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Work-In-Progress: Leveraging Interdisciplinary Topics in First-year Engineering

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Abstract

At Michigan Technological University, students in engineering disciplines tend to see their humanities general education requirements as boxes to be checked off and have difficulty seeing their relevance to their future careers. Simultaneously, engineering educators recognize the importance of humanistic skills and mindsets (communication, critical and creative thinking, comfort with ambiguity, ethical reasoning, etc.) as crucial to students' success as practicing engineers. In the spring of 2019, Michigan Tech launched IDEAhub, an innovation incubator of approximately 80 faculty, staff, and students, tasked by Michigan Tech's president Rick Koubek with reimagining and redesigning the educational experience to meet the needs of the 21st Century. One major focus area of IDEAhub's work is reimagining the first-year experience; in particular, to more closely connect course content in the required engineering and general education first-year courses. To this end, IDEAhub launched prototypes and pilots of interdisciplinary student experiences that directly link content between curricula of traditionally vastly different courses. For the pilot involving first-year engineering and writing courses, the goal was to help students see the relevance of humanities course content while reinforcing content delivered in engineering courses, thus leveraging and building content in both courses. To evaluate the effectiveness of the increased connection between composition and engineering pre- and post-surveys on student attitudes toward writing and communication were collected in composition. Additionally, on a mid-semester early-term feedback survey, students were asked to respond to the following open-ended question, "How is composition supporting and/or how could it better support the work you are doing in other classes?" A qualitative analysis was performed on these responses. For comparison, the same surveys were administered in several comparison sections of composition that were not cohort scheduled with composition and engineering.

The results showed statistically significant gains in appreciation of course relevance of both the engineering course and composition course. This project is significant as the results from this study will be used to better design and link interdisciplinary curriculum and leverage topics in and between all cohorted classes.

Introduction

The importance of writing and communication skills to the academic and professional pursuits of future engineers is well established. ABET lists an "ability to communicate with a range of audiences" as a student outcome for the accreditation of undergraduate engineering programs[1]. Writing specialists have long sought to identify and develop "reliable ways" of helping students prepare for the writing situations they will likely encounter as engineers [2, p. 318]. Yet first-year

students often fail to see the immediate importance of writing skills and view the composition course as disconnected from their central skills and interests [3]. Driscoll concludes that nearly 50 percent either do not believe they will need to write in the future, or are uncertain about whether they will need to be able to write as engineers [4]. Finding that student engineers' attitudes about writing improve as they progress through their programs, Kovac and Sirkovic called for "greater emphasis on communication skills at the beginning of university education" [5, p. 316].

To support writing competencies and improve student perceptions of how writing factors in the "real-world" work of engineers, many compositionists and engineers have sought opportunities for interdisciplinary collaboration. Some universities established specialized writing centers within engineering departments where writing consultants trained in field-specific writing tasks are on hand to support students [6], while others paired specially trained writing tutors with specific classes [7]. At the annual ASEE conference in 2019, a team of scholars from the University of Illinois at Urbana-Champaign described their "Writing Across Engineering" program, in which writing specialists mentored STEM faculty on the integration of writing and communication skills in their courses [8]. In addition to these pedagogical collaborations between writing and engineering faculty, scholars in writing across the curriculum (WAC) and writing in the disciplines (WID) have argued for the further development of "interdisciplinary learning communities," in which student cohorts enroll in two or more classes simultaneously [9]. Learning community participation has been linked with increased student engagement and, as a result, with increased "educational gains," such analytical thinking, adaptability to new social and professional contexts, and the ability to connect and see relationships between ideas [10, pp. 188, 192].

Michigan Tech's First-year engineering students often fail to see the immediate importance of their composition course and how it relates to their future careers as engineers. In fall 2020, we embarked on a mission to better connect students with interdisciplinary first-year content. This included the goal of encouraging learner development of competencies and mindsets to prepare them for the rapidly changing world they will encounter after graduation. Driven to address this immediate challenge, we realized the need to prototype and pilot interdisciplinary student experiences that directly link content between curricula of traditionally vastly different courses. Our goal was to increase student perception of the importance of our humanities composition courses, while reinforcing content delivered in engineering courses, thus leveraging and building content in both courses.

At Michigan Tech we "group schedule" our first-year engineering students in cohorts of 20 students. These students have a common schedule; they have the same math, engineering, chemistry lab, and chemistry classes. Additionally, in the Fall 2020 semester, we piloted adding composition into the common schedules of five (out of 40) cohorts. This study focuses on the

intentional connection between the composition and engineering courses in this pilot group. The fully cohorted study group includes students scheduled into the same engineering, math, chemistry, and composition sections, where engineering and composition instructors shared themed topics. The comparison group includes students with like classes (engineering, math, chemistry, and composition) but whose instructors did not cross collaborate on shared topical themes.

