes. This will lead researchers to generate effective suggestions to accumulate support for the participants with their academic experience with virtual laboratory classes. Moreover, the results of this mixed-method research design can be a basis for future researchers to undertake either pure qualitative or quantitative research design. Data gathered from the in-depth interview and survey questionnaire can be an instrument for the researcher to undergo further explorations since the necessary data needed for both research designs are achieved in this study. The findings of the study also imply that these realities in the Asia Pacific region that schools cannot provide a technologically advanced way of teaching and learning set-up, more specifically in providing virtual laboratory classes that are appropriate for distance learning, digital transformation in the context science education should be investigated and explored to pave the way to possible solutions to this rooting dilemma on the digital divide.

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