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GIFTS: Restructuring a First-Year Engineering Course to Introduce a Variety of Technical Communication Activities

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Motivation

Over the past few years, the Samuel Ginn College of Engineering at Auburn University has been working to restructure the curriculum of the first-year engineering sequence, starting with the Engineering Orientation (ENGR 1100) course. This course meets once a week for 50 minutes and is a required 0-credit hour Pass (S)/Fail (U) course taken by all incoming first-year engineering and computer science students. Two sections of the course are offered each semester, and there is a maximum enrollment of 410 students per section. Traditionally, this 0-credit hour course served as an introduction to college life, campus resources, facilities, academic advising, and engineering departments/programs offered on campus. Often, students found this course boring, not engaging, and a waste of 50 minutes every week. Therefore, to help build first-year students' engineering toolbox and make the course more engaging, topics were added to the course outcomes to address engineering design, problem-solving, engineering ethics, safety, teamwork, sociotechnical engineering problems, and innovation. Before restructuring the course, a survey was sent out to engineering first-year students who completed ENGR 1100 to find out what engineering competencies they felt strongest and weakest in and what topics could be implemented to suit first-year engineering students better. 71% of students responded to the survey that their weakest engineering competency was technical communication.

Technical communication is a key skill that students across many disciplines should be exposed to throughout their undergraduate and graduate careers. Engineers must communicate their designs and findings effectively to their teams, bosses, companies, and/or funding agencies [1]. A lapse in engineering communication can lead to detrimental consequences, such as the collapse of the Hyatt Regency walkway, Space Shuttle Columbia failure upon reentry, and levee failures in New Orleans during Hurricane Katrina [2-4]. In the engineering curriculum, especially first-year engineering courses, technical communication is often not assessed effectively due to the current curriculum design and assessment methods used in many classes [5-6]. To help alleviate the lack of technical communication embedded in the engineering curriculum, the Accreditation Board for Engineering and Technology (ABET) has listed communication as one of the non-technical learning outcomes that should be addressed throughout engineering courses [5].

Based on the survey results and learning outcomes provided by ABET, the Samuel Ginn College of Engineering realized that elements of technical communication needed to be added to the instructional methods of ENGR 1100. In the redesign of the ENGR 1100 curriculum, it became apparent that each lecture topic had opportunities to incorporate some form of technical communication into lesson. This material would be implemented using traditional content delivery methods, such as lectures, in-class activities, homework assignments, teamwork assignments, and a semester-long design project. By implementing these changes, the students can further build their engineering toolbox, prepare themselves for future engineering courses, build their confidence in communicating with others, and prepare themselves for future workplace endeavors.

Objectives

The objectives of the restructured first-year engineering course with the introduction of technical communication activities are as follows:

1) Describing the importance of technical communication and applying it through activities throughout the course.

2) Preparing written documents and oral presentations summarizing results from in-class and engineering activities.
3) Executing a team-based, semester-long design project cumulating in both oral presentations and written reports using technical communication and time management skills taught in class.
4) Describing the responsibilities of the engineering profession.

These objectives follow ABET Student Outcome # 3 (an ability to communicate effectively with a range of audiences) and were evaluated through the activities below [7].

Practical Implementation Details

The following activities were implemented in ENGR 1100 to help build first-year engineering students' confidence in technical communication. The course schedule and timeline of these activities can be found in Appendix # 1.

