TEACHERS’ LIVED EXPERIENCES OF USING DIGITAL AND REAL LABORATORY ACTIVITIES IN BIOCHEMISTRY

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Abstract

The main objective of the study is to describe and evaluate the use of digital and real laboratory activities on science teachers’ conceptual understanding and laboratory performance skills. Digital laboratory activities involved the use of videos and online quizzes through Schoology, a learning management system. In contrast, real laboratory activities employed actual conduct of the laboratory activities, use of laboratory performance evaluation sheets, preparation of written laboratory reports, group outputs, reflective journals, and interviews. This study employed the Plan-Do-Study-Act (PDSA) model utilizing a mixed-method approach. An intact class of in-service teachers (N=16) enrolled in the course Laboratory Teaching in Basic Science Course served as participants in this study. The impacts of the intervention on the teachers’ performance skills were based on the teacher-researcher observations throughout the intervention, teachers’ actual hands-on work, and the written reports, reflections, and narratives. Qualitative data showed that conceptual understanding and laboratory performance skills of the teachers were enhanced using digital and real laboratory activities. Specifically, comprehension and mastery of the content were enhanced with digital laboratory activities, additive skills, written communication skills, and critical thinking skills of the real lab. It also indicated that the teachers’ attitudes towards the activity were improved as they showed collaboration and active participation within the group. Overall findings indicate that the use of digital laboratory activities as part of the laboratory instructions provides learning and the real lab.

Keywords: conceptual understanding, performance skills, digital lab, real lab, collaboration

Introduction

Science laboratories have been part of school science education for a long time now. It is believed that the laboratory became an important means of instruction in science as an aid to support the learning process in school. Specifically, the use of a laboratory is significant in helping students’ thinking processes. With laboratory experiences, students’ understanding through facts can be strengthened (Jones et al., 2016) where it plays a role of connecting field and laboratory conditions as a bridge to deliver students’ thinking pattern to facilitate the process of students’ thinking adaptation in the learning process from the real world into school (Suseno et al., 2019). Despite the many benefits of the laboratory to students’ learning process as revealed in multiple studies, students, on the other hand, perceive that laboratory activities are just an additional requirement for them in school since they cannot figure out ideas of the clear purpose of their work in science laboratory activities.

Further, they perceive that laboratory work is very complex and complicated (Aladejana & Aderibigbe, 2007), where it requires much of their time and effort, yet, unsure if it really equates the benefits, they will get from it after school. As such, students’ performance towards the laboratory is much more affected where it ranges from poor to average (Owokade, 2006). While a few student’s performances are above average, it is overshadowed by the poor-to-average performance results of the majority of the students in the class. Such students’ performances can be attributed to low problem solving and critical thinking skills (Lugtu, 2018). Students’ attitudes and performances towards the laboratory can be associated with their past laboratory experiences. As described, teaching laboratory courses are mostly teacher-centered, which implied rote procedures. With this approach, students have experienced information overload, which inhibits their ability to focus appropriately on the most significant concepts and limits their ability to explore, investigate, and create their own understanding.
The 2018 PISA results reveal that the Philippines fared significantly lower in scientific literacy than all ASEAN countries that participated. The declining test scores and students' low performance can be attributed to the students' attitudes and perceptions towards STEM, in particular, are affected by motivation, the experiences they had, and self-efficacy (Brown et al., 2016). When the students fail to find the real purpose of what they are asked to do, their performances will be more likely than mere compliance, of course. To address this issue, perhaps it is worth reexamining the quality of school science education, including the training and laboratory experiences as part of that education.

