Using a Mock Conference to Develop Academic Writing and Presentation Skills in Undergraduate Students

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***Abstract Full Paper* – Undergraduate engineering education typically focuses on applying knowledge of physical phenomena to solve problems and design solutions. Typically, there is little to no focus on the importance of research, particularly academic publishing. Graduate engineering students, on the other hand, are frequently placed on research projects early in their studies with little or no training or practice in publishing their research results. Similarly, engineering students entering industry may be unaware of the different research procedures that may be expected of them. To bridge this gap in experience, students in a senior engineering elective are presented with an assignment to simulate a typical conference submission experience. This begins with a lecture, during the fourth week of the semester, describing how conferences function. As part of this lecture, there is discussion of how conference papers are submitted and accepted, much of which centers on formatting of submissions and the peer-review process. Finally, students are presented with a call for papers. Due to the limited nature of this project, only two colloquiums are offered: experimental or literature review. Students are given approximately two weeks to format and submit an abstract. A draft version of the paper is due roughly a month later. These papers are distributed to classmates for peer-review. A classroom lesson on how to effectively conduct a peer-review is included during this part of the assignment. Students have around a week to complete this phase of the assignment. Final papers are due around approximately two weeks after the peer-reviews are returned. This is followed by a 20-minute presentation on their paper during a simulated conference during the last week of class. Students are graded and assessed during all phases of this project, as all the components are uniquely important steps that must be understood and require professional participation. Additionally, this project aims to help fulfill the university's general education outcomes concerning written and oral communication using a unique context that enhances student involvement and therefore performance.**

Keywords — undergraduate, innovative practice

I. INTRODUCTION

Engineering programs are always evolving and developing new methods to instruct their students and better prepare them for the next phase of their career, either entering the professional workforce or attending graduate school. Faculty continually search for new and innovative ways to accomplish this. As noted by Svensson [1], one of the goals of engineering education research is to better prepare students for professional practice. While the teaching methods professors use are frequently designed to achieve the desired educational outcome, the methods used must still be evaluated to ensure the desired outcomes are achieved [1]. One way to accomplish this goal, is to document and share new teaching strategies including student projects and assignments. The study of McMartin et al. [2] focused on using scenario-based assignments to help engage undergraduate engineering students. The study of Chidthachack et al. [3], found that students enrolled in a Project-Based-Learning curriculum performed better compared to the desired Accreditation Board of Engineering and Technology (ABET) outcomes than students enrolled in a more traditional engineering program. Boles and Whelan [4] proposed a variety of methods to encourage students to work together and continue to learn.

The study of Kyoung Ro et al. [5], focused on which undergraduate students continue their education in graduate school. The focus of this study was on a students' math education background, particularly in elementary and high school. While mathematical background and grooming is definitely important, some students might be hesitant to attend graduate school because they have no idea what graduate school is actually like. A graduate classroom is likely to feature more detailed equations, derivations, and theories than some undergraduate engineering students would prefer. However, a large portion of graduate school is conducting research under a faculty advisor which involves performing experiments and reading about new technology employed in experiments at other locations.

The curriculum for most undergraduate engineering programs is heavily problem-focused. A majority of the homework and projects, assigned in sophomore- or junior-level courses, are either problems pulled directly out of a textbook or problems of similar difficulty written or modified by the professor. This focus on accurate problem-solving skills is an important part of the training that budding engineers must go through; however, it is not the only skill necessary for a

successful career as an engineer. Whereas some senior level elective courses might allow for more freedom in research and design, this is not a guarantee.

Graduate students, on the other hand, are typically immediately assigned research by their advisor with little or no formal training on the process for conducting experiments or submitting findings. There are parts of this process where "on the job training" seems practical. For example, the skills and procedures learned in most undergraduate laboratories can be reasonably translated into discipline specific laboratory settings. This includes standard procedures such as: accurately recording results, keeping a log of what happens, following written operating procedures, and using appropriate safety equipment. However, the skills and procedures used to write, publish, and review findings are often not formally taught and are expected to be learned by students along the way. It is not clear if this is a matter of tradition or a lack of resources to devote to these types of educational experiences.

