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Overcoming Obstacles to Providing Academic Communications Supports for Engineering Ph.D. Students

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Abstract

Students progressing through an engineering Ph.D. program need communication-related supports that address a complex of skill development for both the efficient completion of their degree as well as preparation for the future professoriate. Although students are often highly motivated to improve their writing and speaking, the demands of engineering Ph.D. programs as well as perceptions that communications training is low priority, can result in students avoiding opportunities to improve. The benefits of strong academic communication skills for students to attain and succeed in academic positions are clear: independence, impact, full participation in the scholarly community and teaching and managing collaborative work among other benefits.

Study of engineering graduate student's needs and how to effectively meet these needs is based on a periodic survey of the entire population of over 1,000 Ph.D. students across nine fields of engineering at a major U.S. university. The latest survey was carried out in November 2022 and indicates broadly that students consider their academic writing skills to be weak in a number of areas and are most likely to take advantage of elective writing and speaking courses if they are encouraged by their advisor or hear from friends that their experiences with the courses have been beneficial. Even with enthusiastic recommendations students, however tend to approach these courses with some hesitations namely, fearing the perceived time investment, questioning whether they will be able to improve among other impediments.

This paper details the evolution of communication supports that have been provided for Ph.D. students in response to perceived needs and utilization over two decades. Initial offerings included a semester long communications course which evolved into a pairing of two half-semester intensive courses, one focused on writing and the other focused on oral presenting. A recent supplementary support to augment the courses that began in fall 2022 has been a dedicated graduate writing center, (GWC) called the Communications Hub. The courses and GWC together support student's efforts to gain mastery and independence of their academic communications.

Introduction

Engineering Ph.D. students face multiple challenges in meeting the academic communication challenges they face throughout the duration of their programs, yet they often find few dedicated resources to support learning and improvement of their critical writing and speaking skills. Even if resources such as courses, individual tutoring or workshops are made available, students are often hesitant to take advantage of opportunities. The factors that explain under-utilization will

be investigated and include several perceptions, namely that it is too difficult to improve ones' writing skills after a certain point in time, and the general concern that such an effort will be too time consuming and will interfere with one's research. Overcoming impediments for students to acquire needed communication skills is critical, and should be based upon understanding student's challenges and then meeting them where they are in order to provide support that they will take advantage of. Although advisor-referral is often a critical feature to motivate students to take courses, the view that communication courses may take away time from primary work is also a permeating sentiment. Finally, students often view courses and tutoring opportunities as not sufficiently calibrated to science and engineering writing. This perception often appears to be based on previous experiences with university writing centers that focus on undergraduates and writing courses that focus on basic grammatical issues and general writing.

Acknowledging and meeting such perceptions has been an important element in encouraging Ph.D. students to take either or both of the available communication courses. The author's institution provides one course that focuses on academic writing and another that prepares students to give academic and professional presentations. Sustaining these courses over the past two decades has required ongoing outreach to advisors and students to demonstrate value and encourage the investment in time. In order to better understand the engineering Ph.D. student mindset and address needs, a regular survey is conducted of the entire one thousand plus population of Ph.D. students across the nine schools of engineering disciplines within the school. The growing percentage of international students enrolled in engineering graduate programs is a prominent trend that also requires attention in order to meet diverse needs that exceed the capacity of basic communication courses. In the engineering school profiled in this paper, about 74% of the graduate student population were born outside of the U.S. International students constitute a high percentage of those taking the communication courses.

The results of this survey broadly indicate that students clearly see that communication skills are critical to their future in the professoriate and furthermore they consider their own academic writing and speaking skills to be underdeveloped. This paper reports on these survey results to identify the obstacles to utilization of existing resources that would in fact help put students on a path towards improvement.

In addition, we discuss forms of support and instructional offerings that complement these courses and help provide a more holistic program that can accommodate student needs progressively as they move through their program, namely a graduate writing center (GWC), that was launched in August 2022. This GWC, called the Communications Hub has provided writing and speaking assistance for Ph.D. engineering students as well as post-doctoral students and even faculty. Ongoing assessment in the form of an intake survey and exit survey filled out by the student users of the Hub has been collected. The Hub's activities also have included ancillary activities such as the Three Minute Thesis, (3MT).®

competition, fall and spring Writing Retreats, and quiet writing time where students can show up and take a small private room to work in and make a plan for themselves.

