CUREing exposure to environmental chemicals from personal care products

Erika L. Doctor, PhD, Melissa Lehman, PhD, and Cassandra S. Korte, PhD
College of Arts and Sciences, Lynn University, Boca Raton, FL

INTRODUCTION

At smaller institutions, resources may present a barrier to providing quality undergraduate research experiences. Course-based undergraduate research experiences (CUREs) provide collaborative environments that foster engagement with the scientific process, while promoting iterative research through the process of discovery (Auchincloss et al., 2014). We implemented an intervention-based CURE project focused on reducing exposure to potentially harmful chemicals contained in personal care products. Exposure to compounds found in personal care products, such as phthalates, is common (Silva et al., 2004) and an emerging public health concern. In this experiment, students analyzed human urine samples collected from an intervention in which participants stopped using nail polish. Students then completed the semester-long project by proposing another iteration of the intervention study. This area of research lends itself to future iterative projects. Students with the best proposals are presented with the option for future individual research internships. This CUREs-based introduction to research lowers the barrier to individual research internships; a highly valued experience for STEM students (Thiry, Laursen, & Hunter, 2011).

TABLE 1. STUDENT LEARNING OBJECTIVES AND ASSESSMENTS UTILIZED IN THE CURE.

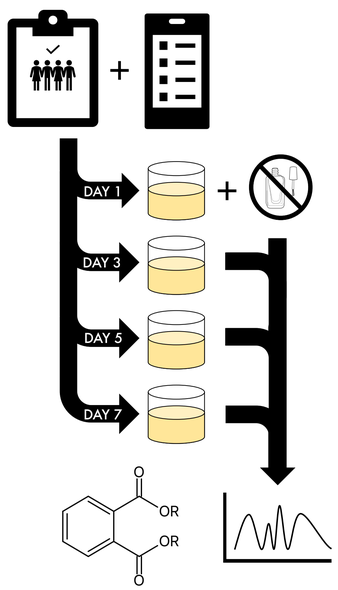
LEARNING OBJECTIVES	ASSESSMENTS
Describe toxicological pathways for absorption, metabolism, excretion of environmental chemicals	Exams
Explain sources of environmental exposures	Exams
Distinguish and properly conduct methods of liquid-liquid extraction and detection	Lab reports and exams
Search and evaluate scientific literature to identify appropriate methods	Oral report
Propose a feasible method of analysis for assigned samples in oral format	Oral report and exams
Quantitatively assess collected data	Lab report and exams
Design a research experiment in written format	Research proposal

CURE DESIGN

FIGURE 1: INTERVENTION DESIGN

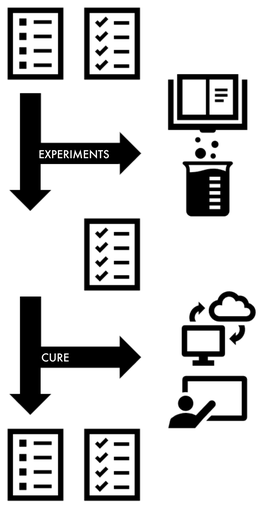
Participants are recruited from a variety of locations across campus. Once recruited, they attend a one-on-one session with a research assistant to obtain consent, complete a survey, and learn about the study requirements.

On day one of the study, participants provide a first morning void, and remove any nail polish they are wearing. They provide samples again on days three, five, and seven. Samples are collected by a research assistant and stored until analysis. Phthalate content is assessed using high-performance liquid chromatography (HPLC).



CURE DESIGN

FIGURE 2: CURE DESIGN



Participants were recruited from Organic Chemistry II Laboratories.

Participants were assessed through content-focused examinations at the beginning, middle, and end of the course. They also took pre-course and post-course PITS surveys (Hanauer et al., 2016).

The first 4 weeks exposed students to methods of extraction and detection through previously designed experiments.

Students were introduced to the intervention study then developed and presented their own hypotheses and methods. The following five weeks were dedicated to extraction and detection of specific phthalate metabolites.