a) ***Lecture on Technical Communication*** **(Objective 1 & 4)** – During this class section, our instructional team stresses the importance of technical communication to the students. Students are introduced to the methods of communication that most engineers use daily, such as design reports, emails, presentations, elevator pitches, etc. During this class, students can work on their elevator pitch first by completing a template worksheet. Then, they had a chance to present their pitch to their group members and in front of the class. The instructors also introduce how to make a resume and create a LinkedIn page to market themselves and prepare students for applying for jobs, internships, and co-ops.
b) ***Resume Assignment*** **(Objective 1, 2, & 4)** – As a homework assignment for the technical communication lecture, students must put together a resume. After completion, the students upload their resumes to Quinncia's resume review feature to get instant artificial intelligence (AI) feedback to help improve their resumes. Students then take the feedback and make changes to their resume before submitting the resume and Quinncia's review report to the Canvas Learning Management System for the instructors to review. Quinncia is provided to all students at Auburn University.
c) ***Career Fair Visit and Reflection*** **(Objective 1 & 2)** – Based on past comments from students, many students are nervous or struggle with communicating/selling themselves to potential employers, and this is often the first time some students are applying for a position. To help prepare students for future career and internship/co-op fairs, we required students to attend one of the engineering fairs on campus during the semester. As a first-year engineering student, many companies do not have open positions, or the students don't have the fundamental engineering skills/knowledge to apply for a position; however, by attending one of the engineering fairs, students can practice their technical communication skills learned in ENGR 1100 before they are at the stage when they are applying for an internship/co-op or a job. The students had to submit proof of attendance, which we verified, and a written reflection describing their experience and what they could improve on in the future.
d) ***Engineering Podcast Assignment and Reflection*** **(Objective 1, 2, & 4)** – During the class on technical communication, students are introduced to different forms of communication such as podcasts. Like a radio show, a podcast is a digital audio program that listeners can subscribe to on their smart devices. As a group, students were tasked with creating a mini podcast (5-10 minutes) about topics (80 topics to choose from) that included engineering disciplines,

engineering wonders, famous engineers, engineering companies, and engineering disasters. The groups were tasked with providing background information about the topic, addressing why this topic is essential for engineering and what lasting impact this topic has had on engineering and the world. If a group chose an engineering disaster, they had to explain why this disaster happened and explain how this could have been avoided. Each group submitted their podcast to the Canvas Learning Management System, and the podcasts were posted for all students in the class to listen to at their convenience. As an incentive to listen to other groups' podcasts, students could complete a bonus assignment (individually) where they could submit a reflection (no more than two pages) describing two podcasts. In their reflection, they had to explain what the podcast was about, what they learned, what details they felt the group should have provided that were left out and give a rating to the overall podcast.

e) ***Project Group Contract Assignment*** **(Objective 1, 3, & 4)** – During our introduction to engineering lecture and introduction to the course project, our instructors talk to the students about the importance of effective communication as a team and how issues can arise between team members if communication is lacking. To help alleviate the problems that arose, we decided to implement an assignment where project groups wrote a contract about how their group would operate during the semester. This assignment helps students determine how they are going to communicate throughout the semester, distributes each member's contact information (phone number and email) to the other members, determines available times when they can meet to work on their project, how tasks are going to be split up between the group, and how to deal with conflict if it arises.

f) ***Human-Centered Design Challenge Activity*** **(Objective 1, 2, & 4)** – The Human-Centered Design Challenge presents first-year engineering students from all disciplines with a scenario where they will use a problem-solving approach to solve problems with a people-first, human-centered design approach. Through this activity, each team should consider how solving the problem affects people and who they are designing for. Student groups spent approximately 20-25 minutes in class responding to questions corresponding to the activity. Students had to discuss their solutions and responses with another group sitting near them and select group responses were shared in front of the class. All groups submitted their response to the questions on the Canvas Learning Management System. This activity promoted communicating ideas and solutions as a team and evaluating/providing meaningful feedback to other team's ideas.

g) ***Semester Long Design Project*** **(Objective 1, 2, 3, & 4)** – For the semester-long design project, each group was tasked with designing a product and company to pitch to a panel of investors as depicted on the television show *Shark Tank*. Each team was required to design a product that would be an advancement in the engineering field and beneficial for people. In creating a product, each team must follow the engineering design process discussed in class (i.e., define the problem, collect information, brainstorm and analyze ideas, develop solutions/build a model, present your ideas to others for feedback, & improve your design). The deliverables for this product included an initial design report due a week after the introduction of the project, 3D printed prototype of the product, a two-page design report explaining how the engineering design process was implemented in the design of the product, a 60-second video (like a commercial) that advertises the product, and an oral presentation (4-minute presentation and 4-minute question session) in front of a panel of judges. As a bonus assignment, each group had the opportunity to submit a page description describing the equity of their group's design. Specifically, each group needed to explain how their product was accessible to different people (i.e., people with disabilities, groups with different socioeconomic status, etc.).