Literature showed that chemistry, for example, is learned best when students can work in the laboratory (Teccan & Bilgin 2004) where they can practice basic skills, such as the different laboratory work techniques. Additionally, laboratory exercises allow students to increase their laboratory-based problem-solving skills (Oudubuni & Balogun 1991, Ayas et al., 1994). Appropriateness of laboratory activities is good at developing students’ inquiry and problem-solving skills (Hofstein et al., 1982) whereas, the availability of trained instructors or laboratory technicians is also important. Students' development of performance skills need not be solely dependent on the time and availability of materials and supplies. Other factors, such as the appropriateness of teaching strategy, and pedagogies on assessing performance skills, need more attention. Once the students acquire the skills, they will become more motivated, independent, and critical thinkers. In that way, students may be able to apply their learning in more complex real-life situations. Teachers play a significant role in leading laboratory experiences in ways that support student learning. Hence, this study is aimed at designing flexible instruction that can support effective laboratory teaching.

Since the early years, laboratory works play a vital role in science (Hofstein, 2004). Specifically, it values the acquisition of new skills and utilization of new equipment and works as an avenue to foster social interaction among others, test and prove the theory, and even create an opportunity for students to perform exemplary (Collis et al., 2008; Hunt et al., 2008). While it is clear that scientific literacy is not about just learning content, most instructions are still focused on developing content knowledge using written assessments such as tests and quizzes. Simultaneously, little attention was given for practical exams, laboratory reports, and written assignments that are believed to develop critical thinking and manipulative skills (Brinson, 2015). Literature shows that the laboratory's role is significant in helping the success of the learning process and results in school. Gandhi et al. (2016) emphasize that laboratory activities can improve the development of experiments and development in students in general. Also, laboratory-based learning enables students to improve science process skills and support the formation of the character of responsibility (Riswanto & Dewey, 2017).

Despite the vision of the science curriculum of developing a literate scientific student, as mentioned earlier, the large-scale assessment results are reflecting low-performance levels among Filipino students. The result can be associated with the following factors: curriculum design, pedagogical approach, and assessment method. Arguably, the most important factor in educating young learners is the quality of educators. Because of this, there is a prevailing demand for teachers' knowledge of science in terms of content, process, and skills to lead effective laboratory experiences. With the advancement of technology in science today, there is a need to design and experiment with new pedagogical strategies to bridge the gap between technology and pedagogy. Since modern-day students are equipped with information and communication technology skills, they can take advantage of their use in the classroom for educational benefit. The use of instructional videos as a teaching tool is widely known. With its feature of play-pause-analyze and play again, it enables the students to learn at a comfortable pace and increase students’ learning skills while decreasing the time spent on learning.

In a study conducted by Duban et al. (2019), the team investigated the opinions of classroom teachers working at schools with different socioeconomic conditions of their science laboratory practices. It is common practice that the experiment was done in the classroom utilizing some stuff from home due to the lack of laboratory. Also, the use of curriculum-based experiment videos in software programs is common practice in addition to video-based experiments on the internet, enabling the students to see the experiment taking advantage of certain things. Among the given strategies used, generally, teachers prefer using the available web-based platforms and making students watch the videos on the internet instead of having them do the experiments due to the schools' physical condition and the risk of going beyond the level of the students. However, based on the findings from the teachers' views, it is claimed that laboratory practices enable effective, permanent, and enjoyable learning (Harman et al., 2016).

Video-based experiments through a web-based platform provided shreds of evidence of its important use in laboratory teaching. A research conducted in Illinois examined students' performances of lab-intensive metal processing classes in two different sections using video-based instructions (VBI) over two years. As
described, the supposed in-person demonstration is replaced with web-based demonstrations via YouTube. Results indicate that VBI when used in a lab environment, can be an appropriate teaching tool for manipulative skills (Morris & Romero, 2018).

Another study conducted by Schmidt-McCormack et al. (2017) investigates the use of videos as instructional tools. The respondents are third- and fourth-year students from the upper-division laboratory course at a large, research-intensive Midwest University, with majors in chemistry, biochemistry, and mechanical engineering. The study focused on the design and implementation of instructional videos for undergraduate lab courses. In the study, set videos were developed for each experiment, including pre-lab lecture, experimental, and data analysis videos. The study results showed that the use of pre-laboratory videos is an effective way to support students in completing experiments.

