

AC 2007-2320: DEVELOPMENT OF PROFESSIONAL COMMUNICATION SKILLS THROUGHOUT THE BME CURRICULUM

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Development of Professional Communication Skills Throughout the BME Curriculum

Abstract

A sequence of six design courses are required in the undergraduate biomedical engineering curriculum at the University of Wisconsin-Madison. This sequence of courses provide a platform for students to develop and improve their oral and written communication skills. After taking a freshman engineering design course, each student admitted to biomedical engineering in the sophomore year does a team design project each semester for six sequential semesters. The teams work on progressively more challenging real-world projects submitted by clients from around the university and from industry. While advancing their technical and problem-solving skills through successive projects, the students also learn interpersonal and public communication skills through this experience.

Introduction

Beginning in 1998, we started teaching a sequence of design courses to all students in biomedical engineering beginning when they are admitted to the B.S. degree program in the first semester of their sophomore year^{1,2,3}. Design courses throughout the curriculum form a unique feature of the BME undergraduate degree program. Every BME student registers for a design course and works on a client-based design project every semester for six consecutive semesters. These six design courses constitute a total of eight degree credits. All the courses are one credit except the 3-credit capstone design course in the first semester of the senior year. These design courses are supervised by faculty advisers. Each faculty member has a weekly two-hour meeting in a computer lab with his/her teams. The courses provide a platform for professional communication throughout the curriculum as well as a relevant structure to discuss many issues related to design including intellectual property, professionalism, entrepreneurialism, engineering ethics, and the need for lifelong learning.

All the design projects are client-based, real-world design problems, solicited primarily from the medical and life sciences faculty around the university, as well as from biomedical engineering companies. Also we do projects with individuals who have specific rehabilitation needs. The design faculty team reviews the proposed projects and chooses those that are well matched to the students' abilities and likely to result in physical prototypes. Once a team of four students is formed and chooses a project, the team interacts with their client and advisor to define the specifications for their project and maintains a dialog with their client throughout the course. The client provides meaningful feedback as the design progresses as well as access to the appropriate clinical or research setting. Faculty are fully responsible for all aspects of the design courses. We do not use teaching assistants.

The Figure shows relationships among the six design courses. As part of the overall goals of learning the design process and creating a physical prototype, each of the courses has different individual goals.

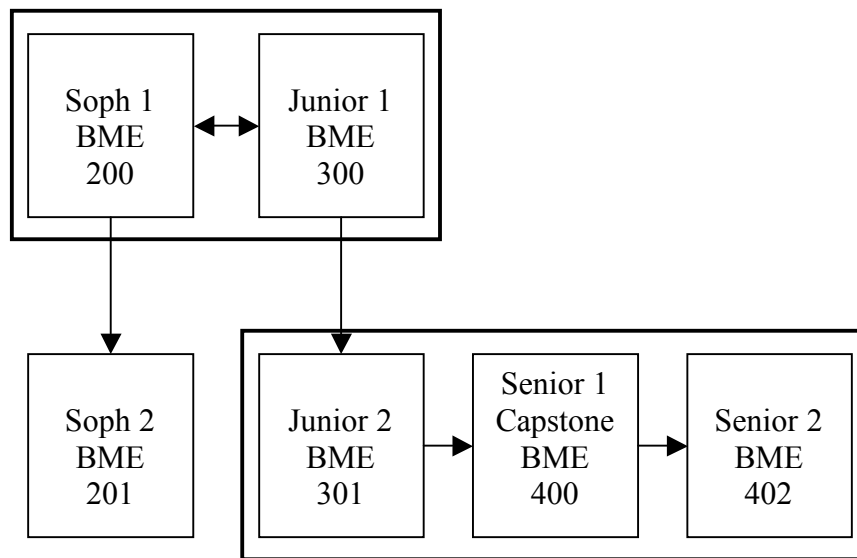


Figure. Functional grouping of BME design courses.

BME 200 – First-semester sophomores work on teams with first-semester juniors on a design project chosen by the design faculty to be achievable in one semester. The juniors are each charged with mentoring and advising one of the sophomores. Typical team sizes are four students (two sophomores and two juniors).

BME 201 – Second-semester sophomores work on four-student, sophomore-only teams on a single-semester design problem. One intent is to instill in them the confidence to complete the design process without upper-class mentors.

BME 300 – First-semester juniors have the opportunity to teach the sophomores something they have learned — the design process. They also serve as big brothers/sisters advising the younger students on curriculum issues. This develops a spirit in the students of being part of a group that is bigger than their own class.

BME 301 – Second-semester juniors start a design project that is chosen by the faculty to be difficult enough that it cannot be completed in one semester. Goals are to do a pilot study that leads to product design specifications and a basic prototype that will be further developed in the subsequent capstone design course.

