Board 44: WIP: Integrating Writing into Engineering Labs: Developing Curriculum and Creating a Writing Fellows Program

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I. Introduction

This paper presents a *Works-in-Progress*. Communication competency is critical for practicing engineers [1]. Research demonstrates that learning to write and communicate in engineering is linked to learning to think like an engineer and to developing a professional identity as an engineer [1], [2]. ABET lists "an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature" in item (g) as a student outcome for general program criteria [3]. However, evidence suggests that engineering programs and universities often fall short of preparing students for the writing expectations of industry managers and leaders [1], [4].

The Engineering program at Loyola University Maryland has a number of challenges teaching discipline-specific writing. It does not have a formal relationship with the Writing Department or the Writing Center, nor does it have a writing consultant that specifically supports the Engineering program. Within the engineering curriculum itself, there is no program-wide approach to ensure students get direct instruction in technical writing and communication. Engineering students could take a stand-alone elective technical writing course offered by the Writing department; however, this approach is considered the least effective for developing technical writing specifically needed for engineering [3]. Furthermore, few engineering students have space in their schedules for a course that does not fulfill a major or core requirement. The Engineering program requires 52 credits in engineering-related coursework, and many engineering students graduate with 140 or more credits, instead of the 120 required by the university to fulfill the graduation requirements.

Required lab courses, which provide small classes and hands-on learning, could be sites for more direct instruction in writing that is integrated with technical material. However, the lab curricula, which rely on prescriptive lab experiments, short-circuits the problem-solving and thinking that is integral to critical writing development in engineering. In addition, beyond their instructors, students do not have access to instructional support to address their writing needs within the specific context of the engineering curriculum. The Writing Center, for example, does not have tutors prepared to support the particular needs of engineering students, and the tutoring service offered by academic support services does not provide discipline-specific training for tutors.

To improve technical writing instruction in laboratory courses, a multidisciplinary team of professors in the departments of Writing and Engineering (1) developed a curricular framework that integrates common practices of teaching technical writing in tandem with existing engineering laboratory courses and (2) trained a set of students to be Engineering Writing Fellows (EWF), undergraduate engineering students who tutored peers in their technical writing assignments. This paper will share the student and instructor opinions of these initiatives employed in the Linear Circuits Analysis Laboratory course. Analysis of the initiatives was conducted via student survey and comparison of student writing pre and post EWF tutoring. Results show students highly regarded the input of the EWFs and students who met with the EWFs at least once were likely to meet with the EWFs additional times. Students thought that the curricular framework in the lab

worksheets were the most useful classroom strategy used to improve their technical writing. (This work was sponsored by the Engineering Information Foundation.)

II. Project Description

The central goal of this project was to improve technical writing instruction in laboratory courses at Loyola University Maryland. To achieve this goal, Writing faculty worked with faculty teaching EG031: Linear Circuits Laboratory to enhance practices for teaching technical writing. EG031 was selected because it is the first engineering laboratory course students take and all Engineering students take this course. Two primary methods were utilized to achieve the goal.

One method used to achieve the goal was the development of a framework of questions and activities that were used in tandem with descriptive lab experiments to improve the student learning and enhance facilitation of technical writing. The framework consisted of worksheets tailored to each lab with a focus on a particular aspect of the lab report that they would be required to submit (e.g., methods, results, and discussion). The worksheets sought to incorporate best practices of teaching writing to engineers [5] including using interactive writing processes, designing meaning-making writing tasks, articulating clear writing expectations, prioritizing assignment quality over quantity, explicitly teaching students the genre moves of the discipline, providing structure for students to learn and gradually removing that structure, building meta-cognitive opportunities, and framing writing as a rhetorical activity.

The worksheets were comprised of three parts: a pre-lab activity to prepare students for the lab; guided tasks, including writing-related tasks, to complete during the lab; and post-lab activities aimed at the writing task to be completed. Partial lab reports were assigned across the semester to encourage quality over quantity, culminating in a full, complete lab report at the end of the semester. Sample questions included in the guided tasks of the worksheet were

- *What is the most important takeaway from your raw data? Explain what you want to show to an audience based on the raw data you recorded from the experiment.*
- *What is the best way to show this (e.g., bar graph, line chart, table, etc)? Why do you think this is the most effective way to make your point clear to your audience?*
- *How do the results achieve the lab's goals and support the scientific principle associated with the goal?*

The second method used to achieve the goal was providing students with enhanced access to tutors with a technical knowledge and training in technical writing. Providing students with enhanced access was accomplished by training a subset of engineering students as well as Writing Center tutors who were science majors to be EWFs. The students selected were trained through a series of three workshops over the first two weeks of the fall semester in strategies for assisting peers in improving their technical writing. Training focused on the content and coverage of EG031, the format and expectations of the lab reports, review of past student reports from the course (including outstanding, satisfactory, and poor reports), and the lab worksheets described above. In addition to logistics such as record keeping and scheduling, tutor training covered strategies for tutoring such as asking questions, listening actively, responding as a reader, and waiting (giving writer time

to think). Tutors also watched tutor-training videos, reviewed a variety of writing samples, and roll played how to conduct tutoring sessions.

III. Project Evaluation

To assess student opinion of the EWF, questions were added to the standard department course evaluation which was conducted on the last day of the course. All of the 21 students enrolled in EG031 were surveyed. The survey questions were aimed at learning how often students sought tutoring, would students recommend the EWF to other students, did students use the EWF for other writing tasks, and which components of the lab worksheet were most useful in their writing assignments.

