AC 2009-435: HOW ENGINEERING STUDENTS LEARN TO WRITE: FOURTH-YEAR FINDINGS AND SUMMARY OF THE UT-TYLER ENGINEERING WRITING INITIATIVE

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How Engineering Students Learn to Write: Fourth-Year Findings and Summary of the UT-Tyler Engineering Writing Initiative

Abstract

The Departments of Electrical Engineering and English of the University of Texas at Tyler have completed the Engineering Writing Initiative (EWI), a four-year longitudinal study investigating how engineering students learn to write, how they apply these skills in their studies, and how instructional practice may be reconfigured to better develop these skills. The questions which formed the charter of EWI were:

- What are engineering students' attitudes, practices and skills with regard to writing, and how do those attitudes, practices and skills develop over time?
- Does writing in engineering courses help students become more involved with those courses and understand and apply the ideas of those courses?
- How can we incorporate what we learn about students' attitudes, practices and skills in order to improve our instructional practice with regard to writing?

EWI employed multiple data-gathering methods (semi-annual writing prompts, individual interviews with students, written surveys of students, and student writing samples gathered in portfolios). It employed several assessment strategies (quantitative analyses of student writing samples, quantitative analyses of written surveys, and qualitative analyses of interview transcripts).

Background

Our resolve to assess and address problems endemic to Engineering students' writing is shared throughout the discipline, a concern that is in part driven by the inclusion of communication as a Program Outcome incorporated into ABET 2000 accreditation standards. Indeed, a literature review of writing assessment related literature since that time reveals a rich array of strategies and solutions. These include formative assessment [1]; a plan for the incremental implementation of writing skills instruction in Engineering courses [2]; an outcomes assessment [3]; the use of written workplace materials in Engineering courses [4,5] ; a review of shared assumptions about writing skills among Engineering faculty [6]; a multiple-trait scoring guide [7]; and the first three iterations of this longitudinal study [8,9,10]. To date, there is no other longitudinal study of Engineering students' writing skills on record. Our four years of work therefore begins to address this gap in knowledge, and it is hoped that this project will be understood as (a) a description and analysis of trends observed within a single cohort of subjects; and (b) an invitation for other researchers to begin contributing similar work to the field of Engineering education.

Our work brings together the disciplinary expertise of an Electrical Engineering faculty member with a Writing Center director's experience in writing instruction and evaluation. Dr. Beams has had over 16 years' experience in industry and 12 years' experience in academia, and he currently teaches (or has taught) Electronic Circuit Analysis I and II (including laboratories), Instrumentation Systems, Senior Design (a two-semester capstone design sequence), and Electric Circuit Analysis I (with laboratory) and II. Dr. Niiler has taught writing at the university level for over 20 years, and regularly contributes to writing assessment initiatives. Our research design is in part grounded in three longitudinal studies of student writing ability performed by Sommers and Saltz at Harvard [11] (2004), Carroll at Pepperdine[12] (2002), and Sternglass at the City College of New York [13] (1997). Sommers and Saltz find that students must understand their writing as having a purpose beyond that of fulfilling the expectations of a single course [14]. Carroll notes that student writers greatly benefit from instruction in writing throughout their entire academic careers, and not just in first-year composition courses [15]. And Sternglass sees in her cohort of research subjects a general lack of awareness of the value of writing, both in their classes and in the world beyond the classroom.[16] In a larger sense, however, our work has been significantly influenced by Johanek [17] (2005), whose "contextualist research paradigm" brings together both qualitative and quantitative methods of inquiry. Through both methods, we can begin to understand (a) our students' knowledge and practices with regard to writing; (b) how they use their knowledge and skills in their coursework; and (c) how we may begin to adapt our instructional methods to better accommodate their knowledge and skills.

