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Tools for Online Transition of Core Science Labs

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During spring 2020, fall 2021, and spring 2021 we transitioned our formerly face-to-face introductory biology lab for majors to an online format. We had many periods of trial and error and have learned quite a bit along the way. This paper shares the pros and cons of three different methods we used in our attempt to simulate hands-on instruction for our online students: (1) pre-existing, prepackaged paid online labs, (2) pre-existing pre-packaged free online simulations, and (3) modifying our existing activities for students to do at home. We found a continuum of experiences in the instructional value, delivery method, ease of use, and student efficacy.

Keywords: online instruction, biology, laboratory, inquiry-based learning, virtual laboratory, simulations

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Introduction

Online or virtual learning has been around for almost two decades but their adoption has been slow in core sciences (Scheckler, 2003; Huang, 2004; Concilla & Albon, 2008; Yaron et al., 2010). A study by Rajendran et al., in 2010 highlighted the utility of virtual labs. In this study 92% of students preferred participating in virtual labs because they felt virtual labs were a safer option to handling hazardous chemicals. Another study found that virtual labs increased student confidence in performing in-person labs (Coleman & Smith 2019).

The hard-core science faculty have been reluctant to offer online only or virtual labs, reasoning that the hands-on experience promised by labs is subdued by online offerings. After all, a click is not the same thing as cutting open a dissection specimen. Nevertheless, rapidly advancing technology has made digital equipment hardware such as the Anatomage table (https://www.visiblebody.com/) and software like 3D Visible Body (https://www.visiblebody.com/) an integral part of engaging students. These tools are being used to complement lectures and engage students (Smith et al, 2019; Park et al, 2019) in classrooms and laboratories.

COVID-19 put a quick stop to the faculty resistance to online only labs and within a matter of weeks almost all higher education institutions were offering online laboratory instruction. Core science faculty who had been opposed to online lab instruction were forced to acknowledge that virtual online labs were here to stay. They are indeed more cost effective, safer lab environments, and interactive platforms for labs (Jones, 2018; Glassey & Magalhaes, 2020).

Recent studies have also found no significant difference in student engagement between online and in-person instruction both in lecture and lab (Brown and Peterson, 2021). Once the benefits were highlighted and the inevitability was established, the question became which virtual labs to adopt.

Texas Woman's University [TWU] is known for value education and we do not have enormous private endowments. Therefore, we were not in the position to adopt all pre-packaged, paid virtual labs

from leading providers such as Labster or Mcgraw Hill. Also, our various levels of instruction (i.e. majors vs. non-majors, freshmen vs. seniors) required customization. As a solution we took three approaches. We adopted some commercial packages, we found other free online resources and we made some of our own.

Over the course of the semester, we used three main models of instruction to move our face-to-face course online. These models included (1) Pre-existing, paid online labs, (2) Pre-existing, free online labs, and (3) Modified activities from our own existing curriculum. There were pros and cons to each of the models which we will discuss here.

Our Reflection

The first model, pre-existing, paid labs include examples such as Labster, BeyondLabs, McGraw Hill, LabX, and Pearson Mastery (see Table 1 for links to examples). These simulations varied in their content, rigor, cost, and overall "fit" for our courses. We were impressed with the ease of integration into our LMS (Canvas), the "done-for-you" option with the labs already created, gradebook integration (a huge timesaver), and consistent expectations for our students when using multiple simulations from the same publisher. We did have to sort through the myriad of labs to find example simulations that fit our curriculum. For example, Labster contained over 150 possible simulations at the time, and we ended up using only 6. This was a one-time issue as we have continued using the same simulations each semester. The negative side to these labs is the cost to students and the fact that the rigor did not always match our student learning objectives and course outcome goals. Some were far too easy, and others were far too complicated. This differed between our majors and non-majors courses as well as our 1000 and 4000 level courses.

The second model, pre-existing free online labs include examples such as The Nobel Prize, NCBI, HHMI, Pearson, and The Concord Consortium (see Table 1 for links to examples). As was the case with the paid online lab simulations, the "done-for-you" aspect of these labs was extremely convenient. We were able to search for simulations on just about any topic imaginable, and the lack of lab prep was nice as it is such a time-consuming factor of our lab courses. These labs, however, were free for students which was a major factor for us. We are committed to keeping our courses as economical as possible for our population of students. The downsides to these labs were as follows. First, there was no LMS integration (and therefore no gradebook integration). Second, we had to search multiple websites and platforms to find simulations that matched what we were looking for. Third, the student submissions were not consistent across different sites and therefore became confusing. And finally, the time involved in matching simulations to our scope and sequence was a huge time commitment.

The final model modified activities from our existing curriculum and was where we started during the shut-down of spring 2020. We did what we could in the quick turnaround time to put some of our activities online. We got more proficient at this as the semesters went on. These activities were the most closely aligned with our course and curriculum goals, and they were also comfortable and familiar to our instructors. However, the students did not always have the materials needed to perform the experiments. We tried our best to keep the materials simple and the cost to a minimum. For example, we had a strawberry DNA extraction lab that we pared down to students needing a strawberry, dish soap, and rubbing alcohol. Students living in the dorms were especially challenged to find some of the materials. We ended up making a recording of ourselves doing the lab as a demonstration and allowing students to use our data if they could not perform the experiment.

Table 1: Examples of Pre-Existing Virtual Labs

Pre-existing Paid Examples	Pre-existing Free Examples
https://www.labster.com/	http://www.nasonline.org/programs/labx/
https://www.mheducation.com/	https://concord.org/
https://www.emindweb.com/	https://www.biointeractive.org/

Discussion

Depending on an institution's finances and student needs, there are multiple options available. The benefits to pre-existing options (whether free or paid) are time and convenience. In the upcoming semester we have decided to drop the paid, per student subscription and go with a university-wide subscription. It is less expensive and can be used in multiple courses. In our case, the department paid our subscription fee, and the student lab fees cover their cost. We felt this was a great compromise where we didn't have to trade rigor for cost. Each program and university will have unique needs for their own student population, so we hope the insights we've presented here will help others make mindful decisions on which resources to choose.

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