In the Philippine context, literature revealed that the use of video presentations as an instructional tool is also effective. A study conducted by Mendoza et al. (2015) with 224 students of a state university shows that the high use rate indicates the student's broad acceptance and usage of video lectures as the form of computer-based instruction is evident. With the data collected, it is presumed that sex is not a variable in the students' perception of the effectiveness of video presentation, while differences in academic level affect their perceptions towards the effectiveness of video presentation. Moreover, this study revealed that the use of video presentations is highly effective in students’ learning.

With the above-mentioned shreds of evidence to the educational community on the use of video-based instruction in science, it is believed that technology-based instruction complemented traditional in-class instruction can be a significant approach to improving laboratory teaching instructions through the introduction of digital and real laboratory activities.

**Methods**

**Research Design**

This study is action research that allows teachers to better understand classroom context and develop and improve teaching methods to address difficult circumstances (Reboledo, Smith, & Bullock, 2016). Specifically, this action research employed the Plan-Do-Study-Act (PDSA) model. Moreover, this study utilized a mixed-method approach that includes integrating qualitative and quantitative data in a research study (Creswell, 2014). This investigation is focused on describing and evaluating the use of digital and real laboratory activities on science teachers' conceptual understanding and laboratory performance skills.

**Participants**

An intact class of in-service teachers (N=16) served as participants in this study to describe and examine how the use of digital and real laboratory activities enhance their conceptual understanding and laboratory performance skills. The teacher participants are graduate students enrolled in the course Laboratory Teaching in Basic Science Course during the second semester of the academic year 2019-2020.

**Procedures**

This action research explored the implementation of digital and real laboratory activities.

**Pre-Intervention.** At the beginning of the study, the teacher-researcher familiarized herself with manipulating an e-learning tool to use as a repository of digital instructional materials for the intervention. For online sessions, the teacher-researcher uploaded and shared all the materials for the digital laboratory in the Schoology, where the participants can download it. Pre-assessment was also employed to evaluate the participating group. Since an intact group participated in the study, all of them underwent the same treatment.

**During Intervention.** During the first week of the intervention, introduction, and orientation of the course, the platform and the developed digital and real laboratory activities were scheduled. Four (4) weeks were used to implement laboratory activities and three other weeks for orientation, interviews, and evaluation. The intervention starts, via online learning through digital laboratory activities and then face-to-face sessions through real laboratory activities. Before the scheduled real laboratory activities, the participants were instructed to perform the digital laboratory activities before coming to class. The teacher-
researcher directs the participants on the use of digital laboratory activities via the links provided to them. They were asked to answer an online quiz before and after watching the video demonstrations and will later submit screenshots of their scores through Schoology.

On the one hand, during the face-to-face session for real laboratory activities, the participants were asked to perform laboratory experiments using the following set of activities: Preparation of Biochemical Reagents; Protein Denaturation and Coagulation; Carbohydrates as Reducing Sugar; and Enzyme Activity. Using rubrics, the teacher-researcher evaluated the conceptual understanding and laboratory performance skills of participants through laboratory reports and LPES (Laboratory Performance Evaluation Sheet). Since two more evaluators were involved in assessing participants’ laboratory performance skills aside from the teacher-researcher, the participants are instructed to record their actual performances for evaluation. Activities from weeks 2-5 followed the same routine both on the use of digital and real laboratory activities. During week 6 of the intervention, the participants were tasked to present their group outputs and were assessed using LPES.

Post Intervention. After completion of all the digital and real laboratory activities, interviews among the participants were facilitated.

Data Analysis

Descriptive statistics such as frequency, mean, and standard deviation were used to collectively describe the quantitative data that were culled from the online quiz scores and LPES ratings. Qualitative data gathered from the participants’ journal entries and interview responses were thematically analyzed using Braun and Clarke (2006).