In the first year of this project, our analysis of surveys, interviews and questionnaires distributed to freshmen writers revealed that they "understood the act of writing as an ancillary, even *ex post facto* activity, a skill that while required by their instructors [was] secondary to their primary function as engineers."[18] This was demonstrated in both freshmen and juniors who were surveyed about their perceptions of the role of writing in engineering at the outset of EWI. Thirty of 44 freshman responses named either "laboratory reports" or "communication" as the roles of writing in engineering; these two accounted for 17 out of 18 responses by juniors. We examined their written work, generally in the form of lab reports. We found that freshmen could organize their reports but showed marked deficiencies in every other significant category we examined—content, mechanics, language, tables/figures/graphs, and technical merit. Review of freshman writing found problems that were "endemic," "deeply rooted," and "more profound than can be addressed…by a written style guide." This contradicts the finding that 9 out of 15 freshmen who took part in the first survey of attitudes toward writing in 2004 agreed or agreed strongly with the statement "I think I'm a good writer." (The remaining respondents were neutral). We noted the writing tasks expected of this cohort of freshmen were perhaps "much more complex and time-consuming than most [of them] realized." [19]

The second year of our study yielded some promising results. In our quantitative assessment of student writing samples, we found improvements in all writing skills categories noted above, with particularly strong improvements in the use of professional language. Tables, figures and graphs showed the least improvement. Questionnaires, surveys and focus-group discussions revealed that students highly valued "frequent opportunities to write and frequent feedback on their writing." [20] In our quantitative assessment of student writing samples from the third year of this project, we found again, incremental improvements in all areas studied with, again, the

exception of tables, figures and graphs. Students' inability to successfully integrate such materials, we suggested, was consistent with the work of students across the disciplines. We noted that "Students often insert not only tables, figures and graphs, but also secondary source materials such as quotes, with little regard to how those materials support, constrain, interrogate or make problematic their arguments." [21] Our review of data from surveys, interviews and focus group discussions revealed, in turn, that students were inclined to overrate their abilities as writers. In addition, the attitude survey from that year reveals a marked decrease in the percentage of students agreeing or strongly agreeing with the following statements: "Writing in Engineering courses helps me understand course material"; and "Writing plays an important role in Engineering courses."

We ended our third-year report with a call for strongly articulated writing heuristics in the engineering classroom and indeed throughout the Engineering curriculum. Drawing on the work of Sorby and Bulleit (2006), we noted that the work of creating technical documents is analogous to the work of designing a circuit or system. The design of a circuit or system "lies within a solution space whose boundaries are determined by such considerations as function, feasibility, user needs, and affordability," we noted; accordingly, the thoughtful student writer needs to consider a solution space circumscribed by audience, purpose, tone, bibliographic and theoretical depth, format, and templates. [22] Lindeman's research has considerable bearing here as well, as she draws upon the work of Aristotle, Neeld, Burke, Larson, Corbett, Wallace, Pike, Winterowd and Bain to create rhetorically-rich and professionally-relevant prompts for student writers: prompts that are not simply checklists or rubrics, but rather productive ways of engaging students in the actual tasks of identifying and accommodating classroom and workplace contexts for writing. [23] Larson's problem-solving model illustrates how such heuristics can help our students better understand engineering-specific contexts. For example, Larson's heuristics ask writers to identify a problem, note the nature of the problem, consider the goals accomplished by solving the problem, prioritize the goals, identify the procedures that will help reach the goals, discuss the consequences of acting to reach goals, explain the value of one set of solutions as compared to another, and commit to the best possible course of action. [24]

Methodology

We used the following tools to gather a variety of quantitative and qualitative information about students' perceptions of their own writing skills and students' abilities as writers:

- A Likert-scale survey of attitudes toward writing;
- A written questionnaire addressing the role of writing in Engineering courses and students' processes and backgrounds as writers;
- Focus-group discussions with students; and
- A quantitative, multiple-trait assessment of writing samples (primarily laboratory reports and, in the final year of the study, senior design project reports).

