AC 2008-468: COMMUNICATION IN A PROJECT BASED LEARNING DESIGN COURSE

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Communication in a project based learning design course

Abstract

Sophomores in the College of Engineering at Rowan University take a two-semester sequence where they are taught design and communication in a project-based-learning setting. In the fall and spring semesters, communication instruction focuses on technical writing and public speaking, respectively. The fall semester has developed into a highly-integrated technical writing and design course, allowing students to comprehend how writing informs the design process as much as the designing informs the writing. Like writing, public speaking is an essential aspect of engineering practice. However, integrating public speaking and design has proven significantly more challenging than integrating writing and design. Even when public speaking deliverables are directly tied to a design project, students often feel that the presentation is an afterthought. Indeed, in many cases the design is completed (or a significant milestone is reached) before the presentation is prepared. Thus, public speaking is often associated with design, but not as an integral part of designing. In this course, students give several mid-semester presentations as part of an ongoing design project, where they are given feedback by engineering faculty and their peers. As a result of this feedback, many students have come to realize that this form of communication is an important part of design.

Introduction

The significant changes that accompanied the ABET 2000 document[1] reflected the observation by academia and industry that engineering education needed to change to better prepare engineering graduates for the current work environment[2,3]. One result of these changes is that both design and communication have been given increasingly important treatment in undergraduate engineering curriculum. Project-based courses have been gaining acceptance as a means to introduce design experiences into the curriculum prior to the senior capstone design course[4-6]. In some cases, communication content has been integrated into engineering content as well[7].

Undergraduate students in the College of Engineering at Rowan University take a sequence of eight project based learning courses, called Engineering Clinics[8,9]. The Engineering Clinics increase in realism throughout the four year experience. The Sophomore Engineering Clinics are specifically charged with teaching design and communication. Formal communication instruction focuses on technical writing and public speaking, in the fall and spring semesters, respectively. Sophomore Engineering Clinic I (SEC I) has developed into a highly-integrated technical writing and design course, allowing students to comprehend how writing informs the design process as much as the designing informs the writing[10]. The design instruction in SEC I is focused on parametric design[11,12]. In Sophomore Engineering Clinic II (SEC II), student teams are required to frame a serious design project for the first time. In this course, students receive two 75-minute instruction periods per week on public speaking, and one 165-minute instruction/laboratory period per week on design. The public speaking instruction

has 15 to 20 students per section, led by a faculty member from the College of Communication (COC). The design instruction has 40-50 students in one section, led by three faculty members from the College of Engineering (COE). A second section of the design instruction/laboratory, also with three COE faculty is run in parallel, but with a different project.

Presentations on completed design projects can provide a link between public speaking and design. Many students have realized that there is a more important connection, as the dialogue that followed mid-semester presentations and feedback on written documents became important aspects of their design process. The purpose of this paper is to describe an existing design project, with particular emphasis on the communication-based deliverables, and to present results of end-of-semester assessment of students that demonstrates the importance of feedback in the design process.

Design Instruction in a PBL Setting

The Sophomore Engineering Clinic courses are intended to move students toward being able to solve the design problems they will encounter in the real world by posing a series of increasingly complex projects while they are under careful supervision by faculty. In SEC I, teams of students were first given a four-week design project that was purely parametric design. The teams started the project with a design that is completely specified except for three parameters. Based on experimentation, teams specified the values for these three parameters that resulted in an optimal performance, then constructed and tested their artifact. Next, teams of students worked on a ten-week design project that started as a concept and finished with the testing of a constructed artifact. More specifically, teams were told to design a truss, but not told the specific type of truss, *i.e.*, number of joints and connectivity. In both projects, most constraints on the project, as well as the optimization functions that were used to evaluate final designs were given explicitly. In other words, many design decisions were already made for the students before they started working on their project. As a result, there was a strong emphasis on parametric design and optimization in SEC I.