Results and Discussion

Teacher Participants’ Manifestation of Conceptual Understanding and Laboratory Performance Skills

Online Quiz

Online quizzes were utilized in this study. The participants were asked to answer four sets of quizzes adapted from Pro Profs Quizzes. This is to give participants a way to remember what they have learned.

![Figure 1: Summary of Pre-test and Post-test Grades](image-url)
Table 1: Summary of the Mean Score and Verbal Description for Digital and Real Laboratory

<table>
<thead>
<tr>
<th>ONLINE QUIZ</th>
<th>PRE-TEST</th>
<th>POST-TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MG</td>
<td>SD</td>
</tr>
<tr>
<td>ACTIVITY 1 Preparation of Biochemical Reagents</td>
<td>81.88</td>
<td>13.35</td>
</tr>
<tr>
<td>ACTIVITY 2 Protein Denaturation and Coagulation</td>
<td>52.56</td>
<td>13.96</td>
</tr>
<tr>
<td>ACTIVITY 3 Carbohydrates as Reducing Sugar</td>
<td>74.75</td>
<td>15.86</td>
</tr>
<tr>
<td>ACTIVITY 4 Enzyme Activity</td>
<td>66.00</td>
<td>19.74</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>68.80</td>
<td>15.73</td>
</tr>
</tbody>
</table>

MG = Mean Grade  SD = Standard Deviation  MP = Mean Percentage

The low mean grades of participants in activity 2 suggest that among the four topics, they have the least background knowledge about topic two during the pre-test, which shows very low grades among all other topics. This result can be associated with the idea that the participants were not familiar with the topics covered for activity 2. On the one hand, it can also be associated with the type of test items presented in every activity. The test items include a multiple-choice type of test for activities 1, 3, and 4 while short answer, matching type, and multiple-choice type of test for activity 2. However, an increase in the mean grades and mean percentage of all four activities during the post-test is evident. Among all four activities, the participants scored better on average activity 1 (during pre-test) and activity 3 (during post-test). Further, the participants had more consistent grades for activity one both for pre- and post-tests.

It can be inferred from the data that the use of video demonstrations helps improve the participants’ conceptual understanding of the topic as reflected in an increase in the mean grade of the participants when pre- and post-test results were compared. This is in parallel to Khouyibabas' study (2010), where it was proposed that the inclusion of technology in facilitating learning allows students to keep focused on the given concepts that are too complicated. Further, in a study of Burewicz and Minanowicz (2006), it indicates that the use of video and interactive computer-assisted activities was most effective in delivering pre-laboratory activities, where there is an increased in the amount of time students spent in completing the pre-lab activities while decreasing the time spent for the experiment. Additionally, the use of e-learning tools to aid the educational process became advantageous compared to those who attended the traditional classroom set-up, as the students considered this tool a personalized learning environment (Nam & Smith-Jackson, 2007).

Moreover, the use of video demonstrations and interactive online quizzes enabled the participants to engage in more analytical thinking before engaging in the analytical action in the laboratory which motivates them to come to classes prepared to engage in the material rather than the physical processes for the practical exercises (Jolley et al., 2016). Though pre-laboratory activity focused on experimental approaches, it tends to result in learners to discuss conceptual aspects more and feel better informed about conceptual aspects which in turn, results in learners' better performances in the laboratory.

Lab Reports

After the conduct of experiments, the participants were given time to work on their laboratory reports to measure conceptual understanding. Table 2 summarizes the mean grades, standard deviation, and mean percentage of all four activities and is illustrated in Figure 2.
Table 2: Summary of the Mean Score and Verbal Description for Digital and Real Laboratory