Student access was constantly an issue throughout the course of EWI. The work of fifteen freshmen was studied during the 2004-2005 academic year; nine sophomores participated during the 2005-2006 academic year. Seven students participated during the 2006-2007 and 2007-2008 academic years. This appears to be the norm in longitudinal studies of student writing skills. In

fact, the Sternglass project noted above begins with 53 students, and ends with only eight: (15% of the original cohort). Carroll follows 20 students in her study, but builds the central claims of her project around the work of just four students (20% of the cohort). To this end, then, we must admit a methodological caveat. The original cohort of fifteen freshmen had dwindled to three (20% of the original cohort) by the beginning of the senior year. This attrition had multiple causes, e.g., changing majors, leaving school, or declining to continue participation. This small sample would provide little assurance that their attitudes and perceptions about writing were representative of the cohort. We believed that the only way to obtain any data representative of the peers of our remaining cohort was to invite the participation other seniors who had not previously taken part in EWI. In any case, written materials that were solely the work of the remaining cohort were not available to us as the senior design project reports (consisting of a mid-year report and a final report) were the work of project teams.

Results of Likert scale attitude survey

Five Likert-scale survey presented students with statements about the role of writing in engineering courses and asked them to give responses on a scale of 1 (strongly disagree) to 5 (strongly agree). Participants were presented with both positive and negative statements about writing (e.g., "I spend as little time as possible working on the writing assignments required in my engineering courses" and "I spend a great deal of time writing working on the writing assignments in my engineering courses"). Table 1 below summarizes the percentage of respondents who agree (rating 4) or strongly agree (rating 5) with the positive statements. A discussion of the results follows the table.

Table 1. Summary of Likert-scale attitude survey results from the Engineering Writing Initiative

Statement	2004-2005 (*n*=15)	2005-2006 (*n*=9)	2006-2007 (*n*=7)	2007-2008 (*n*=7)
I'm an experienced writer.	60	66	no finding (see below)	100 (*n*=6)
Writing in engineering courses helps me understand the course material.	53	77	57	71
I care about the writing I do in engineering courses.	80	88	86	86
Writing plays an important role in engineering courses.	80	88	57	100
I spend a great deal of time on writing assignments in engineering courses.	46	62	71	57

Discussion of Likert scale attitude survey results

Reponses to the attitude survey should be viewed with caution for several reasons. The sample size is small. Also, as previously noted, we found it necessary in the final year to expand the pool of participants beyond the original cohort. There were occasional problems with internal consistency in the responses given by EWI participants. Internal consistency was questioned when a respondent agreed (or disagreed) with both a positive statement (e.g., "I think I'm a good writer") and its opposite. In the 2006–2007 survey, every respondent showed at least one internally-inconsistent response. The statement "In general, I'm an experienced writer" had sufficient inconsistencies that we disregarded the findings. In 2007–2008, however, only one inconsistent response was noted; a respondent agreed with both the statement "In general, I'm an experienced writer" and its opposite. No such problems with internal consistency were found in studies prior to 2006–2007.

Every respondent who gave self-consistent responses in 2007–2008 agreed or strongly agreed that he or she was an experienced writer. This may demonstrate a confidence that they have substantially assimilated the language of discourse of their disciplines. The percentage of participants agreeing or strongly agreeing with the statement, "Writing in engineering courses helps me better understand course material," has returned in 2007-2008 to levels consistent with previous years. A solid majority of participants believes that writing is an aid in learning course material. Even larger majorities agreed that they care about their work and that the role of writing in engineering courses is important. The respondents were less emphatic about the time they devoted to writing assignments in engineering courses.

Results of written questionnaire

Participants involved in this study were asked to complete a written questionnaire in which they discussed several aspects of their writing in engineering classes. The questionnaire is intended to reveal students' views on the role of writing, the process of writing, past and present preparation for writing, and the role of style guides.

The questions included in the survey are as follows:

1. What are you learning this semester in your engineering classes that seems the most valuable to you?
2. Has writing helped you to better understand what you've learned in question #1? If not, has writing helped you understand any of the course material in your engineering classes?
3. What do you believe is the function of writing in engineering classes? Explain.
4. What writing strategies or techniques do you use as you write in your Engineering classes?
5. What has best prepared you to write for your Engineering classes? An instructor, tutor, past or present writing class, etc.? Explain.
6. Do any of your professors use a style guide? If so, what role does it play in your writing?

