

## **Biologically-Focused Screencasts and ConcepTests for Chemical and Biological Engineering Courses**

John L. Falconer and Garret Nicodemus  
Department of Chemical and Biological Engineering

### *Summary*

The goal of this proposal is to increase the use of biological engineering topics in three core courses in the Chemical and Biological Engineering Department: Material and Energy Balances, Chemical Engineering Thermodynamics, and Fluid Mechanics. We propose to prepare teaching materials that can be readily used by faculty who do not have backgrounds in biological topics. We propose to develop two types of teaching materials that incorporate biological concepts:

- ConcepTests, which are multiple choice conceptual questions, used in class with clickers to empathize the important concepts in the course
- Screencasts, which are short screen captures of writing and narration on a tablet PC, can be used to solve example problems and provide further explanations.

Creating these teaching materials will allow students in these three courses to be exposed to biological concepts earlier in their majors. These courses are taken by both Chemical Engineering majors and Chemical and Biological Engineering majors, and were originally developed for Chemical Engineering majors and thus did not incorporate biological concepts or examples.

### *Background & Project Proposal*

The main objective of this proposal is to incorporate biological topics into three core chemical engineering classes. These courses are taken by both Chemical Engineering majors and students enrolled in the relatively-new Chemical and Biological Engineering major. Students in both majors take the same core courses in their sophomore year and the first semester of their junior year, and then their courses start to diverge. The three courses (Material and Energy Balances, Chemical Engineering Thermodynamics, and Fluid Mechanics) have not incorporated significant biological topics to date because they were originally developed for the Chemical Engineering major, and many of the faculty who teach them do not have expertise in biological topics. Thus, the students in Chemical and Biological Engineering major are not exposed to biological engineering concepts and problems in their sophomore and first semester junior year. Topics related to cell metabolism, bioprocess engineering, tissue engineering, and pharmaceutical biotechnology will be incorporated into these courses.

We propose to create ConcepTests and screencasts for faculty teaching these courses to incorporate into their classes. Research on science education has shown that conceptual questions posed in class, when combined with peer instruction, are more effective learning methods than typical lectures<sup>1-6</sup>. These conceptests (multiple-choice questions), which are used in class with clickers and peer instruction, can dramatically increase learning<sup>1,4,5</sup>. When class time is devoted to conceptests, students may feel that they are not provided sufficient examples of problem solving. One way to address this issue is to prepare screencasts, which are video

captures of material written on a tablet PC and accompanied by narration. These screencasts will be calculation examples, mini-lectures, and explanation of concepts. Screencasts will be posted online so students can access them at any time, and they can play them back to study portions that are unclear. Student feedback on screencasts from five courses where we have used them has been overwhelmingly positive. Many students “wish there were a lot more of them” and “found it to be the best part of the class”.

### *Proposed Schedule and Budget*

Initially screencasts and conceptests will be developed for the Materials and Energy Balances course. This is the first chemical engineering course that our students take, and thus incorporating materials into this course will make the progression to biological aspects in subsequent courses follow naturally. Next, they will be developed for the Thermodynamics course since this course has a lot of overlap with the Material and Energy Balances course. In the last part of this project, screencasts and ConcepTests will be developed for the Fluid Mechanics course.

The goal of this project is 30 conceptests and 15 screencasts that incorporate biological aspects in each of the courses. These teaching materials will be posted on our web site and feedback will be solicited from instructors at CU and at other universities. Feedback on the screencasts will also be collected from students in these classes.

The requested funding will be used to support a post-doctorate student with a PhD in Chemical Engineering whose thesis research was in biological engineering. The funds would provide support for about one-quarter of his time.

### *Intellectual merit and impact*

The objective of developing these teaching materials is to help faculty incorporate biological engineering topics into core chemical engineering courses taken by both Chemical Engineering majors and Chemical & Biological Engineering majors. Students will improve their understanding of chemical engineering concepts as they apply to bio-related processes.

These materials will support the ongoing efforts of STEM education by utilizing effective conceptual clicker questions in the classroom and by providing video resources that students anywhere can access anytime. The dissemination of these resources online through our current website ([www.learncheme.com](http://www.learncheme.com)) provides high visibility for the University of Colorado-Boulder. Presenting this work to the DBER group will also help promote these materials on our campus as well as solicit feedback on the use of screencasts.

Working on the creation of screencasts and conceptests will enhance my development as a future professor skilled in active learning methods. The focus on the production of biologically related resources will both help me to build collaborations with other faculty while learning skills necessary in course creation and expansion. Faculty in our department, as well as others, will be able to easily integrate new materials into their course while promoting a more active learning environment.

### *Evaluation*

The number of times that screencasts are downloaded or played on the web site will be tracked by software available on the Vimeo site and Google Analytics. Solicited feedback will help improve ConcepTests and screencasts, as well as focus development on specific topics.

### *Literature*

- 1) E. Mazur, *Peer Instruction: A User's Manual*, Prentice Hall, Upper Saddle River, NJ (1997).
- 2) E. Prather, A. Rudolph, G. Brissenden, and W. Schlingman, "A national study assessing the teaching and learning of introductory astronomy. Part I. The effect of interactive instruction", *American Journal of Physics*, 77, 4, 320-330 (2009).
- 3) M.K. Smith, W.B. Wood, W.K. Adams, C. Wieman, J.K. Knight, N. Guild, and T.T. Su, "Why Peer Discussion Improves Student Performance on In-Class Concept Questions", *Science*, 323, 122-124 (2009).
- 4) R.W. Preszler, A. Dawe, C.B. Shuster, and M. Shuster, Assessment of the Effects of Student Response Systems on Student Learning and Attitudes over a Broad Range of Biology Courses, *CBE Life Sci Educ* 6, 29-41 (2007).
- 5) A.P. Fagen, C.H. Crouch and E. Mazur, Peer Instruction: Results from a Range of Classrooms, *Phys. Teach.*, 40, 206-209 (2002).
- 6) C.H. Crouch and E. Mazur, Peer Instruction: Ten Years of Experience and Results, *Am. J. Phys.*, 69, 970-977 (2001).
- 7) J. E. Caldwell, Clickers in the Large Classroom: Current Research and Best-Practice Tips. *CBE Life Sci Educ* 6, 9-20 (2007).
- 8) D. Duncan, *Clickers in the Classroom*, Addison Wesley, San Francisco (2005).