



Challenges and lessons learned implementing online labs during the transition from traditional to online delivery of a large-enrollment introductory biology lab course



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Introduction

- The Biological Research Laboratory **course-BRL 117** (SAS-Undergraduate Education-Division of Life Science, Rutgers University) is required for all undergraduate biology majors, opening research experience opportunities to a large population of undergraduate students that range between 850-500 undergraduates per semester.
- 832 students enrolled in BRL117 during Spring 2021, the course modality was online fully synchronous, using Zoom meetings.

Capstone Research Project- team project

- One of the research activities is the preparation of a capstone research proposal working in teams; this activity provides students the opportunity to explore further an area of freshwater ecology that interests them.
- During the research proposal preparation students engage in active learning by modeling the scientific process using real-world –authentic data through the use of environmental monitoring databases.
- The use of databases (such as the Raritan River Hydrological Observatory (<https://tessera.rutgers.edu/rrho/>) and the US Geological Service database Water Quality Watch <https://waterwatch.usgs.gov/wqwatch/> provides access to real time water-quality data collected in surface waters throughout the United States and allow students to work with real time long-term observational data from different locations to answer questions (using scientific methodology, Fig 5) about environmental impact on water quality and biodiversity.

- At the end of the semester, students have the opportunity to practice their oral presentation skills by participating in a virtual poster session (Fig. 5).
- The capstone project offers the opportunity to build data manipulation skills, quantitative reasoning skills, graphing and visualizing results to foster conceptual understanding of freshwater ecosystems and to develop analytical and problem solving skills needed for scientific research, upper courses and career preparation.

Lab courses are one of the most challenging spaces to recreate through online learning. Even though the hands-on experience and technical skills of manipulating instruments cannot be fully replicated, the BRL-117 offered students alternative opportunities to engage in a research experience away from the on campus traditional lab space.

The course included new strategies, such as teamwork in breakout rooms, using Collaborations documents, a variety of opportunities to participate and answer questions (polls/Zoom) , simulations (Labster), to engage students and maintain participation and collaboration to complete activities.

Team work in breakout rooms

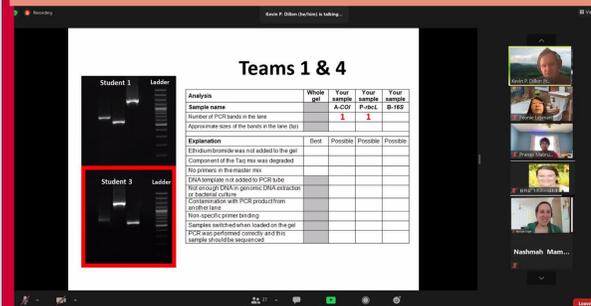


Fig. 1. Students work in teams in breakout rooms to discuss which PCR products would send for DNA sequencing as part of a DNA Barcoding project activity. They present their finding to the rest of the class in the Zoom main room.

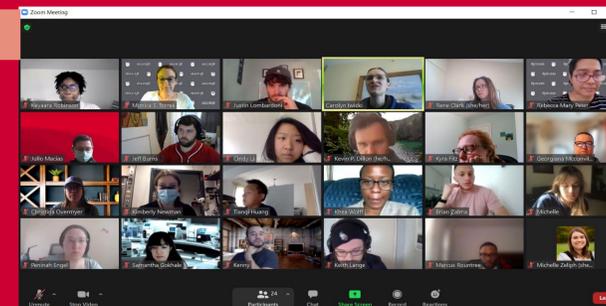


Fig. 2. After completing team activities in breakout rooms using Collaborations documents, the leader of each team share main findings, and the entire class discuss results.

Engaging student in class work

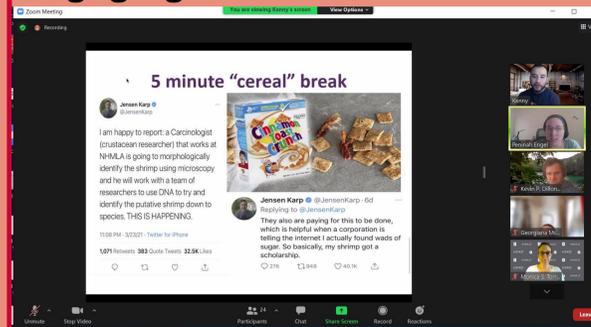


Fig. 3. Each lab section meeting was 2 -3 hours with several breaks , many of the breaks were used to introduce topics related to the course that were on the news during that week.