Clearly, not all undergraduate engineering students go on to graduate school. However, many students may go on to work in industry and government positions where they will also be involved in the academic publication system. Additionally, almost all engineers are responsible for writing, reading, and reviewing others' work in a professional capacity. Therefore, most students may benefit from exposure to academic conference processes, both as a direct introduction to academic research and graduate school as well as to address important transferrable skills, regardless of their post-graduate professional pursuits.

Consequently, students should at the very least be exposed to the interworking of the academic conference system while they are still undergraduates. This desire was the inspiration for the project that is discussed herein. Students in a senior engineering elective were expected to participate in a mock conference. This assignment was designed to excite students about the potential for in-depth research on a topic of their choice and to introduce general procedures involved in academic publishing.

The use of a mock conference as a teaching tool is nothing new. Unfortunately, while this teaching tool has been used for many years in numerous disciplines the practice is actually not very well documented. The study of Hathaway et al [6] found that undergraduates who participate in research were significantly more likely to pursue a graduate degree. The study of Budny et al [7] looked at a mock conference to excite freshmen engineering students about their future as engineers and introduce the library as a tool for research. The study of Lin et al. [8] reported on graduate electrical engineering students setting up a mock conference. However, it appears that the focus was more on the organization and logistics behind putting on conference and not on the research, writing, and review process involved for papers. Kumar [9] implemented a mock conference and poster session for freshmen nursing students, while also stating that the practice could be applied to students in any discipline at any level.

This paper will discuss in detail the assignment as presented to the students including the outcome objectives, and decisions regarding styling, formatting, and procedure. The next section will discuss the student execution during the assignment. This will be broken down by the performance milestones students were required to meet throughout the process. Section IV will provide discussion on the lessons learned during this project and possible ways to expand or improve upon this assignment in the future or at other colleges or universities.

II. Assignment and Student Outcomes

A. Overall Objective

One goal of this project was to introduce students to graduate school. Many students enrolled in undergraduate engineering programs have little familiarity with graduate school unless they have a direct connection, such as a family member who has attended. Unless they are explicitly introduced to graduate school as a post-graduate option, they may not consider attending, and anecdotally, most students do not consider it an option. The timing of considering post-graduate options usually coincides with the last couple years of their degree program, when they would be taking elective courses. These courses often coincide with the students' areas of interest. These courses, therefore, are ideal places to introduce students to graduate school as a possible pathway. One way to do this is to introduce some of the excitement school and research in general, to the students as they finalize their plans for the future.

A second goal of the mock conference was to meet the stated ABET program outcomes. While some of these goals are focused on technical competence, others are more focused on general education and professional development requirements such as graduates possess "an ability to communicate effectively with a range of audiences" [10]. While the authors' University's general education requirements include a focus on oral and written communication the style taught in these courses is somewhat different from what is required in a professional engineering context. Additionally, and the engineering program at the authors' University does not require a technical writing course. Public speaking is also an area that tends to make many students nervous, so the authors feel that integrating speaking opportunities into technical courses is beneficial to the students' further development as orators.

B. Introducing the Assignment

Students enrolled in ENGR 490 Special Topics: Introduction to Combustion, were presented with a unique learning opportunity during the fourth week of the semester. The submission timeline for this project is outlined in Figure 1. This process was designed to provide a background on conference operations and walk the students through a low-cost engineering research project. This began with a lecture covering the reasons and goals of research, including the methods in which results are verified as quality work through the peer review process.

Following the introduction lecture, the students were presented with a formal call for papers. Their papers could fall into one of two colloquia: experimental or literature review. The students were required to submit an abstract by the end of the following week. After these abstracts were approved,

including additional guidance from the professor, students could begin work on their draft paper. These papers were due during the 10th week of the course. Submission of the draft papers was followed by a lecture introducing the peer review process. Students were then given the papers of two of their classmates in order to perform a peer review. They were allowed one week to complete this portion of the assignment. After the peer reviews were reviewed by the professor, they were given to the student along with the professor's "editor" comments. Students then had the final two weeks of the semester to update their papers and prepare their conference presentation, with an expected presentation time of 20 minutes.

