Online Laboratory Instruction as Alternative and Supplementary Mode: Students' Assessment of the BS Agricultural Biotechnology Program

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Abstract

When the COVID-19 pandemic hit the education sector, the University of the Philippines Los Baños (UPLB) faculty started to tailor-fit their lectures and laboratory activities in the form of course packs to continue delivering various academic programs. The BS Agricultural Biotechnology (BS ABT) program is one of the courses that relies heavily on laboratory exercises. BS ABT students were randomly surveyed to: (1) assess faculty's teaching style during online distance learning in terms of lecture and laboratory instructions, educational materials, core subjects with laboratory implementation, and students preferred remote learning-based courses; and (2) explore students' experiences in alternative and supplementary online laboratory. Experiments in all exercises were conducted synchronously and asynchronously through Google Classroom, and commonly accomplished with simplified experiments, simulations online, and supplemented by online videos via their personal laptops and smartphones. Regular synchronous meetings were religiously done every week, with classes meeting once or twice a week. Based on the results, 94.5% of the BS ABT student-respondents were generally satisfied with the teaching style of the faculty, and the remote implementation of the laboratory activities. The present study's findings serve as inputs in enhancing the implementation of laboratory classes remotely in hard science particularly in the BS ABT program.

Keywords: *agricultural biotechnology, laboratory instruction, COVID-19 pandemic, remote teaching & learning, education for agile work environments*

Introduction

The onset of the pandemic during the first quarter of 2020 has prompted the Philippine government to impose lockdown restrictions, putting the entire country under various quarantine classifications as modalities to curb the spread of the virus. Education institutions are one of the hardest hit sectors prompting drastic approaches to teaching and learning processes.

The BS Agricultural Biotechnology (BS ABT), the newest undergraduate program offered under the College of Agriculture and Food Science (CAFS) of the University of the Philippines Los Baños (UPLB), had to revisit applicable teaching and learning modalities to respond to the needs of its stakeholders amid the challenge of the pandemic. Established in 2010, the program aims to utilize biotechnology to create an updated and innovative approach to the agriculture of the country. Every year, the BS ABT program accepts approximately 100 students. An estimated 400 students are enrolled in the course every school year. The program has already produced several graduates who are now excelling not only in agriculture, but also in different fields such as academia , medicine, law, business, etc. Before they reach junior standing, BS ABT students can freely select their desired major among Animal Biotechnology, Crop Biotechnology, Crop Protection Biotechnology, and Food Biotechnology. These major fields and their respective specializations require a heavy load of laboratory activities. During the laboratory exercises, hands-on experience and face-to-face interaction are the more critical factors in retaining students' contentment in the activity, focus on the lecture, and retention of theoretical knowledge. During the virtual implementation of the laboratory courses in tertiary college, improvised laboratory experiments were devised to be conducted in their respective places. Hence, the study sought to answer the following: (1) How effective is the faculty's teaching style during online distance learning in terms of lecture and laboratory instructions, educational materials, core subjects with laboratory implementation, and students' preferred remote learning-based courses? (2) What are the students' experiences in alternative and supplementary online laboratories?

Objectives

The study's objective was to look into the implementation of online laboratory instruction during the COVID-19 pandemic. The study specifically aimed at : (1) assessing faculty's teaching style during online distance learning in terms of lecture and laboratory instructions, educational materials, core subjects with laboratory implementation, and students' preferred remote learning-based courses; and (2) exploring students' experiences in alternative and supplementary online laboratory mode.

Review of Related Literature

Coronavirus 2019

The surge of Coronavirus Disease during the 2019 pandemic affected the daily lives of people worldwide. COVID-19 is a disease with an enveloped, non-segmented positive-sense RNA virus from the *Coronaviridae* family, order Nidovirales, which affects humans and other mammals (Richman et al., 2020). This disease is reported to have originated from the Huanan Seafood Wholesale Market, in Wuhan, Hubei, China (Huang et al., 2020; Richman et al., 2020; Wu et al., 2020). The continuous flight and loose restrictions before the pandemic started the spread of the virus from one country to another. This led to easier transmission since the virus was reclassified as air borne (Tang et al., 2021; Zhang et al., 2020). For over two years, there have been several variants of COVID-19 that have been known.

Patients with COVID-19 commonly experience flu-like symptoms such as high fever, cough, sore throat, malaise, diarrhea, and fatigue (Singhal, 2020; Viner et al., 2020; Wang et al., 2020). On the other hand, COVID-19 had distinct symptoms, e.g., loss or change in smell, loss of taste, weakening of the body, and shortness of breath, which regular flu does not manifest (Viner et al., 2020). This illness affects people to different degrees. Some people can have mild symptoms, while others, especially those with comorbidities, can have fatal conditions and often develop into acute respiratory distress syndrome (ARDS), pneumonia, and multi-organ dysfunction (Singhal, 2020). Since 2019, millions of people around the globe have been killed by this disease. The disease can usually be detected through RT-PCR and diagnostics kits (Pokhrel et al., 2020). Forced quarantine or isolation of the confirmed or suspected COVID-19 patients to their respective accommodations, e.g., personal room, own house, hotel rooms, isolation facilities, has been implemented in every country. A contact tracing system was also used to monitor the possible contacts of the confirmed or suspected patients. Moreover, nowadays, vaccines, which are classified as inactivated, live-attenuated, and viral vectors (WHO, 2021) are being administered in different parts of the world. In the Philippines, the common brands of administered vaccines are Pfizer-BioNTech, Moderna (mRNA-1273), Oxford/AstraZeneca, Johnson and Johnson-Janssen, and CoronaVac (Sinovac) (DOH, 2021).

