Work in Progress: Training Chemical Engineers as Technical Communicators

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Introduction

The ability to communicate effectively is a critical skill for engineers. Strong communication skills are necessary for high-functioning engineering teams, successful projects, promotive workplace interactions, and career advancement. Engineering practitioners, educators, and students recognize communication as one of the key skills for engineering work, with over 60% of engineering seniors surveyed rating communication among the top five most important engineering skills, in a 2010 study reported in Enabling Engineering Student Success [1].

Chemical engineering educators have long recognized the need to educate students in written, oral, and interpersonal communication, and technical communication training has manifested in primarily two different forms. Some university departments have provided supplemental communication training across multiple technical courses in the curriculum. Others have created courses dedicated to teaching Technical Communications (TC) to students. By necessity, technical courses that have a strong communication emphasis prioritize the instruction and mastery of technical content, whereas dedicated courses offer an opportunity to focus deeply on communication content. Thus, it is extremely difficult to provide the same level of instruction, feedback, and opportunity for growth as communicators in an integrated course model compared to a dedicated course. However, dedicated TC courses can at times lack technical realism and pragmatic training. A department's choice to offer TC training through an integrated model may stem from several considerations, including insufficient resources or lack of flexibility in the curriculum. While there are many reasons to believe a dedicated TC course is beneficial, discipline-specific comparison studies on this are lacking. Ultimately, our team seeks to evaluate the potential benefits of dedicated technical communication training for chemical engineers as a basis for better understanding TC training as a whole.

Background

As mentioned, this need to educate engineering students in the written, oral, and interpersonal communication skills necessary for career success is manifested differently across many engineering departments [2]. While some programs provide communication training distributed across many courses (such as writing or speaking assignments in core technical courses), others have developed specific Technical Communications (TC) courses targeted for engineers. Dedicated TC courses are at times coupled closely with either a technical course or a capstone design course. Other dedicated TC courses in engineering curricula are "stand-alone" courses; they are not coupled to a technical course. Stand-alone courses may have several benefits: increased flexibility to cover communication types that are career-relevant but not natural choices for the technical content of a particular course, opportunities to combine instruction for students of multiple majors or multiple levels in the curriculum and ease of addition to existing engineering curricula [3] , [4] , [5]. A major challenge for the instructor of a stand-alone technical communications course, however, is to create meaningful and authentic communications assignments without the context of a shared technical course.

The many factors behind implementing technical communications training into engineering curricula has caused it to manifest itself in different ways across programs. While some programs have built it into required courses, others dedicated resources to provide a course focused on teaching TC to engineering students. Technical communications exists in the school of engineering at our institution in multiple forms, but most notably are integrated methods within capstone or laboratory courses and a stand-alone engineering elective. The elective ENGR 245 (later renamed to ENGR 248) is not required in any of the engineering disciplines' curricula, however, it is taken by many students in the college. This dedicated TC course is designed to be a kinesthetic environment that leverages past experiences of the students. Students are engaged into role playing activities, teamwork exercises, and on the spot presentations to develop their skills in communication and professional development. The goal of the class is to teach firsthand technical communication through these activities rather than through a top-down approach. The class provides opportunities to practice students' essential communication skills in the form of writing, oral presentations, and creating data, figures, and tables. In addition to communication skills, there is also a focus on essential professional skills, such as writing resumes, memos and emails, while also building cross cultural competence in students. By studying these different areas in communication and professional development, the class aims to build beneficial skills for engineers' careers that are not taught in core technical curricula.

As the course has developed over its four years as part of the curriculum, there has grown to be a diverse population of students who have previously taken the course and still attend the university. This presents an opportunity to compare the communication skills of students who took the technical communications course with those who did not. We plan to study students' habits while writing technical reports by analyzing their process of writing and their final product, and from there draw conclusions about their communication skills. We hypothesize that a dedicated technical communications course is effective at developing communications skills among engineering students, and that students who have taken such a course will demonstrate stronger communication skills compared to peers that have not.

