CURE in Antibiotic Discovery Using a Combination of in-Person, Hands-On Laboratory Activities and Remote, Mentor-Type Experiences during COVID-19

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Pedagogy designed to improve student engagement, like the course-based undergraduate research experience (CURE), was given its hardest challenge yet during the COVID-19 pandemic: to find a way to exist and continue productive work in a remote environment. Faculty in STEM disciplines have worked to implement CURE programs into course curriculums, only to have had some of them disrupted during spring 2020. The demonstrated benefits of the CURE in improving student engagement and persistence in the sciences could be at risk if these courses continue to be disrupted. How do faculty make CUREs work when emergency remote learning continues to loom over our institutions? This teaching tip focuses on how one antibiotic discovery CURE used technology and individual meetings to continue the students’ experience and research process. The instructor remained alone in the laboratory with the student samples and acted as the students’ hands, in order to continue testing and characterizing samples collected earlier in the semester, while students watched and directed the process during the online meetings. The change in methodology helped to restore some of the individual and small group mentor-type activity provided in the principal investigator–student researcher relationship present in undergraduate research experiences that was lost with the development of CUREs and the move to remote learning.

INTRODUCTION

Course-based undergraduate research experience (CURE) programs provide students with research experience and the opportunity to use scientific principles, discover new insights, work on relevant topics, participate in collaboration, and build on previous knowledge (1). These programs also improve students’ perceptions about science, help their persistence in science, and increase the potential of leading to a career in science (1, 2). Spring 2020 caused many CURE projects to come to a screeching halt as many institutions began emergency remote learning. Some biology CURE projects continued using online programming or modeling, such as in silico bioinformatics courses using online software and databases (3, 4). In contrast, one chemistry CURE project was modified into literature reviews of articles related to small-molecule drug pathways to help connect organic chemistry to real-life applications (5). Microbiology laboratory courses, in general, were hard hit due to the nature of the content, which lead some instructors to “show and tell” exhibits of standard plates. The hands-on experiences of the microbiology laboratory were hampered, since the emergency move to remote instruction either happened while students were away for break or so quickly that safe, take-home kits were not available. The pandemic created new problems for implementing the CURE laboratory model (Appendices 1, 2, and 3). In my antibiotic discovery CURE, two new problems presented: an excess of prepared media and, more importantly, student samples waiting to be investigated.

PROCEDURE

In my teaching/research laboratory, I was faced with the need to shut down research and destroy all students’ samples that were not ready for storage, thus severely impeding the student experience. Since the potential to do a last purification and store the samples existed, I needed to find a way to involve the students. That thought lead to the question of how an instructor alone in a laboratory with some technology could keep this antibiotic discovery CURE alive.

The answer to the question of how to engage students safely and continue the CURE was Zoom. Students scheduled individual 1-h meetings with the instructor during our remote learning, which allowed students to play an active role in their project and obtain some last characteristics of their bacteria (Appendices 4, 5, and 6). Many media plates and tubes were inoculated during these meetings to provide...
students with their specimens’ characteristics as originally intended for their projects. Selective and differential media, along with biochemical characterization and antibiotic resistance tests, were performed on the isolated specimens. Students were given some choices about tests to proceed with, but to follow the model originally prescribed, students generally performed all tests on their samples.

In order to have students see as much of the process as possible and help direct it, the instructor modified a laboratory space to include a laptop with a camera, a phone with a camera, and a surface mount for the cell phone to stabilize it so the instructor had both hands free to work with samples (Appendix 7). During the sessions, the instructor would place the sample plate under the phone camera and have it spotlighted for the meeting. This technique allowed the student at home and the instructor in the lab to see the plates and movements, while also seeing the other person, which added to the sense of engagement for both the instructor and the student. Then, with direction from the student, the instructor would obtain the specimen sample aseptically and then plate the sample with a simple streak. The goal was to have the student explain the process and the instructor simply act as the hands for the experiment. Since the meetings were individual, they allowed for discussion between the instructor and student about why choices were made in favor of that specimen, which mimicked more of the principal investigator–student relationship present within undergraduate research experiences (UREs) (6).

To enable students to continue writing descriptive notes about their specimens, pictures of each test result were taken using a camera and shared with students on Microsoft Teams. Students met with the instructor to review results the following week and the conferencing allowed students to ask more questions about the type of results they achieved. Zoom recordings were sent to individual students, so they could review any of the discussions.

Instead of losing the small group experience of peer reviews and discussions during the pandemic, these methods were incorporated into this emergency model to provide students some interactions with other students experiencing the same problems and questions, much like the experience of UREs (4). The small groups permitted students to explain their data to one another and plan for our online symposium. Though the students no longer had the individual faculty review of their projects before the symposium as originally planned, the small group Zoom meetings allowed the students to comment on the design of each other’s presentations and required all to think of their audience and their data. The process also helped the instructor spend time with members of the groups and resolve problems experienced by multiple students at the same time.

CONCLUSION

Though this antibiotic discovery CURE was not optimal, lessons about how to save CUREs during emergencies can help future programs. In the IRB-approved teaching and scholarship study already under way, students expressed the desire to perform the characterizations in person, so they could observe more-intricate details from their samples. They appreciated the opportunity to continue their work, as they learned more about their bacteria. However, many wished for the opportunity to physically continue the work and test their specimens against other pathogens for potential antibiotic production. The allied health majors in this introductory microbiology lab also learned how antibiotics should be used, the need for more discovery including the type of work they were doing, and how efforts to educate the public need to be enhanced. Students preferred Kirby-Bauer antibiotic resistance testing and would have enjoyed spending more time with that procedure because of the connections they saw with their future careers in medicine.

From the instructor perspective, this method of individual meetings may not be feasible for all institutions or classes because of the time investment, unless additional assistance is obtained. The lab consisted of two sections, each with approximately 20 students, that met for 2 h twice a week, except during appointment weeks. Each of the approximately 40 students scheduled 1-h appointments weekly for several weeks with the one instructor. There were no lab assistants. To become more feasible, having assistants meet with students to set plates using the presented methodology and later recording results can reduce the primary instructor’s time investment, so that principal investigator–type meetings focus on discussions about the results and ways to move forward (Appendix 8). Such modifications could further mimic UREs.

SUPPLEMENTAL MATERIALS

Appendix 1: Course description
Appendix 2: Objectives
Appendix 3: Original CURE course outline set before pandemic
Appendix 4: Modified course schedule with considerations of pandemic
Appendix 5: Basic breakdown of 1-hour meeting with students for inoculation day
Appendix 6: Basic breakdown of 1-hour meeting with students for results day
Appendix 7: Description of modified laboratory setup
Appendix 8: More detailed description of beneficial modification with addition of an assistant

ACKNOWLEDGMENTS

The author has no conflicts of interest to declare.

REFERENCES


