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Engineering Faculty on Writing: What They Think and What They Want

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Abstract

Writing has been identified as an important skill for engineers. While faculty generally agree that writing should be included in the engineering curriculum, there are many barriers that may discourage them from bringing writing into their classes. Through development and deployment of a survey, the authors investigated instructor perceptions of writing in engineering. More specifically, this paper reports results from a survey (n=53 responses) administered to instructors in the College of Engineering at Purdue University, a large doctoral university with very high research activity in the Midwestern United States. The survey first asked respondents to report on the extent to which they incorporate writing in one of their recent undergraduate courses, including types of assignments and use of related tools and practices. A second major section of the survey probed instructor perceptions of student writing skills, while also asking about reasons for – and challenges associated with – incorporating writing in engineering classes. The final parts of the survey ask respondents to identify specific resources that might help them expand inclusion of writing in their courses, followed by a series of demographic questions to better characterize the participant population. Most generally, the survey results suggest that faculty recognize the need for and importance of writing in engineering, which is in part reflected in their own courses. However, they continue to perceive challenges associated with including writing in engineering courses, with a particular emphasis on various resource constraints. The paper concludes with a brief overview of next steps, including plans for developing supporting resources for faculty and students and collecting survey data from multiple institutions.

Introduction

Writing is an important skill for engineers, but it is not necessarily thought about or taught as an "engineering skill." Because of this, and despite ABET accreditation criteria directly related to writing,[1] the inclusion of writing in engineering programs varies widely from program to program and course to course. While writing in engineering practice varies in scope from informal emails and memos to large scope reports and proposals, writing in engineering courses is often limited to formal laboratory or project reports, if it is included at all. This often causes a disconnect, leaving engineering graduates lacking in writing knowledge and skills, including as related to understanding of structure and organization, document and graphics formatting, and audience and genre awareness.[2] Many studies have more generally identified a persistent "competency gap" associated with communication skills, with the capabilities of engineering graduates often falling well below what is sought by the organizations hiring them.[3,4,5]

To shed further light on the current state of writing in engineering degree programs, this project surveyed instructional staff in engineering programs at multiple universities to investigate: 1) their attitudes about the current state of writing in engineering classes and writing skills in students, 2) challenges they encounter when trying to incorporate writing, and 3) resources they believe would most help improve the teaching of writing in engineering courses and curricula.

In this paper, the authors present preliminary survey results, namely by reporting on the responses of instructional staff (n=53 respondents) at Purdue University, a large public doctoral university with very high research activity located in the Midwestern United States. In the larger study, we seek to understand how writing is typically incorporated and practiced in the classroom, especially in large, core engineering science courses. For example, two other related investigations in which we have explored writing in engineering focus on student responses to paragraph writing assignments in a fluid dynamics course[6], and a textbook analysis that examined whether and how writing questions were included in textbooks for core engineering topics.[7] While writing is already to some extent being included in engineering courses, we wanted to better understand how and why writing is being incorporated, as well as what challenges instructors face and what resources they think they need to include more writing in their courses.

Literature Review

Writing is clearly an important part of engineering. For instance, one study found that aerospace engineers reported a minimum of 19 hours per work week spent writing technical documents,[8] while still other researchers have found that engineers spend more than 30% of their time writing.[9,10] Yet instructors find that students frequently resist required writing in the engineering curriculum.[10,11] Additionally, the "neutrality myth" – that writing simply reports factually "what is" rather than acknowledging that engineering writing occurs in a context for a particular audience and purpose – persists among undergraduate engineering students. Only after completing their studies and entering careers do engineers typically start to recognize the importance of writing as a part of engineering practice.[12,13] In fact, Reave analyzed findings from various engineering alumni surveys to conclude that graduates now in the workforce believe that their job-related need for writing skills is significantly greater than their preparation for writing.[14]

Despite evidence from practicing engineers regarding the necessity of writing, and the fact that ABET identifies effective communication as an essential learning outcome, writing is not often included in engineering courses, particularly at the sophomore and junior levels.[15] These engineering science courses are usually focused on technical problem solving and are often lecture-based; additionally, they tend to be large-enrollment courses.