Method of Research

Designing a method for this study was focused around building a discipline-specific comparison on the potential benefits of dedicated technical communication training for chemical engineers. In order to compare the effect of dedicated technical communication training on a student's ability to form technical reports, baseline student data and data from students who have completed ENGR 248 is needed. By acquiring comparison data, leading research questions surrounding the effects of dedicated technical communication training can be answered. Leading research questions include:

Our primary research question is: Do students who complete a dedicated technical communication course report the deliverables from a subsequent capstone course project better than students who have not taken a dedicated communication course?

Within this, we are interested in assessing differences in how well each group is able to:

- Report deliverables
- Develop technical content into evidence

- Synthesize technical content and evidence into a report
- Use techniques to monitor the process of their writing

In addition we are interested in analyzing the process of our subjects' writing by understanding:

- What techniques are being used by the different groups?
- What task environments affect the different groups during their writing processes?

Currently, the Chemical Engineering Department hosts 48 junior and senior students, of which 6 have taken ENGR 248. Our team believes that the population of students that have taken the course will give good baseline data on the tendencies of students writing technical reports who have previously been enrolled in a dedicated technical communications course.

Data collection is split into an evaluation of a student's process of writing and a student's final written product. Evaluation of a students 'Process' is based on a novel method for time-dependent data analysis that will use screen capture technology [6]. Real-time data capture offers the ability to capture all behaviors and activities and also allows for investigators to transcribe and code behaviors done by the subjects. Behaviors that are transcribed and coded have been deemed likely behaviors while composing a technical report based upon literature search [6], [7]. The ability for this method to capture the ability of a student to express certain behaviors in the cognitive writing process while also leaving room to evaluate activities that have not been previously valued as important during the process allows for this portion of the study to build up quantitative and qualitative data. Groups of students who have taken ENGR 248 and groups of students who have not will be graded on a rubric of cognitive writing processes to see which behaviors reflect previous dedicated technical communication training. Similarly, a students final product can be assessed on a rubric of different performance areas in a technical report [8]. These rubrics use a four-point Likert scale to assess different performance areas from 1 (Benchmark) to 4 (Capstone) using descriptor words. These rubrics were developed in order to answer leading research questions by breaking down each question into performance areas (or objectives) that have been measured in previous studies [3], [6], [9]. A sample of the rubric is shown below.

Table 1. Excerpt from "Product" Rubric to be used to evaluate student written abilities

		Scale			
Questions	Objectives	1	2	3	4
How well do the different groups develop technical content into evidence?	Writer shows depth in the subject by explaining methods and theories	sketchy	fundamental	impressive	profound

Evaluation is based upon students' ability in different performance areas, labeled as "Objectives" in the rubric. A sample of the "Product" Rubric is included above in Table 1, and includes the scale for evaluating writers' depth of knowledge in a subject, method, or theory. For example, a

writer that lists an equation that pertains to the report and identifies the units of each variable would be given an objective score of 1 (sketchy). Writers that are able to develop background theory, relate an equation to an experiment or set of data, establish assumptions and constraints, and connect this information to the overall deliverables of the report would be given an objective score of 4 (profound).

With the data collection/evaluation method determined, an activity was designed around being able to draw up quantitative conclusions while also being able to make observations about student habits. Subjects will be asked to participate in a writing session sometime during the spring semester of 2019, and investigators will be evaluating the products of this writing session, which will include a response memo produced by the subjects, any supporting documentation, and a screen capture recording of the students. The written memo and supporting documents will be evaluated under the "Product" Rubric. In addition, the screen capture recording of the subjects' writing session will be evaluated under the "Process" Rubric.

Further analysis of subjects' "Process" and "Product" scores will give preliminary comparison data between students that have completed the dedicated TC course and those who have not. Video capture data will be transcribed into a list of activities and timestamps of each activity in order to provide additional insights. In addition to whether the students have taken the dedicated communications course, we will keep track of potentially confounding factors where available, including: gender, internship or research experience, class year, etc.

Conclusion and Future Work

With the following method of capturing comparative data of technical writing between students who have taken a technical communications course and those who have not, preliminary qualitative data about the benefits of dedicated TC courses can be studied. Observations will be used as a basis for future dedicated technical communications studies, with the hope that the potential benefits can be quantified, thus better understanding technical communication training as a whole.

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