

Exploring the Benefits of Online Labs for On-Campus Teaching

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With the move to online teaching and learning in response to COVID-19, online biology labs are no longer a niche endeavor and more of us than ever now have some experience teaching in this mode. As we look forward to a return to campus, how might our online teaching experiences inform our face-to-face teaching? Researchers have investigated the changes in attitudes and strategies of instructors in a variety of disciplines who have returned to face-to-face teaching after having taught online. For example, Kearns (2016) found that instructors became more aware of the potential applications of online technologies, saw less of a distinction between in-class and out-of-class learning activities, and demonstrated an increased focus on how students learn, while Andrews Graham (2019) documented changes in instructors' communication strategies, instructional practices, and perceived roles in the classroom. This panel discussion explored the theme of 'transferable benefits of online teaching' in the context of laboratory teaching; panelists shared insights and specific examples of how experience with online labs can make our face-to-face labs better.

Keywords: online, virtual, biology, transferable benefits

Introduction

The switch from predominantly in-person to remote learning across all levels of education due to the COVID-19 pandemic poses challenges and opportunities for educators (Delgado, Bhark, and Donahue, 2021; Majewska and Vereen, 2021; Noel *et al.* 2020), many of whom are teaching online for the first time. The topic of this panel discussion is an extension of a major workshop offered at the 2014

ABLE meeting at the University of Oregon, where participants were guided through some preliminary planning to convert face-to-face labs to online delivery and vice versa (Gass and Van Dommelen, 2015). Faulconer and Gruss (2018) present a narrative synthesis of the literature on the relative merits of online and face-to-face labs, noting that the variety of practices makes direct comparison of outcomes challenging and emphasizing the importance of one's own context when making choices between online and face-to-face instructional

modes. We acknowledge that the rapid adoption of emergency remote teaching during a global pandemic is a fundamentally different experience than the purposeful development of curriculum for a new mode of delivery, and at the same time recognize that some of the practices and materials developed during this time can be used to enrich our face-to-face hands-on labs as well as improve student mastery of key concepts and content.

This article presents the questions that were discussed during the panel session and summarizes the responses from the panelists and attendees; panelists also contributed prepared notes. Readers may use the questions to reflect on those aspects of their own experience with teaching labs online that might influence their face-to-face teaching.

The Panel's Conversation

Emerging Themes

The panelists identified several transferable benefits of online labs that manifested themselves in different ways in their courses. Online labs can increase accessibility in a number of ways: for example, by offering the opportunity for do-overs, eliminating some safety concerns, and providing the opportunity for students to learn by making low-stakes mistakes. Instructional elements of online labs can be incorporated into and bring these features to similar face-to-face labs. Online labs can become part of the regular schedule of face-to-face offerings as alternate options ('swing labs') during short-term disruptions such as storm closures or as make-up labs for students who are absent. Online labs can focus students' attention on aspects of scientific work that might be de-emphasized in their face-to-face labs, such as data presentation and writing. Where an online lab doesn't allow students to collect their own data, provided ("canned") data may be cleaner or noisier; either can be beneficial to learning depending on context and can be modularized for use in face-to-face active learning. Finally, the remote and largely asynchronous nature of online labs caused panelists to think carefully about communication both in terms of content of their messages to students and the means by which they kept in touch. Panelists agreed that they were more transparent with students about their choices with the labs and what they hoped to achieve, and adopted new ways of communicating (LMS announcements, e-mail, asynchronous discussions, virtual help sessions, etc.) that can also be used in a face-to-face lab environment.

Questions to the Panel

Panelists prepared their remarks to the first two questions in advance of the session; the remaining questions were open to all panelists and attendees.

Question 1: Can you describe specific examples of improved learning (or potential for improved learning) as a result of your online labs?

KN: Lab experiments involve technique, data analysis, and presentation; online labs can improve learning on all three of these dimensions in different ways. For example, online technique simulations can work well as a "dry run" for later hands-on practice, provided data can be less noisy for students, allowing them to focus their attention on the relevant patterns, and online labs can give students an opportunity to develop software skills with programs such as ImageJ (Fiji). They also develop online presentation skills.

DP: More attention was focused on writing and interacting with the scientific literature. By implementing a genome-scale bioinformatics project, students were able to explore real data, learn to use multiple bioinformatics tools and resources, and were challenged to apply their prior knowledge to explain the findings, tying it to what is known in the literature. It was a more intense and challenging writing assignment than what is usually assigned, and required greater critical thinking skills. The forced move to online created an urgent need for development of the project which had been in consideration for years but time had not allowed for development.

EV: Building research questions and carrying out appropriate analysis to answer them is often the ultimate course activity within biology lab courses. In an effort to improve and assess student learning at Morehouse in our Biology program, there has been a push to increase the incorporation of discovery-driven modules and those that contain real-world relevance into lecture and laboratory curricula. In the sciences in particular, inquiry-based

learning has been widely promoted to increase literacy and skill development (Khalaf, 2018; Friesen and Scott, 2013). Our online labs and remote learning activities have emphasized inquiry, empowering students to explore topics by focusing more on the questions and methodology, than on potential solutions. Most students believe that they are going to be experimenting any time they are given a laboratory assignment in biology labs, or in science courses. However, more often than not, students are doing something other than experiments. Working remotely and online, students (and instructors) became acutely aware of this which is not necessarily a bad thing and was noted as one of the improved learning outcomes that is also transferable beyond online learning. By focusing on inquiry more than the experimentation, students benefit beyond the immediate online lab class in that the activities provide training in essential research skills (critical thinking, problem solving, analysis) and can also include scientific communication (preparation of a lab report and presentation) that also prepare students for graduate and professional studies, and scientific careers in STEM fields.