Students cited "the design process" and "teamwork" most often as the most valuable knowledge learned in the preceding semester. Eight responses were received to the second question; five of

them affirmed that writing had helped them in this regard. It appears, however, that the role of writing was largely still seen in the light of laboratory or project reports since half of the responses specifically mentioned these. This is substantiated by the students' perceptions of the function of writing in engineering courses. Seven of eight responses specifically cited a transactional role, i.e., the communication of ideas to others. Only one respondent's response suggested that writing could play a role in learning. This contradicts a finding we had previously stated [25] in our 2007 paper that students surveyed were developing an understanding of the function of writing that was "clearly *not* limited to information transfer." However, it must be noted that most of the students participating in the 2008 survey were not involved in previous surveys, and we draw no firm conclusion from this contradiction.

The most-common writing strategies cited were the composition of drafts followed by proofreading or peer review. One curious response to this question was "I do not do drafts necessarily, but usually do ask someone to proofread and then edit the original as necessary." (It would seem that the original serves the function of a *de facto* draft version).

Only one respondent (out of eight) cited freshman grammar and composition classes as beneficial in their preparation to write in engineering classes. Exposure to writing in technical courses, frequent repetition, and the use of a style guide were cited my more than one respondent as valuable in learning to write for engineering courses. This is in agreement with findings of previous years, as noted in our 2007 paper. [26]

Discussion of written questionnaire

With regard to the role of writing for student writers, Sommers and Saltz [27] have indicated that the strongest student learners tend to "see in writing a larger purpose than fulfilling an assignment." Certainly this is true of the senior-level EWI cohort, some of whom understand that the kind of writing assigned in class will be the kind of writing required on the job. With regard to the process of writing, Lindemann[28] cautions against overly "simplistic" and reductive models of writing, which "do not account for individual differences among writers" and "do not appreciate the complex intermingling of activities, decisions, constraints, and goals writers juggle." Accordingly, we suggest, now as in the past three years, that some students surveyed still do not understand the complexity of the writing tasks assigned them. This may play a crucial role in some students' apparent inability to draft stronger prose. With regard to preparation for writing, we hold with Reither[29] that writing is essentially a social and rhetorical task: occurring in communities of other writers, all of whom work under conditions and in pursuit of goals that, ideally, transcend the classroom setting. This kind of sophisticated awareness of rhetorical agency and exigency is evident among some students surveyed. Style guides, finally, appear to be appreciated by students as powerful means of sharing disciplinary standards for written documents. This will have implications in terms of pedagogical and curricular changes.

Results and discussion of focus-group discussion

Thirteen students participated in focus groups in the spring of 2008. All participants were senior students; seven were mechanical engineers and six were electrical engineers. As we will show

below, students' answers largely confirm extant studies on the role of writing in student learning. Additionally, answers provided during this year's study were congruent with answers from prior years—especially with regard to students' perceptions of the importance of writing in Engineering courses. We did not, therefore, detect any evidence of participants attempting to please questioners through answers that would bias our results. The following questions were asked in these groups:

- Looking back, what do you now wish you had known about writing in engineering courses when you started the program?
- What role has writing played in your course of study?
- What does it mean to "write like an engineer" (as opposed to, say, writing in other fields)?
- Is the writing you do in engineering courses a vehicle for learning?
- Do you see the writing you do in engineering courses as a way of contributing to knowledge in the field?
- What advice do you have for incoming engineering students with regard to writing?

Several themes emerged from the responses to the first prompt. Four respondents cited the freshman-level Introduction to Engineering course as helpful in orienting them to engineering communication. Four respondents were surprised by the amount of writing they were expected to do; two respondents admitted they had not expected to do *any* writing in their engineering courses. Three respondents stated that standard English classes were not very helpful because writing in Engineering was qualitatively different. Prior writing, for them, appeared more subjective; one participant stated that Engineering writing "wasn't like writing an English paper, not as much fluff or big words…make a statement, support it with evidence." We suggest that these responses corroborate much of what is known through widespread WAC (writing-across-the-curriculum) practice–writing proficiency within a given discipline is created by writing within that discipline. This is congruent with what Norback has noted, above, with regard to the efficacy and relevance of discipline-specific writing practice.