This study extends scholarly attention to writing in undergraduate engineering instruction by focusing on the attitudes and perceptions of instructors about writing in the engineering classroom, as well as understanding why they might not include writing. Related work by Matusovich et al. involved interviews about perceptions of teamwork and communication skills among both students and teachers, including 50 civil, mechanical, and industrial/systems engineering faculty.[16] They found that instructors were concerned about how writing assignments might take time away from what they perceived to be more important engineering instruction. However, their study asked faculty much more broadly about how they taught communication and teamwork, with information about faculty writing pedagogy only an incidental result. Another study involving a survey of graduate engineering faculty at six universities found that faculty almost universally placed high value on writing as part of engineering; the one disconnect was that while 88% rated writing skills as having high importance after graduation, only 72% rated it as having high importance in being successful in

their graduate programs.[17] And again, despite the 88% figure in support of writing's importance, nearly the same percentage of respondents (81%) noted that their students did not have to demonstrate proficiency in writing in order to graduate. So even among engineering faculty who appear to value writing, there is evidence that efforts to teach and assess writing in engineering graduate programs is not well-aligned with its recognized importance for engineering practice.

The apparent disconnect in perceptions of writing between academic training and professional practice is also not limited only to engineering. For instance, Zhu interviewed business as well as engineering professors and discovered that while both felt that it was important for students to learn how to write, engineering professors tended to incorporate much less writing, and much shorter writing assignments, into their classes.[18] Salem and Jones studied the attitudes of faculty about writing from a broad range of disciplines, unified only by their significant use of writing in their classrooms.[19] In this diverse group of instructors who included writing in the curriculum, there was a considerable variation in attitudes about considerations such as grading time and instructor preparation. Salem and Jones suggested that rather than helping "the faculty" incorporate writing more effectively into classrooms, writing advocates should think about "faculties" in the plural, i.e., clusters or groups that share different attitudes about the challenges and opportunities associated with teaching and assessing writing.

In addition to attitudes that may inhibit bringing more writing into engineering courses and curricula, related instructional practices are neither consistent nor predictable across programs. Reave identified partnerships between engineering faculty and English or communication faculty as a best practice, yet she found that only 16 of 73 top North American engineering programs actually employed this partnership approach to writing instruction, and only one went so far as to require students to develop writing portfolios showcasing their skills.[14] And Matusovich et al. found that even among faculty who viewed communication and teamwork as important engineering skills, the majority of respondents demurred that those skills were the responsibility of other parts of the university, not engineering.[16]

It is further worth noting some exceptions to these writing-averse practices. For instance, Paretti and Burgoyne recommend problem-based learning as an approach that can enable greater attention to communication instruction and practice in upper-level design courses, finding that both students and faculty found these kinds of writing assignments useful.[20] And House et al. described a curriculum where approaches such as student writing portfolios, incorporating writing into several engineering courses, and using a combination of rubrics and peer review improved student learning outcomes related to communication.[21]

While these sources advocate for more writing within the engineering curriculum, Matusovich et al. go so far as to call for communication and engineering to be "embedded" together within the classroom,[16] and Paretti et al. argue that communication instruction should be situated within an engineering context.[13] Working toward such goals would benefit from a deeper understanding of faculty beliefs about writing, their current practices in writing instruction, and desirable resources to improve their writing instruction. Jenkins et al. , for instance, studied faculty perceptions of writing skills among engineering graduate students and related efforts to improve graduate student writing, but they end up concluding that what would really be helpful would be for students to develop more writing expertise as undergraduates.[17] The present study, then,

brings together closely related concerns about writing as a part of engineering education in order to identify prevalent beliefs, practices, and desired resources among current instructors.

Methods

The purpose of this study is to understand faculty perspectives on writing in engineering courses. With such a broad goal and many associated teaching strategies available, it was a logical next step to wonder about differences in perceptions and practices across departments and even institutions. Surveys offer an ideal data collection approach to gauge perceptions of many instructors. This paper reports on survey results received from a single institution, but our future work includes surveying larger numbers of faculty members at many institutions nationally. Here we present our research questions, followed by additional details about our survey development and deployment process, the subject population, our approach to data analysis, and limitations.

