dB-SERC lunch discussion topic: Low cost approach for designing authentic learning experiences in upper-level laboratories
Discussion leader: Dr. Brian D'Urso, Physics and Astronomy

Lunch summary

Dr. D'Urso is redesigning upper-division physics labs to include more authentic research experiences for students. The redesign is low cost (~$50 for Arduino microcontroller boards and free open source software). Some of the questions and suggestions from faculty are discussed below:

Question: Would students in the upper-division laboratory course get credit for creating electronic devices for use in Dr. D'Urso's research lab? This type of activity may create a more meaningful, authentic learning experience for the students.
Students sometimes transition from the upper-division lab course to do undergraduate research in Dr. D'Urso's research lab. The project that they work on in the laboratory course can also be used in Dr. D'Urso's research laboratory.

Question: What is an example of a "prompt" that students receive? Answer: Students would be challenged to measure the resonant frequencies of a metal box and determine mode patterns. Given certain equipment, they should be able to answer the question.

Suggestion: Perhaps students can work with a computer simulation which deals with the research question, or prompt, before they work with the actual lab equipment. This might help students see the bigger picture of the experiment without getting "bogged down" in the details of setting up the equipment.

Suggestion: One way to set up the laboratory is to first guide students in using the equipment – help them get comfortable using and predicting how the equipment works. After students get familiar with the technology/equipment, students can then work on a "prompt." The first stage is more focused on scaffolding students to learn about the technology/equipment, and the second stage is more inquiry focused because students use what they learned about the technology/equipment to answer the "prompt."
For example, students could first learn about a device called a lock-in amplifier – learn the physics behind it and get comfortable using it and predicting how it works (as opposed to it being a "black box"). Then they can use the lock-in amplifier to answer a prompt, e.g., determine the resonant frequencies of a metal box. (Elia Crisucci, Sean Garrett-Roe, and Peter Drain all discussed how this type of method works in their own courses and how it could be adapted for Brian D'Urso's lab course).

Suggestion: Since there is one TA in Dr. D'Urso's laboratory, the TA needs to be trained. The TA should be helped to think about inquiry based approaches and how to act as a guide as opposed to just "giving the answer."

Question: What are the skills that the laboratory course develops? Are they general skills vs. physics content skills? Do students reflect on the types of skills used in the lab reports?

Suggestion: Part of the laboratory report should include a reflection in which students think about what general/specific skills were used. As students complete more labs, they can also compare and contrast the different labs and reflect on what skills were used in different cases (e.g., why a particular skill was used in multiple labs vs. why a particular skill was used in one lab but not another).

Suggestion: Students could report on their laboratory design (e.g., innovative design of an Arduino microcontroller) in a peer-reviewed journal. In addition, students could write a peer-reviewed grant proposal and other students in the course give feedback. Different departments in the university could request for proposals for solving a real problem in a lab and students in the upper-division lab course can write proposals to solve the particular problem. All of these activities help students see the “real world” application of their work and contribute to the authentic learning experience.