Work in Progress - Enhancing Students Learning Through Instructional Videos during Hands-On Laboratories on Renewable Energy Sources

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***Abstract* – At the University of California Santa Cruz, a renewable energy sources course is a theory based course that includes six hands-on laboratory experiments. The course is designed for engineering and non-engineering undergraduate students and does not require any advanced mathematics or physics background. Each laboratory experiment introduces a miniature version of an energy conversion device that mimics the insights and workings of a real scale device. The hands-on laboratory experiments illustrate principles of the; solar pathfinder, flywheel, hydroelectricity, wind turbine, thermoelectricity and a fuel cell. In the past, each laboratory consisted of paper based instructions, pre and post questionnaires and a laboratory kit. Since many students in the class were non-science majors and had difficulty following the paper based instructions, we substituted the paper based instructions with instructional videos to ease the kit assembly and enhance student learning by providing more time to focus on the data gathering and analysis processes by minimizing the assembly time. The instructional videos demonstrate the experimental set-up and a method for collecting the data during each hands-on experiment. This work in progress paper presents results of our findings.**

Index Terms – Hands-on laboratories, instructional videos, renewable energy sources.

INTRODUCTION

If a picture is worth a thousand words, then a five minute, 30 frames per second video is worth nearly nine million words. At the University of California, Santa Cruz, the Renewable Energy Sources course is a theory based course with 20 lectures and six hands-on laboratory experiments. Each laboratory experiment introduces a miniature version of an energy conversion device that mimics the insights and workings of a real scale device. The course is offered every spring quarter. This year, the six hands-on laboratory experiments demonstrate the principals of the; solar pathfinder, flywheel, wind turbine, hydroelectric, thermoelectric and hydrogen fuel cell car. All laboratory experiments can be found at http://seed.soe.ucsc.edu

Approximately 65 undergraduate students are enrolled in the course and are expected to complete all six hands on laboratories. The course is offered without any prerequisites and in this year the student body represents more than a dozen of diverse majors which included sociology, physics, environmental studies, astronomy, chemistry, bio molecular engineering an music.

In the 2009 offering of this course, a thorough assessment of all hands-on experiments was conducted and completed. During each laboratory session, teaching assistants wrote down questions that were asked by the students during each laboratory experiment. At the end of the quarter, it was concluded that the instructions for assembling laboratory kits and directions for gathering and analyzing the data needed further improvement. Our first intuitive response was to add more descriptions of the laboratory kit parts and the laboratory experiment set up. Since every laboratory session was limited to 1 hour and 10 minutes, more descriptions and more text would take longer for students to read and understand. We realized that since many students in the course had a variety of different backgrounds, many of them being non-technical, it was clear that no matter how many more lengthy descriptions we could add, it would not improve but rather complicate the process. A video graphic representation of the assembly, data gathering and analysis processes of each laboratory experiment was proposed. A number of universities are in the process of developing audio-video based tutorials to enhance student's knowledge and skills in signals and systems, digital logic, control systems, electromagnetics, power systems, AC and DC circuits and biomedical measurements [2,3].

METHODS

In order to accomplish the desired tasks, we recruited two undergraduate students, one from the Film and Digital Media Department and another from the Baskin School of Engineering who had successfully completed all laboratory experiments in the previous year. Their task was to record a video of laboratory kit assembly, data gathering and analysis processes of each laboratory experiment.

Since each laboratory experiment is held in room with 12 laboratory stations, only 24 students can complete the laboratory experiment at the same time. Since playing the same video recording at each laboratory station at different times creates overlapping noise problems, we decided to have silent videos with subtitles. We also wanted to limit each video to be no longer than 5 minutes.

After all videos were recorded and completed, we recruited another undergraduate student from the Baskin School of Engineering. Her task was to upload, display and transfer all recorded videos and laboratory instructions to online format. Furthermore, this student made an additional effort and put together on-line forms that allowed students to answer all laboratory questions online. This also gave us an option to have all entered questions graded simultaneously. Figure 1 contains a sample snap shot from the Solar Pathfinder Laboratory Experiment which demonstrates the assembly process of the solar pathfinder tri-pod set up. For more information and to view our work, please visit our web-site http://seed.soe.ucsc.edu

In order to record the level of improvement, each student is given a questionnaire before and after completing each experiment and at the end of the academic term. Each questionnaire consists of five different types of questions relevant to an individual renewable energy source studied at the time. For each experiment, the mean and the standard deviation is calculated. A t-test will be used to determine whether the difference between the means is statistically significant. The test will be performed by calculating the difference between two means and dividing the result by the standard error of the difference. The alpha level that will be chosen is 0.05. All questionnaires were transferred to on-line format and are graded as soon as the student clicks the "Submit" button which is located at the end of each questionnaire.

In order to test our new laboratory experiments with instructional videos, we asked 40 students from the Sustainability Engineering and Practice course to complete the Solar Pathfinder experiment and provide us with feedback. To our surprise we learned that it took them a much shorter period of time to complete this experiment. We received all very positive comments with a few suggestions to slow down the videos so that the students could assemble the laboratory kits as the video plays.

In conclusion, this year's course on Renewable Energy Sources is held from March 29th - June 3rd, 2011. The students are starting their first laboratory experiment, the Solar Pathfinder, the week of April 4th. We are looking forward to collecting student's answers and feedback, analyzing the data and improving laboratory experiments for future generations.

FIGURE 1
INSTRUCTIONAL VIDEO FROM THE SOLAR PATHFINDER LABORATORY EXPERIMENT

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