MAKING THE MOST OF HANDS-ON LEARNING – AN INTEGRATED COURSE AT RENSSELAER

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I. INTRODUCTION

Rensselaer Polytechnic Institute's (RPI) Nuclear Engineering curriculum takes advantage of available facilities to provide hands-on experiential learning to augment the classroom teaching of nuclear theory. Experimental facilities that are integrated into the curriculum include a radiation measurement and counting laboratory, a multi-purpose laboratory nuclear physics and fluid dynamics laboratory, a 100-watt Reactor Critical Facility (RCF), and a 100-MeV linear electron accelerator (LINAC). Performing laboratory experiments requires a sufficient understanding of the underlying theory of the experiment, which is typically drawn from material presented separately, usually in other courses in the curriculum.

Focusing initially on the experiments at the RCF, RPI has sought to enhance the effectiveness of the hands-on laboratory experience by allowing students to review background theory at their own pace through an on-line blended learning environment. This multi-media platform is also used to record and preserve the experimental procedure to allow access to the experience away from the facility.

This blended learning modality enables delivery of the hand-on course both internally at RPI and externally to other institutions. This work was done in collaboration between RPI and United States Military Academy (USMA) at West Point which enables testing of the concept of remote delivery of laboratory sessions at the RCF.

II. CONSTRUCTING AN INTEGRATED COURSE

II.A. Theoretical Modules

The theoretical information necessary for performing the critical reactor laboratory experiments was broken into a series of topical modules, which were each assigned to an appropriate cognizant faculty to prepare. Each established experiment was associated with at least one of the theoretical modules so that each student would individually review the appropriate module(s).

The theoretical modules are presented through the *Blackboard* [1] environment consisting of note slides and a video of the faculty presenter. Presentations vary to best fit the lecture material, and may consist of a continuous lecture, or may be broken into small sections with "gateway" questions that students must answer before proceeding to the next section. Video demonstrations may be interspersed with the lecture material. All theoretical modules conclude with a quiz that is required for the student to demonstrate their competence in the relevant areas before being allowed to complete the experiment.

II.B. Laboratory Experiments

The laboratory experiments are well established, although minor updates may be included from year-to-year. Students perform a series of experiments throughout the course of the semester, rotating through various jobs such as operating the reactor controls (under the supervision of a licensed operator), monitoring reactor conditions, and taking measurements. For this project, the procedure is recorded using *MediaSite* [2], which permits both live streaming and later playback. The reactor facility has been outfitted with a set of cameras covering the reactor room, the control room, and the counting room. *MediaSite* can also display and record the output of a series of digital strip charts displaying the current reactor conditions, and a digital whiteboard in the facility where data may be recorded.

Video of experiments is not intended to supplant the hands-on experience at the reactor for Rensselaer students, but there are several options for its use. The recorded experiment may allow students to review the progress of the experiment individually after the fact. Due to limited space in the reactor facility, it is possible that a large class could be split into several sections, with one section physically present at the reactor for a given experiment, while other sections participate remotely via live streaming. Live streaming from the facility can also be used to involve students at remote sites, such as at other institutions, in experiments that they cannot attend.

III. RESULTS

Elements of the integrated course were pilot-tested in Spring 2010. A select set of theoretical modules have been produced and made available to students. Several of the experiments were also recorded to permit post-experimental review by students and sharing with USMA. A laboratory experiment recorded in the RCF was provided to USMA to enhance classroom and laboratory instruction at West Point. Army cadets majoring in nuclear engineering conducted a remote laboratory by watching a video and by writing a laboratory report based on the data from the laboratory provided by RPI.

The feedback from the cadets was positive. USMA has a well established laboratory program and their facilities include a sub-critical assembly but they do not have a research reactor. The cadets appreciated not only the opportunity to watch how a laboratory is conducted at another university and instructor but they also found utility in being able to see how a critical research reactor is used.

A key lesson from the pilot experience was the need for a movable or handheld camera to supplement the fixed camera positions in the facility to include a point-of-view record of the experiment and to cover areas that are not properly covered. Feedback from the produced modules will be reviewed to improve remaining modules. Future development also includes the integration of experiments at the LINAC facility into the blended learning course.

IV. CONCLUSIONS

Theoretical material necessary for performing hands-on nuclear engineering experiments is presented through blended learning platforms and integrated into an established laboratory course at Rensselaer. Experimental procedures are also recorded for possible later review or transmission to remote locations, such as USMA. The use of these tools is intended to enhance the effectiveness of the hands-on experience for the students.

ACKNOWLEDGMENTS

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REFERENCES

[1] Blackboard, Inc., Washington, DC, blackboard.com
[2] Sonic Foundry, Madison, WI, www.sonicfoundry.com