The design project in SEC II is more complex. In the first week of the class, students were shown brief presentations describing both this project and a second project (which is not described herein) and allowed to choose which project to work on for the semester. Slightly more than half (46) of the students taking SEC II selected this project. Students were directed to websites describing various design competitions[13,14] as sources of inspiration, and challenged to develop their own ideas that could lead to contest submissions. As the scope and timing of these competitions made an actual submission that semester unlikely, the stated objective for the end of the semester was to make sufficient progress and a sufficiently persuasive case to convince an appropriate faculty member to mentor the team next year to allow the team to complete its design. The result of this challenge is that students started with a perceived need and strived to develop a feasible concept.

During the third and fourth week of class, each student gave a 90-second "elevator pitch" where they attempted to interest other students in their proposed design topic. A flight of ten students made their pitches in rapid succession. Each flight was followed by a 15-minute networking session, which allowed audience members to ask the students additional questions face-to-face in an informal manner. At the end of these classes, each student filled out a selection sheet where they identified the projects that they were most interested in working on. The engineering faculty then considered the student preferences, along with their own initial perceptions of the feasibility of each suggested project and assigned the 46 students to one of twelve projects that were selected to run. These teams were announced at the beginning of the fifth week of class. Each faculty was primarily responsible for four teams, but also assisted with the remaining eight teams.

The schedule of the project, as defined by due dates for deliverables throughout the semester is shown in Table 1. Three types of deliverables were required. Oral presentations and formal written reports were graded and counted toward the students' grades in the course. Informal written reports were evaluated by faculty, but not counted toward the students' grades.

Table 1. Deliverables for SEC II.

Class Number	Date		Deliverable	Type
	Jan.	15	*Holiday – No Class*	
1		22	Project selection	
2		29		
3	Feb.	5	Elevator Pitches	Oral
4		12	Elevator Pitches	Oral
5		19	Problem Statement	Informal Written
6		26	Constraints and Criteria	Informal Written
7	March	5	Alternatives and Evaluation Criteria	Informal Written
		12	*Spring Break Week – No Class*	
8		19	Background Speeches	Oral
9		26	Background Speeches	Oral
10	April	2		
11		9	Report 1 Technical Speeches	Formal Written Oral
12		16	Technical Speeches	Oral
13		23		
14		30		
15	May	7	Final Report Final Presentations	Formal Written Oral
Finals		14	Final Presentations	Oral

Informal Reports

Student teams submitted three written deliverables that did not directly count toward grades. These were intended to help guide students through the design process and ensure that timely progress was being made early in the semester. A COE faculty member read each informal report and gave written comments for the beginning of the next class. These reports were tied closely to design benchmarks discussed in the textbook by Eide, *et al*.[15], which was used as a text for Freshman Engineering Clinic I and II.

For the first informal report, teams were asked to frame their initial problem statement during the first class that teams were assigned (class 5). COE faculty were available for consultation during this time to answer questions, and to give feedback and advice. It was anticipated that the problem statement would follow closely the statement used to form the initial elevator pitch. However, input from other teammates could lead to modification and refinement of the initial statement.

At the end of class 5, students were given the second informal assignment: to develop their list of constraints and criteria for their designs. This was to be prepared for the beginning of class 6. However, in some cases, these were further refined during the class time. Simultaneously, students were asked to begin to brainstorm potential solutions and to document all of their ideas without eliminating or evaluating any of them. At this point, students were also told to begin researching concepts or products that would be either competition or useful to their designs.

Students were asked to compile their ideas that resulted from internal brainstorming and research, and to define the state of knowledge on Dixon's taxonomy[16] for each of them by the beginning of class 7. Students were also asked to specifically revisit their problem statement, constraints and criteria, and to revise these as a result of the discussions and research that had occurred to date. Teams were asked to pay special attention to how the criteria could be used to make decisions about which ideas to pursue further.

Formal Reports

The first formal report was due at the beginning of class 11. The purpose of this report was to document the team's efforts of the first six stages of the design process identified by Eide, *et al*.[15], namely: Identify Need, Define Problem, Search, Constraints, Criteria, and Alternatives, and to begin to cognize what should be done next. Writing and feedback from the informal reports were expected to be incorporated into this report. For this report, teams were not expected to begin to make decisions on which design ideas are best.