Shift to Online Learning

In the surge of the COVID-19 pandemic, the Philippines' higher education institutions (and even basic education) had to address the failure to continue delivering instruction. Proximity was indeed a tremendous delivery challenge for teachers and learners, and therefore, there is no other way but to utilize the technology to bridge the former and the latter in an attempt to uphold quality education even during the pandemic.

On March 17, 2020, the Philippine government, following the Inter-Agency Task Force (IATF) Resolution No. 13, Series of 2020, imposed a lockdown to prevent the spread of the virus in the country (DOH, 2020). However, the lockdowns also resulted in the disruption of the daily routine of Filipinos. This includes the offering of education especially to the Filipino youth at all educational levels. Thus, a shift from a regular face-to-face set up to an online learning method was imposed.

Distance learning or remote learning, usually through online learning, is a product of re-designing or re-engineering education systems resulting in a so-called "new" learning method (Kumar Basak et al., 2018; Nicholson, 2007). Online learning covers using Information and Communication Technologies (ICT) like internet websites, emails, chat, texts, and video conferences, to enhance knowledge retention and deliver quality education (Dhull & Arora, 2019; Tibaná-Herrera et al., 2018). This also includes digital learning (d-learning), mobile learning (m-learning), and computer-based learning, or electronic learning (e-learning) (Kumar Basak et al., 2018).

Before the pandemic, online learning was offered as another modality of education. This is popularly availed by working students and professionals

(Rawlings et al., 2019), who cannot have face-to-face classes since it concurs with their working hours. The FIC can organize synchronous - the FIC and students simultaneously meet for the real-time class through video conference, and asynchronous meetings - the FIC assigned activities that can be done by the students remotely. Furthermore, another essential element in online learning is a functional platform, a learning management system.

Learning Management System. It is a software or online platform utilized by teachers as a support and management tool for learning purposes, achieving course objectives, and delivering course materials to the students (Tinmaz & Lee, 2020; Turnbull et al., 2021). The course materials, such as lectures, lecture notes, class exercises, multimedia, notes, outlines, course syllabi, pictures, bibliographies, diagrams, videos, tests, instructional handouts, illustrations, drawings, art, educational videos, websites, and software, are being uploaded to the LMS to serve as their guide through the whole course. Because of this, according to Bradley (2021), the faculty-in-charge (FIC) can organize the course of the discussions, schedule the online activities, set learning expectations, offer the students with learning options, and build critical thinking of the students in terms of problem analysis. The use of LMS plays a critical role in the remote learning environment of the students, for it serves as an avenue for interaction between the students and teachers (Adzharuddin, 2013). This also strengthens the engagement and communication between the students and FIC. Thus, mismanagement of LMS may result in disinterest or dissatisfaction of the students in the distance learning setup.

Laboratory Instruction through e-Learning

During the COVID-19 pandemic, the lectures and recitation classes, especially at the onset of the COVID-19 pandemic, are compromised. Most of the students needed help in connecting theoretical and practical theories and concepts since laboratory experiments were not being offered. Moreover, the methodological and troubleshooting skills that are necessary to be developed during laboratory experimentation have been a big problem among the students. Remote learning, commonly designed for courses with lectures and recitation classes only, is rarely applied to laboratory instructions. In the study conducted by Achuthan et al. (2021), alternative methodological approaches, such as the use of Transactional Distance Theory (TDT) and remotely triggerable (RT-UTM) laboratory platforms for engineering students, have been proven effective for remote laboratories in engineering education. In the field of biology at the tertiary level, although online instruction was offered, students preferred to have face-to-face meetings for laboratory experiments and group meetings (Sarvary et al., 2022). In support of implementing laboratory instructions for undergraduate biology subjects, Parrington and Giardino (2021) recommended nine (9) points to the institutions, faculty, and undergraduate students to keep up the quality of biological experiments.

Materials and Methods

A survey was formulated by the researchers for the assessment of the laboratory instruction among the BS ABT students at the University of the Philippines Los

Baños (UPLB). The survey through a Google Form was distributed to randomly selected respondents from different year levels, age brackets, and majors of the said degree program. Simple random sampling through a random number generator was used to select respondents. Only students who enrolled during the COVID-19 pandemic and had an experience with online distance learning were asked to participate in the survey. An estimated 10 to 14% (55 students out of 400 students) of the total number of BS ABT students enrolled during the pandemic was included in this study. Before answering the survey, all respondents were assured that their personal information and responses would be protected under the Philippines' Data Privacy Act of 2012 (Republic Act No. 10173) to protect their identity.

Furthermore, the participants' consent was asked, and they were assured that they could withdraw their participation anytime. All participants were also informed about the content and objective of the survey, which took 15 to 25 minutes to accomplish. All in all, it was made sure that no physical or mental harm was done intentionally or unintentionally to the respondents.

Research Instrument

To cross-examine the factors affecting the laboratory instruction among the students, the questionnaire consisted of close and open-ended, multiple choice, modified Likert Scale questions (ranging from "Very Satisfied" to "Strongly not Satisfied"). Other confirmatory questions were also created answerable by Yes, No, and Not applicable. The questions focused on topics such as access to virtual learning, mode of teaching, lecture-related, remote laboratory instruction, and recommendations. The access to virtual learning focused on technology-related questions such as internet connectivity, gadgets of the students, and common problems encountered. The mode of teaching focused on the platforms, frequency, and way the courses are taught. Lecture-related information discussed the courses and how the students feel about the implementation of the said courses. This also included the students' assessment of the quality of the activities and courses. Remote laboratory instruction emphasized the varieties of student assessments being used in the courses with laboratory activities. The recommendation part gave the respondents the chance to voice their experiences and personal feedback on how the courses could be improved.

