Supplemental Material

CBE—Life Sciences Education

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Supplemental Material

Supplemental 1. The additional prompts from the open-ended survey (Step 2) and responses from the lead designer.

Questions from the open-ended survey	Responses from the lead designer
In your own words, please describe the biochemistry lab course that you will be implementing as part of the IUSE NSF project.	In the lab, we use a CURE approach. The instructors have some ideas about the possible role of the enzymes we are studying, but the final answers are unknown and there is lots of room for discovery.
What are the necessary components that characterize a research-like laboratory course experience?	1. Develop a hypothesis 2. Propose experiments 3. Collect data 4. Interpret results 5. Repeat the process iteratively
In your own words, please describe hypothesis-driven thinking.	You encounter a problem and want to find a solution. You look at the evidence and the system. Based on that knowledge, you suggest the next thing that you think will happen. Then you design experiments to test that suggestion or hypothesis.
Please explain the process you, or other scientists, use when generating a hypothesis about protein function.	1. Collect all available data using structural bioinformatics tools. 2. Compare the results from the different tools and look for common threads. 3. Study the organism that is the source of the protein. Is there anything unique or unusual about this organism that might provide a clue about the protein's function. 4. Hypothesize a function for the protein. 5. Identify possible substrates, ligands or binding partners from the literature and commercial suppliers. 6. Buy the stuff and test your hypothesis.
Now that you have had experience learning about and teaching the computational portions of the lab course, what are some important things you have learned that you hope students will learn as well?	1. The results from the computational tools sometimes seem very clearcut, but every result contains significant uncertainty. 2. The data you input affects your results.
Explain how you, or other scientists, use enzyme assays and any other biochemical experiments to confirm protein function.	1. Enzyme assays will demonstrate if a protein will modify a substrate. 2. The assay results can indicate if a substrate might be physiological, based on the Km and Vmax values that are found. 3. It is possible to perform binding studies on a protein if you find a suitable probe.
Now that you have had experience learning about and teaching the biochemical experiments and assays used in this lab course, what are some important things you have learned that you hope students will learn as well?	1. A yellow color confirms a type of reaction. 2. That yellow color does not confirm function. It is only the beginning.

Supplemental 2. Full semi-structured interview protocol (Step 3).

1. In the survey, there was a question asking you to list and describe the types of representations you use, and how you use them, when thinking about or explaining protein function. You provided the following representations:

A. Enzyme assays: chemical reaction drawings help us to understand how the parts of a protein catalyze a reaction.

B. Molecular visualization: ligand binding demonstrates if a substrate binds to an active site.

    i. Enzyme assays
    ii. Chemical reaction drawings
        1. How the parts of a protein catalyze a reaction
    iii. Molecular visualization
        1. Ligand binding

   Could you please talk me through:

   a) How you would use each representation to reason about protein function;
   b) What types of biochemistry representations are useful for students to be familiar with to help them in this course?
   c) How you would like students to use them;
   d) What you observed students doing with each representation?
   e) Whether these representations are new to the students, or did they have some previous experiences with them? If so, describe the experiences they had.
   f) How would you know if students were having difficulties and whether they were improving?
   g) What type of things did students do to practice and overcome these difficulties?

2. Which biochemistry topics were most difficult for students?
    a. Were these topics new to the students, or did they have some previous experiences with them? If so, describe the experiences they had.
    b. How did you know if students were having difficulties and if they were improving?
    c. What type of things did students do to practice and overcome these difficulties?
    d. What were the biochemistry topics you hoped students would learn or improve on, as part of this course?

3. Which research skills were most difficult for students?
    a. Were these skills new to the students, or did they have some previous experiences with them? If so, describe the experiences they had.
    b. How did you know if students were having difficulties and if they were improving?
    c. What type of things did students do to practice and overcome these difficulties?
    d. What were the research skills you hoped students would learn or improve on, as part of this course?

4. How will you know if students meet the learning objectives of the course?
    a. How and what do you intend on assessing students?
    b. What things do you feel are easier or harder to monitor, observe, or assess?

Ask questions 5, 6, and 7 only if either these topics did not come up in response to above questions or you wish to explore them further:

5. What do you think about how the process detailed in the current protocols relates to the discovery process actual scientists apply to understanding protein function?

6. Please briefly explain how students learn the computational tasks in your class. What are students expected to do during this part of the lab?
    a. What do you hope students learn, and are able to do, after performing the computational portion of the lab?
    b. How do students, or scientists, use these techniques to come up with hypothesis?

7. Please briefly explain how students learn the wet lab tasks in your class. What are students expected to do during this part of the lab?
    a. What do you hope students learn, and are able to do, after performing the wet lab portion of the course?
    b. How do students use this part of the lab in assessing their hypotheses?