The impact of unplanned remote instruction on a CURE paired with cookbook-style laboratory exercises

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INTRODUCTION

Course based-undergraduate research experiences (CUREs) have been well defined in the literature. These authentic research experiences can be designed in many different ways, ranging from fully faculty-guided to completely student-driven (Spell et al., 2014). The implementation of CUREs is growing within biology education because they have been shown to provide collaborative environments that foster engagement with the scientific process, while promoting iterative research through the process of discovery (Auchincloss et al., 2014). Due to the COVID-19 pandemic, the semester-long CURE developed by our group experienced a rapid transition to remote instruction, creating a pseudo-experimental condition to compare student performance across semesters in on-campus versus remote learning conditions. In this semester-long set of laboratory modules, students develop skills to assess exposure to environmental chemicals. As originally designed, students participate in hands-on cookbook-style labs to learn about sample extraction methods and are introduced to the CURE-project, which entails authentic sample extraction, data analysis, and presentation of a poster. Rather than completing the full set of modules, the COVID-19 cohort completed the canned labs, but were tasked with virtually viewing the experimental process and analyzing previously collected data. Previous work by Kirkpatrick et al. (2019), has determined that there was no significant difference in the positive impacts on students' attitudes between students who completed a computer-based CURE versus a bench-based CURE. This study examines if that holds true when the same research project is taken to a remote format.

METHODS

Participants (2019, n=29; 2020, n=39) were recruited into the study at the beginning of the term. After providing informed consent (IRB #18.34), students completed a pre-course questionnaire to assess baseline scientific self-efficacy and scientific identity using the persistence in the sciences survey (PITS; Hanauer et al., 2016) and a pretest consisting of short answer questions relating to the chemistry of chemical extractions and detections. Students then completed the course as designed or with transition to remote learning (see right). An identical midtest was performed after the initial sequence of cookbook labs. After completion of the CURE component, students again completed the PITS survey and the identical posttest.