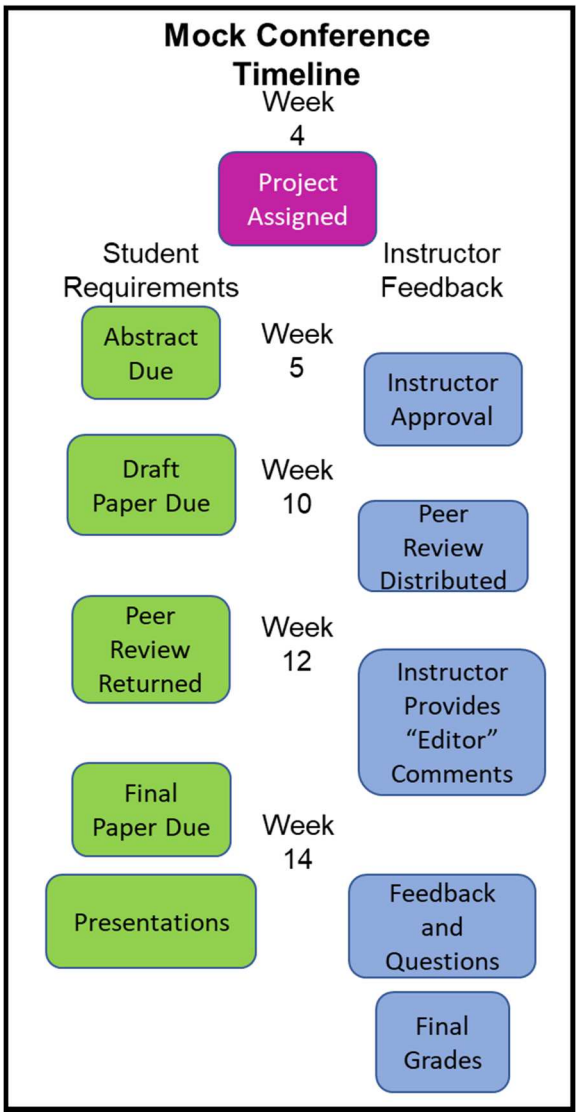

Fig. 1. Flow chart showing the timeline of the project, including student due dates and scheduled feedback opportunities from the instructor.

Students enrolled in this course have previously taken both a college chemistry course and two semesters of calculus-based college physics. Therefore, they are familiar with the scientific method and have practiced its use throughout their college career. The students are also required to take a public speaking course. Therefore, basic practices of public speaking are not taught at this time. The aim is to give students an opportunity to practice those previously learned skills in a more technical environment.

This project has been assigned to two sections of this class. The first section during the spring semester of 2021, included 4 students. The second section enrolled during the spring semester of 2022 included 3 students. This assignment initially accounted for 15% of the students' overall grade in the course, which increased to 20% of the overall grade in the second offering.

While the enrollment is low and therefore unable to provide suitable data, the current average graduating class of engineering students at this university is between 5 and 8 students. Therefore, around half of the university's engineering students are actively participating and hopefully learning during this project. Even though the current data set is small, the results are still useful, and can potentially be extrapolated to larger programs.

C. Abstract Submission

All students successfully submitted their abstracts by the appropriate due date. The call for papers included an abstract target length of 250 words. Of the seven students across the two iterations of the course, only two reached this minimum. The shortest abstract submitted was 151 words, while the longest abstract was 274 words.

One student initially submitted two abstracts. This appears to have been an attempt to obtain feedback from the professor about which topic would be either more interesting or easy to complete. The student was informed that he only needed to submit one abstract and whichever one he chose to pursue was acceptable.

