Building a COVID-19 legacy with innovative teaching

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A new semester is upon us and post-secondary students and educators are entering a semester of remote teaching because of the COVID-19 pandemic. These times feel daunting. Educators understand we must all stay safe; they also want to give their students a meaningful learning experience.
"We can do some creative things this year if we re-frame the crisis into an opportunity for innovation," says Dr. Joseph Rubin, Co-Chair of the Canadian Society of Microbiologists (CSM) Committee on Microbiology Undergraduate Education (CMUE). The CSM-CMUE provides resources to university educators in Canada about effective, evidence-based teaching. CSM-CMUE members recently published two letters in the *Canadian Journal of Microbiology* about teaching during the COVID-19 pandemic.
"With the pandemic, we have had to see what we could do to support educators. We have had people contact us asking what they should do this year, it is something a lot of people are worried about," says co-author Dr. Tanya Noel, Science Learning Specialist in the Department of Integrative Biology at the University of Windsor, and one of CSM-CMUE's founding members.

In the letters, CSM-CMUE members suggest educators avoid re-inventing the wheel and use online resources that already exist. They emphasize being creative with at-home labs and planning to teach core lab skills in-person—when safe to do so—on a condensed "boot-camp" style schedule.

"I also started thinking about how I could give my students the best experience. I want them to learn transferable skills that I may not usually have the time to focus on in a normal school year," says Dr. Maria Davis, Laboratory Instructor in the Department of Biology at the University of Regina, and Co-Chair of the CSM-CMUE.

Re-vamping your curriculum

The committee describes five specific ideas educators can use for the upcoming semesters.

Noel points out that teachers could take this list to their Dean or Head to show what the community is doing.

1. Emphasize critical thinking

Most first- and second-year microbiology students do not yet analyze data, interpret results, and draw conclusions. Why not replace cookbook/survey labs with critical thinking activities like interpreting graphs from a peer-reviewed journal? This activity—which can be applied to all scientific disciplines—can also help students develop their communication skills.

"I plan to have my microbiology students analyze student-collected growth curve data that we have been gathering for many years," says Noel.

The *Consider, Read, Elucidate the hypothesis, Analyze and interpret the data, and Think of the next Experiment* (C.R.E.A.T.E) method can also be used to encourage students to interact with primary literature. To teach critical thinking skills, the case studies from the National Center for Case Study Teaching In Science are free and comprehensive resources.
2. Discuss experimental design

Discussing concepts like replication, sample size, and reproducibility are not usually focused on in undergraduate labs but are crucial when designing experiments. Lessons on these concepts can give students a stronger foundation for when they physically return to the lab. The National Institute of General Medical Sciences has free training modules on data reproducibility.

3. Build communication skills

There is an urgent need for science literacy in society, yet science majors often do not get trained on communicating science. As a remote learning project, students can create podcasts, write blog pieces, or get involved in citizen science. The California Academy of Sciences and Tiny Earth are excellent resources for citizen science projects.
"You can be creative with it," says Rubin on ways to help students develop communication skills. "My students will be writing Wikipedia articles on important organisms in veterinary medicine. This will get them thinking about turning their expert knowledge into clear ideas. That's an important skill to have when they talk to clients in their professional careers as well."

4. Develop bioinformatics know-how

"Omic" technologies are used across disciplines and produce large datasets. Knowing how to work with these datasets is an essential skill. This semester is an opportunity to teach students to use the Unix command line, R, and Python, for example. The bioinformatics mastery rubric developed by Rochelle Tractenberg and colleagues and the software carpentry website are both great resources.

5. Discuss equity, diversity, and inclusion

Discussing equity, diversity, and inclusion (EDI) should be part of all curricula regardless of the global situation. Students need to take part in conversations about EDI initiatives in classrooms and labs. The *Journal of Microbiology and Biology Education* is an open-access resource that publishes research and perspectives about inclusive science.
Davis will be organizing a live session on EDI reflections in science this year. "I will send prior readings, then have a live discussion facilitated by myself and a TA [teaching assistant], and finally a reflection project like artwork, a poem, an essay, or a video," she explains.

You can also use the meta study by Nicole Woitowich and colleagues as a resource for discussing historical biases and how they are being challenged.

What about labs?

Educators can still teach labs remotely, with students completing activities safely at home. Labster, Jove, and BioInteractive are online resources with free and paid access to lab simulations, educational videos, and interactive data analysis.

Educators can also send lab kits such as Foldscopes or preserved level 1 biosafety organisms to students in the mail. Practical at-home experiments like baking sourdough bread can also show microbiology at work.
There are many hands-on skills students can only learn in the lab, however. What is more, microbiology students and other science majors need lab experience to get into certain professional programs, graduate schools, or laboratory-based jobs.

Universities will have to try organizing condensed lab courses for students to get those hands-on skills. Noel suggests that "we could find a way to allow students from nearby cities to come to one university campus to do a boot-camp together for a week or so, once it is safe to do so."

Athabasca University already has a condensed in-person lab component in place for students enrolled in their online microbiology course. Educators can look at their model for inspiration.

Reducing the burden of grading

With a challenging semester ahead, educators can use peer-review methods to lessen the burden of grading. This is also a way to engage students in group work.

"I plan to use the free app Teammates for peer review," says Davis, "It allows students to give anonymous peer feedback and instructors to use it for grading."
Noel also points out that, "some universities already have a peer review system built into their learning management systems (LMS). That's something educators can look into."

Keeping students engaged

Factors like poor internet connections and low motivation could become problems this semester.

Davis will be giving her students a survey at the beginning of the term asking whether they have good Wi-Fi. "Based on that I will create secondary assessments for students if they can't make it to one of my live sessions," she says.

Communication with students will also be imperative this semester. The free app Slack is a good option for keeping the lines of communication with students and teaching assistants open.
"I will be encouraging my students to stay organized, manage their mental and physical health, ask questions, and adjust their study strategies. If they usually study in big groups in a coffee shop for example, they could set up study Zoom sessions or meet in a park instead," explains Noel.

Educators are all in the same boat this year and will be learning together. Out of necessity, educators are already creating many unconventional and valuable resources; resources that can be used in the future to ensure science education is more accessible.

"If we play this right, we can leave a COVID-19 legacy," says Rubin.

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