Data Analysis

The gathered data were analyzed using descriptive statistics. The respondents' demographics, such as admission year, age, program, major, semesters taken, and total earned units were also analyzed in percentage. The graphs and figures, portraying the descriptive data, were generated through Google Forms. A thematic analysis was conducted for the qualitative data to highlight common themes. To analyze the data, manual coding was done. The verbal statements of the respondents were also presented to support the analysis.

Results and Discussion

Data about the Respondents

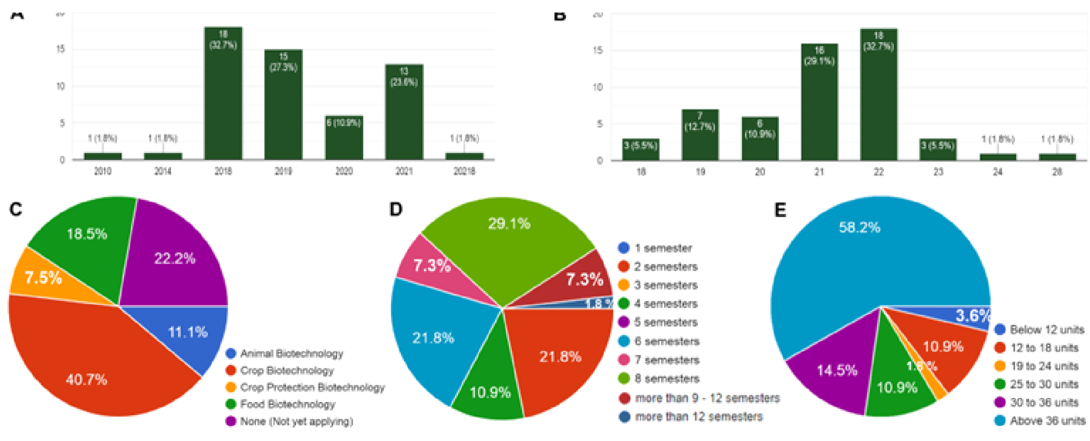
To understand the status and experiences of the students (n= 55 responses), questions related to their background and the length of stay in college were asked. The respondents were almost 10-14% of the total enrolled BS ABT students with laboratory instruction during the transition period to remote learning (2nd semester 2020 to mid-year July 2022). Figure 1 shows the demographic distribution of the respondents in this study. Some students who participated in the survey were from the Batch 2018 (32.7%) and 2019 (27.3%), with ages ranging from 18 to 28 years old. Most of the students are 21 (29.1%) and 22 (32.7%) years old (Figure 1B).

Among the total respondents, 40.7% of students are from the Crop Biotechnology major, followed by Food Biotechnology (18.5%), Animal Biotechnology (11.1%), and Crop Protection Biotechnology (7.5%), respectively. Some students have yet to decide on their chosen major, mostly those in their 1st year or 2nd year in the program. Further, some students have already attended 8 semesters pegged at 29.1%, 2 semesters (21.8%), and 6 semesters (21.8%). There was an outlier to the respondent as well who enrolled almost more than 12 semesters in the college.

The pandemic has also prompted some policies to be implemented to respond to the needs of the students. The regular academic workload has been reduced from 15 units to 12 units. Owing to the entire credited units under the program, respondents of the study had generally earned more than 36 units (58.2%), while the lowest units earned ranged from 19 to 24 units (1.8%). Overall, the data gathered displayed diversified experiences among the students.

Figure 1

Demographic distribution of the respondents for the assessment of the laboratory instruction among BS ABT students



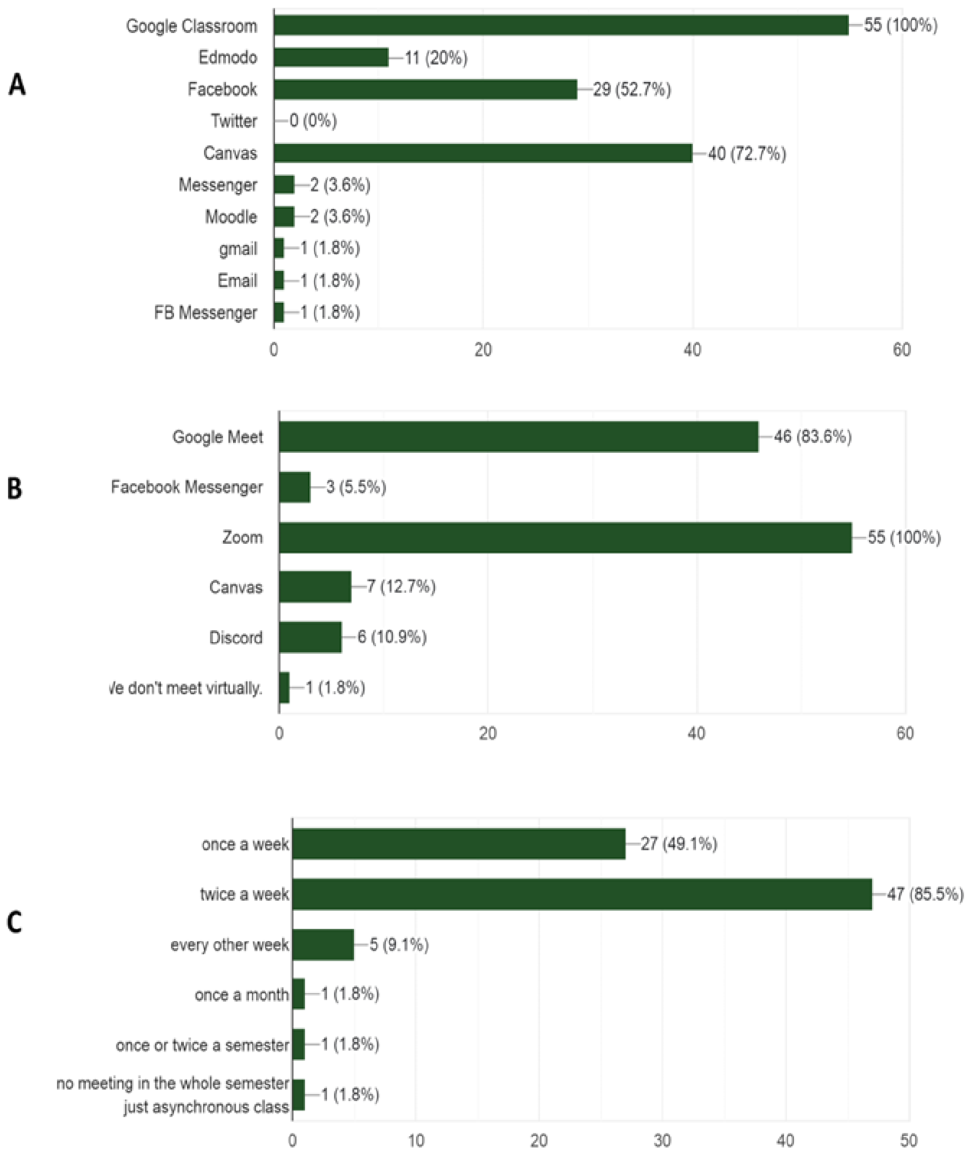
Note. (A) Year of Admission; (B) Age; (C) Major of the Students; (D) Total Number of Semesters as Students; and (E) Total Number of Units Earned by Students