Research Questions

In order to further understand faculty perspectives on writing in engineering courses and to develop a variety of supporting resources, we aim to answer three broad research questions:

1) To what extent do instructors report incorporation of writing activities and assignments in their classes?,
2) What barriers do instructors perceive as inhibiting the inclusion of more writing in engineering courses?, and
3) What resources do instructors desire in order to expand and improve the inclusion of writing in engineering courses?

Survey Development

The survey for this study was developed in part based on literature describing typical engineering writing activities and assignments, as well as the authors' own experiences and challenges related to including writing in a variety of engineering classes. The survey design also drew upon feedback from conversations at previous conferences regarding the barriers and challenges faculty face regarding the incorporation of writing into their engineering courses. An initial draft of the survey was piloted with six subject matter experts in various roles (e.g., faculty and staff who teach and/or study writing in engineering) at Purdue University. The feedback from the pilot responses was especially helpful in improving the clarity of the survey questions, while making it more likely that the collected data would be useful in addressing our research questions.

The survey developed for this project first asked instructors about their writing practices in the most recent engineering course they taught as a way to elicit actual instructional practices. That is, we sought a mechanism by which instructors could answer survey questions about a finite experience rather than trying to summarize a wider variety of practices in a variety of classes. Additionally, this structure was intended to relieve concerns over any specific exceptions while answering a survey question. It is also expected that this collection of data about "most recent courses" would be broadly representative of teaching practices and perspectives about writing in general across engineering departments, programs, and courses.

Second, respondents were asked to reflect on specific practices regarding their writing assignments, such as the frequency of their use of grading rubrics. Third, instructors were asked to think about where and why writing should be included in the curriculum for engineering students. Fourth, instructors reported on challenges they face and resources they desired for writing inclusion. Finally, respondents were asked a series of demographic questions.

Survey Deployment and Data Collection

The online survey was deployed at Purdue University, a large public doctoral university with very high research activity. The survey recruitment materials and link were widely distributed by an engineering dean via e-mail lists to reach all engineering faculty and instructors in the College of Engineering. No incentives were given to survey participants. The survey was administered online via the Qualtrics survey software, and closed approximately one month after deployment.

Subject Population

The faculty and other instructional staff that participated in the survey (n=53 respondents) were of mixed status, with the full professor rank being most represented, as shown in Table 1. As indicated in Table 2, all major engineering departments and programs were represented in the subject pool, although some instructors chose not to specify their affiliation.

Table 1. Participant status and rank descriptors (n = 53)

Status/Rank	Number of Participants	Percent of Participants
Assistant Professor	11	22%
Associate Professor	15	28%
Full Professor	24	45%
Other Instructor	3	6%

Table 2. Participant department and school descriptors (n = 53)

Department/Program	Number of Participants
Aeronautics and Astronautics (AAE)	6
Agricultural and Biological (ABE)	3
Biomedical (BME)	3
Chemical (ChE)	2
Civil (CE)	8
Construction Engineering Management (CEM)	2
Electrical and Computer (ECE)	1
Ecological and Environmental (EEE)	3
Engineering Education (ENE)	6
Industrial (IE)	5
Mechanical (ME)	5
Material Science and Engineering (MSE)	2
Did not specify	6

Note: Participants were able to select more than one department/school

Description of Most Recent Course

The courses about which instructors responded came from all levels of undergraduate engineering curricula, from advanced courses with small enrollments (less than 15 students) to large first-year courses (more than 100 students). These courses also represented a wide range of course types, including core courses and technical electives, as well as project-based courses and laboratory or studio courses. Tables 3, 4, and 5 give an overview of the reported course levels, enrollments, and formats/structures, respectively. About 75% of respondents also identified their most recent courses as either core/required technical, technical elective, or capstone courses.

Table 3. Reporting by course level, n = 53

Course level	Number	Percentage
100 level	5	9
200 level	7	13
300 level	15	28
400 level	15	28
500 level	11	21

Table 4. Reporting by class enrollment, n = 53

Course Enrollment	Number	Percentage
25 or fewer	10	19
26-50	13	25
51-100	14	26
101 +	16	30

Table 5. Course Format/Structure

Course format/structure	Number*	Percentage
Traditional	34	64
Blended/Hybrid/Flipped	13	25
Project Based	15	28
Laboratory	11	28
Other	3	6

*NOTE: Participants could select multiple course descriptors.