Online labs are also accessible in terms of scheduling and facilitate both synchronous and asynchronous collaboration via tools such as Google docs or discussion boards. Some types of online lab activities, such as simulations, allow for low-stakes mistakes and repetition if necessary, and alleviate safety concerns.

Question 2: Which aspects of your online labs will you bring forward to your face-to-face labs?

DP: Because students had to use “canned” data from past years, the opportunity to really wrestle with the analysis of things that did not work well in their hands was missing. To counter this and to provide a lot of opportunities for students to really practice critically thinking about how to interpret things like restriction digest gels, Southern/western blots, and PCR results, problem sets were developed with a myriad of less-than-ideal results. These practice problems really reinforced key concepts and helped students understand the chemistry happening in the experiments. These will be maintained going forward.

I also developed journal club assignments to introduce a new topic (microarrays and CRISPR) and had each group share the details on how a specific technique within the paper worked to increase their knowledge of the most commonly used methods in the research lab. It was a way to improve their skills at reading the literature and understanding data, help them to start seeing these individual techniques as part of larger project flows needed to address a research question, and practice their presentation skills in a format similar to what they would experience if working in an academic research lab as a graduate student or often in industry as well. These assignments can work on campus or online, and I plan to keep them as a “swing lab” in case of emergency closures due to weather or other similar short-term events.

We will also retain our short video clips that demonstrate lab techniques, because it is difficult for all students in the lab to easily view a live demonstration and the videos are specific to our equipment. Finally, the peer review feature in Turnitin makes it much easier to implement rubrics and facilitate peer feedback, even for written assignments in face-to-face courses.

EV: We encountered a challenge when Adobe Flash disappeared at the end of 2020, which meant we could no longer use some of the simulations and other digital products we had been relying on. Digital media needs to be double-checked regularly, and ideally should be integrated into the LMS for easier student access.

Attendee Question: I like the ‘swing lab’ idea; are you thinking of retaining any online labs as part of the regular schedule and not just as a backup plan?

DP: We are keeping it in the last week of the schedule because it is easier to mark and gives the TAs a bit of a respite near the end of the term, but it can be moved to earlier in the term as a swing lab if necessary.

Question 3: How have your students responded to online labs; all things considered?

KN: We purchased a Labster package that covered all of our labs for the year (plus some extra that we didn’t use); it’s a kind of gamified platform and students seemed to like the labs.

DP: We also used Labster; there were some minor tech issues but they were quickly resolved. We were anticipating poor student evaluations but students responded positively – the key was to clearly explain why we were doing what we were doing. They really appreciated that we didn’t film ourselves doing a lab for three hours

and then hand over some data for them to write a report about.

EV: Our students enjoyed Labster too; we also used publicly available data, QUBES, HHMI BioInteractive, etc. Like Donna we expected potentially poor evaluations, but received the opposite. Students really appreciated the effort of providing a lab experience.

Question 4: Did your online labs provide an opportunity to explore aspects of scientific work that were de-emphasized in your face-to-face labs (such as working with more data, writing, etc.)?

DP: Both [data and writing]! We created multiple data sets and scenarios that might not necessarily arise in the face-to-face lab. Now that they're developed we can use them during our face-to-face classes and labs during breakouts or while gels are running.

EV: We shifted more toward inquiry-based work, thinking more deeply about research questions, hypotheses, and predictions; focusing more on the scientific method and de-emphasizing the outcomes of the experiments.

KN: We did more phylogeny online because it was easier to do with online tools and a variety of images. Although scheduling was a bit difficult because we were allowed to do some face-to-face labs but were restricted to eight students at a time.

Attendee Question: Will you continue to invest time in online materials or will you limit the time you spend on revising them?

DP: We will keep and refine some, but not all.

EV: Agreed.

JVD (moderator): It's important be wary of 'Course-and-a-Half Syndrome' now that we have more options; it's still necessary to make choices about what to keep and what to let go and to be careful not to overload students with online work in addition to on-campus work.

Question 5: Do you see benefits to online teaching that transcend the laboratory?

EV: We will continue to move toward an inquiry-based approach.

KN: We are a commuter school and students are happy to do less commuting; the asynchronous communication options such as discussions and chat rooms worked out better than I thought. I was also able to combine lab with lecture sometimes.

DP: Students developed transferable tech and video presentation skills.

JVD (moderator): I found that online office hours and help sessions were more convenient.

Attendee Question: Were there any activities that you tried that didn't work?

KN: We found that dissections didn't work very well online.

Attendee: We did fetal pig dissection in BIO 2; recorded video and photos of dissections in labs and used Notability; online students labelled the videos and images.

EV: GIS story mapping was a challenge given my limited experience with GIS.

Attendee Question: What's your biggest takeaway from doing things online?

DP: The importance of clear communication and the value of redundancy in communication; e.g. using different channels such as e-mail and LMS announcements.

EV: That the students appreciated our transparency in describing why we were doing what we did, and they shared their gratitude that we are able to do things online.

KN: Online labs encouraged me to be more organized and creative.

Materials

Resources and discussion related to developing and teaching online labs are posted in ABLE's 'Biology Labs Online' forum, <https://www.ableweb.org/forum/biolabs-online/>.

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Acknowledgments

The panelists would like to thank Laurel Rodgers and the ABLE board for organizing the ViABLE 2021 meeting, and thank the attendees for their active participation during the session.

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Citing This Article

Jennifer Van Dommelen, Martin Hicks, Kathleen Nolan, Donna Pattison, and Ethell Vereen. 2022. Exploring the Benefits of Online Labs for On-Campus Teaching. Article 51 In: Boone E and Thuecks S, eds. *Advances in biology laboratory education*. Volume 42. Publication of the 42nd Conference of the Association for Biology Laboratory Education (ABLE). <https://doi.org/10.37590/able.v42.art51>

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