Learning Management System during Pandemic Period

During the transition phase of education, i.e., during the COVID-19 pandemic, the LMS played a vital role in sustaining the teaching and learning process, ensuring that disruptions in education are addressed. Figure 2A shows the most used LMS platforms for announcement and class activities, usually for asynchronous set-up, are indicated. The most used platforms are Google Classroom (100%), Canvas (72.7%), Facebook (52.7%), and Edmodo (20%). Zoom (100%) and Google Meet (83.6%) are the most preferred applications for the synchronous delivery of lessons. In Figure 2C, the online classes are usually held twice a week (85.5%), once a week (49.1%), or every other week (9.1%).

Figure 2

Platforms for instructional delivery during remote learning



Note. (A) Platforms for Announcements and Class Activities; (B) Platforms for Synchronous Meetings; and (C) Frequency of the Class Meetings

Google Classroom allows interaction between the teachers and students by posting announcements in forum type; uploading materials like videos, PowerPoint slides, PDF readings, or website links; submitting worksheets or documents; uploading assessment tools like quizzes, exams, surveys, or grading sheets, and monitoring students' progress. In a study conducted by Okmawati (2020), Google Classroom has been considered an effective platform for fulfilling the learning objectives of the course by following the theory of effectiveness of the communication by Hardjana (2003) - the effectiveness based on the message recipients, contents, communication media, format, source, and timing. Education institutions around the world utilize this LMS for their mode of communication with the students in college- level, vocational schools (K A'yun et al., 2021; Kado et al., 2020; Novita et al., 2022; Saimi & Mohamad, 2022; Syahfitri & Herlina, 2022; Zuniga-Tonio, 2021). As reported by the study respondent, Canvas requires in-depth training and further mastery.

Table 1

Laboratory Courses enrolled by the students during the remote learning

No.	Course Number	Course Title	Classification of the course	Number of students enrolled	Percentage
1	ABT103	Experimental Techniques in Agricultural Biotechnology I	Core	2	3.64
2	ABT104	Experimental Techniques in Agricultural Biotechnology II	Core	1	1.82
3	ABT106	Molecular Markers	Core	1	1.82
4	AGR150	Method in Plant Breeding I	Specialized	7	12.73
5	AGR153	Method in Plant Breeding II	Specialized	5	9.09
6	AGR21	Introduction to Animal science	Foundation	15	27.27
7	AGR22	Introduction to Livestock and Poultry Production	Foundation	15	27.27
8	AGR31	Fundamentals of crop science I	Foundation	15	27.27
9	AGR32	Fundamentals of crop science II	Foundation	15	27.27
10	AGR41	Principles of crop protection I	Foundation	18	32.73
11	AGR42	Pest Management	Foundation	13	23.64
12	AGR50/CRSC105	Principles of Plant Breeding	Specialized	4	7.27
13	AGR51	Principles of Soil Science	Foundation	11	20.00
14	ANSC101	Anatomy and Physiology of Farm Animals	Specialized	1	1.82
15	ANSC103	Principles of Animal Breeding	Specialized	1	1.82
16	ANSC104	Livestock Sanitation and Disease Control	Specialized	1	1.82
17	ANSC105	Poultry Sanitation and Disease Control	Specialized	1	1.82
18	BIO30	Genetics	Foundation	8	14.55
19	BOT20	Elementary plant physiology	Elective	2	3.64
20	CHEM 18, CHEM 18.1	Fundamentals of chemistry	Foundation	6	10.91
21	CHEM 40, CHEM 40.1	Basic organic chemistry	Foundation	3	5.45
22	CMSC12	Introduction to Computer Science	Foundation	7	12.73
23	FST101	Food Chemistry 1	Specialized	1	1.82
24	FST122	Food Fermentation	Specialized	1	1.82
25	FST167	Principles of Food Safety	Specialized	1	1.82
26	HORT132	Plant Growth	Specialized	4	7.27
27	HORT133	Plant Tissue Culture	Specialized	7	12.73
28	MCB11	Biology and Applications of Microorganisms	Foundation	7	12.73
29	MCB180	Introductory Food Microbiology	Specialized	2	3.64
30	STAT162	Experimental Designs I	Core	2	3.64

Table 1 presents the laboratory courses the students enrolled in from March 2020 to July 2022. Courses taken are classified as foundation (46.67%), core

(13.33%), specialized (36.67%), and elective (3.33%). Most of the courses with the highest enrollees belong to the core courses category. This includes AGR 41 - Principles of Crop Protection I (32.74%), AGR 21 - Introduction to Animal Science (27.27%), AGR 22 - Introduction to Livestock and Poultry Production (27.27%), AGR 31 - Fundamentals of Crop Science I (27.27%), AGR 32 - Fundamentals of Crop Science II (27.27%), AGR 42 - Pest Management (23.64%), and AGR 51 - Principles of Soil Science (20%).

