Work in Progress - GOING GLOBAL: An Innovative Course for Sophomores

Ron Rosenberg
Michigan State University, rosenber@egr.msu.edu

Abstract - **Twenty-first-century engineers will be practicing their profession in an increasingly globalized world. The changing nature of engineering practice calls for accompanying relevant changes in engineering education. In partial response to this imperative we have developed the course GOING GLOBAL. The course is part of a recently re-designed curriculum for our Applied Engineering Science undergraduate major, a broadly-based cross-disciplinary program in the College of Engineering. The primary audience for the course is engineering sophomores. In this paper we describe our goals for the course, the current course design and implementation, and course impact on learning outcomes from our experiences in fall 2008 with twenty students and in fall 2009 with forty students. Anecdotal data suggest that the learning goals are being met effectively.**

Index Terms – Active-learning, Communication skills, Globalization, System models.

INTRODUCTION

Twenty-first-century engineers will be practicing their profession in an increasingly globalized world. In the words of Clark Kerr, "The nations of the world are increasingly interdependent in a political, economic, and environmental sense. American education … (n)ow must teach global perspectives suitable for citizens of what is increasingly a worldwide … community." [1] In the view of James Duderstadt, "The changing … needs of a global knowledge economy are dramatically changing the nature of engineering practice, demanding far broader skills than simply the mastery of scientific and technological issues." [2] Since engineering practice is changing rapidly, engineering education needs to change as well, as has been recognized by major professional societies such the NAE, ASEE, and the IEEE. [3-5]

One response to this imperative at Michigan State University has been to develop the new course *GOING GLOBAL: Economics, Engineering, and the Environment*. We chose to introduce a new course because we were unable to identify an existing course that seemed suitable for our target audience of engineering sophomores across all majors. *GOING GLOBAL* is part of a recently re-designed curriculum for our Applied Engineering Sciences undergraduate major, a broadly-based cross-disciplinary program in the College of Engineering.

In the following sections we describe the current course design, its implementation, and course outcomes to date. The Conclusion presents the next steps we will take to continue to improve the course.

COURSE DESIGN: GOALS AND CHOICES

The four major course goals are (1) to increase the students' understanding of significant issues that arise due to globalization; (2) to grow the students' ability to frame complex issues in a systematic manner; (3) to increase the students' broader communication and teaming skills; and (4) to enhance their motivation to make positive contributions in their roles as professionals and as citizens. The goals are presented to the students as a three-dimensional learning space, with the axes being content, systems and communication skills, and motivation. Their challenge is to individually achieve 'maximum growth' in the time we are together, recognizing that they start at different points in the learning space.

Content. Globalization is a complex and encompassing activity; as such, it presents many options for choosing course content and organizing it to induce effective learning. After careful review of many courses and references, we chose to organize the content by presenting globalization as a set of four interacting sub-systems, the "four Es." These are (1) Economic systems as the driver of globalization, (2) Engineered systems as the enabler, (3) the Environment as a constrainer, and (4) Equity as the socio-political controller. Because there is not enough time to cover all four topics effectively in a fifteen-week three-credit-hour course, the Equity topic is not developed, but its importance is stressed and students are encouraged to pursue it in subsequent studies.

Skill development. Both system modeling skills and communication and teaming skills are developed through active learning. System models are made of various examples that arise during the content development, with reliance on simple diagramming as the main tool. Communication skills are developed through active listening, through team-based project presentations, and through solo presentations.

Motivation. Motivation is developed by presenting the material in a "neutral" or "you make up your own mind" manner. The students have to grapple with a variety of viewpoints that arise naturally among the set of guest speakers, which furthers the attainment of this goal.

COURSE IMPLEMENTATION

The course meets Tuesdays and Thursdays. The content is presented on Thursdays through (1) an overview of globalization, (2) three guest presentations about the environment (Spaceship Earth basics, thinking globally using maps and satellite-collected data, sustainability), (3) four guest presentations about economic systems (global trade, global finance, global corporations, and the Michigan economy), (4) five guest presentations on various engineered life-support systems (energy, water, The Internet, cyber-security, urbanization), and (5) a 'futurology panel' of returning guest speakers. All presentations are video-captured and made available through web access.

Students' professional skills are developed through active learning on Tuesdays. Twenty percent of the time is devoted to in-class work on systems and eighty percent is allocated to presentations by student teams that build on the prior Tuesday's content. The students make eleven presentations in all: two solo, two in a team of two, and seven in a team of four. Presentation times vary from two to twenty minutes, and include two three-minute 'elevator talks'. They also produce a 'letter-to-the-editor' and send it to a specific newspaper. All presentations are video-captured and made available for student review. Through these activities the students increase their ability to identify and research a topic of interest to the entire group, to organize it logically, to present it effectively, and to work in teams. In addition the students practice active listening during the guest presentations, documented through written questions and 'take-aways' turned in at the end of class.

COURSE OUTCOMES

The pilot version of the course was offered in fall 2008 to a group of twenty students. The initial group drew from seven majors and ranged from freshman to senior level. Based on the assessment of learning impact during that experience, a number of changes were made for the fall 2009 offering. Many of the suggestions for changes came from the students, who were very interested in helping to improve the course for their colleagues to follow. Anecdotal data, such as student response forms (required and submitted anonymously), reinforced the fact that most students had a very positive learning experience.

A follow-up course was offered in fall 2009 to forty students, again including seven majors and spanning all four years. We wanted to test the scale-up potential for significantly larger class sizes in the future. They met for a common lecture on Thursdays and met in their own section of twenty on Tuesdays. The most important change to the course organization was to group the presentations about each main sub-system -- the environment, economic systems, and engineered systems -- to allow students to focus on one area for several weeks. Both sections had good outcomes, so it appears that the current organization will support scale-up of course size without loss of effectiveness.

Several types of data were used from the fall 2009 course to infer learning outcomes about content, growth in communication and systems modeling skills, and student motivation. Most of these data were derived anecdotally, e.g., by observing and noting presentation skill strength and weakness changes over the semester. The most informative data were contained in the required two-page self-reports of personal learning submitted at the end of the course. The students were asked to support their self-evaluations with 'hard evidence,' and most tried to do this. It seemed possible to determine which student reports were based on serious reflection (almost all) and which were 'pro-forma.' The overall comments were very positive, but the data showed that the course organization made demands somewhat beyond what many first-year students were able to meet at the professional level expected.

CONCLUSION

At this point we believe that the course is effective in meeting the content learning goals, improving the students' communication and systems thinking skills, and strengthening their motivation in their roles as professionals and citizens. To demonstrate to ourselves and others, and to enable continuous course improvement, next we will introduce systematic assessment tools based on the course goals to provide objective feedback.

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