Pilot course-based undergraduate research experience (CURE) results in student gains and novel urban ecology data

Suchy, A.K[1]., J.J. Elser[1], S.E. Brownell[1], N.B Grimm[1], and E.E. Shortlidge[2]

[1]School of Life Sciences, Arizona State University, PO Box 874501, Tempe, AZ 85287-4501; and [2] Biology Department, Portland State University, PO Box 751, Portland, OR, 97207

Introduction

- Course-based undergraduate research experiences (CUREs) are courses in which students experience the process of science through addressing novel research questions that have relevance to local and/or scientific communities.
- CUREs have the potential to amass valuable scientific data while also engaging students in genuine research, ultimately improving student interest and retention in science.
- We implemented a pilot CURE in two sections of an introductory biology course lab (Bio 151). Six sections remained a "traditional" lab with weekly labs corresponding to lecture materials. In this quasi-random design, students did not know before signing up for the section that they would be doing a CURE or a "traditional" lab.

Course Objectives

Students will:

- Engage the "process of science"
- Make connections between course content and their local environment and lives
- Learn hypothesis-driven research skills
- Work collaboratively
- Gain relevant quantitative skills
- Communicate science

Causal question addressed in CURE lab

- What affects CO_2 emissions and nutrient limitation in urban lakes?

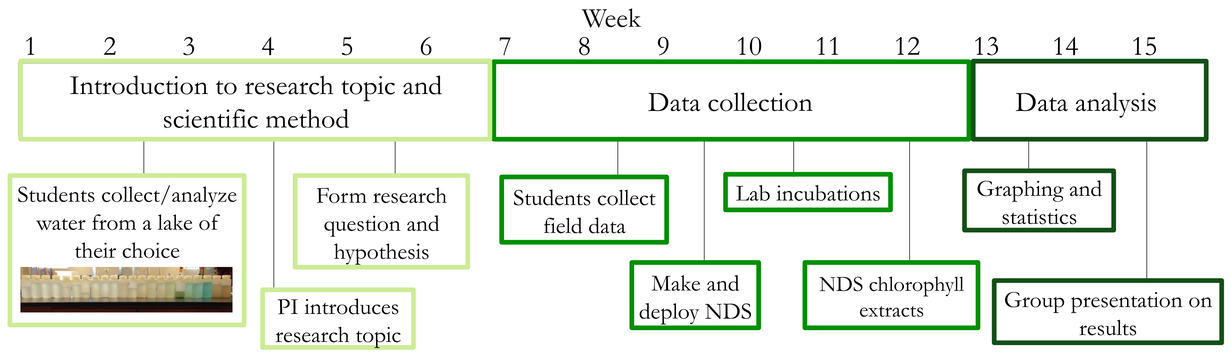
Hypothesis

- We hypothesized that water source affects CO_2 emissions and nutrient limitation.

Approach

- Six lakes in Tempe, AZ were selected: 3 were maintained with groundwater and 3 with surface water.
- Students collected data on water chemistry, CO_2 emissions, and nutrient (N,P) limitation via lab incubations and nutrient diffusing substrata (NDS; Figure 3).

Course Timeline



Student Outcomes

CURE students perform better in Bio 151 than predicted

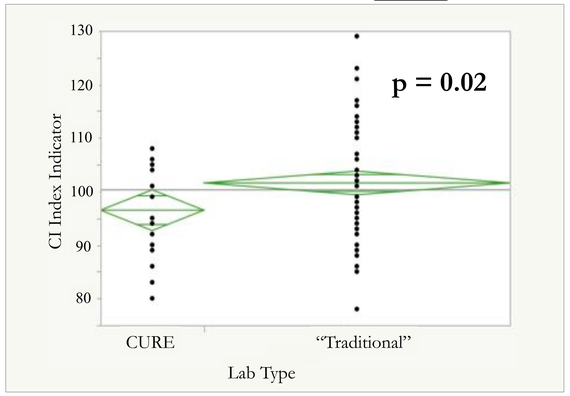


Figure 1: Comparison of CI scores for students in CURE and "traditional" labs. CI score is a significant predictor of students' final grade in Bio 151.
CURE lab n= 24; "Traditional" lab n = 71; t=2.30