Assessment of the Teaching Style of the Faculty-in-Charge

The delivery of the lectures is very important to establish the interaction and connection between the teachers and students. Figure 3 shows that most faculty members still conduct regular synchronous meetings (96.4%), and upload PowerPoint presentations or handouts (89.1%) in Google Classroom. Other teaching practices reported are uploading reading materials (76.4%) and pre-recorded videos (74.5%) and conducting simulation or interactive activities through internet websites (34.5%).

Figure 3

Faculty-in-Charge's style in teaching lecture and laboratory instructions

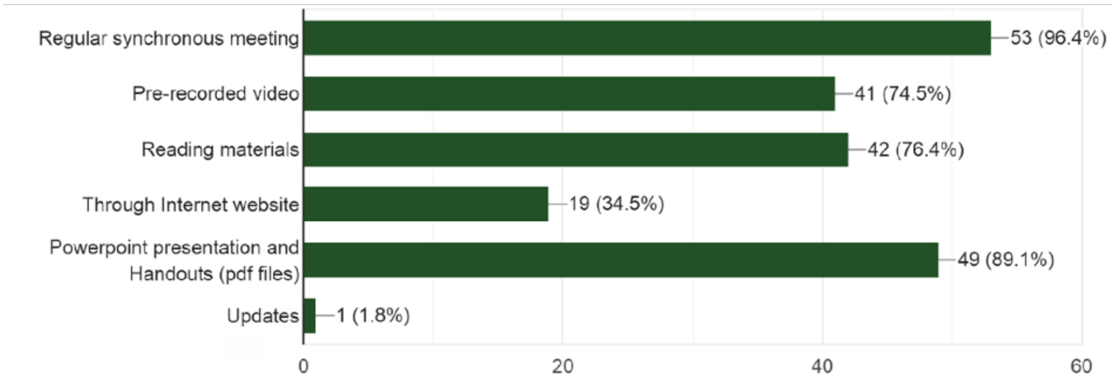
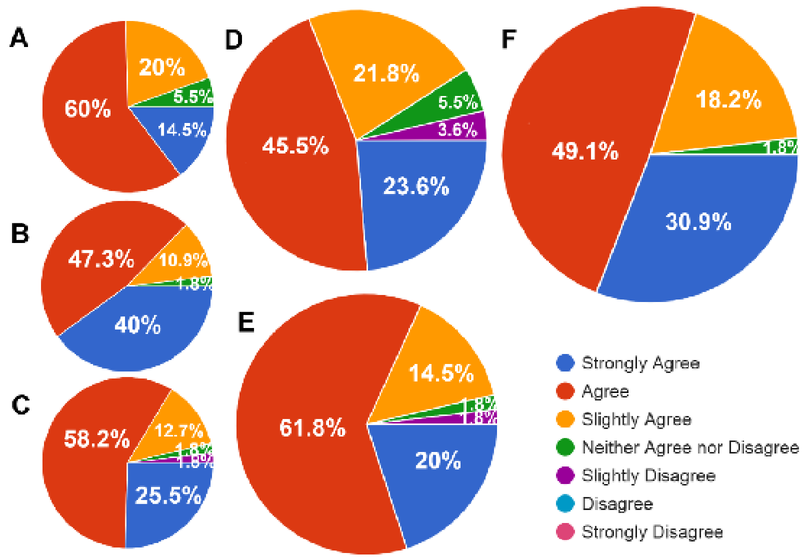


Figure 4 presents the students' satisfaction with the teaching style. Figure 4A shows that the teaching style and activities earned the approval of the students. It can be gleaned from the figure that 94.5% (14.5% strongly agree, 60% agree, and 20% slightly agree) of the respondents generally agreed to the delivery of lecture and laboratory instructions. The students are also satisfied with the topics from the course syllabus, where 98.2% (40% strongly agree, 47.3% agree, and 10.9% slightly agree) of the participants express their appreciation of the content of the course (Figure 4B). Figure 4C shows that 96.4% (58.2% strongly agree, 25.5% agree, and 12.7% slightly agree) of the students unanimously agree that the experience allows them to achieve the learning outcomes, while 1.8% slightly disagree.

Figure 4D assessed the understanding and mastery of the faculty-in-charge in the subject. The students rated 90.9% (45.5% strongly agree, 23.6% agree, and 21.8% slightly agree) for this category, while 3.6% of the respondents were slightly disagreeing. In Figure 4E, the participants evaluated the coherence and integration of the topics in all courses. This means that the topics outlined in the specific course are well-organized, well-designed, and well-thought-out, and they can be combined or associated with other topics as well. This can be implied by applying the concepts as well, showing 96.3% (20% strongly agree, 61.8% agree, and 14.5% slightly agree) of them agree, while 1.8% expressed slight dissatisfaction. Lastly, in Figure 4F, 98.2% (30.9% strongly agree, 49.1% agree, and 30.9% slightly agree) agreed that the lectures and activities in the courses during the remote learning are all updated.