BME 400 – First-semester seniors improve on the initial prototype and complete the implementation of their design in this course.

BME 402 – Final-semester seniors test, evaluate, improve and produce final documentation of their device. In addition, all students complete an outreach requirement, typically by giving a talk in a K-12 classroom. Also all students write their project reports as technical papers in a format appropriate to a target journal or conference.

Every semester, three of these courses are taught (i.e., BME 200, 300 and 400 in the Fall or BME 201, 301, and 402 in the Spring). A minimum of two faculty are assigned to each course, so a total of at least six faculty teach the design courses each semester. Due to the size of our student

body, which we control by limiting admissions, this translates to a student-to-faculty ratio of no more than 20-to-1 (i.e., four-to-five teams of four students advised by each faculty member). Since several faculty rotate in and out of the course each semester, the group of faculty who teach the design courses represents a substantial percentage of the core faculty of the BME Department.

All faculty meet with their design teams once per week, and the six faculty teaching the course also meet together each week. The faculty meetings are for planning the design course activities throughout each semester, educating faculty who are participating in the courses for the first time on educational goals and strategies for the courses, reviewing our observations on student achievement of outcomes, etc.

Professional communication requirements

Each semester, all design courses require the following deliverables as well as the final design and physical prototype:

1. Each student keeps an engineering notebook.
2. Each team submits a weekly progress report to their advisor and client by email.
3. Each team does a mid-semester PowerPoint presentation and written draft report.
4. Each team produces an end-of-semester final report.
5. Each team maintains a web site.
6. Each team does an end-of-semester poster presentation.
7. Each student does peer review of other teams' PowerPoint and poster presentations.
8. Each student does a self and peer performance evaluation.

In addition to these deliverables that all represent aspects of professional communication skills, other experiences that students get with professional communication are:

1. Each junior-level student mentors a sophomore who is part of their team when the BME 200 and 300 students are combined in teams.
2. Each team meets with their faculty advisor every week for a design review.
3. Each student participates in at least one K-12 outreach activity.
4. Each team writes at least one technical paper as part of the final design course.
5. If the project results in unique intellectual property, a team may file for a patent.
6. If the project involves human subjects, a team may participate in developing a human studies protocol for the IRB.
7. All students complete a tutorial and receive certification in human subjects training.

The Table shows the number of times a student experiences the various types of professional communication activity in the six semester sequence of courses. Although every student does not individually do every activity, we have designed most communication requirements so that every student is involved in some way. For example, in all presentations, all team members must have a speaking role. Also in the weekly reports, each student must, in the minimum, report his/her activities and how time was spent on the project in the prior week.

Type of professional communication	Once per degree	Once per semester	Twice per semester	Weekly	As appropriate
K-12 outreach	1				
Technical paper	1				
Peer mentoring	2				
Oral PowerPoint presentation		6			
Poster presentation		6			
Web site implementation		6			
Mid-semester written report		6			
Final semester written report		6			
Peer review of presentations		6			
Peer review of posters		6			
Peer and self team evaluation		6			
Reflection paper		6			
Design notebook			12		
Oral design review meeting				72	
Written progress report				84	
Patent disclosure					x
Human studies protocol					x

Table: Number of times a BME student experiences each type of professional communication during the six-semester BME design course sequence.

To insure consistency across the faculty who teach these courses, we have developed a set of assessment forms for the major communication elements of the courses. These forms direct faculty to evaluate various desired educational outcomes in the different types of professional communication. For example, there are forms to evaluate oral presentations, notebooks, reports, etc. These assessment forms can be found on our course web site⁴. The BME Department also has a separate Assessment Committee that randomly samples examples of student design course work at all levels—sophomore, junior, and senior—and analyzes direct measures of student educational outcomes including the ability to communicate by oral, written, and graphical modes.

Summary

Through a process based on solving unique, real-world design problems that repeats every semester for every student in the curriculum, we have developed a strategy for students to continuously improve their professional communication skills. Each team receives written and oral feedback from their faculty advisor on the mid-semester and final reports. The objective of

the critiques is to continuously move the students toward a written communication style suitable for producing professional publications. This effort culminates in the senior year where students must write a paper targeted for a specific professional publication. In all the courses, students are required to write both peer and self performance critiques and peer evaluations of other students' presentations in order to develop their critical analysis skills. The mid-semester platform presentations and the final poster presentations are conducted in a conference style with 15-minute time slots. Two BME faculty and the team clients attend these presentations. The two faculty complete assessment forms for each talk so that the students get constructive criticism from more than one faculty member on their performance. The intent is to give the students insight on how to improve their oral presentation skills and to learn the best practices of conference and business communication.

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