Ten responses were received from the focus groups in response to the second prompt. Laboratory reports and documentation emerged as the principal roles played by writing in engineering courses in these responses (cited in six responses). Four comments stated that writing was a major component of their coursework, using phrases such as "essential," "huge role," and "big ticket." One respondent estimated that 30% of his time spent in electrical engineering courses was in writing. Another respondent made an intriguing comment about her growing skill as an engineering writer; she said that "[it] took me 8 or 9 hours on lab reports when I started school, now I can do one in 1½ hours."

Not surprisingly, those who described their views of what it meant to "write like an engineer" gave responses in which certain themes were repeated. Engineering writing was described as "factual," "quantitative," "more technical," "short and concise," and "to the point." The objective nature of engineering writing as opposed to other disciplines was particularly notable. Two comments underscore this point. One respondent said that engineering writing was "short, concise, to the point, [with] sufficient information to get point across…in other fields, there is often no one right answer." The other stated, "Technical aspect—straight to the point—just

wrote a literature paper 'Is Art Truth?' It was 3 pages, 2½ of which were [nonsense]." This confirms one of the key claims Carroll makes in her longitudinal study of how student writing skills develop: Students, she notes, "do come [in time] to better understand the genres and demands of their disciplines."[30]

Respondents were unanimous that writing in engineering courses was a vehicle for learning. A typical comment was "you learn things more thoroughly when you try to convey a point to someone else." Such responses are consistent with Sommers and Saltz's conceptions of mature student learners, as noted above. Participants, however, were evenly divided whether their writing was a vehicle for contributing to knowledge in their disciplines. This can be attributed to their being undergraduates who are not expected to be breaking new ground; as one student said, "the field contributes to us at this point."

Eleven responses were elicited by the prompt regarding what advice they would give to new students. The comments touched on a variety of subjects, but the most-evocative comment was probably this: "Get ready to write—you're going to be surprised if you have the mentality you're going to do only three reports. Reports of variable length will be encountered. Don't fixate on a certain format."

Results of multiple-trait assessment of writing samples

The writing samples from previous years were chiefly laboratory reports written by individuals or small teams. The work evaluated was thus principally the work of the EWI cohort. The writing samples evaluated in 2007-2008, however, consisted of senior capstone project reports from seven design teams whose total membership was thirty students (seven from electrical engineering and 23 from mechanical engineering). Each team produced a preliminary design report (known as a Primary Design Document, or PDD) at the end of the first semester of capstone design and a Final Design Report (FDR) at the end of the second semester. The curricula of electrical and mechanical engineering in the senior year at the University of Texas at Tyler have few writing assignments outside of these capstone reports; it thus was not possible to find examples that were principally or exclusively the work of the EWI cohort. A total of five PDDs and seven FDRs were evaluated by both Drs. Beams and Niiler as in the previous three years. The samples were evaluated with the rubric below. It should be noted that the criteria are commensurate with multiple trait assessments performed at several other academic institutions, including the University of Arizona, the University of South Florida, and the University of Washington.[31, 32, 33]

- Organization: Written material is organized appropriately into discrete units-for example, title page, project description, methods and materials, results, discussion, conclusion, and references.
- Content: Written material is presented in paragraphs, each of which is focused on one topic. Written material is also coherent, with strong transitions between ideas. Written material is well-developed, in that the writer fully explains, describes, summarizes and/or analyzes, as needed. Finally, equations are relevant and necessary to the development of the written material, with all variables clearly defined.

- Mechanics: Written material adheres to all relevant conventions of grammar, punctuation and spelling. Equations are formatted correctly; fonts are uniform; scientific notion is accurate.
- Professional language is employed. Slang, colloquialisms, first person, second person, and the imperative mood are avoided. Primary emphasis is on a replicable process or experiment, not a personal account of an activity.
- Tables, figures, and graphs: All tables, figures and graphs are well-formatted, comprehensible, and used appropriately.
- Technical merit: Material is free of errors in technical matters.

We independently assessed the examples and assigned scores in all categories except technical merit for each work, using a scale of 1 (strong disagreement) to 5 (strong agreement). (Technical merit was scored by engineering faculty member Dr. Beams alone). Each paper was read and scored independently, and the median value of the rating of each team's work was determined for each evaluator. Figure 1 below shows the median scores for Dr.Beams' evaluations for the 2007-2008 writing samples and contrasts these with the results for previous years. It is noted that only three years of results appear in Fig. 1 because the rubric above was not adopted until the second year of EWI; therefore no data for the 2004-2005 academic year are presented.