RESULTS

Twenty-nine participants were initially recruited from Organic Chemistry II lab, 26 completed both the pre- and post-course survey. Participants ranged in age from 19-29, with mean age of 21 and were mostly graduating (65.5% were graduating in their third or fourth year). Backgrounds were diverse (31% white, 27.6% Hispanic, 31% black, 3.4% Asian, 3.4% other).

TABLE 2. PAIRED-SAMPLE T-TEST FOR SCIENTIFIC SELF-EFFICACY AND SCIENTIFIC IDENTITY PRE- AND POST-COURSE.

	Pre-course		Post-course				
Measure	*M*	*SE*	*M*	*SE*	*t*-test	*df*	*p*-value
Self-Efficacy	4.69	0.23	5.33	0.13	2.83	25	0.009
Scientific Identity	3.96	0.16	4.25	0.15	1.60	25	0.122

TABLE 3. NETWORKING ABILITY, OWNERSHIP OF PROJECT CONTENT, AND PROJECT EMOTION AFTER COMPLETING THE COURSE.

Measure	*M*	*SE*	*t*-test	*df*	*p*-value
Networking	3.75	0.22	3.44	25	0.002
Project Ownership Content	3.62	0.19	3.29	25	0.003
Project Ownership Emotion	3.56	0.17	3.22	25	0.004

TABLE 4. EXAM PERFORMANCE BEFORE, DURING, AND AFTER THE COURSE.

	M	*SD*	*N*
Exam 1	3.55	4.963	27
Exam 2	19*	10.146	27
Exam 3	37.78**	21.287	27

$F(2,52) = 66.29, p < 0.001$
* for significant difference in exam performance compared with exam 1 by paired samples t-test, $p < 0.001$
** for significant difference in exam performance compared with exam 2 by paired samples t-test, $p < 0.001$

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?

"The project for this lab, extraction and quantification of phthalates from urine, was really cool because it was a real world application of the science. Also, just going to be real, it was pretty awesome seeing the paper I found actually work and have a reproducible procedure that gave a result."

"I enjoyed working with a team to create a finalized poster that showed off our work. It did not get me more interested in research in science though, as organic chemistry is not my favorite science subject."

"I liked how all the experiments performed through the semester prepared and trained us for our final research project. It was a cumulative learning experience."

FIGURE 3: EXAMPLE STUDENT POSTER

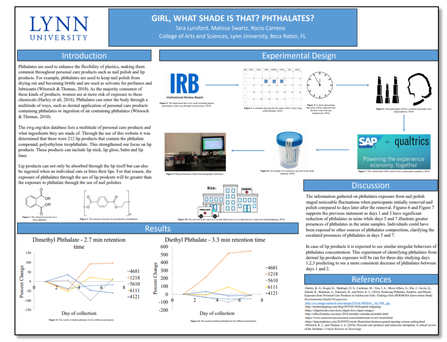


FIGURE 4: EXPOSURE RESULTS

CONCLUSIONS & FUTURE WORK

Overall, we found that students:
- Reported enjoying the CURE
- Recognized its real-world applications
- Significantly increased in Self Efficacy
- Had higher Networking and Project Ownership Content and Emotion
- Requested to continue with the project

In the immediate future, we plan to continue performing the CURE in our Organic Chemistry laboratory class to increase sample size, and thereby statistical power. In our next iteration, we plan to capitalize on our small class sizes and collect qualitative data through open-ended survey questions about students' experiences.

ACKNOWLEDGEMENTS

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REFERENCES

Auchincloss et al., 2014. *CBE-Life Sciences Education, 13,* 29-40.
Hanauer et al., 2016. *CBE-Life Sciences Education, 15*(54), 1-10.
Silva et al., 2004. *Environmental Health Perspectives, 112*(3), 331-338.
Thiry et al., 2011. *The Journal of Higher Education, 82* (4), 357-388.