Data Analysis

The analysis presented here is largely descriptive and exploratory. We examined how instructors are currently incorporating writing in engineering courses, where they include it and why, the top challenges they face, and finally, what additional resources they desire. We report the frequency of responses to show the distribution as well as the mean value for all questions. The findings are presented in the order the sections were presented to the survey respondents.

Limitations

We acknowledge the limitations of our study design, including those related to the participant sample since respondents self-selected into the study and potentially already had interests related to writing. We additionally acknowledge the limitations inherent in collecting data from a single institution of a particular type. We will address the latter issue by deploying the survey to instructors at other schools.

Findings

How, Where, and Why: Incorporation of writing in engineering courses

In exploring Research Question 1, *to what extent do engineering instructors incorporate writing activities and assignments in their classes?*, respondents were asked about the frequency of writing tasks that they assigned and how they might support student writing efforts. Specifically, in response to the question *how often did/do your students perform the following types of tasks and assignments that include writing?*, the most common tasks and assignments that instructors reported were: project documentation and reports, other written homework assignments or responses, written explanations of numerical homework solutions, group/team writing assignments or activities, and short answers on quizzes or tests. Textbook problems that require writing and electronic format writing were the least common tasks and assignments assigned to students. Table 6 provides a summary of these seven tasks and their response rates.

Table 6. How often did/do your students perform the following types of tasks and assignments that include writing?

Frequency of writing tasks	1=Never	2=Sometimes (1-2 times/semester)	3=Frequently (3+ times/semester)	Mean
Project documentation/reports	14	15	23	2.17
Other written HW assignments or responses (non-numerical)	17	10	24	2.14
Written explanations of numerical HW solutions	18	11	22	2.08
Group/team writing assignments or activities	18	10	22	2.08
Short written answers on quizzes and/or tests	17	15	19	2.04
…	…	…	…	…
Textbook problems that require writing	36	8	5	1.37
Electronic format writing	35	8	4	1.34

When instructors were asked about practices associated with writing assignments in their classes, most stated that they frequently used a grading rubric to evaluate submissions. However, they do not always share that rubric with students. Table 7 shows this potential gap in practices.

Table 7. When writing was/is assigned in your most recent course, how often did/do you:

Statement	1=Never	2=Sometimes (1-2 times/semester)	3=Frequently (3+ times/semester)	Mean
Use a grading rubric to evaluate/score submissions?	9	13	31	2.42
Provide a grading rubric to students, prior to submission?	18	18	17	1.98

Also in response to practices regarding writing assignments, most instructors identified a particular audience or purpose for the assigned writing, but most did not provide resources, allow for revisions, or utilize peer review. In fact, most respondents acknowledged that they never provide opportunities for revisions or utilize peer review. Table 8 summarizes these responses.

Table 8. When writing was/is assigned in your most recent course, how often did/do you:

Statement	1=Never	2=Sometimes (1-2 times/semester)	3=Frequently (3+ times/semester)	Mean
Identify a specific audience or purpose for the writing?	14	8	30	2.31
Provide opportunities for revision and/or multiple drafts?	23	18	10	1.75
Share writing resources (hand-outs, writing lab, writing samples, etc.)?	20	28	5	1.72
Utilize peer review?	32	15	5	1.48

Finally, when instructors were asked about their levels of satisfaction with their students' writing skills, only 8 of 53 (or 15%) respondents agreed that they were satisfied and no instructors strongly agreed. A majority of instructors disagreed with this statement (38%), and a substantial number (15%) strongly disagreed. Instructors were also asked to report on their satisfaction regarding specific writing skills possessed by students, as presented in Table 9. On a scale from poor (1) to excellent (5), all averages fell in the middle, demonstrating that instructors are typically describing their students' writing skills as somewhere between fair and good. Instructors appear most satisfied with the ability of students to write for intended audience(s), provide appropriate data representations, and adhere to appropriate document formats, and least satisfied with their ability to develop coherent and grammatically correct writing.