Unfortunately, all students elected to go the literature review route. While this is disappointing, since it would have been interesting to see students develop and conduct their own low-cost experiment, it is understandable as the perceived effort for an experiment may be higher than for a literature review.

D. Draft Papers

In keeping with the mock conference theme, all students were sent an email informing them their abstract was accepted and reminding them of the submission timeline. The students then continued to work on their projects as the semester progressed along with the scheduled lectures, assignments, and quizzes as stated in the class syllabus. All students successfully submitted a draft paper by the stated deadline.

The students in the first year reviewed a wide variety of topics. The first student researched Hydrogen Enriched Compressed Natural Gas as a fuel source. The second student studied the use of Hexanitrostilbene (HNS) and its use in oil and gas mining. The third student researched the use of Oxy-fuel combustion where either pure oxygen or an oxygen carbon dioxide mixture is used in lieu of air for the combustion process. The final student investigated a new Hydrogen Cell-based engine advertised by a company the student found online.

The second batch of students also reviewed a wide variety of topics. However, this group was more interested in general engine design and performance. The first student conducted a literature review serving as an overview of the current biofuels available, including the formation, sources, and limitations of each. The second student wrote a history and comparison of carburetors to fuel injectors. This included a comparison of the fuel efficiency, performance, and emissions from each method of introducing fuel into the engine. The third student looked at comparing gasoline to diesel engines and determining why either engine would be selected for use in various conditions.

This assignment exposed weaknesses in students' research skills. This is partially evident by the lack of sources cited in their papers. This topic will be discussed in more detail in the section on the final papers. This is most likely due to a lack of practice using the resources available to them. One student came to the professor shortly before the draft paper due date unable to find sources. As it turned out, this student was unfamiliar with the use of resources such as Google Scholar and interlibrary loan. While on some levels this lack of knowledge seems shocking, the department faculty were not aware that these are resources that may not require utilization in other writing-focused courses. It is much better for students to learn of the presence of and gain an ability to utilize these resources prior to their capstone courses.

E. Peer Review

The students were assigned two classmate papers for peer review. They were given a week to complete this portion of the assignment. Due to the small number of students a blind or double-blind peer review was not possible. While this might have hindered comments or participation, the exercise was still a useful component of the overall assignment.

The students appeared to be somewhat hesitant to conduct a thorough peer review. It can be inferred that this is partially due to lack of practice. A major factor might be the students lack confidence in their own understanding of the material, rendering them unable to ask a pointed or difficult question to a classmate about their paper. For this reason, most of the comments consisted of minor grammatical corrections. The grade based on this portion of the exercise was primarily a completion grade, as docking students for not asking insightful questions during their first attempt at a peer review seems overly harsh.

F. Editor Comments

The professor served as the editor for the student submitted papers for this assignment. This included distributing and collecting the peer-review comments and including additional questions or comments on the paper. Since the students had done a decent job catching most of the small grammatical errors within the papers, this allowed the professor to focus on technical and content questions the students should include in their final papers. These comments included requests for students to expand sections to include more detail and to search for additional sources. These comments were returned in writing to the students within a couple of days of the peer reviews being submitted.

G. Final Paper

Students had an additional two weeks to prepare their final papers. The students accepted the provided peer review and "editor" comments and made some of the necessary changes. At this time, none of the students came to seek extra help or guidance from the professor regarding ways to improve upon their paper. Since most of the comments were minor and grammatical in nature the overall nature of the papers did not change significant.

The first group of students included a relatively low number of sources in their papers. Three of the students included five sources, while the final student only included three sources. However, the sources that were included appear to be of high quality. As shown in Figure 2, 61% of the cited sources were peer-reviewed journal articles [11]–[20]. Also included among the citations were two conference papers [21], [22], the course textbook [23], a patent [24], a government website, a paper published by a university that appears to be non-reviewed [25], and a corporate website.

The second group of papers improved somewhat between the draft version and the final version. While some of the reviewer comments were thoughtfully addressed during the rewrite, others were ignored by the students. However, this is probably mostly due to the student's workload at the end of the semester and therefore being willing to receive a lower grade for not completely fixing their papers.