A theme was chosen prior to the semester that would help engage the interests of incoming engineering students. This theme was the National Academy of Engineering Grand Challenge of providing access to clean water. The instructors of the five composition sections met weekly with the instructor of the engineering course along with composition and engineering first-year program coordinators. To discuss current topics and identify points of commonality. We have been able to identify and share resources for common topics and genres. For example, in engineering, the students analyzed an ethical issue related to the Flint water crisis, while at the same time in composition students performed a rhetorical analysis on materials related to the Flint water crisis.

Methods

Methods of Collaboration - Integration of Engineering Themes into Composition

Following meetings between engineering (ENG1101) and composition (UN1015) instructors, composition instructors in cohorted sections integrated material into their course in a variety of ways. In general, instructors reframed existing assignments in the composition course, inflecting them with engineering themes and topics. Instructors also updated their slide presentations to include visual elements that emphasized the overall theme of water. Across all the sections, talking about the Flint water crisis from a humanistic perspective proved a comfortable area of intersection with ENG1101. Most sections drew upon examples from the media (from reports to memes) about the Flint water crisis as sources for rhetorical analysis examples.

The template for the composition course currently has four core assignments: a rhetorical analysis essay, an annotated bibliography, a researched argument essay, and a multimodal assignment. In general, students were encouraged to use the rhetorical analysis essay to analyze a multimodal (integrating verbal, visual, and aural modes of communication) object or text that was related to the overall water theme, with some sections specifically looking at the Flint water crisis. Several instructors carried the water theme explicitly across the entire course, including asking students to do their research argument on a topic that connected the theme of water to their major.

Aside from the core assignments, instructors also attempted to point to connections with the water theme and with science and engineering in general across a range of assignments. This

intervention included having students use elements of the IMRaD (Introduction, Methods, Results, and Discussion) essay structure in their writing. One instructor created an activity about battling "bad science" and used engineering papers as examples when teaching about John Swales' studies of move structure in relation to academic article introductions. Another instructor included specific elements from ENG1101 into students' critical reading response assignments due throughout the semester, with topics like "The Science of Flint's Water Crisis" and "Writing and Engineering." Another instructor created a supplemental assignment in which students viewed two documentaries on the Flint water crisis and drew information from those sources in a written response.

In engineering, connections with composition were reinforced by including conversations on literature reviews, technical citation and formatting assignments taking place in composition classes and how they can add to current project work and report writing within the engineering class.

Methods of Data Collection and Analysis

To evaluate the effectiveness of the increased connection between composition and engineering, surveys were administered in both composition and engineering classes. The following surveys were administered in composition:

- Mid-semester early-term feedback survey
- End-of-semseter survey on student attitudes toward writing and communication

These surveys were given to students in the cohorted sections of composition and in several sections of composition that were not cohorted for comparison.

In engineering, several questions were added to an end-of-semester survey. The survey was given in engineering sections that were cohorted with composition along with a comparison group of students who were in first-year engineering sections that were not cohorted with composition.

Results

Analysis of Qualitative Responses in Composition

We carried out a thematic analysis for questions from the early term survey and end of the semester surveys. Through articulating broad thematic categories based on the survey responses to the questions articulated below, we were able to draw general conclusions about how students were thinking about the connection between their composition courses and the other courses, specifically ENG 1101. The three questions that were analyzed are as follows:

1. How is UN1015-Composition supporting and/or how could it better support the work you are doing in other classes?

2. How has UN1015-Composition supported, or how could it better support, the work that you did in other classes this semester?
3. What suggestions do you have for themes, topics, or genres (types of writing) that could be shared between UN1015-Composition and other classes (such as Engineering or other first-year classes)?

The first of these questions was given to students in a survey four to seven weeks into the semester. The last two questions are from the end of the semester survey. By including responses from the early term survey, we were able to see how their general thoughts and attitudes changed throughout the course.

Themes and Analysis:

Since there were three different questions, one of which was administered at an earlier point in the semester, this analysis is broken up into four parts. The first three sections focus on one of the three survey questions. The last section draws broader conclusions about what each overarching theme from the student responses could imply and draws a brief conclusion about what these responses suggest for questions concerning the merit behind a cohorted section course design.