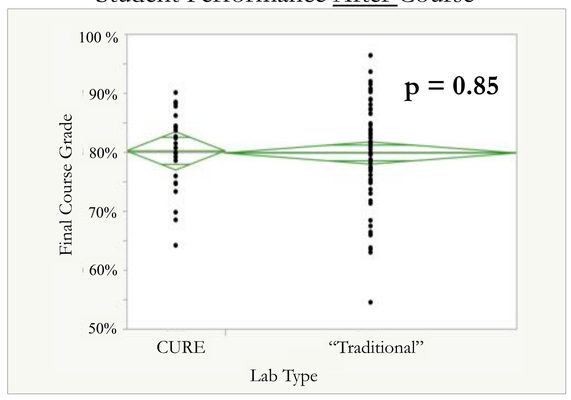


Figure 2: Comparison of final Bio 151 grade for students in CURE and "traditional" labs.
CURE lab n= 24; "Traditional" lab n = 71; t=-0.19

Attitudes

Students were asked: **What is your level of interest in the research question we are addressing in class? Why?**

	Positive Response	Negative Response
Before Experiments	20	20
After Experiments	30	10

Table 1: Open-ended responses were coded as "positive" or "negative" before and after the completion of the class experiments (n=40).

	Week 4	Week 13
Explain what you think it means to 'think like a scientist'.		
CURE Student 1	"To think like a scientist is to analyze current situations while keeping in mind different laws of science. It is to use the scientific method to derive a hypothesis or a theory."	"To think like a scientist is to think positively and analytically. You cannot expect to get things right the first time around so you must be resilient and not give up."
Was working collaboratively with your peers in Bio151 a positive experience, a negative experience or something in between?		
CURE Student 2	"Working collaboratively was definitely a positive experience for me. Basically all I got out of the whole exchange was a nice comment about how good my summary was, so I think that made this experience a positive one. I liked getting the positive feedback on my paper and I also enjoyed seeing how someone else would write their summary."	"Working collaboratively was definitely a positive experience because I love working together with a couple of people and all achieving one main goal. It feel like a cool learning and bonding experience and I like how it brought me closer to a couple of people who I worked with."

Table 2: Student responses to weekly survey questions at the start and end of the class.

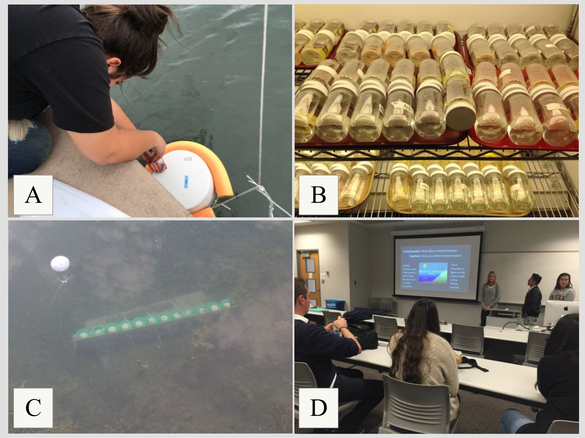


Figure 3: (A) Student taking gas samples in the field; (B) Incubations; (C) Nutrient diffusing substrata; (D) Students presenting their final results.

Results/Conclusions

- Students successfully collected novel data on urban lakes suggesting urban lakes maintained with groundwater tend to be phosphorus limited.
- Final course grades did not differ between CURE and "traditional" lab students. It appears as though the CURE diminished the achievement gap between these students populations (Figure 1).
- CURE students did not appear to be disadvantaged from a lack of reinforcement of lecture "content" in lab.
- Open-ended formative assessment reveals that at the end of the CURE, students perceived the CURE research question as more important than they did at the beginning of the CURE (Table 1).
- Preliminary analysis indicates that students may be able to better recognize the complexity of the scientific process and the value of collaborative work at later points in the course (Table 2).

Acknowledgements

Many thanks to Jennifer Hale for lab support; Courtney Currier and Lindsey Pollard for all their limnology insight; Emily Olsen for qualitative data analysis; Ariel Anbar for summer support; the Bio 151 students who made all this possible.