Table 9. In general, what is your perception of undergraduate students' writing skills in each of the following areas?

Statement	Poor (1)	Fair (2)	Good (3)	Very Good (4)	Excellent (5)	Mean
Appropriateness for intended audience(s)	4	22	18	7	2	2.64
Appropriate data representations (descriptive, graphical, tabular, etc.)	4	22	20	6	0	2.54
Adherence to appropriate format for technical documents	6	20	19	7	0	2.52
Overall structure, organization, flow and logic of documents	9	21	18	4	0	2.33
Quality and coherence of paragraph level writing	8	28	14	1	1	2.21
Grammar, syntax, punctuation, spelling	10	23	18	1	0	2.19

Attitudes among respondents were also generally favorable towards including writing in the engineering curriculum. With four options to choose from, only 3 of the 58 respondents believed that writing should be dealt with in non-engineering classes only, while almost half chose the option “As many engineering and non-engineering classes as possible.” Additionally, the most common reason indicated for including writing in undergraduate classes was “importance of writing in professional contexts.” Table 10 presents the top five reasons reported by respondents for including writing in their courses.

Table 10. Main reasons for incorporative writing (respondents were asked to choose the their top three reasons for including writing from a list of 9)

Statement	Number of responses	Percentage of participants
Importance of writing in professional contexts/careers	44	83%
Meet higher learning objectives (e.g. critical thinking)	34	64%

Intrinsic to certain types of assignments (e.g. projects, labs)	32	60%
Meet accreditation criteria (ABET outcome 3g: an ability to communicate effectively)	22	42%
Personal passion for writing and/or teaching writing	17	32%

Barriers and Challenges Faced by Instructors

In exploring Research Question 2, *What faculty-level barriers inhibit the inclusion of writing in engineering courses?*, we asked respondents to identify the greatest challenges they faced related to including more writing in their courses. From a list of 18 items, participants were asked to identify their top 3 barriers. Large class enrollments was by far the most frequently selected item (34 responses or 64%), followed by lack of time (18 responses or 34%) and ability of teaching assistant(s) to grade/assess writing (17 responses or 32%). Conversely, no respondent felt that a lack of confidence or personal in writing were among their main barriers to including more writing in their courses. Table 11 summarizes the barriers instructors perceive they face.

Table 11. Main barriers to incorporating writing (when asked to choose their top 3 of 18 possible reasons for including writing)

Statement	Number of responses	Percentage of participants
Large class enrollments	34	64%
Lack of time	18	34%
Ability of teaching assistant(s) to grade/assess writing	17	32%
Poor quality of student writing	15	28%
Working with English-as-a-Second-Language (ESL) students	13	25%
Too much other content to cover	12	23%
Student resistance to writing	10	19%
Heavy teaching loads	8	15%
Other	8	15%
Linking writing assignments to main course objectives	5	9%

Lack of institutional resources and/or support	5	9%
Creating high quality writing assignments	5	9%
Not confident in own abilities to teach and/or assess writing	3	6%
Plagiarism	3	6%
Central control/coordination of course content	2	4%
Uncertain about standards/criteria for grading writing	1	2%
Lack of confidence in own writing ability	0	0%
Lack of own personal interest in writing	0	0%

Desired Resources

In exploring Research Question 3, *What resources do instructors desire in order to improve writing instruction and inclusion in engineering courses?*, we asked respondents to identify both general and specific resources that would make the greatest differences for them in regard to including writing in their courses. We wanted to see what resources engineering instructors would find most useful in their efforts to include writing in their engineering courses. We first asked about the perceived value of some general resources, with respondents by a large margin selecting teaching assistants trained to support writing as their most desired resource. Instructors also selected handouts, strategies, and rubrics to support their writing activities and assignments in their courses. Faculty development workshops, by contrast, were the least-desired resource. Tables 12 and 13 respectively present complete summaries of responses regarding general and specific resources desired by the responding instructors.