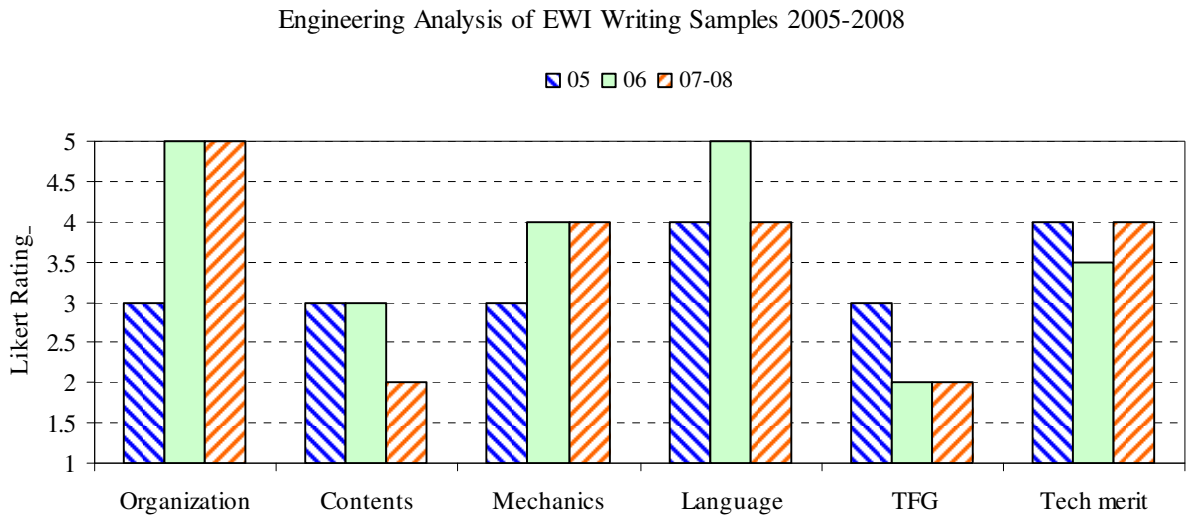

Figure 1. Median scores of evaluation of engineering writing samples from 2005, 2006, and 2007-2008 by engineering faculty member Dr. Beams. The label "TFG" is an abbreviation for "tables, figures, and graphs."

Figure 2 below shows the same statistic for Dr. Niiler's evaluations.

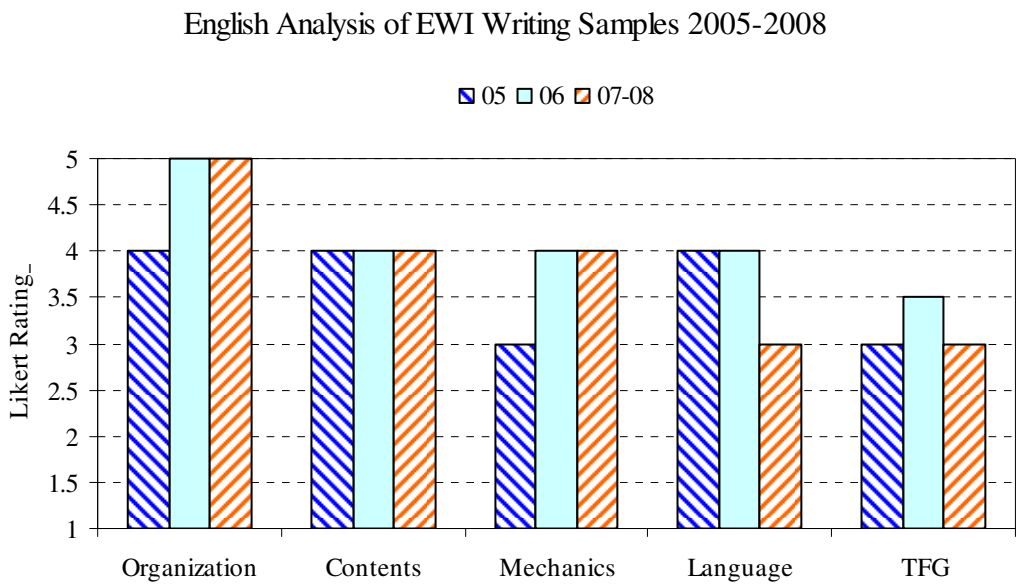

Figure 2. Median scores of evaluation of engineering writing samples from 2005, 2006, and 2007-2008 by English faculty member Dr. Niiler. The label "TFG" is an abbreviation for "tables, figures, and graphs."