Figure 4

Satisfaction of the students with the faculty-in-charge's style of teaching



Note. (A) Delivery of Lecture and Laboratory Instructions; (B) Topics from the Course Syllabus; (C) Achieving the Learning Outcomes; (D); Displaying Breadth and Depth in Teaching; (E) Coherence and Integration of the All Courses; and (F) Up-to-date Lectures and Activities.

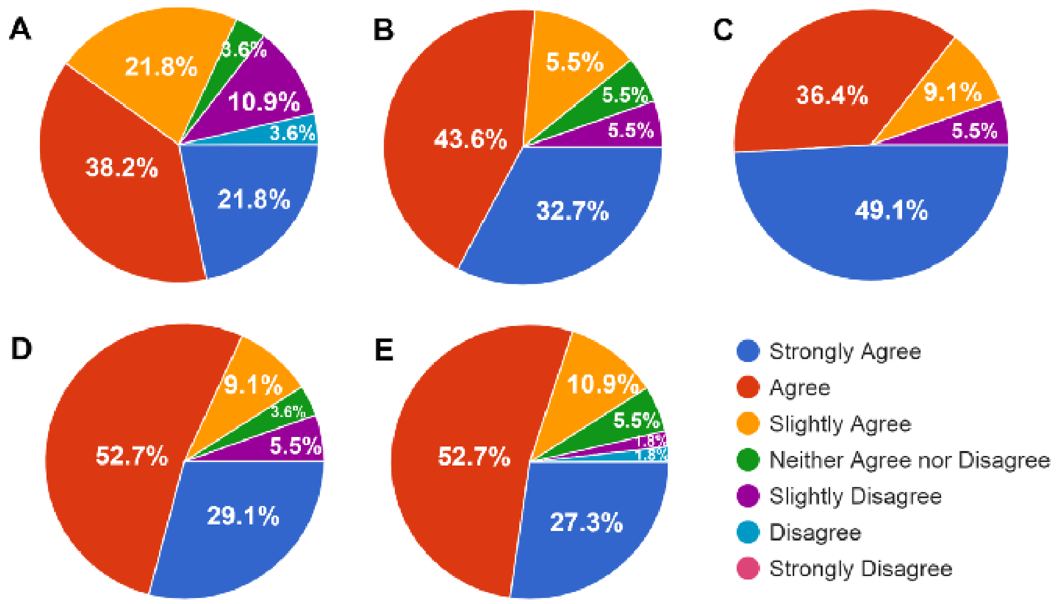
Quality of Educational Materials in the Laboratory Instruction

Materials used in the instructional process such as textbooks, video and audio tapes, computer software, and visual aids, play an important role in the instruction of the teacher and the learning progress of the students (Kitao & Kitao, 1997). In Figure 5, participants were able to rate the quality of education materials used in online laboratory instruction. Figure 5A portrays the revised laboratory manual, which is adjusted for remote learning during the pandemic period. A total of 81.8% (21.8% strongly agree, 38.2% agree, and 21.8% slightly agree) of the participants expressed their satisfaction with this material; however, 14.5% (10.9% slightly disagree, 3.6% disagree). For the lecture syllabi (Figure 5B), 89% (32.7% strongly agree, 43.6% agree, and 12.7% slightly agree) of the students are collectively satisfied with the material, while 5.5% slightly disagree . Audiovisual presentations such as PowerPoint slides and educational videos (Figure 5C) garnered 94.6% approval (49.1% strongly agree, 36.4% agree, and 9.1% slightly agree), while 5.5% of them disagreed. For the hand-outs, including reading materials (Figure 5D), students had an approval rating of 90.9% (29.1% strongly agree, 52.7% agree, and 9.1% slightly agree).

During the Covid-19 pandemic, the UPLB adjusted the course content and activities without compromising the quality of lectures in the form of course packs (Figure 5E). Students gave a 90.9 approval rating of 90.9% (27.3% strongly agree, 52.7% agree, and 10.9% slightly agree) while 3.6% disagreed (1.8% slightly disagree, 1.8% disagree).

Figure 5

Rating of the students in the faculty-in-charge's educational materials

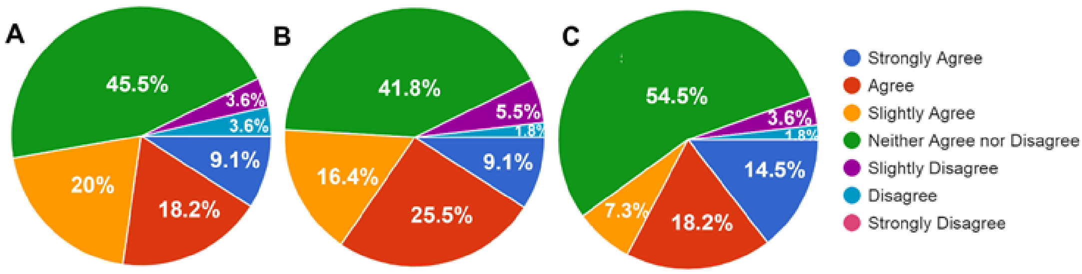


Note. (A) Laboratory Manuals; (B) Lecture Syllabi; (C) Audio-visual (PowerPoint, videos, etc.); (D) Hand-outs; and (E) Course Packs.

Aside from the materials mentioned in Figure 5, there are software , applications, and internet videos from YouTube, LabX, and others that are used as educational materials for delivering lectures and laboratory classes. Meanwhile, in Figure 6, the students rated the implementation of the core subjects such as ABT 103 - Experimental Techniques in Agricultural Biotechnology I (Figure 6A), ABT 104 - Experimental Techniques in Agricultural Biotechnology II (Figure 6B), and ABT 106 - Molecular Markers (Figure 6C). Each of these courses received an approval rating of 47.3%, 51%, and 40%, respectively. The rating in the neither agree nor disagree category can be related to the students without major subjects yet.

