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Re-designing Biochemistry Laboratory to Implement BASIL CURE: from Structure to Function, from Student to Researcher

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Abstract

Course-based undergraduate research experiences (CUREs) have recently emerged as an alternative to traditional science laboratory instruction. Cross-institutional faculty communities help crowd-source curricular design and assessment, as well as facilitate data sharing and trouble-shooting. As participants in the Biochemistry Authentic Scientific Inquiry Laboratory (BASIL) community, we re-designed our upper level biochemistry laboratory course to incorporate CURE. Scientific objectives of BASIL focus on characterizing biochemical activities of proteins with known structure and unknown function. BASIL curriculum (freely available on GitHub **https://basilbiochem.github.io/basil/**) includes modules on computational predictions of protein function, protein purification, and analysis of biochemical activity and kinetics.

Over the course of four years, our implementation has evolved to accommodate local needs and constraints and to address technical, logistical and pedagogical challenges we encountered along the way. We discuss this evolution in light of recommendations for CURE course design (Kloser et al., 2011) and the five dimensions of CURE (scientific practices, discovery, relevance, collaboration, and iteration; Auchincloss et al., 2014). Three main challenges for our implementation included 1) scaling of research training from the “apprentice” model to the classroom, 2) alignment of course learning objectives, activities and assessments with research goals to create optimal conditions for productive struggle, 3) student buy-in.

CURE implementation presents challenges with timing of research experiments in a scheduled course, availability of equipment, management of reagent requests and hazardous waste. Instructional support staff (AML) was critical for overcoming a number of logistical, technical and pedagogical challenges. In addition, undergraduate students pursuing research projects outside of class contributed to the CURE by developing new protocols, testing new proteins or generating computational predictions using tools that were outside the scope of the course. To understand if/how students in our course develop laboratory research skills, we began assessing anticipated learning outcomes previously defined by Irby et al. (2018), focusing on students’ evaluation of protein purification experiments. Initial assessment results revealed learning difficulties and led to modifications in instructional activities, including use of simulated experiments. To gauge student frustration and to help students improve their metacognitive skills, we asked students to reflect on their experiences in short weekly structured journal entries. Students’ negative perceptions of failed experiments, potentially, rooted in fixed mindset, require additional intervention.

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