While the students in the second year of the class cited significantly more sources, for a total of thirty-two sources, the quality noticeably decreased. As seen in Figure 3, a majority of the sources used by these students were random websites or blogs. This was followed next by information gleaned from government websites. Journal articles [26]–[29] government reports [30], [31], and ASTM standards [32], [33].

H. Presentations

The mock conference was held during the second to last week of classes for the semester. To increase the attendance for the presentations, all sophomore and junior engineering students were invited to attend the presentations. The students were encouraged to dress professionally.

The presentations of the initial group of students went very well. All four students went significantly under the 20-minute target time. The presentations ranged in length from just under 7-minutes to 15-minutes. All available department faculty were invited and participated in proceedings which included the question-and-answer session and a discussion on how to improve the student's overall presentation style.

As expected, based on the previous experience, the presentations for the second group of students also went very well. These students were also given a 20-minute presentation slot. This allowed for a 15-minute presentation and time for questions, similar to what is allotted at many engineering conferences. The actual presentations, prior to questions, ranged from 10-minutes to just over 15-minutes. The audience consisted of all available engineering faculty and about twenty students from another engineering elective that were invited to serve as an audience.

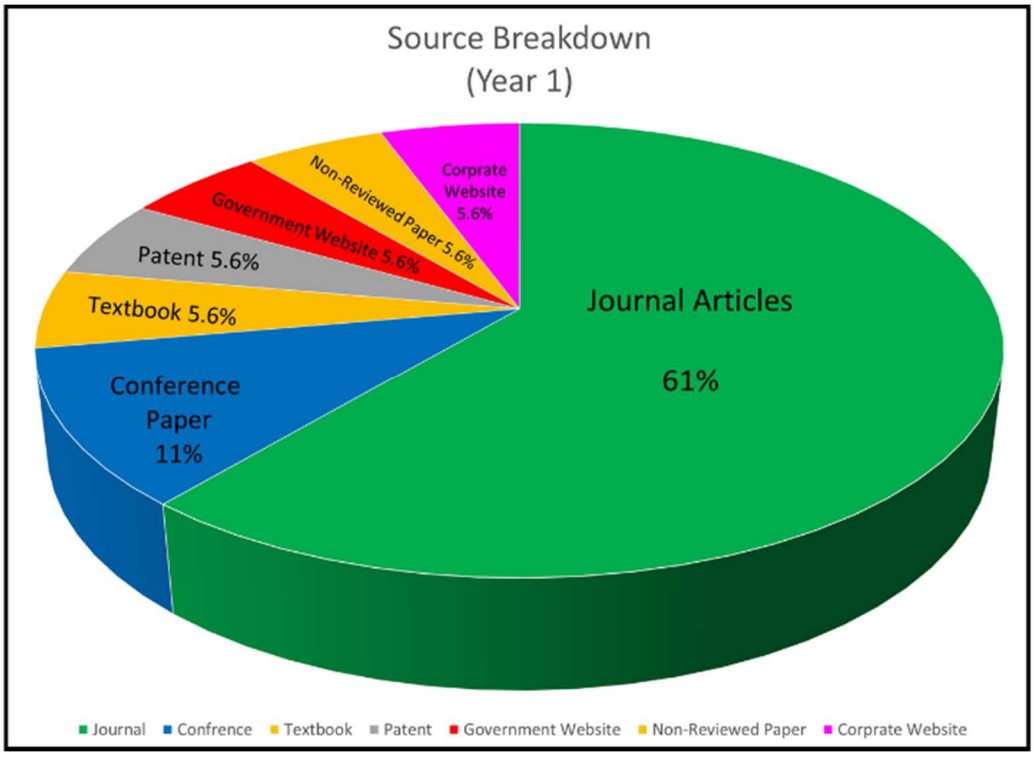

Fig. 2. Breakdown of the sources cited by the students in the first iteration of the class.

