Abstract - A new cross-disciplinary first-year course, “Introduction to Society's Engineering Grand Challenges,” has been developed as part of a college-wide initiative at the University of Wisconsin-Madison to transform undergraduate engineering education for 2010 and beyond. The inspiration for developing this new course was the National Academy of Engineering’s “Engineering Grand Challenges” project. By emphasizing humanitarian applications in an introductory engineering course, we expect to not only inspire future generations of engineers and show students how the skills they will be learning can have a positive impact on quality of life, but also encourage more women to pursue engineering degrees.

While the percentage of women enrolled nationally as undergraduates in the biological sciences now exceeds 50%, the corresponding figure for engineering is only about 20% [2]. Furthermore, there is considerable variability between sub-disciplines within engineering. For example, the percentage of women receiving B.S. degrees in both electrical and mechanical engineering is much lower than 20%, while those with more visible connections to health, such as biomedical engineering, have a much higher percentage. The Women’s Experiences in College Engineering project sponsored by NSF and the Alfred P. Sloan Foundation identified factors that contribute to women continuing their engineering studies [3]. The report emphasizes the importance of exposing women students early on to how engineering can solve societal problems.

Thus, we hypothesize that a first-year course on society’s engineering grand challenges, with its emphasis on humanitarian applications, will help increase gender diversity within the undergraduate student body across all departments within our College of Engineering (CoE).

COURSE OVERVIEW

The two-credit course is divided into three modules. During the introductory team-taught module, all students meet together in a single large lecture section and are introduced to the engineering disciplines, the engineering design process, and the NAE grand challenges. Modules 2 and 3 are theme-based and are taught in smaller discussion sections. Each faculty instructor leads one of the theme-based sections during Module 2, and then repeats that instruction with a different group of students during Module 3. Each section focuses on a specific societal theme that ties together several engineering grand challenges.

In-class activities and out-of-class assignments introduce students to the basic principles, potential, and positive impact on quality of life, but also encourage more women to pursue engineering degrees.
The new course targets pre-engineering and “undecided” students, and provides first-year students with an additional option for satisfying our college-wide requirement of an introductory engineering course. Prior to the pilot run of the course, we advertised the course to the wider campus community. We are specifically encouraging the participation of undecided students (the majority of whom are women) as a recruitment mechanism for increasing the number of women in our undergraduate engineering programs. The participation of non-engineers also has the potential to achieve the following goals: 1) increasing the diversity of perspectives in the course, making the discussions more interesting and helping engineering students to appreciate design constraints imposed by those non-engineering perspectives (future clients for whom they will eventually be designing products and solutions), and 2) raising the technology literacy of non-engineers on campus, introducing them to engineering problem solving, and improving the general public’s understanding and appreciation of how engineering shapes our world.

The new course addresses three of the “Educating the Engineer of 2020” recommendations from the NAE’s Committee on Engineering Education [4], namely that 1) engineering schools should introduce interdisciplinary learning in the undergraduate environment, 2) engineering educators should explore the appropriate use of a case-studies approach in undergraduate curricula, and 3) the engineering education establishment should participate in a coordinated national effort to promote public understanding of engineering and technology literacy of the public.

EXPECTED OUTCOMES AND PRELIMINARY RESULTS

Course activities are designed to achieve specific learning objectives. We expect that upon completion of this course, students will be able to identify the role of specific engineering fields in multi-disciplinary engineering projects, research an aspect or case study of an engineering grand challenge, create materials for oral and poster presentations, articulate an understanding of the engineering grand challenges that human societies face in the 21st century, demonstrate an awareness of societal and multicultural issues encountered in engineering, and express an appreciation of non-technical issues (e.g. economic, ethical, social, political) that influence or constrain engineering solutions. We also expect that the contextual background of important societal applications of engineering provided by this course will better engage students in the theoretical and applied engineering courses in their chosen fields of study.

Our survey-based course assessment plan was reviewed by the UW-Madison Education Research IRB and granted an exemption as a study of educational practices. Our course assessment is based, in part, on the existing assessment tools used in two other interdisciplinary first-year courses offered by our CoE, to permit comparison with existing survey data from those courses. Several preliminary measures of success specific to our course can be reasonably well assessed at the end of the semester. Examples include students’ motivation for considering an engineering major and engineering career, their appreciation of the impact of engineering on human quality of life, and their level of awareness of the economic, ethical, and political constraints on engineering solutions. Other measures of success, such as whether we are recruiting characteristically different students and increasing gender diversity, will require longer-term assessment. Nevertheless, the data from the spring 2008 will provide important preliminary insights. For example, this course has already shown great promise for recruiting students from outside of engineering. Our enrollment this semester is 98 students; 28% of the students have non-engineering status (the highest percentage of any of our introductory engineering courses) and 24% are women.

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REFERENCES


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