RESULTS

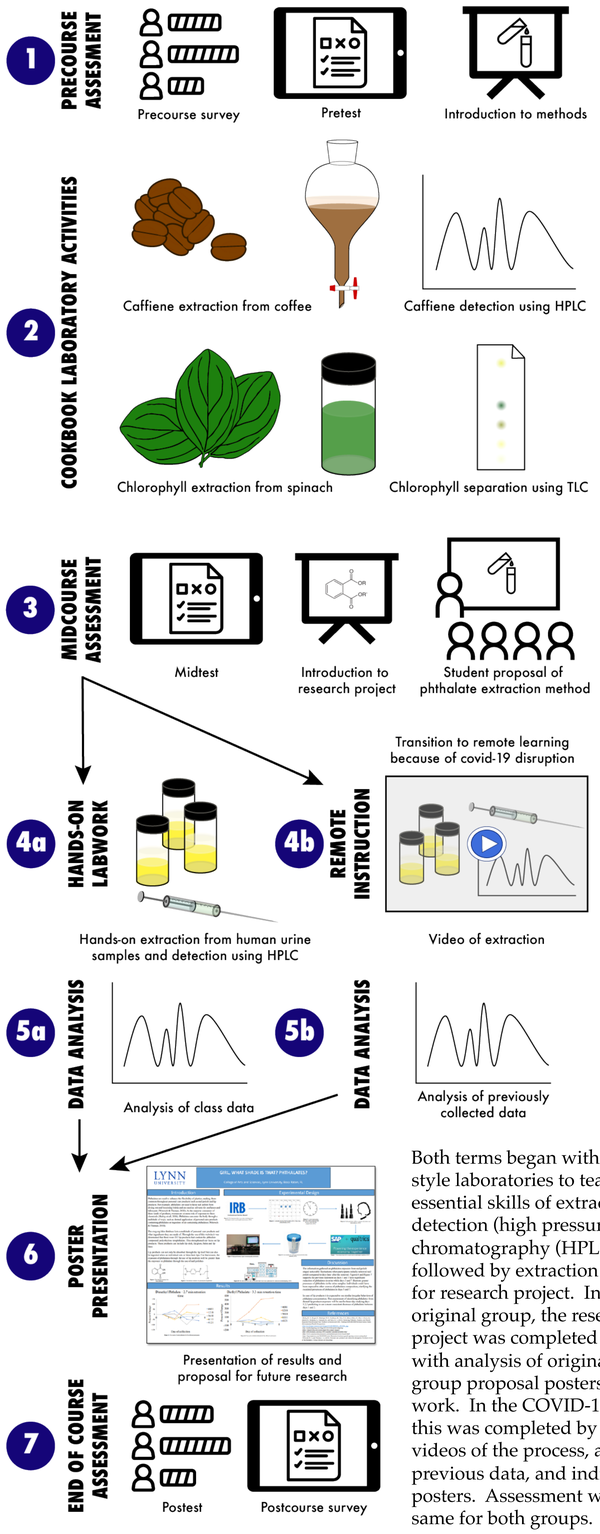
EXAMPLE STUDENT FEEDBACK

What did you like about the research project you participated in this term? Did it get you more interested in research in science?

"I like being able to participate in the phthalate research project this term because it made me fell like an actual scientists. It was great being able to learn real-life skills and techniques utilized within the lab, such as pippetting, using HPLC equipment and working with human-subjects."

"The research project that i participated this term was kind of short lived but still very interesting. What i like about it was finding out the huge results that phthalates in the urine showed and see how stoping the use of it really decrease by alot."

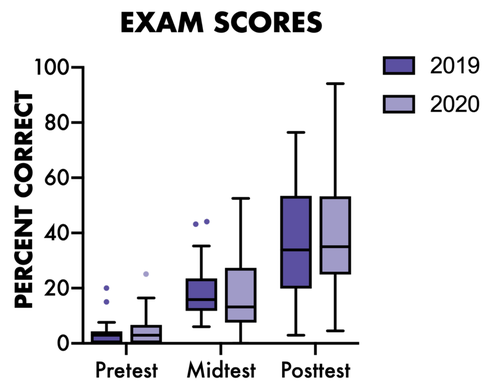
CURE DESIGN



Both terms began with cookbook style laboratories to teach essential skills of extraction and detection (high pressure liquid chromatography (HPLC)) followed by extraction proposals for research project. In the original group, the research project was completed in person with analysis of original data and group proposal posters for future work. In the COVID-19 group, this was completed by watching videos of the process, analysis of previous data, and individual posters. Assessment was the same for both groups.

Image credits: Survey by Adrien Coquet, teaching by Rajive, iPad by Anna Sophie, exam by BomSymbols, Test Tube by Barbara Marsillac, and presentation by Ikipoh from the Noun Project

RESULTS



Exam spread for pre, mid, and posttests across both academic terms (2019, n=27; 2020, n=37). Exam scores significantly improved through the duration of each term, $F\ (2, 124) = 138.92$, $p < 0.001$. However, there were no significant differences in exam scores between years, $F(2, 124) = 0.425$, $p = 0.655$.

	2019		2020				
Pre-course measures	*M*	*SE*	*M*	*SE*	*t*-test	*df*	*p*-value
Self-Efficacy	4.026	0.151	4.271	0.188	-1.274	64	0.207
Scientific Identity	3.99	0.178	4.08	0.207	0.407	64	0.685

Comparison of pre-course surveys across both academic years. No significant differences were observed across the two terms, indicating each student population was similar to each other. Post-course survey scores were not compared because of low completion rate in 2020 (n=9).

CONCLUSIONS

Overall, we found that students:
- Still reported enjoying the CURE
- Recognized the real-world applications of the CURE
- Requested to continue with the project

CURE implementation is growing as literature supports their efficacy in student learning and persistence. However, there are significant barriers to execution. This study highlights that use of cookbook-style experiments can have positive impacts on student learning when paired with a research project, even if the research project is not hands-on. Because cookbook labs may be both cheaper and easier to prepare, the bar for implementation of CUREs in undergraduate science courses may be lowered.

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