



A Model for a Course-Based Undergraduate Research Experience (CURE) in a Field Setting[†]

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INTRODUCTION

Undergraduate research experiences have many positive effects on students, including increased engagement (6), understanding of scientific processes (11), interest in science as a career (4, 9, 10), and persistence in scientific fields (5). Despite this strong incentive, many students are leaving college without authentic research experiences (10). At the University of Minnesota, where undergraduate research experiences have been widely promoted for many years, fewer than 20% of the students in the College of Biological Sciences are participating in faculty-mentored research. Course-based undergraduate research experiences (CUREs) enable more students to gain research experience, compared with the traditional *apprenticeship* model, in which a student works in a principal investigator's lab alongside post-doctoral associates and graduate students (2). CUREs therefore represent a promising tool for providing more students with valuable research experiences.

Several CURE models exist for traditional laboratory settings (1–3), and CUREs are now being developed for field settings (examples can be found on the CUREnet website at <https://curenet.cns.utexas.edu>). However, students seeking field-based research experiences may find the more typical off-site experiences prohibitively expensive (for example, a one-month Organization for Tropical Studies field course costs ~\$6,000, excluding international airfare), and field-based, National Science Foundation–supported Research Experiences for Undergraduates (NSF-REU) programs are staggeringly selective, with opportunities severely limited by federal investment. Therefore, students who are interested in meaningful field-based research experience may rely more heavily on CURE options than those pursuing laboratory-based research opportunities. To overcome the barriers associated with engaging students in field-based research experiences, we propose expanding on the CURE model to provide field-based research experiences to more students.

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[†]Supplemental materials available at <http://asmscience.org/jmbe>

Previous work on CUREs in traditionally field-based disciplines, such as ecology, have shown promising impacts on student achievement and self-confidence (8), warranting the development of additional models for field-based CUREs.

In the same way that laboratory-based CUREs scale up the typical apprenticeship model for student research, field-based CUREs have the potential to give many students authentic science experiences in a field setting. Previous work has demonstrated that students participating in field experiences reported an increased interest in intellectual challenges and confidence in ability to solve problems, two skills that are imperative for training students to address complex research questions (7). Providing students interested in field biology options for research experience early in their career will help develop the next generation of adequately trained field researchers, and using a CURE format could address some of the access issues that undermine participation by students in previously underrepresented groups in fields such as ecology, forestry, and conservation biology.

PROCEDURE

We report on a successful field-based CURE, Foundations of Biology Lab, offered as one of several options for a required introductory-biology research-focused course. Students historically enroll in a bench-based version of the course, offered on the University of Minnesota's main campus (in the Twin Cities, MN, USA). This modified version of the course is advertised as a field-based, summer-enrollment option for students with interests in ecology, animal behavior, or aquatic biology. Students are expected to invest approximately 30 hours per week in the course—in and out of class. The course is offered at the University's field station, Itasca Biological Station and Laboratories (IBSL), in Itasca State Park. IBSL is situated on the shores of Lake Itasca, two miles from the Headwaters of the Mississippi River, and within easy access of dozens of glacial lakes, prairie, bogs, and pine forests. The course is taught as an upper-level course, typically enrolling students the summer between their sophomore (2nd) and junior (3rd) years.

Our experience (including research outcomes and student feedback) suggests that a five-week field-based

CURE is successful in providing a small group of students (ideally, 10 to 20) with authentic field-research experiences (Table 1). Students are assigned readings prior to the start of the course and are encouraged to brainstorm research questions, using the assigned readings as a springboard. An online collaborative bibliography, with meaningful annotations, is a useful tool throughout the course, and student submissions are expected weekly. In the first class meeting, students discuss their assigned readings in a “jigsaw” format, whereby each student reads one or two papers but becomes familiar, through group discussion, with the main points of several works. Students spend the first week in the field getting practice with field techniques and becoming familiar with model systems (our course emphasizes a parasite–host system—fathead minnows and a trematode that encysts in the minnow’s brain—and antibiotic-resistant microbes in natural settings) and conclude the week with the first draft of a research proposal. The bulk of the course involves daily planning sessions, followed by student-driven field and lab work. Instructors and onsite experts facilitate student activities. Additionally, written work is subject to regular peer review.

CONCLUSION

The following criteria have been identified as essential features of a CURE experience (2): use of scientific practices, discovery, broadly relevant or important work, collaboration, iteration. Appendix 1 illustrates how our course meets these criteria, while giving students the skills expected from participation in a longer-term, more-traditional research apprenticeship. Post-course focus groups showed that student ownership of projects was high, possibly because they selected their own research question and worked in self-selected research teams, so project success was not dependent on randomly assigned team members. As a consequence, students were willing to work nights, weekends, and in inclement weather to collect necessary data. Students reported that they spent more time on this course than on other courses of similar credit value but also reported that they learned significantly more in this course.

Additionally, students reported increased confidence levels due to a variety of interactions with research professionals throughout the course.

In addition to positive self-efficacy outcomes and general enthusiasm for the experience, students produced high-quality written reports that may form the basis for future publications in the primary literature. All students presented their projects at the end of the five-week period. Evaluation of these written reports and oral presentations showed student growth akin to that typically seen after an entire semester in a traditional apprenticeship-style research experience. Overall, our experience suggests that a five-week field-based CURE is an effective tool in not only engaging students in field-based science, but also promoting growth in broadly applicable science skills.

SUPPLEMENTAL MATERIALS

- Appendix 1: Characteristics of a CURE and demonstration characteristics from field-based CURE
- Appendix 2: Example of student final research paper
- Appendix 3: Example syllabus
- Appendix 4: Example research paper guidelines
- Appendix 5: Example research paper grading rubric

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TABLE 1.
Recommended timeline and activities for implementation of a CURE in field settings.

Time Period	Activity/Assignment	Product(s)
Pre-Course	Assign reading and guiding questions	Brainstorm research questions, begin annotated bibliography
Week 1	Literature jigsaw in targeted model systems Preliminary feedback on research questions, skill building for field work	Collaborative annotated bibliography, first draft of research proposal
Weeks 2–5	Independent field work with instructor feedback throughout the week	Drafts, with peer-review and instructor feedback, of introduction, methods, results, and discussion
Week 5	Data analysis and writing of final presentations	Final oral presentation and written report

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