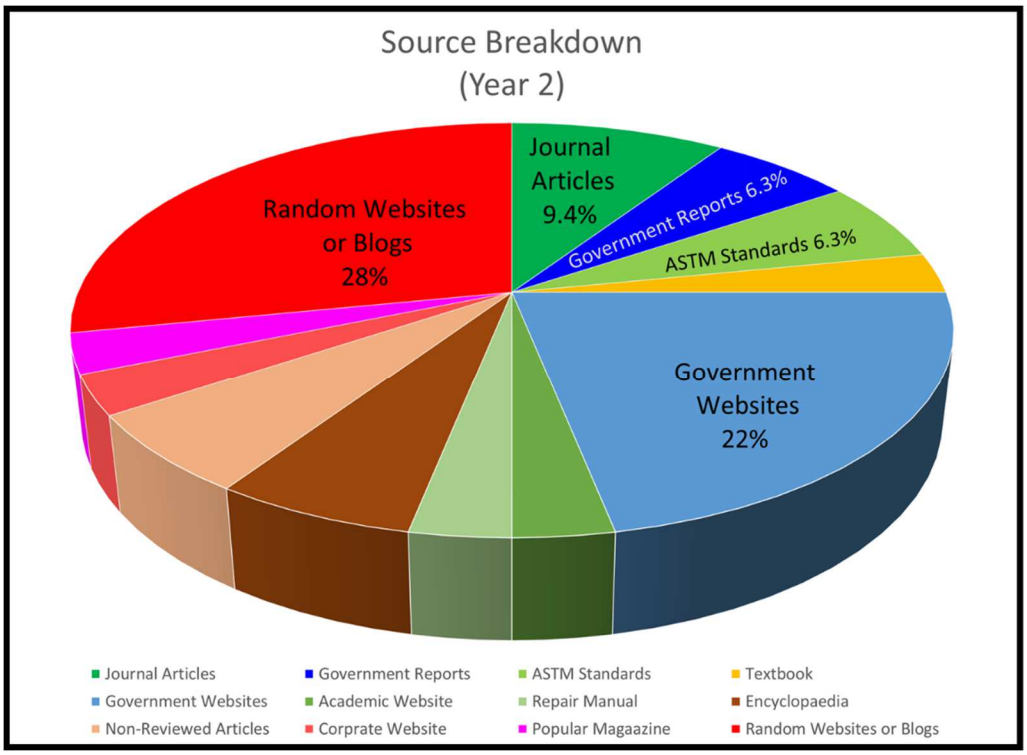

Fig. 3. Breakdown of the sources cited by the students broken down by major category. Major categories and desired categories are highlighted.

III. Discussion

A. Teaching Challenges

Assigning a project that is continually progressive is somewhat challenging. For students to move on to the next step they must clear the previous hurdle. Thus, the student abstracts must be approved for them to move on to writing their papers. The professor must stay involved with the student projects otherwise the students will not learn the overarching goal of familiarizing themselves with the submission process. This requires instructor oversight and feedback at multiple points throughout the process, while allowing students room to explore topics that interest them and familiarize themselves with the writing process on their own.

Engineering students, in particular, do not appear to have much practice conducting a technical literature review. The students appeared to view the literature review in the same way an English or History student might. As noted above, they relied heavily on popular sources that were easy to access. Undergraduate engineering classrooms typically do not require students to spend much if any time in the library. This leaves the students ignorant of the vast resources that are available to them. While large research universities have subscriptions to many major scientific and engineering journals, this is not always true with smaller schools. This sometimes leaves students to complain about needing to pay to purchase access to articles that could potentially be useful to their topic, making it instantly clear that these students are unfamiliar or unpracticed with the procedures of Inter-Library Loan. While it might take a few days, and thus prior-planning, copies of most articles can reach students' hands at no additional cost to the student. In order to prevent this pitfall, it is recommended that engineering departments require students to utilize the library early and often throughout the program. The professor could also invite the university's research librarian to come and talk to the class about the resources available as the project is assigned.