<table>
<thead>
<tr>
<th>Laboratory Reports</th>
<th>Mean Grade (MG)</th>
<th>Standard Deviation (SD)</th>
<th>Mean Percentage (MP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY 1 Preparation of Biochemical Reagents</td>
<td>82.94</td>
<td>2.57</td>
<td>82.94%</td>
</tr>
<tr>
<td>ACTIVITY 2 Protein Denaturation and Coagulation</td>
<td>82.19</td>
<td>1.72</td>
<td>82.19%</td>
</tr>
<tr>
<td>ACTIVITY 3 Carbohydrates as Reducing Sugar</td>
<td>83.31</td>
<td>1.30</td>
<td>83.31%</td>
</tr>
<tr>
<td>ACTIVITY 4 Enzyme Activity</td>
<td>82.44</td>
<td>2.31</td>
<td>82.44%</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>82.72</td>
<td>1.98</td>
<td>82.72%</td>
</tr>
</tbody>
</table>

MG = Mean Grade  SD = Standard Deviation  MP = Mean Percentage  Total Score = 100  Class (N = 16)

Based on the data collected, it can be inferred that there is little difference in the mean grades for all four activities. It has been reported that, to some extent, when pre-laboratory activities are not mandatory, many students do little or no laboratory preparation at all (Pogacnik & Cigic, 2006). While this study employs mandatory pre-laboratory activities via digital lab activities (video demonstrations and online quizzes), it was found to be in agreement to the findings of Pogacnik & Cigic (2006), that when pre-laboratory activities are mandatory, participants spent more time preparing the lab and less time completing the post-lab reports. Laboratory reports simply exhibit an account of activity and less of gained knowledge because they struggled to incorporate and find connections between pieces of literature and results on hand. However, this isn’t true to all. As observed, some participants do well in lab reports and value its importance as hands-on work. The participants quoted:

“I learned a lot from doing the lab reports, and that’s an advantage. It deepened my knowledge about scientific concepts and helped improve my written communication skills.” With the help of the laboratory reports format included in the quick start guide writing lab reports becomes easier.”

“During laboratory experiments, I tried to be more observant and careful in data recording to obtain the actual results in every experiment. I learned to become creative in writing lab reports. I used to relate the data gathered with what I have read in other studies.”

With the use of digital laboratory activities (video demonstrations and online quizzes), the participants showed an increase in a positive attitude towards lab activities. However, it does not emphasize a greater increase in performance on laboratory reports.
Laboratory Performance Skills

The participants' laboratory performance skills in terms of hands-on lab work, was also analyzed. The level of performance was assessed using the rubric (LPES). Table 3 summarizes the mean scores and mean grades of all four activities and is illustrated in Figure 3.

![Summary of LPES Results](image)

**Figure 3: Summary of LPES Results**

<table>
<thead>
<tr>
<th>Laboratory Performance Evaluation Sheet (LPES)</th>
<th>MS</th>
<th>SD</th>
<th>MP (%)</th>
<th>MG</th>
<th>SD</th>
<th>MP(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY 1 Preparation of Biochemical Reagents</td>
<td>33.38</td>
<td>1.90</td>
<td>83.45%</td>
<td>86.19</td>
<td>2.47</td>
<td>86.19%</td>
</tr>
<tr>
<td>ACTIVITY 2 Protein Denaturation and Coagulation</td>
<td>33.38</td>
<td>1.52</td>
<td>83.45%</td>
<td>86.19</td>
<td>1.98</td>
<td>86.19%</td>
</tr>
<tr>
<td>ACTIVITY 3 Carbohydrates as Reducing Sugar</td>
<td>34.81</td>
<td>1.96</td>
<td>87.03%</td>
<td>87.63</td>
<td>2.16</td>
<td>87.63%</td>
</tr>
<tr>
<td>ACTIVITY 4 Enzyme Activity</td>
<td>34.5</td>
<td>1.15</td>
<td>86.25%</td>
<td>87.31</td>
<td>1.57</td>
<td>87.31%</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>34.02</td>
<td>1.63</td>
<td>85.05%</td>
<td>86.83</td>
<td>2.05</td>
<td>86.83%</td>
</tr>
</tbody>
</table>

As shown in the collected data, the participants' laboratory performances are also influenced by the use of digital pre-laboratory activities (video demonstrations and online quizzes) employed in every activity. This result is in agreement to the study of Jolley et al. (2015) that through multimedia pre-laboratory activities, an increased in learners' perception of being prepared for laboratory work is evident, which later influence learners' overall experience of the laboratory (Galloway et al., 2016). Moreover, it enables the learners to reduce anxiety about knowing what to do during their practice session, which leads the learner to develop a positive perception towards laboratory work. One participant said,

"First-hand experiences will not be difficult since I’ve experienced simulated activity that better prepares me for the experiment’s conduct. Also, manipulation of laboratory equipment and procedures gave me more knowledge, which I used to enhance my skills."