We acknowledge the need for more systematic study and evaluation of outcomes, but thus far, students who have visited the Hub are appreciative and rate the value of learning and help on their projects very high. Likewise, evaluations of the writing and oral communications courses are highly rated with enrollment sustained primarily through word-of-mouth recommendations. Future work includes definition and implementation of an assessment study to analyze short and longer term outcomes in order to develop a systematic transferable model and pedagogy to support an engineering Ph.D. communications program.

Literature Review

The importance of effective writing and speaking skills for engineering Ph.D. students intending to enter the professoriate or industry is much noted, however, despite a current interest in improving attrition rates for Ph.D. degree completion, more research examining the the specific communication needs of engineering graduate students and pedagogical approaches to address these needs is needed [1]. In addition, textbooks that focus on engineering communications tend to target undergraduates or technical communications for industry professionals, rather than Ph.D. level academic writing and speaking. Joshua Schimel's *Writing Science* is among the few resources for learning how to write scientific and engineering journal papers along with H. Glasman-Deal's textbook focusing on science writing for non-native English speakers [2,3]. Engineering communications theory and practice is described in [4], and a recent effort to develop an engineering writing course for Ph.D. students in China is elaborated in [5].

[6] investigates the benefits of providing ethics education in an engineering graduate program in order to raise awareness of ethical norms and wider exposure to the societal implications and context of the field of engineering. In fact, the addition of ethics-based writing assignments to the communications courses recently has proven highly useful in supporting discussion and awareness of interdisciplinary links. Students also write about the broader social impact of their research which has also proven successful in aiding student to find ways of discussing their work with others who are not in their field. [7] notes that identifying writing projects that students care about, even if they are of an non-technical nature, supports the motivation to express. These efforts have served as bridges that lead students to improvement in their scholarly writing.

Finally, work has been carried out to examine issues faced by international students, beyond communication challenges, and include societal influences related to understanding and managing adjustments to US culture [8,9,10]. While international students do face challenges related to their citizenship status, and concomitant communication issues that necessarily should be supported within their Ph.D. program, the existence of dedicated communication courses along with the GWC at our university appears to have provided a useful support to addressing general writing and speaking issues.

Methodology

This paper provides descriptive data about two communications courses, including experiential information around efforts to build communications supports for Ph.D. engineering students in light of their communications-related challenges. These two elective courses have been

sustained over time; students noting that they have improved their works-in-progress and one-on-one feedback has supported progression. Survey data has been collected from Ph.D. engineering graduate students at a major engineering school within a research university in California to inform the design of communication supports that will prepare engineering students for the successful academic careers in the profession. In addition, a smaller subset of feedback from Ph.D. students was collected from students who completed the writing and academic presenting classes. Admitedly, surveying student perceptions and likewise student course evaluations must be viewed with some caution. Objective measures of writing and speaking improvement are difficult to acquire, however. We will continue to collect information on successful outcomes when possible, along with student reporting of their conference presentation experiences, positive meetings with advisors and other feedback. Faculty feedback has also been supportive of the value of the courses and GWC.

The wider survey was distributed by email to all current Ph.D. engineering students by the doctoral programs administrative unit of the engineering school to some 1,000 full time doctoral students, with nearly 80% of this number representing foreign students[1]. Some 50% are native Chinese speakers, 15% are Farsi speakers, 12% are Korean speakers and 10% are Spanish speakers from the 106 responses. A handful of respondents are U.S.-born native speakers. All departments within the school of engineering, are represented among the respondents with the majority coming from computer science and electrical engineering, the largest departments. The majority of respondents indicate an interest in pursuing tenure track academic positions. A few select survey results are displayed in this paper, all figures show the combined percentages of respondents agreeing to a very great extent and to a great extent on a 5 point Likert scale. This survey has been administered four times in the last ten years to the entire Ph.D. population with minor revisions. The results of this most recent effort are consistent with past results, including the response rate (nearly 10%).