Assessment Methods

A variety of assessment procedures (surveys, written documents, oral presentations, etc.) were used to test student growth in the above objectives and ABET outcomes through technical communication activities in a first-year engineering course. Each of the activities above lists the aim that was evaluated. Each activity had opportunities to assess students' progress with technical communication in all different forms, and the instructors could provide feedback before the next activity. In terms of graded assignments, the average on the initial project design report (due at the beginning of the semester) was a 77% and increased to an 86% on the final design report. This result was promising and reinforced that the students took the feedback from their initial assignments and material learned in class to improve their writing over the semester. Also, the judges for the design project at the end of the semester gave an average of 3.47/4 for technical communication on their evaluation forms for the students. Also, at the beginning of the semester, students were shy and did not want to speak or present in front of the class. By the end of the semester, this was not a problem, and students happily volunteered to give a presentation in front of the class. Hence, the students showed improvement over the duration of the semester.

In addition to the positive response to the listed activities, students completed pre- and post-course surveys and evaluations. In the pre-course survey, students were asked fifteen questions with two questions regarding technical communication. The first question asked, "which of the following is your weakest engineering competency?" Students could choose from leadership, critical thinking, design, modeling, computer programming, problem solving, or technical communication. 71% of students responded that technical communication was their weakest engineering competency. The second question asked, "when working on past team projects, which of the following was the most challenging?" Students could choose from finding time to meet outside of class to work on the project, team communication, equal workload between team members, listening to each person's ideas, and following through on assigned task. 67% of students responded that team communication was the most challenging. After participating in the class activities, students were given a post-course survey with 25 questions that addressed similar topics to the pre-course survey. One of the questions asked, "which of the following engineering competencies do you believe this course helped you improve?" 92% of the students selected that their technical communication skills were improved through the ENGR 1100 course. Also, the students were asked, "when working on the course team project, which of the following was the most challenging?" 88% of the students responded that finding time to meet outside of class to work on the project was the most challenging, which was a change in result from the pre-course survey. Hence, the activities offered in ENGR 1100 improved their confidence in technical communication.

In the future, an IRB-approved study should be performed between students who participated in the redesign of ENGR 1100 with a technical communication focus compared to students who did not undergo these activities. This study should track the student's technical communication progression from their engineering cornerstone sequence to the end of their capstone sequence to see if these activities impact the student's technical communication skills. In conclusion, by restructuring the ENGR 1100 curriculum, an enhanced learning experience has been delivered to the students, preparing them for their future classes and future professional endeavors. By incorporating technical communication activities, we have aligned the course with the ABET outcomes and filled the gap that students previously identified as deficiencies in their educational journey.

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Appendices

Appendix # 1: Course Schedule

Class #:	Lecture:	Assignment Due:
1	Introduction and Auburn Engineering	Assignment # 1 (Initial Engineering Survey)
2	Meeting with the Dean, the Makerspace, and Project Groups & Contracts	Assignment # 2 (Group Contract)
3	Engineering Problem Solving and Introduction to Project	Assignment # 3 (In-class Balloon & Skewer Group Activity)
4	Human-Centered Design Activity	Assignment # 4 (Human-Centered Design Challenge)
5	Engineering Communication and Making a Resume	Assignment # 5 (Resume)
6	Industry/Alumni Panel with CDCR	Assignment # 6 (Visit the Career Fair and Reflection)
7	Talk from Engineering Students Services	Assignment # 7 (Initial Project Design Description)
8	Project Workday, Artificial Intelligence (AI), and Engineering Ethics	
9	Table Browse – Engineering Student Organizations and Engineering Departments	Assignment # 8 (Table Browse Assignment)
10	Innovation	
11	Session with Cupola	Assignment # 9 (Engineering Podcast)
12	Project Workday, Undergraduate Research, and Engineering Safety	
13	Project Presentation Day	Project, Engineering Design Video, Design Report, and Project Bonus Assignment Due
14	Semester Wrap Up and Reveal Winning Projects	Assignment # 10 (Final Project & Class Survey) Bonus Assignment: Engineering Podcast Reflection