Discussion of multiple-trait assessment of writing samples

The results contain reasons for both optimism and pessimism. We make the following observations about the data presented in Figs. 1 and 2:

- Organization was greatly improved by the junior year (judged by writing samples gathered in fall, 2006) and remained so through the 2007-2008 (senior) year. This is probably attributable to the use of style guides and templates.
- Drs. Beams and Niiler diverged considerably with respect to their evaluations of content. Neither evaluator saw improvement in content; however, Dr. Beams found their senior-level writings to have *declined* in the quality of their content. This was principally because many of the documents reviewed (five of eleven) contained *no* equations whatsoever, and equations in at least two reports lacked definitions of variables. Effective use of mathematics is an indispensable component of the language of discourse of the profession, and it is dispiriting to see seniors making so little use of it.
- The mechanics of punctuation and formatting were generally acceptable. However, in the matter of scientific notation, Dr. Beams noted a number of instances in which students used exclusively English units (pounds and feet). Senior Design courses require either that SI units be used exclusively or, if English units were used, that the equivalent SI units be given as well.
- Language was an area in which both Drs. Beams and Niiler found declines. Dr. Beams' notes recorded numerous examples of colloquialisms and a few malapropisms (the most notable of which was the use of "assignation" to describe the assignment of functions to the pins of a port of a microprocessor).

- Both evaluators agree that the use of tables, figures, and graphs is consistently the area of greatest weakness. Dr. Beams' notes from the 2007-2008 writing samples contain numerous citations of poor use of tables, figures, and graphs. Six documents out of eleven contained SEPPs (Self-Evident Pretty Pictures), figures that are neither introduced nor referenced in the text. In one case, a PDD contained figures that were drawn by hand on notebook paper! This *clearly* does not meet professional standards for the language of discourse. In many cases, students preferred to use written descriptions rather than figures if it meant having to create those figures with a drawing program (e.g., Visio).

The Pearson product-moment correlation of ratings of 2007-2008 writing samples is 0.47, representing a moderate positive correlation.

As noted previously, the data represented in Fig. 1 are *median* scores. Scores of 5 by both evaluators in Organization do not mean that *every* sample submitted earned an exemplary score for this trait. The table below summarizes the *mean* ratings of the 2007-2008 literature sample as scored by both Drs. Niiler and Beams. Comparison of these ratings shows that the evaluators were in good agreement in their ratings.

Table 2. Comparison of mean ratings per trait of the 2007-2008 EWI literature sample by both evaluators. The abbreviation "TFG" stands for "tables, figures, and graphs."

Evaluator discipline	Organization	Content	Mechanics	Language	TFG
English	4.36	3.73	3.55	3.36	3.27
Engineering	4.82	2.64	3.64	3.27	2.18

Curricular applications of findings

By their senior year, students in the EWI cohort demonstrated the following attitudes, practices, and skills with regard to their writing:

- The understanding of writing both as a means of transmitting information and learning course content;
- An awareness of writing skills within an Engineering environment as markedly different than writing skills taught within lower-division interdisciplinary writing courses;
- An appreciation for the amount of writing required in Engineering courses;
- An appreciation for strong models of writing within the discipline of Engineering;
- An appreciation for multiple and myriad opportunities to write;
- A lack of awareness of how writing can contribute to knowledge within the discipline of Engineering;
- A lack of awareness of the complexity of writing tasks involved in Engineering; and,
- An ongoing need (in lab reports) for improvement in the use of professional language; tables, figures and graphs; and content.