Meeting Ph.D. Students' Diverse Communication Needs in Ph.D. Communications Courses

Basic academic writing principles are often not taught to incoming Ph.D. engineering students. A frequently heard remark in our school is that "I have never learned this." Rather students tend to learn the forms and language of an academic paper by reading papers in their field and following the conventions as they see them. While this "absorption" process is part of the graduate student academic acculturation experience, learning the communication forms of one's field can be formalized through courses that explicitly point out accepted conventions and note changing trends in academic and scientific expression.

A value of courses that student's often point out is the ability to discuss the discourse of their field; through identifying options and comparing across engineering fields in the classroom, students learn the choices they have in terms of vocabulary, tone, style and structure. A result of these guided conversations in the classroom is a greater sense of confidence, through better understanding of the communication norms of one's field. Such lessons are somewhat hidden – students do not enroll for writing or speaking courses to learn about scientific academic writing,

[1] The surveymonkey online survey application was utilized for this survey. An incentive, consisting of a baseball cap that had the School's logo embosed on it was provided to students who completed the survey.

rather the majority have identified specific needs. The first day of class students are asked to enumerate the reasons that they take the writing and speaking courses. The primary motivations for taking the writing course relate to mechanical issues – grammar, use of tense, finding the "right word," clarity and precision, and many if not most note difficulties in getting started, and establishing comfortable writing habits.

Those taking the oral presentations course report often that they would like help overcoming fear of presenting, organizing their thoughts and generally connecting with their audience. In learning basic principles of oral presenting, e.g. structuring information, using transitions and signposts, the basics of opening and closing a presentation, they feel better prepared. Simply having basic principles to apply to their presentation task provides a structure for improvement. An outcome of both courses is that students find unintended value, namely a better sense of audience due to interaction in the classroom with other Ph.D. students from other fields who provide often unexpectedly useful feedback and new perspectives. While some progress around sentence level issues is possible with diligence, students often find that they have improved awareness of their writing and feel the possibility of continued progress.

Shown below the survey responses note the elements of writing that students find most problematic. Figure 1 shows the survey responses to a question asking students to report on the issues they have with academic writing. As can be seen motivation and deadlines are problematic for the majority of graduate students, although writing for multi-disciplinary audiences is considered problematic for nearly 80% of respondents. Sentence level issues defined as "clarity and readability" are also a difficulty for the vast majority of respondents.

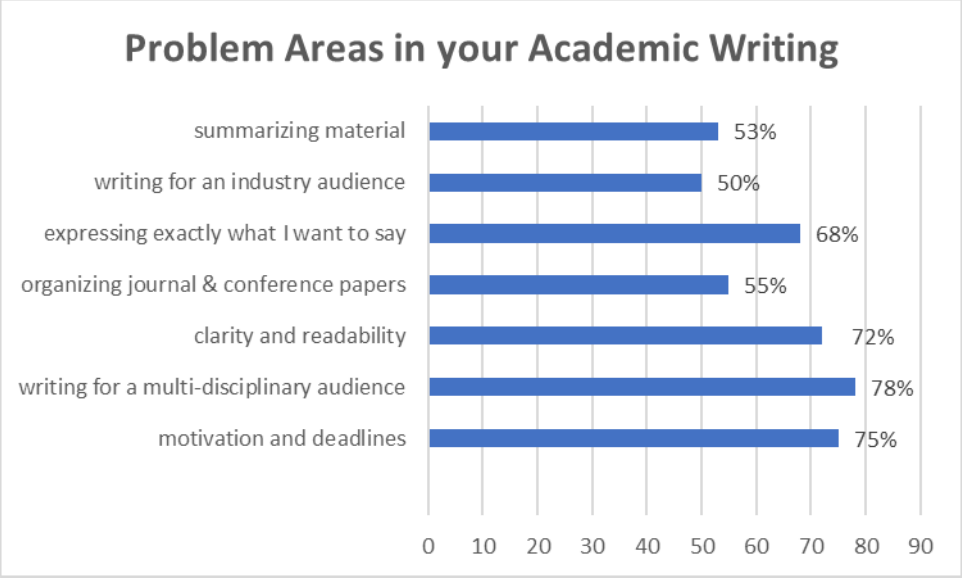

Figure 1: Problematic areas for Ph.D. student writing include clarity, readability, multidisciplinary writing and meeting deadlines