Likewise, the use of video resources develops students' confidence towards work and increases engagement in completing the laboratory experiment (McCormack et al., 2017).

Although the participants spent more time completing the video demonstrations and online quizzes, on the other hand, with this kind of pre-laboratory instruction, the participants took less time to complete the actual experiments and exhibited better manipulative skills.

The results suggest that understanding concepts related to biomolecules was more likely developed
using activities 1 and 3, while performance skills (manipulative) were improved with activities 3 and 4. Moreover, the current results can be associated with the type of questions asked in online quizzes, topics presented, and the complexity of laboratory experiments' tasks.

Overall, the analysis suggests that the participants benefited from using both digital and real laboratory activities. As a result, this study supports the use of digital laboratory activities complementing real laboratory activities. However, for the successful implementation of these interventions, pedagogical considerations be given attention.

Teacher Participants Learning Experiences on the Use of Digital and Real Laboratory Activities

Insightful Learning

Digital laboratory activities have been used as part of the intervention to improve the participants' laboratory performance skills. Utilization of digital laboratory makes learning more convenient, yet, meaningful. As illustrated in the following quotes,

"Video demonstration made me appreciate the importance of the internet in the generations of today. Reading is essential for learning, but animation and online demonstrations make the written materials less complicated and give confidence to the students."

"I realized that learning takes place, even by means of a digital lab. It gives me great opportunities to explore and experienced a new mode of learning. Learning new things is very fulfilling. Being able to experience different activities developed eagerness in me to learn more, practice more, and be better."

It was clear in both reflective journal entries and interviews that the participants were using the video demonstrations as intended. They mentioned:

"Video demonstrations provide predetermined knowledge and further understanding of the topics presented. There were topics that are too complicated and difficult to understand but became easier with the help of these video demonstrations. It also provides know-how on the methodological approach in performing experiments."

"The use of video demonstrations made me focus on the concepts I need to learn. I really find it important to facilitate the learning of concepts as well as sequential procedures. Such video demonstrations are very interesting. Learning can be achieved even without leaving one's comfort zone."

The following quotes indicate that the primary impact of watching video demonstrations was an increased familiarity with the instruments and the procedures, where it allows the participants to perform the activity more than once and train themselves until they mastered it.

On the other hand, authentic experiences are evidently using a real laboratory. Some participants averred that:

"With the real lab, I have experienced manual application of experimental procedure which gives light to further understanding of the processes and procedural set up while performing laboratory experiments."

Additionally, similar thoughts were brought out by another participant, they said,

"Real laboratory experience is more effective in enhancing and developing my manipulative skills. I learn more as I experience it. It is better to have the real experience where the learner manipulates things to finish the task."

In general, both modalities are good and beneficial and have an authentic contribution to the learning process in different ways. One participant commented,

"I just can't let go of one of the two modalities. Indeed, it is a good experience to work in a real lab where I can experience working with real materials and equipment. I've learned a lot of things necessary for me to better understand every experiment. But on a similar note, my experiences of using digital lab activities also contribute a lot to my learning as it prepares me to perform better in an actual lab experiment."

Discipline increases productivity and can make ones' work highly efficient. Likewise, focus on work is important. Though the collected data suggest that the participants become more autonomous to perform laboratory experiments, the use of video demonstrations did not eliminate the need for laboratory support staff in the lab.

