

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

Hongwei Liao and Alexander Ganago
Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor

Motivation

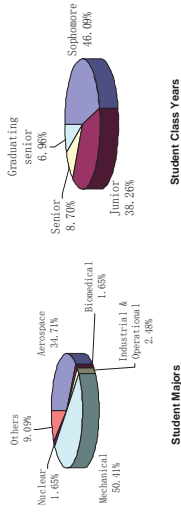
- Today all engineers use electronics and work in interdisciplinary teams.
- Our Electrical Engineering (EE) course is required for non-EE majors.
- The newly developed lab project integrates the knowledge taught in the course and provides a practical application scenario.

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.

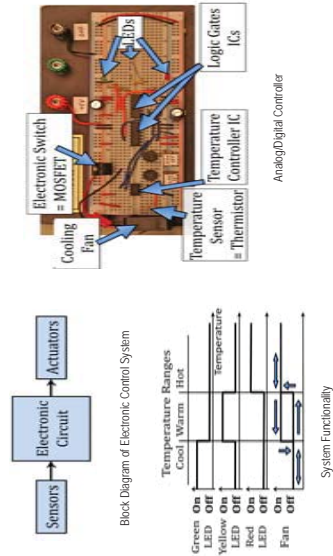
Student Demographics

- 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 student's major.
- The first system is an Analog/Digital controller based on TC621 IC and two ICs with logic gates.
- The second system uses a programmable device based on PSoc EVAL1 evaluation kit by Cypress Semiconductor.



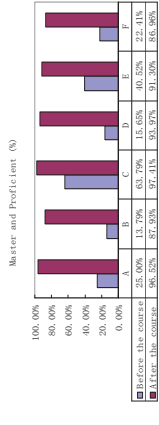
Learning of Technical Skills

At the lab level:

- In questionnaire survey, 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 (71.9%).

In focus group discussion, many students expressed their interest in learning more about EE beyond the scope of this course, and mentioned the topics of interest ranging from control systems to signal processing, from microelectronics to embedded systems, all of which are related to this lab project.

At the course level:



Mastery of Skills

Levels: Master: Proficient; Limited hands-on experience; No hands-on experience

The columns of both bar graphs represent:

- A = Operation of instruments, B = Use of Virtual Instruments, C = Soldering, F = Troubleshooting (what to do if your circuit does not work?)

Multidisciplinary and Communication Skills

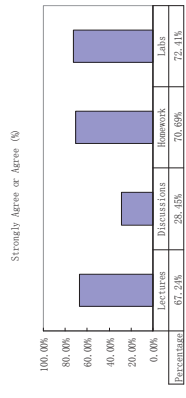
At the lab level:

- 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:

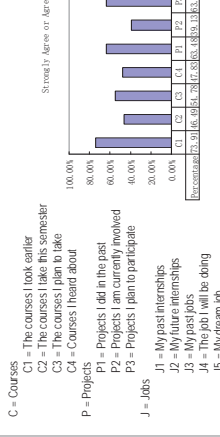
- The students' responses to the following statements in questionnaire survey:
- "I am able to apply the concepts and skills learned in this lab to my projects in other courses" (56.9% agreed or strongly agreed);
 - "The concepts and skills learned in this lab are valuable for my future career" (53.9% 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 Lab."
- 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 ..."



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, open-ended questions, 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.