Ph.D. students are extremely cognizant of how they spend their time, and necessarily focus on their research and primary coursework. Communications training is perceived as ancillary and

students express hesitancy about the level of time commitment required for a dedicated communications course. Enrolled students often show resistance to writing that is not clearly tied to their own work, e.g. a conference paper or other publication. Writing that doesn't directly apply to ongoing work frequently needs to be justified, and writing assignments that have buy-in are those most closely aligned with current needs. Class time is often used to break down and practice steps in the writing and speaking process to equip students to tackle their own academic communication tasks. Through the practice of writing methods for example, attempting to reverse outline a few paragraphs, students gain the tools to make progress on their drafts. Other activities involve close analysis of exemplars across fields and genres. Finally, both in class and individually students are provided with materials to motivate reflection on the broader implications of their research contributions and to support idea generation and linking. Students have varied reactions to supplemental readings ranging from excitement to read outside their field, others require encouragement to venture beyond material in their field. Figure 2 below shows views of individuals perspectives on their oral presenting problems with stage fright reported as the most difficult issue that students face (86%) followed by generally connecting with an audience (84%) and finally, explaining concepts and information with clarity (78%).

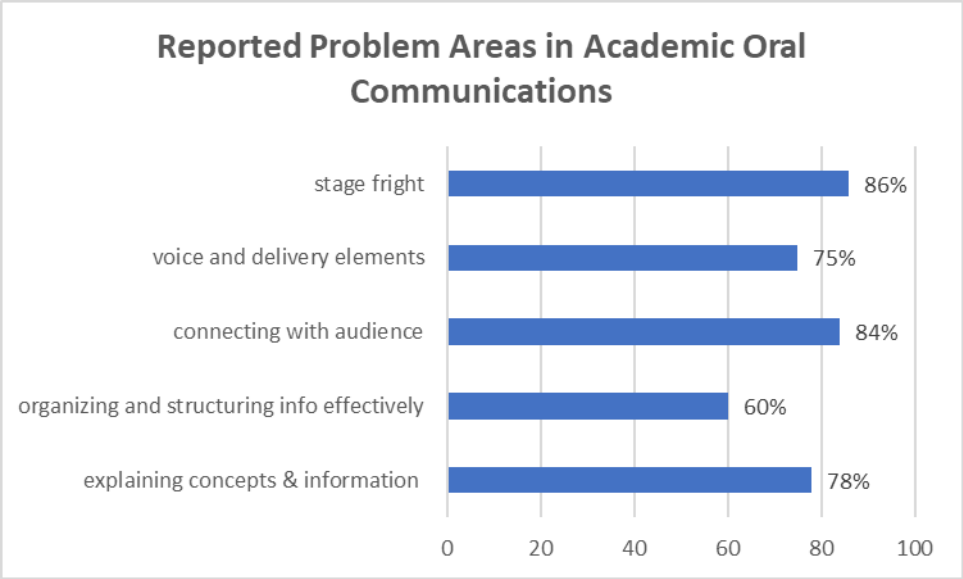

Figure 2: Problematic areas for Ph.D. students oral presenting include stage fright, connecting with an audience, explaining concepts and information

An unexpected benefit that students universally experience is the feedback and discussion that comes from showing work to others in different fields. Questions from students in adjacent and seemingly unrelated research areas often reveal linkages, similar approaches to different problems and new avenues. These working collegial relationships are a valued experience that many take from these courses and are a support to understanding the social processes of research and academia.

The writing classroom has been a useful outlet for students to discuss their research. Students in fact have taken this course more than once for the benefit of such support. Although students appreciate individualized instruction, they also find that they share much in common with each other. This includes efforts to communicate with precision and clarity in their own field, to those in adjacent fields

and to a broader audience. Classroom meetings thus have many useful purposes, including students seeing that they are not alone in facing qualms about getting started with writing projects, in managing advisor's expectations, in feeling anxious before a presentation, and in handling a journal reviewer's comments. Below in Figure 3 students who have taken either the writing course report that the most visible benefits are improved ability to edit their own work. All respondents who answered the survey found that they have improved their abilities to assess their own work and to revise it going forward.