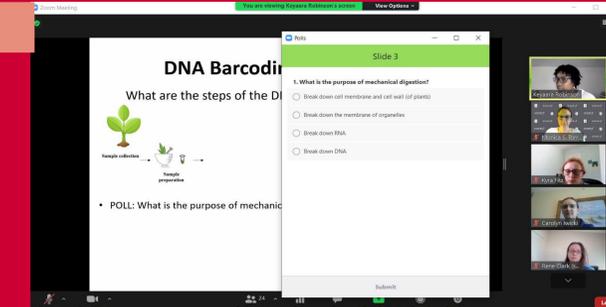


Fig. 4. To maintain engagement and participation a combination of questions that students can volunteer to answer and polls were used.

Capstone Research Project- team project

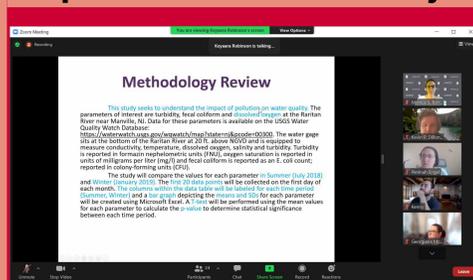


Fig. 5 Example of methodology preparation and review during class time. Using critical reading skills.

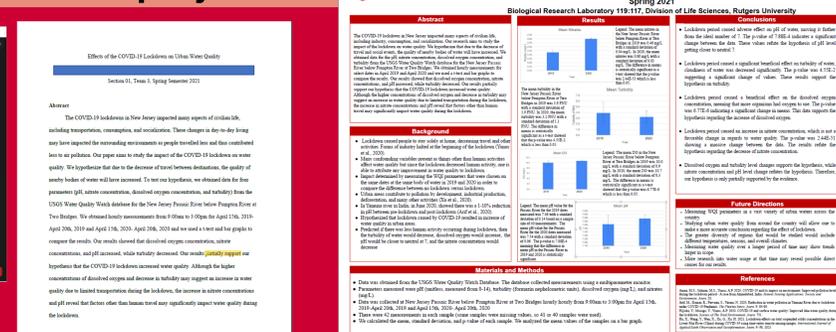


Fig. 6 Example of scientific paper and poster prepared and presented by a team (Spring 2021)

Students Perceptions of Online course delivery

In a survey conducted after 4 weeks of classes in Sp2021, students were asked:

Which topic /activity have you found the most difficult so far? What do you think made it difficult?

- Conducting a serial dilution was difficult for me in the first week of class but I quickly learned how to properly do it.
- Making graphs and interpreting data has been a bit difficult because of the use of Microsoft Excel.

Please describe your sense of the purpose of the in class simulations (Labster and LoggerPro). How does it fit with the broader goals of the course?

- Class simulations help solidify my understanding and conceptualization of the topic at hand. It helps with the broader goals of the course such as application and understanding how to do certain things in a lab or research environment
- I think Labster was a brilliant platform to use. It is as close as we will probably get to simulating an in-person lab. Plus, it has detailed simulations that you wouldn't even be able to see in a real lab, like zoom-ins of chemical interactions.
- Since we are not able to go to school and physically attend labs, class simulations allow us to at least learn from doing the simulations. Unlike other schools who just watch videos, we actually get to do the labs.

Was there anything you expected to encounter in this course that haven't been addressed ?

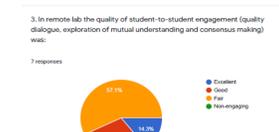
- NO, but not in a negative way. It is more interactive than I thought which teaches me more
- No. The activities are actually more fun than I expected. Team work is really interactive and the labster simulations are amazing for online learning as they are informative and visually appealing to work with. I was expecting to simply read a lab manual and go through numbers with a small group but the activities are way more involving.
- Overall, Bio-lab has proven to be very helpful in learning new concepts and its exciting to see more visual aid rather than textbook learning.
- Thank you for making the best virtual experience I could have ever imagined for a lab! The group is a huge help in doing the lab because we could all put in our input and help each other whenever anyone's struggling with any topic or anything else.

TA Perceptions of Online course delivery

- TAs perceived team work as good (71.4%) or excellent (28.6%)



- TAs perceived the quality of student to TA engagement as excellent (14%), good (42%) and fair (42.9%)



- TAs perceived that compared to pre-pandemic in-person lab, the level of student readiness for lab (prepared to make/discuss and execute lab activities) in remote lab no significant difference (85%)