Figure 6

Rating of the students in the implementation of core subjects with laboratory classes



Note. (A) ABT103; (B) ABT104; and (C) ABT106

Among the subjects with laboratory instruction offered, core, courses such as ABT103 (21.82%), ABT 104 (27.27%), and ABT106 (14.55%) received the top affirmation. Students favored the activities like bioinformatics, designing primers, DIY mung bean DNA extraction, protein extraction, and molecular markers analysis in ABT104; home set-up plant tissue culture and kimchi making in ABT103; and molecular marker-related analysis and research proposal writing in ABT106. The next highly favored courses are from the foundation course of the BS ABT program, such as AGR21 (9.09%), AGR22 (12.73%), AGR31 (5.45%), AGR 32 (10.91%), AGR41 (12.73%), and AGR51 (3.64%). Meanwhile, some students did not respond to this category (14.55%).

Table 2

Courses that the students preferred most during the remote learning

No.	Course Number	Students who like the course	Percentage	Desired Topic
1	ABT103	12	21.82	Home set-up Plant Tissue Culture; Kimchi making
2	ABT104	15	27.27	Bioinformatics; Designing of primers; Mung Bean DIY DNA extraction; Protein extraction; Molecular Markers
3	ABT105	1	1.82	Necropsy
4	ABT106	8	14.55	Primer designing, Making of Dendrogram, Molecular Markers Analysis, Research Proposal writing
5	AGR160	3	5.45	PGR collection, Regeneration, Characterization of different chili accessions
6	AGRI150	2	3.64	Cross pollination
7	AGRI21	5	9.09	Tocino and Pastillas making; Farm blueprints; Rating of animal appearance
8	AGRI22	7	12.73	Lassoing; Milking
9	AGRI31	3	5.45	Growing of plants; Seed germination
10	AGRI32	6	10.91	Mini garden; BIG set-up
11	AGRI41	7	12.73	Herbarium; Identification of Weeds
12	AGRI42	1	1.82	Insect pests and weed identification
13	AGRI51	2	3.64	Soil Assessment; Computations of Fertilizer application
14	BIO30	1	1.82	DNA structure
15	BOT20	1	1.82	Chlorophyll extraction
16	CHEM18.1	1	1.82	Nuclear Reactions
17	CMSC12	2	3.64	Writing codes, Programming
18	FST101	1	1.82	Effect of heat and acid on vegetables
19	HORT132/ BIO132	2	3.64	Corn planting; Growth of an intact plant
20	HORT133	2	3.64	Corn embryogenesis; Callus initiation
21	MCB11	2	3.64	Drawing of Microscopic Organisms; Computations of CFU
22	MCB180	1	1.82	
23	No Answer/ Uncategorized	8	14.55	

For the overall rating of the implementation of remote laboratory instruction, 45.45% of the students expressed their satisfaction, while 34.55% showed dissatisfaction. 9.09% and 10.9% were undecided and unable to give their opinion, respectively.

Students' Voices on Their Online Laboratory Experience

The present study also gathered students' qualitative remarks about their overall experience with online laboratory set up. It could be noted that students are affirming the positive, innovative style in teaching the course amid the challenges faced along with attempts to improve instructional materials.

DIY Experiments as 'Substitutes'

It is worth noting how students were able to navigate the experiments given the do-it-yourself directions in conducting such activities. Students believe this set up could be considered a substitute for the actual experiments done in the laboratory. With this, students are encouraged to maximize available resources at home, especially when mobility and travel have been restricted due to the pandemic. Experiments utilizing available materials at home contribute to the success of this activity. Some students also preferred these DIY tasks rather than watching online videos.

> "So far yes. Most laboratory exercises still enabled us to apply our skills. The exercises also consider the different set-ups of each student in their

respective houses." (Participant 54)

These experiments, however, present challenges, as some limitations are encountered. Issues related to the overall experience and achieving the course's intended learning outcomes are prime concerns.

> "I was only slightly satisfied because not all laboratory exercises have ample explanation or can be only answered based on videos and the module. Some ABT, AGRI, and FST courses require home experiments to answer the exercises." (Participant 14)

Learning Materials: As Supplement and as Guide

The era of remote learning gave rise to asynchronous and synchronous sessions. As it fosters independent learning, effective learning can only be ensured depending on the quality of materials provided to the students. Supplementary materials come in the form of recorded videos instead of experiments and assigned activities. As most participants recognized the need to shift to this modality, they were also satisfied with the quality and quantity of the handouts and other materials.

> "Yes. The lab profs gave us enough time to finish our lab exercises. They also gave demonstrations and sufficient website resources on how we can do, and experience actual lab works." (Participant 15)

> "Some courses such as the ABT106, the laboratory class was somewhat challenging however, a lot were taught well, and the assessments done were sufficient. Most of the ABT courses have a lot of teaching materials that were through video presentations such as the proper execution of some techniques in the laboratory which I think is okay. Overall, I am satisfied." (Participant 42)

While this works well for others, some students expressed inconvenience.

> "I'm slightly satisfied because some of the laboratory classes would only require us to attend webinar and then we'll just have to answer guide questions or make a narrative report." (Participant 33)

Hands-Off on Laboratory Equipment: Lack of Hands-On Experience

Other students expressed their dissatisfaction with the online learning of laboratory classes. They also stressed some points that need to be improved or acquired by the students when taking up the respective course. As courses are conducted online, with prerecorded tasks and lectures, students had to express their clamor to work in the field. Comparatively speaking, some respondents have noted that the experience at home differs from the actual laboratory experience.