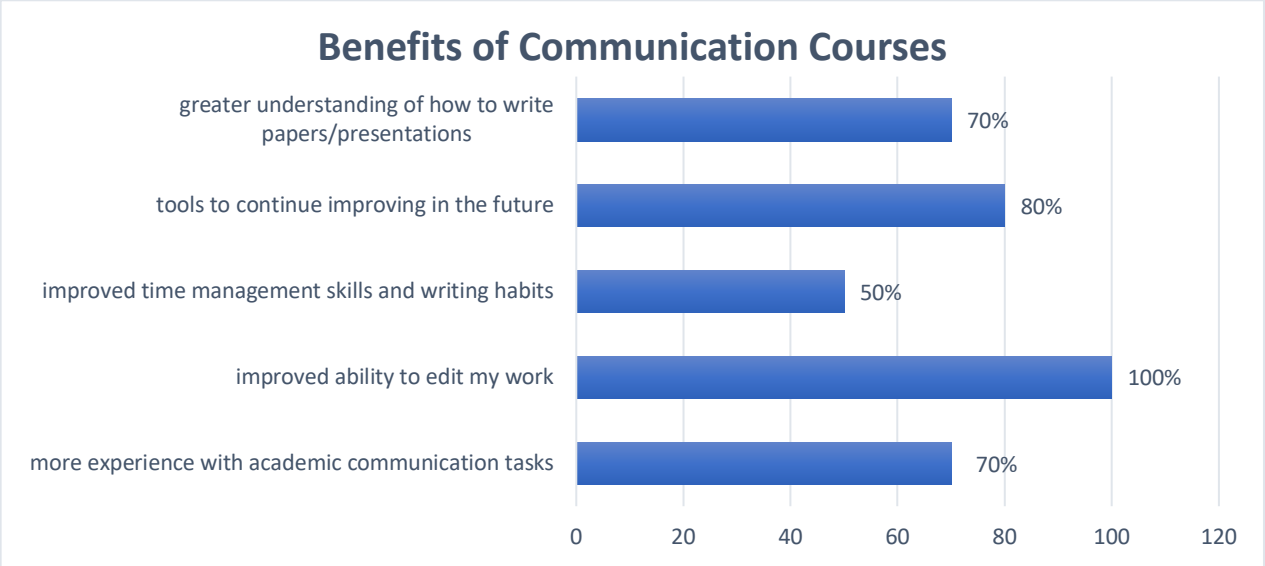

Figure 3: Primary benefits of taking the communication courses include an improved ability to edit work and tools to continue improving in the future

Teaching Communications to Ph.D. Students

Given student's time pressures and prioritization of their research work, and the short-form nature of the communications courses, strategies that help students gain as much value as possible include detailed one-on-one feedback, getting started and making progress on writing tasks in the classroom, along with in-class dynamic, interactive activities involving rhetorical tasks. These activities are low stakes ancillary assignments that are equally accessible for students at all levels. In class discussions efforts are made to draw connections between current ethical dilemmas, discussions about language and its use in academia and the public sphere.

Meeting the diverse and evolving communication needs of the engineering graduate student population requires frequent modification and retooling of the course. A high percentage of students are multilingual language learners as well as native speakers, and students at different stages of their program, ranging from their first to sixth year and beyond. Meeting such different starting points requires an individualized approach that includes extensive feedback with follow through to support meaningful revision. Most students go through multiple iterations of class assignments which mirrors the extensive revision process of academic output. Guiding students in revising their work has meant

being available to provide feedback when they are in process of writing a consequential communication, often up to submission deadlines.

Components of the writing course include research ethics and writing about societal impact—an inclusion often in journal paper discussion sections. These ethics-oriented assignments generate material for discussion and serve as a gateway to specialized writing in individual engineering fields. Submissions for these assignments indicate that students have not written about these subjects extensively, yet they are motivated and write meaningfully. Overall, the course framework from start to finish parallels the rhetorical conventions of scientific journal papers starting with introductions and concluding with discussion sections, and encompasses student's efforts to compose dissertations, prepare defenses, proposals and other academic writing. Course material is built from student's active writing projects that are shared in class. The course is taken by students at all levels so while those further along in their programs have their own materials to engage with through the classes while first year students may need to rely on the set class assignments.