The question "How is UN1015-Composition supporting and/or how could it better support the work you are doing in other classes?" was administered around the midpoint in the semester. At this point, students were moving on to the second core assignment in their composition courses. Since many of the assignments in UN1015 are scaffolded, it might have been difficult for some students to identify a clear connection to their other courses, specifically Engineering. Many of the initial responses we received were concerned with either gaining or acquiring technical writing skills. Some students specifically mentioned skills such as writing better, writing professional articles, writing academic essays, or generally practicing different types of writing. Among mentioning technical writing skills, some students also articulated their appreciation for the acquisition of practical research skills. This includes finding and evaluating appropriate scholarly sources and synthesizing such sources. At this point in the semester, answers to the survey seem to indicate that many students found a direct utilization of acquired skills for other classes as well as viewed this course as one supporting their other course work. Several students articulated the stratification with how their composition course assignments seemed to align or directly related to what they were learning in their engineering course and their social science global issues course. Moreover, many of the answers indicating they viewed the composition course as supporting their other coursework also gestured towards a satisfaction or identification of transferable skills. Responses that focused on transferable skills also identified elements of technical writing skills as well as utilization of acquired skills. Many of the responses that indicated a positive association between the composition course and their other courses also mentioned the technical skills of citation and formatting. Some responses specifically mentioned a growing comfort level in writing and working within the IEEE style guide.

Many of the responses received indicated a growing level of comfort with technical writing skills, technical citation and formatting skills, as well as acquiring a set of analysis, critical thinking, genre writing, and research skills. While the majority of responses indicated a positive relation of skills and assignments between the composition course and their other courses, some students articulated either a dissatisfaction with the composition course or did not consider any link or support to their other courses to be present. That said, the majority of the responses to the mid semester survey suggest that many students at this point in the semester saw a clear link or practical function for our cohorted course design.

Two end-of-semester composition survey questions were analyzed: "How has UN1015-Composition supported, or how could it better support, the work that you did in other classes this semester?" and "What suggestions do you have for themes, topics, or genres (types of writing) that could be shared between UN1015-Composition and other classes?" We inquired about their perceived level of support that composition offered in relation to their other courses. The responses indicated a positive association. Responses initially began by highlighting the technical writing skills that were acquired during composition. But unlike in the early term survey, students saw a clear utility for what they were learning. Many students mentioned genre specifically. That is to say, the students indicated that through composition, they acquired skills in writing in a genre that they encountered or will encounter in their other course or profession. Moreover, some responses indicated an acquisition of technical skills such as formatting and citation. These responses did not, however, express a perceived explicit link to their other courses. They simply indicated they had acquired a new skill. There were several responses that suggested that composition had not linked to their other course or that they would not use writing in their discipline and therefore did not need the skills acquired in this course. Similar to the early term survey, these responses made up less than half of the responses and did not offer any explicit recommendation to improve linking composition to their other course. However, other responses indicated that students saw a positive correlation between writing style, academic prose, and technical writing elements to improving writing in their disciplines.

Other responses indicated that they feel composition supports their other course, but they did not mention explicitly how. These responses suggest that the composition course, regardless of a perceived link to other courses, merely reinforced skills they acquired prior to college.

The final category for the second question is regarding theme and suggestions students have for themes that relate directly to the last question in our survey, "What suggestions do you have for themes, topics, or genres (types of writing) that could be shared between UN1015-Composition and other classes (such as Engineering or other first-year classes)?" The students who mentioned theme with regard to the second question rather than the last question mentioned one of three things. Either they wanted more STEM related topics explicitly, they wanted specific genres like

report writing, or they did not offer any suggestions for specific themes but just thought there should be a link. The last question on our survey explicitly requested suggestions for themes and topics that could be shared between composition and other courses like Engineering or other first year classes.

There were a few responses that indicated they did not have a preference for any overarching course topic or any theme. These responses typically indicated wanting to choose what they write about regardless of a possible cross-link to other courses. Their responses in this category suggested that we should have no theme at all and to "let the students write about whatever they want." Several responses offered the suggestion of an engineering theme or a technical writing theme. While many did not elaborate on what that would entail, we would like to point out we have a course dedicated to technical and professional writing that many students are required to take later in their academic career. Many indicated they were interested in genre and provided suggestions about what type of writing genre they thought would be most productive. For instance, some students mentioned wanting more lab reports, technical reports, memos, and more research based assignments. Several of these students suggested genres are yet again offered in the technical and professional communication course. However, such responses gestures towards a concern over direct utility of skill. Other responses mentioned wanting topics relating to the Father's Day Flood, which had a significant cultural impact on this region of the Upper Peninsula[11]. The rest of the responses are separated into miscellaneous suggestions that do not fit into any of the aforementioned categories and have no suggestion or simply responded to the question with "not applicable." What is interesting with the miscellaneous responses is that several suggested a creative topic not relating to any STEM field at all. Such responses indicated an interest in exploring topics completely unrelated to their discipline.

We found an overall shift in thinking about the potential connection of the composition course and its applicability to other courses. Many students saw composition as offering the required tools for writing in their other courses. Some students saw a direct utility of technical writing and citation skills to immediate courses. However there were few indications of students perceiving the course's relationship to long term success in their fields. Many responses to the three questions examined here suggest a concern over utility rather than direct applicability of skills in other courses. Students seemed concerned with acquiring a set of conceptual and technical skills they could operationalize for their other courses and not necessarily indicating concern about the explicit linkage between composition and other courses. These responses might suggest a lot about a student's prediction about the composition course as well as their field. These predictions have a clear impact on what they were satisfied and dissatisfied with as well as what suggestions they offered. Whether the student saw a link between the composition course and engineering course, we would argue, is rooted in preconceived assumptions about different disciplines. However, these responses overall indicate that students do see a link between courses and

suggest that they are satisfied with the skills they acquired to assist with their success in their engineering courses.