B. Improving the Peer Review

The students completing this portion of the assignment are peers in every sense of the word. This step needs to be reiterated and reinforced with the students in order to for them to function at their highest level. Most researchers write their first peer review as a graduate student, typically assigned by their advisor, or an early career professional. Since most peer reviews are either blind or double-blind, it is easy to assume, especially early in one's career, that the author is vastly more experienced. This leads to only making minor comments on the obvious errors and typos. It is important that the students understand that they are capable of participating in all aspects of the peer-review process.

As noted by Caputo [34], the peer review process is designed to be a gatekeeper for acceptable scholarly practice. Therefore, the role of the reviewer is to be both rigorous and fair. When reviewing a paper that is experimental, it is common to look for uncertainties with the equipment or procedure. With a paper that is strictly a literature review, this is more difficult. The primary critique should be to question the literature sources reviewed. This would require the reviewer, in this case a fellow student, to conduct some research into the topic and see if there are any important sources the author overlooked. The second critique the reviewer could have concerns the author's conclusions about the literature. Once again, this requires the reviewer to potentially read a number of relevant sources and arrive at either the same conclusion or an alternative conclusion from the author.

With these implied steps in the process, a single lecture on how to complete a peer review simply is not enough. Students may need additional coaching and mentoring about the best ways to write a review. This could be implemented by having an additional faculty member walk through the papers with the students individually to help them identify what their questions and comments are, and how best to ask them. Without additional mentoring it is hard to expect the students to accomplish significantly more than proofreading and editing their classmate's paper.

C. ABET Program Outcomes

This project was used as a stepping stone help and meet the required ABET program outcomes, specifically number three which states that graduates will possess the "ability to communicate effectively with a range of audiences" [10]. While senior engineering students are assessed on this outcome as part of their capstone senior design project, this project presents another opportunity for them to practice their communication skills. The audience for the written paper is designed to be their classmates who, as discussed previously, are peers as well as the professor. The oral presentation includes a larger and more broad audience, including other faculty and freshmen to junior-level students. This is an effort to gear the presentation to a broader audience thus encouraging the students to communicate on multiple levels. If this assignment were given to all senior students, it could be used as another opportunity for ABET assessment.

D. Adaptability of Assignment

This student project could be adapted to other junior- or senior-level engineering courses. The goal of this assignment was familiarizing students with the process of writing and submitting a conference paper and allowing them the opportunity to practice presenting in front of an audience. Therefore, the particular topic of focus in the course is not important. To enhance the conference proceedings further, the project could be expanded to include multiple classes with different areas of focus. At larger institutions, it would be more important to guide students to resources such as the librarian and university writing center to reduce the course instructor's load.

Presentation times were targeted at twenty minutes. This caps the number of students who could present each day to 2 students during a typical 50-minute class period, or 3 students during the longer 75-minute class period. A larger class of say 15 students, a decent number for an engineering elective, would require dedicating two weeks of class time in order to allow each student a 20-minute presentation. Since lecture time in

class is so valuable the recommendation would be to either shorten the presentations to 10 or 15 minutes or require students to attend one or two block sessions outside of normal class time in order to fit in all of the sessions.

Another possibility, which one of the authors has successfully implemented in a course of 20 students, would be to hold a poster session during one or two lecture period(s) in place of the presentation. This implementation requires that poster preparation instructions would need to be included during a course period.

IV. Conclusions

This student project has proven to be a success and will be continued in future iterations of the class. Ultimately, the goal of an undergraduate engineering education is to prepare students for their future endeavors, whatever they may be. It is true that not all engineering undergraduates go on to graduate school or a research-based position in industry and therefore might not be exposed to the rigors of the academic publishing world immediately, if ever. However, an introduction to this uniquely perplexing and highly effective system of ensuring quality will help prepare them for any system of distributing new information that they will encounter in their careers. The activities involved in this project also address ABET outcomes regarding acquiring new knowledge and developing communication skills.

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