The oral presentations class focuses on the delivery of conference presentations, adjusting material and delivery to audiences outside the field, principles for teaching technical material, and presenting in situations that require strong delivery and clear content. Presentations are recorded for self-review to correct and build confidence. Developing each student's own understanding of how to use every speaking experience as a stepping-stone to advancing their capabilities is stressed. Guided assessment takes place to build student's self-appraisal skills.

Many video examples are used in class to show presenting styles, use of different structures, opening and closing a talk, gesturing, tone and adapting information to different audiences. Students analyze the speeches of Hans Rosling, Max Tegmark, Barack Obama and other globally known speakers and scientists, as well as presentations from their peers. Focused observation of speakers helps students define their own presentation style and also supports in-class exercises that break down the many elements of a presentation. Targeting single elements such as transitions or fielding questions allows students to build capacity through experimentation. As with the writing course, Ph.D. students greatly benefit from speaking and discussing their research with students from a variety of engineering fields.

Barriers to Taking Advantage of Communication Resources

As noted, students express need and motivation to improve their communication skills, but nonetheless often need encouragement to take action. Figure 4 shows some of the common reasons students do not enroll in the courses, namely they are uncertain whether they will benefit. This reason is followed by a feeling that they lack the time to devote to improving their communications skills. Faculty advisors refer students to take the communication courses if students appear to have difficulties. Students are rarely referred for general improvement, and students with already solid writing and presenting skills usually receive little encouragement. Nonetheless, students who already are well-equipped are frequently enthusiastic class participants, and report high levels of satisfaction with the courses.

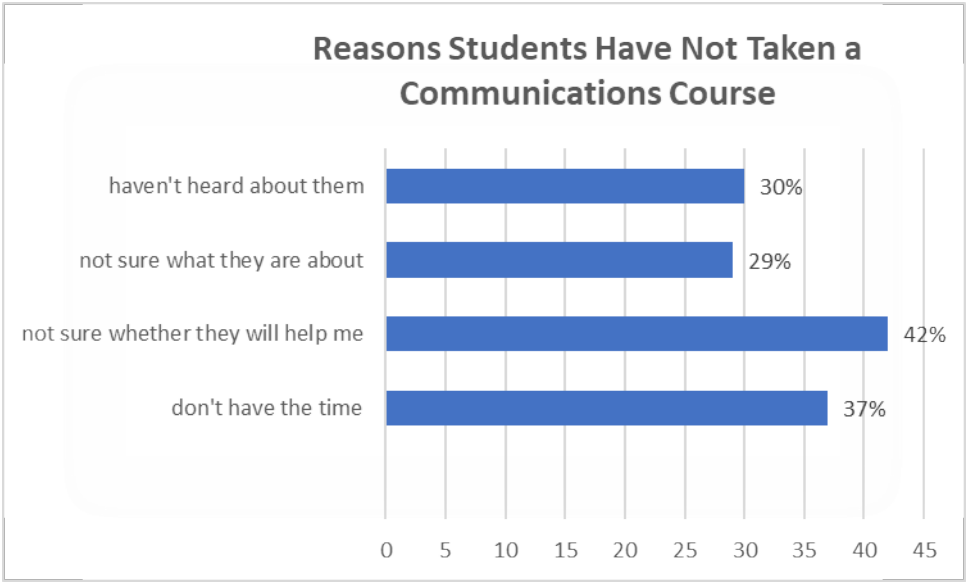

Figure 4: Students Avoid Taking Communication Courses Because they are not sure of value and they do not Think that they have Time

Communication Supports: form and function

Exploration of the forms of communication courses and co-curricular offerings that are most effective and attractive to Ph.D. engineering students and their advisors has been undertaken over the last two decades that the graduate courses have been offered. Initially, a semester long writing course was offered which was followed by a companion oral presentations course both of which were electives and offered as credit, rather than graded courses. It was determined that students would find an intensive shorter form easier to work into their schedules, and so these courses were then offered as half-semester intensive courses. Student enrollment did not change substantially with this change, although in fact many students note that they would prefer a more sustained and gradual approach.