Several of our findings corroborate the work of other researchers who note that students do not acquire the writing skills needed for success in the Engineering classroom and workplace in two-semester sequences of English composition classes. Schneiter (2003) repeatedly underlines the point that "Technical writing is not English composition." He notes that because technical writing for engineers must be taught in engineering contexts, "the English department is not the place to teach engineers to be proficient technical writers." [34] The same dynamic holds true in university writing centers, as Mackiewicz' work on expertise in Engineering writing tutorials (2004) shows. Mackiewicz' study demonstrates that tutors with stronger backgrounds in Engineering provide more relevant, salient advice than tutors whose academic backgrounds are primarily English. [35] This suggests that writing instruction for lower-division undergraduates in Engineering might well be undertaken by instructors with stronger Engineering backgrounds instead of English instructors: or, conversely, that Engineering might begin to teach its own lower-division, writing-intensive courses. Of course, many engineering faculty resist teaching writing—an understandable reservation, given their lack of background in this area. Therefore, as we have noted in prior years' reports, effective teaching and evaluation of student technical communication will continue to require ongoing formal and informal collaborations between engineering and writing faculty.

We have also observed that students in the EWI cohort generally see the role of writing in their engineering coursework as positive or beneficial, and, as such, should be provided with every opportunity to write like engineers do in workplace contexts. But we will do well to reappraise our reliance on the lab report as a primary vehicle for student writing in our classes. As Manion and Adams (2005) indicate, the lab report is an atypical document; it does not successfully replicate the type of document that students will encounter in industry. Manion and Adams also note that in their Engineering program, no real improvements were noted in student writing as long as lab reports were assigned. However, when the students were provided with more "realistic" assignments, such as memos and data analyses directed toward project managers, improvements were noted.[36] Carroll, in turn, encourages faculty teaching writing to "rethink student work as 'literacy tasks' and not 'writing assignments.' She asks that we "focus on writing differently, not just 'better." She argues that our understanding of literacy should not be limited to one form of written expression, but instead considered from the standpoint of what students really need to know, how they need to know it, and what specific genres might best accommodate that knowledge.[37]

In light of the above, we proposed [38] in our 2007 paper an initiative called "Design for Communication" that regards creating effective technical communications as a design process closely allied to the engineering design process itself, a concept developed by Sorby and Bulleit, as noted above. A PowerPoint presentation was created to draw the parallels between the technical communications process and the engineering design. This presentation was given to students in Electronics I and II laboratories in fall, 2007 and spring, 2008. They were also required to complete a pre-laboratory form prior to each laboratory procedure, listing the following:

- Title of laboratory procedure;
- Purpose of the laboratory exercise;
- Measurements to be made;

- Communication type (formal report, memorandum, oral presentation, other);
- Intended audience;
- Report requirements.

While this was a well-intended effort, the results were not particularly impressive. Students seemed to treat it as another hoop through which they were to jump and not as a prompt for thoughtful reflection. This was underscored by the observation that frequently students were observed printing the forms immediately after entering the laboratory and completing them by hand to be submitted on the spot, with little apparent forethought.

Conclusion

Our study of the maturation as writers of the cohort of EWI students has culminated in an NSF proposal (#0837338) to improve the quality of student writing at all levels of the Engineering curriculum. In the study Drs Beams, Niiler, and a cohort of Engineering faculty from the University of Alabama will reiterate this study with a much larger and statistically significant sample size (500 students), and use the results to develop a software-based avatar system that will create specific rhetorical contexts for student writing. Additional web-based instructional materials, such as student and/or instructor presentations, will be created. We anticipate that this project will create a set of best teaching practices based on current research of students' actual learning processes. Through its software applications, the project will also provide a way for students to actually practice Engineering writing skills without having to rely on their Engineering professors: who, as our experience has shown us, are concerned with the quality of their students' writing but do not necessarily wish to teach their students to write. This second iteration of the EWI, finally, will provide students with a conceptual framework to see communication as a design process in its own right, which we believe will be a step toward addressing the rhetorical deficiencies that often characterizes engineering writing by students. More than this, we hope that our work will encourage other researchers to ask similar questions of additional cohorts at their own institutions.

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