FY14 Innovations in Teaching with Technology Awards: Transforming Content Delivery in Advanced Chemistry Laboratory Courses

FY14 Innovations in Teaching with Technology Awards

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<th>Proposal Title:</th>
<th>Transforming Content Delivery in Advanced Chemistry Laboratory Courses</th>
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<tr>
<td>Investigators:</td>
<td>Renee Cole, Scott Shaw</td>
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<td>Org Unit:</td>
<td>College of Liberal Arts</td>
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<td>Department(s):</td>
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Laboratory experiences are a key component of learning in science and engineering fields. Well-designed laboratories help students develop skills in experimental design, data analysis, logical argumentation, scientific communication, and laboratory techniques. Finite resources and increased enrollment have made it impossible to use a method of 'linear' instruction in these courses, in which all students participate in pre-lab lectures, carry out the experiment, and perform analysis in parallel. The current approach, which is common across institutions with large enrollments in advanced laboratories, has students perform experiments in a rotating fashion, which entails multiple experiments running simultaneously each week. A challenge in this approach is delivering pre-laboratory lectures to ensure all students are prepared for each experiment. Traditionally this is accomplished by presenting pre-laboratory lectures for all experiments to all students at the beginning of the semester. This creates a significant disconnect between when students learn about the experiment, the instrumentation, and the data analysis and when they actually need to implement it.

The objective of this proposal is to circumvent this disconnect by creating digital content modules for each experiment in Analytical Measurements (4:143) and Physical Measurements (4:144). Content for each experiment will be scripted, choreographed, and recorded, allowing the 30-40 students in these courses each semester to access and review key information as needed. These videos will be structured in 10-15 minute installments in 3 general categories:

1. Fundamental underpinnings of the relevant experiment, physical theories and equations, and background for qualitative and quantitative understanding of the chemical process or measurement.
2. Demonstration of experimental process, technical aspects,, including sample preparation, instrument calibration, the process of the actual measurement
What do you intend to do?

3. Data analysis, creating spreadsheets, appropriate representation of data in figures and plots, and preparing written reports.

Videos will also contain important safety information for materials, techniques, and instrumentation to be utilized in the laboratories. To ensure that students have obtained the necessary information from these videos, we will develop computer-graded quizzes that will be completed by students prior to beginning each experiment.

The content of 4:143 and 4:144 includes a total of 18 experiments. Video development will be completed during summer 2014 to allow for implementation in 4:144 in Fall 2014; followed by 4:143 in Spring 2015. Evaluation of the effectiveness of this program will be carried out during the 2014-2015 academic year, and a comprehensive review will be produced in the summer of 2015 to determine needed revisions and possible extension of this model to other laboratory courses.

Content development will primarily occur during Summer 2014 with initial implementation during the 2014/2015 academic year.

1. The Co-PI’s will prepare and record the category 1 videos and will mentor both graduate and undergraduate students in scripting, recording, and video editing the data collection and analysis videos. The Co-PI’s will evaluate the effectiveness of this new content and be responsible for revisions.

2. The undergraduate student will be hired for 10-weeks in the summer to conduct and record experiments. She will work with the graduate student in video editing and annotating the videos for implementation.

3. The graduate student will work to develop quizzes with assessment items identified by the Co-PIs. The graduate student will also work with the undergraduate student to carry out video editing and processing to ensure key objectives are properly introduced and explained during the tutorials. The student will also assist with classroom observations to collect data for evaluation of the impact of the tutorials.

How will it improve student learning?

Numerous studies have shown that students who are well prepared for the laboratory are more successful in developing skills in experimental design, data analysis, scientific argumentation, and communication in addition to critical technical skills. There is also evidence that students need both conceptual and procedural understanding of experiments in order to obtain any long-term benefit of completing these activities. We know that in the absence of this support, students tend to focus on the immediate technical skills of collecting data rather than correlating the experience with the conceptual understanding that would lead to deeper learning. Studies have found that a blended approach to laboratory experiences where pre-laboratory activities are facilitated online improved the nature of student preparation and resulted in better...
experimental outcomes and improved student perception of the value of the laboratory experience.

We will need support for creating and editing the videos and for conducting the assessment of impact. The primary limitation for the implementation of these videos is the time and support involved in creating quality videos. Dr. Cole has made some attempts to create pre-laboratory videos for Chem 4:144. The implementation of these videos has received positive responses from students, but significant concerns by the instructor, TAs, and students have been noted regarding the quality of the videos and the need for additional resources. These videos have been made by simply recording the experiments while the instructor went over the procedure with the TAs. This experience has demonstrated the need to have a more structured approach to creating and editing the videos.

To accomplish this, and undergraduate student who is currently enrolled in Chem 4:144 and has previously taken Chem 4:143 has agreed to work on creating the video materials. Advantages of undergraduate student input in this project includes insights into what specific content is most needed to support student learning in the finished products. We will also need support to make sure the experiments work properly. The laboratory support technician (Deb Williard) has agreed to be available for 10 days during the 10-week period allotted for the execution of the experiments. She will aid in instrumentation troubleshooting, maintenance, or repair as needed for the 18 experiments to be conducted. This is a critical component to ensure the success of the project and has been financially sponsored by the Department of Chemistry.

Interactions with students during the laboratory sessions have also raised concerns regarding the extent to which students are engaging with the videos in preparation for the laboratory. To address these concerns, the co-PIs will work with a graduate student to create a set of pre-laboratory quizzes to promote appropriate student engagement with the videos. This will also comprise part of the assessment.

The department has access to a digital video recorder and tablet computers needed to create the videos, but will need some support from ITS in editing, formatting, and annotating the videos.

We propose to hire an undergraduate student for 10 weeks in summer 2014 at a cost of $4600 in salary + fringe benefits. This is comparable to the salary provided to students engaging in undergraduate research experiences in the department for the summer.
We propose to support a graduate student for two summers at a cost of $10,500 to help with the development and assessment of the materials.

IT Support Information