The final report, due at the beginning of class 15, was to include much of the initial work summarized in the first formal report. The new work was to use the criteria and constraints that the team developed, as well as results from mathematical models that

were developed to help make design decisions. Efforts toward development and testing of prototypes were also discussed.

Oral Presentations

The project required four types of oral presentations. The first presentation, the elevator pitch, was individual and has been described above. The remaining three presentations were team based. Students were required to participate in the actual presentation in at least one of the three team presentations and were expected to participate in developing all of the team presentations.

In the background presentation teams were asked to inform the audience of a perceived need, how others have addressed this need, and how they will address this need. Teams needed to present and justify their design constraints and criteria to justify their approach over currently existing solutions. The objective of this presentation was to thoroughly vet each team's design problem statement. Following these presentations students receive feedback from the faculty and their peers. Teams are asked hard questions regarding their assumptions, decisions and conclusions. In many cases, teams realize that they had not defined their design problem with enough specificity, or had unwittingly imposed unnecessary constraints on their designs.

In the technology presentation teams were asked to inform a tech-savvy audience of technological concepts that were considered key to their team's success. The purpose of this presentation was to give the COE faculty, and the other students the background that would be necessary to evaluate their design decisions.

The final presentation was the team's opportunity to persuade one or more faculty members that their idea was feasible and worthy of additional support as an internally sponsored Junior/Senior Engineering Clinic project. Each team was given the freedom to approach the presentation in their own way. However, teams were aware that a well-formulated and important problem, thorough research, and careful design choices were essential components to making a persuasive case.

Assessment of Student Perceptions – The Importance of Feedback

It has become clear to the faculty that feedback on the various deliverables plays a key role in the design framing and development process that student teams undergo. Many students also realize, albeit perhaps after the fact, that the presentations are an integral part of the design process, not just about the design process. This realization is ultimately important for students to realize the *dialogic* nature of communication. Presentations are not, and should not be, a monologue that happens at the *end* of the design process. Rather, they are central to producing the type of dialogue that enables good designs to be developed.

Forty one out of the forty six students in the class chose to answer surveys that were distributed near the end of the semester. Students were asked to provide a response

ranging from "strongly disagree" to "strongly agree" to each of a series of six statements that were posed as "___ helped the design process." The responses are summarized in Table 2. Average scores for these responses are given in Table 3. Here, the first column represents the average response regarding students' perceptions about preparing the three types of deliverable. This represents an epistemic function of communication. The second column represents the average response regarding to feedback on the three types of deliverables. This represents a dialogic function of communication.

Table 2. Summary of responses to question regarding what helped with the design process.

	1 Strongly disagree	2 Somewhat disagree	3 Neutral	4 Somewhat agree	5 Strongly agree
Preparing the written design reports	1	4	10	20	6
Feedback on the written design reports	3	3	10	18	7
Preparing the design presentations	1	1	12	24	3
Feedback on the design presentations	1	3	13	19	5
Preparing the informal writing assignments	2	4	12	18	5
Feedback on the informal writing assignments	1	3	14	17	6

Table 3. Summary of average scores from assessments

	Preparing	Feedback
Formal Reports	3.63	3.56
Presentations	3.66	3.59
Informal Reports	3.49	3.59

These results suggest that students found that all three types of deliverables, and both functions of communication of approximately equal importance. In the fall semester, a strong and explicit emphasis on the epistemic function of writing was made. In the spring semester, the dialogic aspects of communication (either oral or written) were not given explicit treatment. Despite this, students realized dialogical aspects of both writing and oral communication were as important as the epistemic aspects of writing to their design processes.

Summary and Conclusions

This paper describes a design project that is used as a vehicle for an integrated design and communication course. Particular emphasis is placed on describing the communication-based deliverables. One feature of this project is that it allows two mid-semester presentations on teams' design work. The low student-to-faculty ratio allows meaningful feedback to be provided for all of the deliverables. The results of assessment suggest that by the end of the course many students realize the importance that feedback on their written and oral presentations has on their design process. This realization reflects a developing understanding of the dialogic nature of communication.

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