Teaching and Learning Biology at CU: Final iSTEM Project Report
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Overview
The iSTEM funding supported three purposes: First, an evaluation of the MCDB 4811/5811: Teaching and Learning Biology (TALB) course, including an examination of its effectiveness as a teacher education and educational research recruitment tool; second, suggested revision of the course when it is offered again in the fall of 2010; and third, dissemination of the course model.

In meeting these research goals, I have produced three outcomes:
• Evaluation and suggested revisions of course through analysis of TALB data.
• Dissemination of course model by organizing and chairing a National Association of Research in Science Teaching (NARST) symposium.
• Draft editorial manuscript on the TALB course.

I will detail each of these outcomes in the sections below.

Evaluation and Suggested Revisions of TALB

Qualitative analysis of the data indicated that the dataset for evaluation of the course was incomplete in many areas; we had only four interviews, and only 8 consented to complete the full evaluation survey. Future offerings of the course will focus upon collecting data from more students to be able to more completely describe how student learning changes through the course (e.g. through journaling, repeated administrations of the BCI and other conceptual inventories, shorter interviews with more students). From the data we did collect, the following themes emerged.

Students are not accustomed to reflecting upon their own knowledge of biology, in particular their understanding of evolution.
Documents from the first weeks of the course indicate that students were frustrated by shortcomings in their own knowledge of biology, in particular evolution, in the first weeks of the course. The mechanistic view of cellular processes seemed to put students in a position where, when asked questions about organisms and environments, they had little knowledge to stand on. As one student put it, “Sometimes I forget I forget we’re talking about living things.” Future iterations of the course should more explicitly support students in the reconstruction of their own understanding of fundamental topics in biology, rather than just showing them they didn’t ‘get it.’

Students are not considering educational research as a potential career because they do not know it exists.
In reviewing the evaluation data on the course, this was clearly the most important outcome of TALB: the fact that students in the molecular biology department – and, in fact, most likely many of the science departments – are not being exposed to teaching and educational research
as potential careers. According to one student in an interview, “I didn’t realize there was gonna be so much focus on the research aspect of things, especially since I didn’t even know that realm really existed.” On the course evaluation survey, students also commented “I’m more interested in teaching than I was before” and “It increased my knowledge on educational research sciences.”

Students had mixed reactions to the course topics and project. Student responses to the evaluation survey indicate that course goals were not clear. Some students wanted more specific emphasis on teaching and classroom applications, while others thought that too much time was spent on certain topics.

Students completed a wide array of course projects in which they conducted ‘Private Universe’ style investigations into student understanding of a core concept in the life sciences. These projects were challenging to students and required them to read educational research on a concept, conduct focused conceptual interviews with multiple students, code their data, and write up their results.

Students expressed mixed responses to the course project. One student felt it was irrelevant and another thought it took up too much course time. In contrast, other students thought that they should be able to start their course projects earlier.

These results suggest that the goals for the course should be more clearly articulated at the beginning of the course so that students and instructors are all clear on the purpose of the course, as well as the role of the final project in meeting that goal. We should be clear with students that the intention of the course is not to teach instructional methods, but to investigate students’ own understanding of biology, and to learn about how the process of educational research informs what we know about how students learn science.

The course served as a recruitment pathway into education-related careers and experiences. Among the 22 students who took the course in the fall of 2008, I observed students pursuing a number of biology education-related experiences, including:

- 2 new applicants to teacher education programs
- 1 MCDB Honors thesis focusing on educational research;
- 2 students were awarded UROP funding to work in my research group;
- 1 student sought work after graduation in educational research projects, took a school of education course, and will attend graduate school at Purdue to receive a discipline-based educational research PhD.

This result suggests that future iterations of the course should more explicitly involve field experiences for students wishing to engage more deeply in the process of educational research or teaching. A possible way to involve students could be a course assignment in which students choose from a menu of half-day experiences and write about it in the context of course readings. Options could include shadowing a K-12 biology teacher in a local school, attending an educational-research oriented symposium on campus, interviewing a graduate student or professor in the school of education or MCDB department to discuss their own career pathways, or assisting in an educational research project.
**TALB has a potential audience in the School of Education**

Since offering the course, I have responded to a number of queries about when it will be offered again from students in our education programs. For many of these students, it is important that they be able to take the course in the School of Education toward their degree programs. To make TALB more accessible to the School of Education audience, I have cooperated with Jennie Whitcomb, Associate Dean for Teacher Education, to rewrite the course description and present the course to be cross-listed in the School of Education and more directly marketed to our teacher education and Master’s Degree audience. The course timing will be moved to meet once a week in the late afternoon to make the course accessible to practicing teachers as well. Due to the schedule of courses being rolled out as part of the CU Teach program, it was not possible to teach the revised course in the Fall of 2010; however, I have spoken with Prof. Klymkowsky and we currently have plans to teach the course again in 2011.

**Dissemination of Course Model at NARST**

Another major outcome of the funding has been dissemination of the course model itself, and the facilitation of a conversation across university sites with professors who have developed similar course models. To that end, I organized and chaired a session at the NARST conference, held in Philadelphia, PA in March 2010 on “Exploring the Utility of Discipline-Specific Pedagogy Courses in Science Teacher Recruitment and Preparation.” The format of the symposium was to have each professor share the model of the course at their university, and then hold a focused discussion among the presenters and attendees regarding the courses.

The symposium included the following speakers and presentations:

**Model 1: Teaching and Learning Physics in a School of Education**
Jill Marshall, University of Texas at Austin

**Model 2: Teaching and Learning Physics in a Physics Department**
Noah Finkelstein, University of Colorado at Boulder

**Model 3: Teaching and Learning Biology in a Biology Department**
Erin Marie Furtak & Michael Klymkowsky, University of Colorado at Boulder

**Model 4: Teaching and Learning (High School) Biology in a School of Education**
David E. Kanter, Temple University

The symposium was well-attended by professors in science departments and schools of education, and the discussion led to a number of interesting avenues for future work. Of particular interest was the perspective taken by each professor on the role of his or her course and the exchange of suggestions for course projects and readings. When Prof. Klymkowsky and I teach the course again we will be in contact with other presenters from the symposium for input and feedback.

**Draft Editorial Manuscript**

Another proposed outcome of the iSTEM funding was to draft a manuscript on the course for
Cell Biology Education or Science Education. However, as I described above, the limited data we collected from the course make the construction of a complete manuscript that documents student learning through the course difficult. Future iterations of the course will involve more systematic data collection to tell the story of students’ learning as they progress through the course. In the meantime, Prof. Klymkowsky and I continue to work on a shorter, editorial version of a manuscript that describes the course and our finding about student access to educational research careers. This manuscript is currently in preparation and we intend to submit it to a journal such as Science or The American Biology Teacher.

In closing, I express my gratitude to the iSTEM Program Directors for their gracious support of my evaluation of the TALB course. The funding made possible more systematic reflection on the course than would have otherwise happened, and facilitated connections between other professors teaching similar courses with faculty at CU-Boulder.