With real laboratory activities, it concluded that participants gain hands-on knowledge and improve lab skills while gaining self-confidence and independence.
Challenges Encountered

The following discussions elaborate on the different challenges encountered while using digital and real laboratory activities in a science classroom. Despite the potential benefits that digital learning offers, some challenges associated with it were encountered during its implementation—first, lack of social interaction among the learners. While utilizing digital learning, no direct interaction is observed and expected. Social interaction among participants is limited, given that communication is done electronically. Since the participants deal with the activity alone using his/her gadget, of course, less to no supervision from the teacher is expected, and there is no guarantee that learning will take effect. Similarly, Rovai, Wightning, & 37 Liu (2005) contended that isolation and frustrations are common among learners due to psychological distance in online learning. On the contrary to the above claims, Ascough (2007) found that online social communities fostered a collaborative environment among learners leaving a positive effect on course grades.

The second challenge associated with the use of digital laboratory activities is the accessibility of technology. The success of the use of digital laboratory depends on internet access and its speed. Without this, the implementation of education technology is less feasible and poses a greater challenge. The following quotes illustrate this theme. The most challenging and difficult part of using the digital lab is not the activity itself but the internet connectivity. "We have gadgets with us, but it won’t work unless we have good internet connections.”

"Every digital laboratory activity includes video demonstrations and online quizzes, which I find interesting. However, I feel frustrated whenever the internet connection is poor. Instead of spending less time doing the pre-lab activity and assessment, due to poor internet connection, it becomes longer."

When access to technology is limited, technology becomes a barrier to learning as it causes delays in the learning process and, thus, leads to the learner’s frustrations. Moreover, these frustrations may lead the learners to decreased motivation and may even lead to failing the course (Sife et al., 2007).

On the other hand, time management and equipment availability are the two challenges associated with the real lab. Unlike in a digital lab where much time and effort are saved, much time and effort are required when conducting real lab activities. Likewise, a certain activity is possible only if the equipment and materials are available. A limited number of materials may only cater to a few learners’ needs at a time, and, therefore, some learners may be struggling to finish well after the scheduled time.

Application of Learning to the Practice of Teaching Science

With all the important learnings they acquired using both the digital and real lab activities, the participants shared their plans for applying their learning to the practice of teaching science. The results are illustrated in the following themes:

Pushing Beyond the Comfort Zone: No real growth comes from staying within the comfort zone. In the teaching-learning process, it is important to push the boundaries of his/her comfort zone and integrate the relevant technology and constructivist pedagogy.

"As a teacher, I cannot teach and give everything to my students, but I can find ways to help them gain more knowledge. In this time, where the classrooms are composed of 'digital native' students, it would be better for them to be immersed in an environment where they can enjoy and learn things at the same time. It is important that I design my instructions utilizing more interactive activities where pedagogy and technology meet."

"I want to help hone my students' skills by using appropriate teaching strategies and modeling how I expect them to do the task. To help them discover and learn new things, I need to prepare an experiential learning environment for them. Utilizing the advent of technology will make my plans a lot easier."

"Digital lab is an easy-access tool for learning which I can adapt and let my students experience. Learning never stops. This activity gives new learning which I can use for my personal and professional growth. With the available tools online, teaching and the learning process is more possible."

Make Learning Fun and Exciting. Hands-on activities accompanied by technology are a fun way for learners to learn. Learning is most fun when it is surprising, thus increase the students’ willingness to participate and take risks—having fun while learning is fulfilling. These are illustrated in the following narratives (which were left unedited to capture the authenticity of the data).
"My science class must be interesting and fun. I will make it possible by adding more interactive activities to capture their interests and encourage more students to become active in class."

Besides, with the use of both real lab and digital lab activities, the learners can achieve higher mastery level as they immerse themselves in hands-on experiences supplemented by virtual learning (digital lab activities). They can re-visit digital lab activities to facilitate a better understanding of science concepts and skills. The following narrative illustrates this concern.