Additionally, students often time their enrollment to coincide with a conference or journal paper they are writing or a presentation, and they hope to gain support for these efforts. The survey asked students about other resources and courses that they would be interested in if made available, and the results show below in Figure 5 that more opportunities to give presentations of their research to various kinds of audiences, including interdisciplinary venues would be valued. In addition, dissertation seminars, workshops on various topics and a writing lab would all be valued supports. Online modules and resources are of less interest and in fact 40% of respondents stated that they would not be at all interested in this kind of resource.

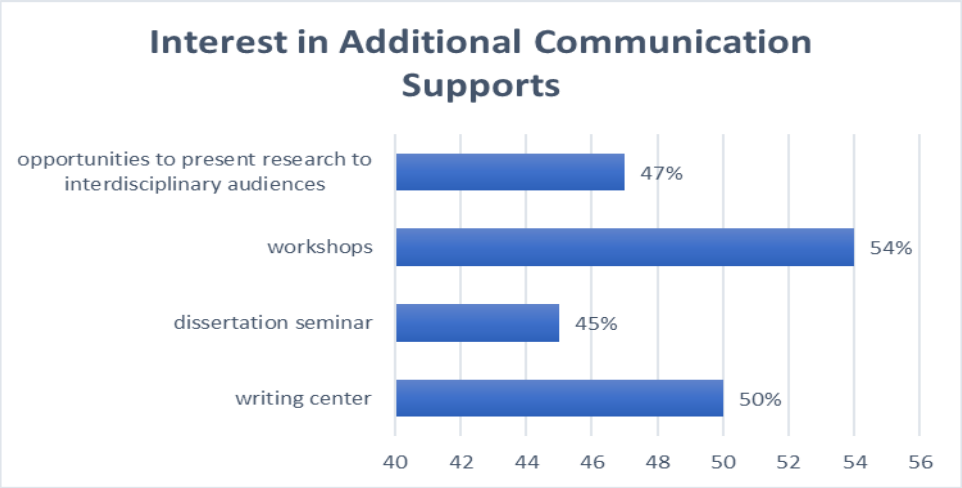

Figure 5: Students Express Interest in Workshops, Writing Centers and Opportunities to Present to Interdisciplinary Audiences as Additional Supports

Given identified need by students for tutoring beyond the confines of the classroom, supplementary support is now provided by a graduate level writing center (GWC) that provides students with assistance on critical communications including journal papers, dissertations, fellowship applications and presentations. Van Dyke [11]suggests that supporting student's writing with instructional supports is vital, and meeting this need with extracurricular activities is a critical input. They suggest the creation of multidisciplinary spaces that allow students to connect to one another about their writing and provide peer support to one another.

Workshops and targeted events such as the 3MT® provide a variety of interventions that allow students to take advantage of resources that incrementally support their writing and speaking proficiencies. The Hub has been set up as a unique academic support facility, based on the premise that graduate students carry out advanced disciplinary research and have extensive writing needs with a high level of rhetorical complexity that are distinct from those of undergraduate writing. Students may be defining original research questions and making claims that involve a level of knowledge transformation that exceeds the standard approaches of traditional university-wide writing centers.

Thus, students are assisted with their consequential communications: journal articles, proposal and fellowship applications, career documents, teaching statements, lab reports and other in-progress work. Evidence that the Hub is meeting critical needs is its continued full capacity use and the reporting back from students that their materials were greatly improved by using this resource. At the end of the fall semester term (August 25 2022-December 1, 2022) 101 unique visits to the Hub were recorded with 65% of these visits consisting of repeat visits. Many students submitted papers, dissertations, and other critical documents with assistance from the Hub. We have identified successful outcomes such as the awarding of fellowships and internships, paper submissions, and other results. A preliminary dynamic of making this resource available was a drop in enrollment in the writing courses in the fall semester. This required messaging to students and faculty to clarify the difference between the immediate

assistance offered by the GWC and the value of a dedicated course that supports continued progress.

In sum, providing such "short form" targeted communication instruction that is systematic throughout the span of an engineering student's Ph.D. studies shows promise in terms of the perceived value and therefore is utilized by students. Such gradual skill building fits into a rigorous doctoral program and meets the stated preferences and needs of students. Next steps include more systematic analysis of benefits to students in terms of improving their communications. Outcome-based data to supplement surveys of student views would support further development of a programmatic approach. Collecting data that indicates value and improvement potential would have clear value in framing engineering graduate communication supports and would facilitate program design.

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