Figure 1 illustrates the student usage rates of the EWF. Student usage of the tutors was lower than hoped. As indicated in Figure 1, 43% of students did not attend a session. However, 24% went 2 or more times, which indicates that for many students, the tutoring was helpful.

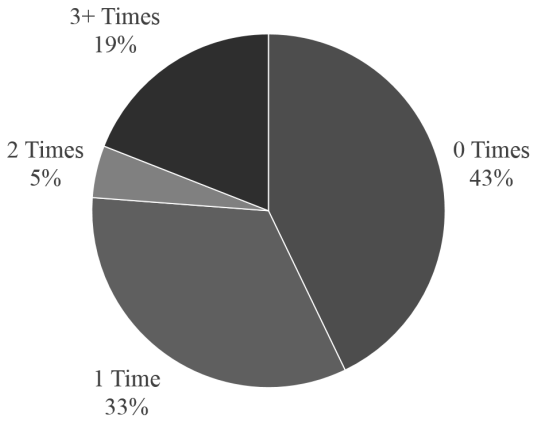

Figure 1: Student participation rates with the Engineering Writing Fellows. The pie chart indicates what percentage of students had 0 sessions, 1 session, 2 sessions, or 3 or more sessions with the EWF. The question posed within the department course evaluation was "*How many times did you visit the Engineering Writing Fellows?*" Tutor logs were also checked for usage.

Student feedback indicated the classroom strategies targeting their writing assignments were valued by students. Figure 2 shows the student rankings of the different types of instructional support incorporated in EG031. Most students identified the lab worksheets as most helpful in improving their writing. The fact that most students found the lab worksheets the most useful is an important indicator of the value of the guided questions/tasks embedded within the lab experiment itself.

Student written comments on the survey were generally positive and said that they found the EWF very helpful. The one repeated negative comment was that the EWF should have more availability and that there should be an easier way to schedule appointments with the EWF. (Students had to contact the EWFs to schedule an appointment although drop-ins were also allowed.)

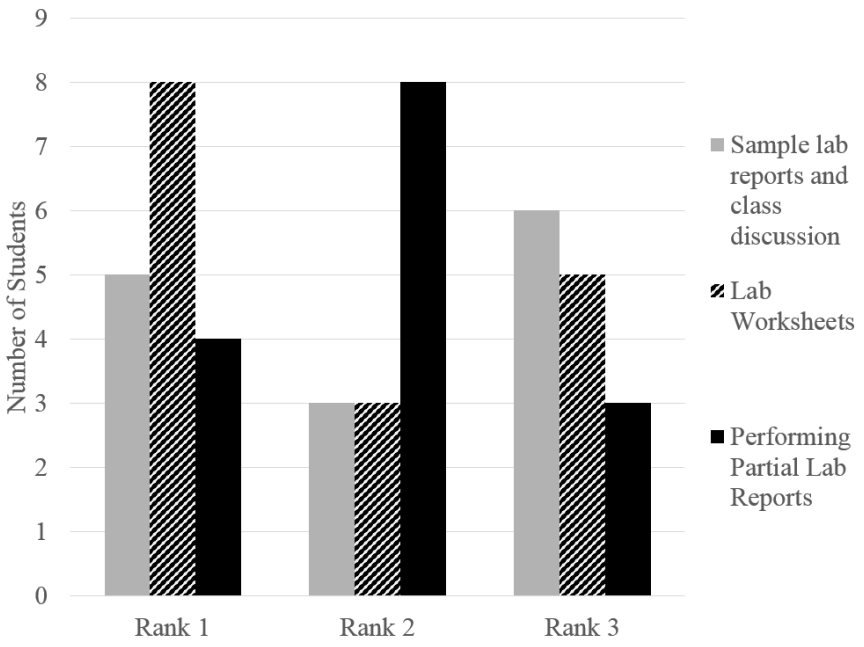

Figure 2: Student opinion of which classroom teaching techniques/strategies they found most useful in writing their lab reports. Rank 1 corresponds to the item students found most useful. Rank 2 corresponds to the item students found the second most useful. Rank 3 corresponds to the item students found the least useful.

The EWF maintained a log of the tutoring appointments, assignment, length of appointment, and general purpose of the appointment. Tutor feedback indicated that most of the students came because they were "encouraged" or "required" to attend a tutoring session. Few students self-selected to attend, especially students in other engineering courses. Tutor feedback also indicated that many tutors reiterated and reframed instructor comments with students. Also, a majority of the time was focused on structure, content, and style and not on grammar and spelling.

Preliminary observations from the EG031 instructor were that the EWF and the lab worksheets were both very helpful in improving the quality of lab reports. The instructor observed that the EWF were exceptional in helping students with poor reports (a C- or lower) revise their reports to a satisfactory report (B- or higher). For a report where a revision could be submitted after meeting with the EWF, the average percent increase in the grade between the first and second drafts was 15.6%. Responses to the guided questions on the lab worksheets showed that further instruction is needed in how to communicate through tables and figures.

IV. Conclusion

Overall, both the curricular strategies were successful at helping students improve their technical writing skills, according to the student feedback. The Linear Circuits Lab instructor also indicated marked improvement in some of the students' lab reports when comparing their earlier writing samples to the later ones. For the future, it is desired to make the EWF permanent by leveraging the existing infrastructure of the campus Writing Center. Also, the authors want to explore if designing experiments with larger data sets combined with more specific instruction on communicating through tables and figures can improve teaching technical writing.

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