Quantitative Analysis of Post Course Surveys in Engineering

During the last week of the semester a survey was administered to a total of 462 students taking the first-year engineering class ENG1101 - Engineering Analysis and Problem Solving. Students were given points for completing the survey. Of this group 45 students were in the fully cohorted study and 417 in the comparison group. For this study, we only examined responses from students concurrently enrolled in both engineering and composition courses.

Three questions were added to this survey for this study. The following two prompts asked students to rate their level of agreement on a five point Likert scale, with 1 being strongly disagree and 5 being strongly agree:

1. I can see how the material I learned in Composition (UN1015) is relevant to my engineering class.
2. The themes/topics/concepts in your Engineering class enhanced your Composition class?

The third question that was added is qualitative in nature and will be discussed in the next section.

The responses to each question are shown in Tables 1 and 2. When responding to the relevance of composition to engineering, the cohorted students showed nearly a half point higher ranking with a score of 3.28 vs 2.82 for the comparison group (Table 1). A quarter point gain was recognized by students in the study group on how topics in engineering enhanced their compositions class, reporting a 2.76 vs 2.49 for the comparison group (Table 2). Both gains are statistically significant to 90% confidence using T-test analysis.

Table 1. Student responses to Question 1 on end-of-semester survey in engineering

Question: I can see how the material I learned in Composition (UN1015) is relevant to my engineering class.				
	Average	No. Completing survey	No. offered Survey	Response rate
Fully Cohorted (n = 29)	3.28	29	45	64%
Comparison (n = 179)	2.82	179	417	43%

Table 2. Student responses to Question 2 on end-of-semester survey in engineering

Question: The themes/topics/concepts in your Engineering class enhanced your Composition class?				
	Average	No. Completing survey	No. offered Survey	Response rate
Fully Cohorted	2.76	29	45	64%
Comparison	2.49	179	417	43%

Qualitative Analysis of Responses in Engineering:

A thematic analysis was performed on the third question added to the end-of-semester survey in engineering. This question was, "How has this engineering class supported, or how could it better support, the work you did in other classes this semester?" Of the 45 students in the study group, those enrolled in both the cohorted composition and engineering sections, 32 completed the end-of-semester survey, resulting in a response rate of 71.1%. For comparison, a random sample of 32 responses was selected from students enrolled in non-cohorted sections of engineering and composition.

In the study group, five of the 32 responses indicated a connection with composition: two cited the shared water theme while other students mentioned the citation format and the importance of writing in both courses. A number of students reported that they felt their engineering course supported their math course (four students), programming (four students), or future courses (one student). Two students reported that engineering helped them with problem solving in other courses. Five students indicated that their engineering course helped them to develop student success skills such as time management, course preparation, work ethic, and working with others. Nearly one-third of the students (ten students) reported that they didn't see a connection between engineering and their other courses.

In the comparison group, only two students reported a connection with composition, and one of those students indicated a desire to have a stronger collaboration with composition. They wrote, "It would have been nice to have more preparation for the mini-projects, knowing how to format the report better. [We] Could have had an assignment collaboration with Composition maybe?" Students also stated that engineering helped support them in their math class (six students), or indicated that more should be done in engineering to support their learning in math (three students). Five students indicated that the programming learned in engineering was helpful to their other courses, two indicated that engineering supported their learning in physics, and one identified it was useful for future classes. Two students mentioned problem solving. One student reported that engineering helped them with their organization. Seven students did not see a connection between engineering and their other courses.

Summary and Conclusions

The more extensive cohorted pilot study which incorporated both first year engineering and first year composition classes was a success. Both qualitative and quantitative results show students gain a deeper appreciation for both courses and have developed a greater level of understanding on how composition enhances and is deeply needed for a successful career in engineering. The simple inclusion of a shared topic, meaningful to both engineering and composition, helps to expose the inherent linkages of the discipline to the student. Michigan Tech plans to build on this pilot study by expanding the number of students enrolled in cohorts that include both engineering and composition courses.

While not directly part of this study, the faculty engaged in the process found the once a week meetings were helpful on several levels. These meetings served as:

- a brief check-in for topic progression throughout the semester
- a chance to tweak and leverage assignments or topics
- a bridge building activity between disciplines
- a means to identify students who were struggling

These meetings were scheduled weekly on Zoom, and typically lasted between 30 and 45 mins, between 8-10 faculty members.

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