Student Learning in Electrical Engineering (EE) Lab Project for Non-EE Majors: From Technical Skills to Multidisciplinary Teamwork

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Motivation
- Today all engineers use electronics and work in interdisciplinary teams.
- Our Electrical Engineering (EE) course is required for non-EE majors.
- The newly developed lab project integrates the knowledge taught in the course and provides a practical application scenario.

Educational Objective
- Teach students the concepts and skills applicable to their major fields.
- Emphasize transferability of learning EE to many fields of engineering.
- Foster their communication skills in interdisciplinary teams.

Student Demographics
- Fall 2010: 209 students; Winter 2011: 166 students.
- Students are from multiple engineering majors and academic years.

New Temperature Control Lab
- Students gain hands-on experience with two temperature controllers — Analog/Digital and Programmable. All key concepts of this project are covered in lectures and may be transferable to other fields of engineering, in which the students major.
- The first system is an Analog/Digital controller based on TC0811C and two ICs with logic gates.
- The second system uses a programmable device based on PSoC EVAL kit by Cypress Semiconductor.
- Students agreed or strongly agreed that:
  - they had enough time to relate the theoretical concepts to the lab (70.7%);
  - the lab helped them to understand the principles of the system (74.9%);
  - the lab was interesting (84.4%) and valuable for their learning (7.19%).

Learning of Technical Skills
At the lab level:
In questionnaire survey, students agreed or strongly agreed that:
- "I am able to apply the concepts and skills learned in this lab to my future career" (53.3% agreed or strongly agreed).
- "The concepts and skills learned in this lab are valuable for my future career" (53.3% agreed or strongly agreed).
In focus group discussion, students told us that:
- "(This lab) matches up perfectly with our course on systems and dynamics (in Mechanical Engineering)."
- "(This lab) is related to Nuclear Instrumentation Labs".
- "One student observed the use of programmable controllers during internship at NASA."

At the course level:
I clearly see the connection between this course and . . .

Multidisciplinary and Communication Skills
At the lab level:
- In focus group discussion, many students told us that the lab project has helped improve their ability to work on a multidisciplinary team and to communicate with people from other major backgrounds.
- These are two important outcomes listed in the ABET Criteria (3d) and (3g).
- The lab environment is multidisciplinary: non-EE students work on EE projects, guided by EE instructor.
- One student said that the lab made him more confident to "work on large, comprehensive project, and communicate with electrical engineers on the team.

At the course level:
The students' responses to the following statements in questionnaire survey:

"The following components of the course have been very valuable for my learning of interdisciplinary connections among fields of engineering."

Transferability of Knowledge
At the lab level:
The students' responses to the following statements in questionnaire survey:
- "I am able to apply the concepts and skills learned in this lab to my projects in other courses" (55.9% agreed or strongly agreed).
- "The concepts and skills learned in this lab are valuable for my future career" (53.3% agreed or strongly agreed).

In focus group discussion, students told us that:
- "(This lab) is related to Nuclear Instrumentation Labs".
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Conclusion and Future Work
- We investigated student learning in a newly developed lab project, and found that it invokes students' interests and teaches students various important skill sets.
- Our research is focused on technical skills, multidisciplinary skills, and transferability of knowledge.
- Our research tools include questionnaires, multidisciplinary skills, and focus group discussions.
- We also extended the survey to the course level; the results confirmed our observations.
- We plan to conduct follow-up surveys with the students who took the course in the Fall 2010 semester and, within a year, would take advanced courses, go through internships, etc.
- We also plan to further investigate the student learning in other components of the course, such as homework assignments and other lab projects.