> "I feel like the two years of studying laboratory in an online setup is a

> waste because the skills we must acquire as lab students were not properly practiced since we rely on videos and not actual application." (Participant 3)

> "No. Most, if not all, laboratory exercises were not conducted by the student. Students are typically given a recording or link to a YouTube video of the experiment or exercise which they are to assess. Sometimes, only written handouts are given, too, which describe the procedures." (Participant 37)

Difficulties Encountered: Lessons Learned

With the nature of the academic program being science-based and relying heavily on lectures and experiments, students faced numerous difficulties, given that assigned activities are implemented at home. Students were guided by materials provided to them. Further, the respondents expressed that some materials to conduct experiments are unavailable at home, if not difficult to secure. This is addressed by providing videos online or through virtual laboratory programs.

> “I know my profs did all they can to teach their respective courses and help the students to attain the learning objectives. But there are lapses and gaps that were not sealed nor bridged which is not something to blame to the profs, the institution, or the students. It's just the situation didn't allow to fully deliver the course the way it should. So, I am not fully satisfied but I am thankful. Really thankful that everyone did try." (Participant 8)

> "Some were too intensive since they are groupworks and getting ahold of groupmates is difficult." (Participant 12)

> “Sometimes the load of worksheets are overwhelming for me and I am often unsure of what I do and the scope of my answers. Although there are alternative activities, actual lab work remains a regret." (Participant 40)

Towards an Improved Online Laboratory Instruction

Based on the findings of the study, the following inputs are proposed to improve online laboratory instruction:

1. *Use of low-cost materials for the experiment or early announcement of the materials.* As the students would need to look for materials to be used in experiments at home, it is suggested that these items are easily found or bought. Student’s ability to source materials for the experiment equitably positions the student to participate and conduct assigned tasks. Further, it is also helpful that the needed materials are announced beforehand so students can work on the procurement beforehand.

2. *Provision of detailed instructions on the experiments and regular*

consultation with the faculty. Given the nature of structured experiments and activities, students require detailed instructions on the conduct of experiments at home, if not the supervision of the faculty-in-charge.

3. *Conduct of activities and lectures based on structured sequence and time frame.* As planning becomes vital to students to successfully attend to their school tasks and other academic needs, strictly following a particular timeline and sequence, mostly stipulated in the syllabus, would help identify students' priority areas. In classes where laboratory experiments play a significant role in assessing students' learning, how the class progresses from one topic to the other matters. Working on a particular timeframe could help students stay organized and able to plan.

4. *Promotion of student support through equitable class requirements.* An optimal approach to maximizing learning in a remote modality involves careful planning and preparation. As essential competencies are identified, class requirements to be submitted by the students should also be revisited as regards the need and impact. With great consideration of equitability and learning demonstration, these requirements should reflect how authentic learning is manifested.

Conclusion

The present study provides crucial discourse in the conduct of online laboratory instruction. Various platforms need to be scrutinized to determine whether these respond to the needs of the nature of the class. Online videos and laboratory programs need to be revisited to ensure equity and authenticity of the totality of the students' learning experience.

As teaching styles matter, implementing laboratory activities at home requires careful planning, especially when it comes to providing materials available at home. The conduct of synchronous classes serves as a vital component in the delivery of lectures. Quizzes, exams, and written reports are also considered to be essential. Requiring group activities and projects need to be enhanced, justified, and strengthened, as students find these least desirable.

Whether or not online laboratory instruction is here to stay, the present study is significant in designing courses implemented in preparation for a disruptive-free teaching and learning process. Innovating approaches to certain classes should be encouraged as these highlight efforts to address contemporary issues and concerns. Allowing students to plan and implement their academic activities leads to positive gains. Attending to student needs through consultation and supervision appears to be a much-needed response, especially during the pandemic.

In addition, using online learning materials is indeed a challenge for the students as it may be of high provision and maintenance cost for the students themselves. Hence, platforms must not only be accessible but affordable in consideration of the socio-economic conditions of the students.

The present study also presents limitations. The findings, results, and interpretation may not be generalized to all students with online laboratory experience since the nature of academic programs, classes, and approaches need to be taken into consideration. Since respondents of the study are from the BS ABT program, given the online modality of data gathering, findings cannot be generalized to all science courses and laboratory classes.

Recommendations

In relation to instructional practices and student learning assessment, it is recommended that faculty-in-charge fosters a healthy and nurturing online learning landscape for both teachers and students. Managing expectations and emphasizing responsibilities would mean establishing how both teachers and students could maximize the benefits of learning through online modality. Further, the present study opens new discourse on teacher education research. Teachers are recommended to survey student needs and expectations and align these with classroom rules, requirements, and regulations. Innovative and data-based decisions and practices could fuel effective teaching preparation and implementation. Constant checks and balances on student satisfaction and needs assessment surveys could also contribute to the efficient delivery of each lesson. The teacher should be sensitive to these elements as evidence of students' learning and academic progress. Higher education institutions are encouraged to craft policies that highlight addressing student welfare by identifying the essential learning competencies in laboratory sessions. Provisions must explicitly state the consideration of the availability of needed resources for home-based experiments, structured and regular consultation, and equitable student requirements. In the future, prospective avenues to study include how students address the challenges of online laboratory instruction, curriculum implementation processes vis-à-vis student s' home-based experiments, and institutional support provided to students and teachers to deliver online delivery instruction effectively. Another promising area of inquiry includes teacher professional development vis-à-vis training and capacity building for teachers who handle courses under this delivery modality. A qualitative research approach would also contribute to addressing research gaps in this area. Furthermore, future researchers may explore existing literature to crosscheck the results of the study further. They may also explore more cases, studies, and examples of how Google Analytics enhanced or created learner-centered, personalized apps to better understand online distance learning tools.

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