Virtual Labs for General Education Biology
Robert Desharnais, Paul Narguizian, & Ji Son
Biological Sciences & Psychology, Cal State LA

Abstract
We redesigned a GE biology course using web-based software to replace traditional wet labs. Two new modes of lab instruction were compared to the traditional offering: (1) all labs online with a "drop-by" help center and (2) a hybrid "flipped lab" model. Both modes included a face-to-face lecture. Engaging inquiry-based exercises were developed around each online activity. Assessment involved the tracking of student attitudes and performance using grades and pre/post surveys. The flipped lab format was the best, showing increases in student grades and attitudes.

Motivation
GE biology labs should involve students in doing science, but most wet labs involve "cook-book" activities. GE labs are also a bottleneck for progress to graduation. Sections are limited to 24 students and must be staffed by an instructor. Many students register for these courses in their senior year. Virtual labs provide a hands-on opportunity for students to "achieve an understanding and appreciation of scientific principles and the scientific method," as specified in the CSU GE Breadth Requirements. Virtual labs are less costly and allow an increased number of sections to relieve graduation bottlenecks.

Course Redesign Models

Model 1 - All Labs Online
- All labs were offered online F13 & W14.
- Drop-in help center staffed 30 hrs/wk.
- Nine virtual labs used.
- Guided experiments designed around course concepts.
- Multiple choice questions to assess their learning.
- For three labs, students addressed a scientific problem by
  o formulating a hypothesis;
  o designing and carrying out experiments;
  o analyzing the results;
  o writing a brief scientific report.

Model 2 - Hybrid Flipped Lab
- Flipped lab model: guided assignments at home and higher-level group activities aided by instructors in lab.
- Students met every other week during Sp14 in the physical lab facility where
  o instructor introduced lab topic and software;
  o students discussed in groups the individual virtual lab assignments;
  o students worked in groups to formulate hypotheses, design and run experiments, analyze results, and write a brief scientific report.
- Off weeks, students worked on individual virtual lab assignments similar to Model 1.
- Class was divided into tracks A and B which met asynchronously throughout the quarter.

Online Labs that Were Used

Assessment Results
Students performed better with the flipped lab model and showed fewer repeatable grades.

Costs of Different Lab Models

Student Comments
"I liked the opportunity to put into practice what we were discussing in class and see the results for myself."
"I liked the fact that the virtual labs can be taken at home. It gave me a sense of independence. It made it possible for a lot of people to take this much needed course to graduate."
"Fun, interesting, and relevant to what we were learning in class."
"I liked the ease at which the experiments were manipulated, as well as the simple yet deep control of the experiment."
"Really simple to use, and you can go at your own pace."

Conclusion
Virtual labs used with a hybrid flipped lab model have the potential to increase student learning and attitudes towards science while simultaneously reducing bottlenecks to graduation.

Acknowledgements
This project was supported by the CSU Enrollment Bottleneck Solution Course Redesign with Technology program.

Contact Information
Robert Desharnais
Department of Biological Sciences, Cal State LA
Phone: (323) 342-2056
Email: rdesha@calstatela.edu