Table 12. General Desired Resources

Statement	Not valuable (1)	Somewhat valuable (2)	Very Valuable (3)	Number of responses	Mean
Teaching assistants (undergraduate/graduate) trained to support writing	7	13	32	52	2.48
Writing resources for faculty and students (website, textbooks, etc.)	15	19	16	50	2.02
Grants to fund development/implementation	20	19	9	48	1.77

of writing in courses					
Consultant/staff to help individual faculty incorporate writing into courses	25	14	10	49	1.69
Community or group for collaboration, support, networking, etc.	23	19	6	48	1.65
Faculty development workshops (~2 hours to half day in length)	29	16	2	47	1.43

Table 13. Specific Desired Resources

Statement	Not valuable (1)	Somewhat valuable (2)	Very Valuable (3)	Number of responses	Mean
Handouts or slides for students that explain various elements of writing	9	20	23	52	2.27
Systems or strategies to support peer review of student writing	13	20	19	51	2.12
Various grading rubrics that can be used for writing assignments	12	21	18	51	2.12
Sample graded student writing assignments of varying quality	16	19	15	50	1.98
Sample engineering course assignments that include writing	17	20	12	49	1.90
Sample engineering course plans or syllabi that include writing	23	18	9	50	1.72

Discussion

Our survey results suggest that most engineering instructors view writing as a very important aspect of engineering education and a necessary skill for engineers. A large majority of respondents also believe that writing skills should be developed within engineering courses, potentially in combination with non-engineering courses. However, this same group of respondents also perceives that the writing skills of engineering students are mediocre, at best. These results align with previously published results, including a survey about writing practices showing evidence that students understood the importance of writing in engineering and believed writing should be taught within the scope of engineering classes and not solely in communication or other writing courses.[2] However, these students also perceived their writing skills to be 'good', indicating a potential disconnect between student and instructor perceptions.

Many instructors point to large class enrollments and not enough time as the major barriers to including more writing in their engineering courses. While these barriers are difficult to tackle, providing faculty with resources, strategies, and tools that can be used to easily and efficiently integrate writing into their existing courses and teaching practices might be a way to scale up writing in engineering. Respondents also identified teaching assistants as the most desirable resource that could support incorporation of writing in their classes. The next best resource, which is potentially more feasible for faculty across many institutions, was writing resources such as handouts, rubrics, and websites.

Respondents did not view workshops or writing consultants as desired resources; nor did they seem to need much inspiration or guidance on how to include or craft writing exercises in their classes. Taken together with the desired resources listed above (teaching assistants, handouts, rubrics, etc.), it seems that the average instructor responding to our survey knows *how* they would like to include writing in their courses, and are simply seeking additional support and resources to execute their ideas.

In response to this finding, our research team is developing a website that will feature many such supplementary resources. If instructors are already including writing, they can easily supplement any activities and assignments in a low-overhead way. For example, rather than create a new rubric for every assignment, many rubrics would be made available that are easily adapted for different assignments and a variety of assessment purposes. Similarly, a guide to adapting any textbook problem to include a writing component could support faculty to include more writing without much extra effort. This may be more useful in encouraging writing exercises by faculty who are not already incorporating writing.

Conclusions

This paper reported results from instructors responding to a survey about writing in engineering. We sought to investigate how and why faculty are including writing in their engineering courses, and also their perceptions of barriers, challenges, and desired resources. We found that while faculty recognize the need and importance of teaching writing in engineering, they face many challenges when trying to incorporate writing in their courses. Faculty identified time as the largest challenge, and wanted more teaching assistants trained in teaching and assessing writing.

Given the larger goal of this study to understand, expand, and improve writing instruction in engineering, one of our next steps for the project is to deploy the same survey to engineering instructors at multiple institutions. The results would then be used to further guide the design of writing resources and training materials that respect faculty members' time constraints while still providing support for ongoing efforts to develop the kinds of writing and other communication skills that engineering graduates are expected to have as they transition into their careers and/or further education. Since we reported on data collected at a single institution in this paper, our main next step is to see how these responses might vary by institution. A larger sample will allow for us to delve further into the data analysis and see if there is any significant variation in faculty practices and attitudes based on the type of course taught, status of instructor, institution type, etc. Additionally, broadening the survey population beyond the self-selecting subset of engineering instructors who chose to respond to our writing survey is desirable. This would help to ensure the results are applicable to all engineering instructors, and not just those already inclined towards the inclusion of writing exercises in their classes.

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