"I want my students to learn and improve their skills by letting them experience real lab by themselves. When one commits mistakes, there's nothing to worry about. Let them practice their skills by fixing their mistakes. Also, learning does not only improve with the real lab. Learning is best achieved utilizing digital lab in complement with the real lab."

Conclusions

Based on the data collected from the three measures of learning in the laboratory namely: online quizzes, lab reports, and laboratory performances, performance ratings can be associated to different variables such as the type of questions asked in an online quiz, topics presented, and the complexity of the tasks for laboratory experiments.

The use of digital laboratory activities (video demonstrations and online quizzes) helps improve participants' conceptual understanding of the topic as reflected in an increased mean grade of the participants when pre- and post-test results were compared. Though the collected data suggest that the participants become more autonomous to perform laboratory experiments, the use of video demonstrations did not eliminate the need for laboratory support staff in the lab.

Authentic experiences are evidently using a real laboratory. Discipline increases productivity and can make one's work highly efficient. Likewise, focus on work is important. Performance ratings supported by interview results suggest that participants gain hands-on knowledge and improve lab skills while gaining self-confidence and independence through real laboratory activities.

In general, the participants perceived that both modalities are good and beneficial and have an authentic contribution to teaching and learning. This proves that digital and real laboratory activities influence conceptual understanding and laboratory performance skills despite the various challenges they have encountered.

Examining the participants' experiences on the use of digital and real laboratory activities provides an understanding of how their laboratory performance skills were enhanced over time and what laboratory instruction means to them. A digital laboratory can provide participants with supplemental materials to improve knowledge acquisition by providing diverse activities in a peaceful and safe environment. No doubt, the digital lab helps develop comprehension, understanding of concepts, mastery of the content, and even prepare participants for better real lab experience. However, this cannot be considered a substitute for real lab experience where manipulative and critical thinking skills were enhanced.

With the teachers' positive feedback on the intervention, ways to improve the implementation of both laboratories in the classroom were identified. If the following will be put into place, no doubt both the teachers and the students will be benefited. First, there should be more varied activities for experimental practice. Students' interest can greatly influence their attitude towards learning. And, their interests are affected by the variety of activities presented to them. The more interactive and diversified the activities are, the more the students become interested and active. Second, the complexity of the laboratory activities must be dependent on the level of the learners. The teachers should have a good plan for the preparation of the activity and be mindful of the characteristics of the participating learners. Third, sidestep the comfort zone. Maximize the use of technology. Never feel afraid to explore and try to learn new things. For learning, selects no age. However, in the absence of internet connectivity, activities should be downloadable, if possible. And lastly, consider allowing more time for work. Ample time is crucial for the introduction of new classroom strategies to both young and old students. Thus, they will become oriented enough for its usage and benefits.

The results of the study provided insights for teachers to improve the practice of laboratory instructions using digital and real environments. While the study is limited in nature (scope and time), teachers can adopt the same intervention applied to a much broader scope. Though the study results were
seen to be effective within this group of participants, it will not guarantee that it will merit the same results to other participating groups. Teachers should consider the needs of learners in addition to diversity. Therefore, this study recommends the need for more research to determine the effectiveness of the two types of laboratory learning experience (with the use of digital and real laboratory activities).

In response to the current educational challenges brought about by the coronavirus pandemic, many institutions are pivoting the transitioning to online learning. The timeliness of using digital and real laboratory activities in laboratory instruction is gradually reshaping the academic landscape of science education. This paradigm shift in science instruction from traditional to a blended learning modality is learner-centered and tailored to learners' different circumstances in this time of the pandemic. Pitching the selected technology at the right level will provide a wide range of adaptability for the learners. Additionally, both the teacher and the learner's readiness for this transitioning program should be considered and emphasized to facilitate an effective and efficient teaching-learning process in the 'new normal.' Well-planned instructional designs matched with technology-savvy teachers will likely bring-out success in this transitioning program. Furthermore, proper implementation of technology-based instruction in complementing traditional classroom interaction will benefit the learner, whatever the setting will be.

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References


