Engineering Student Writing Shortcomings and Remediation Strategies

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Abstract — *Engineering student reports for senior term projects were evaluated from the three engineering disciplines taught at California State University Los Angeles: Civil, Mechanical, and Electrical/Computer Engineering. The reports were evaluated for organization, completeness, clarity, grammar and punctuation, and understanding of documentation conventions for the disciplines. While assignments as well as findings vary per discipline, there are enough commonalities in terms of the weaknesses that the findings as well as related recommendations are presented for the all engineering students. Three pedagogical approaches can bring significant improvements to the writing products produced by these students: assigning jointly written reports, providing training on documentation conventions for professional reports, and requiring students to draft early and undergo multiple peer reviews and revisions.*

Index Terms —Engineering writing, engineering writing pedagogy.

Introduction

The most recent ABET visit to Cal State L.A. resulted in an assessment that the writing skills of our engineering students needed to be improved. In order to develop writing improvement strategies for our engineering students, I evaluated student papers from the three engineering disciplines taught at the university: Civil Engineering, Mechanical Engineering, and Electrical and Computer Engineering. I evaluated three sets of student reports from the three disciplines: a research paper from ECE (N=9), group-authored senior design reports from CE (N = 8), and senior design reports from ME (N=11). Although the number of reports I examined was relatively small, I have taught technical writing to engineering students at our university for more than eight years, and I found the reports I examined to be typical of engineering student writing. Cal State L.A. is an urban university with one of the most diverse student populations in the nation. This diversity is reflected in the engineering department. Specifically, non-native English speakers comprise more than three-quarters of the engineering student population.

The reports were evaluated for organization, completeness, clarity, grammar and punctuation, and understanding of documentation conventions for the disciplines. While assignments as well as my findings vary per discipline, there are enough commonalities in terms of the weaknesses that the findings as well as related recommendations are discussed first for all three engineering disciplines. More specific teaching approaches are then recommended, and finally specific recommendations are offered regarding the writing assignments for each discipline.

Overall Findings and Recommendations

In terms of organization and completeness, in general the reports were neither well organized nor complete. At times a misunderstanding of the assignment seemed to be the cause; also, confusion about the audience or expected contents of the report seemed evident. While it is clear for some assignments that the students were given a contents template, additional discussion about what the contents should contain would help students to improve their organization and completeness.

Students could benefit from a report template or else a model report that they could use to help them understand how to best order their presentation of material and to ensure that they have included all expected material and justificatory arguments. Students have been reading textbooks and learning techniques—they have not been reading professional documents and thus they are unaware of conventions for those documents. They need to be introduced to those conventions. Documentation conventions for design reports, research reports, and project reports need to be discussed in class before the reports are written. Students do best when they are given clear guidelines to follow, and students appreciate having a model or template to work from.

Issues of clarity were present to a great degree in all the student documents, and were tied to two weaknesses: failure to understand the expectations of the audience in terms of completeness of the technical argument, and to a greater degree, failure to express themselves competently in English. The first cause can be remediated with more guidance on audience expectations in terms of technical argument and completeness of evidence.

The second cause—ESL issues—is not so easy to address during a student's academic timeline, since mastery of English as a second language is a lifelong learning endeavor. Importantly, an estimated 85% of the documents I reviewed were written by ESL students. However, there are several remediation strategies. First, where students are writing in a group, ensure that one group member is a native English speaker or else highly proficient in English. Second, have students complete a draft that is then reviewed and edited either by the professor or by the Writing Center. Third, have the students conduct peer review or read each other's documents, with students receiving coaching on peer review techniques that encourages them to point out sections of writing that aren't clear to them. Several of these strategies can be used in conjunction. Students need to be encouraged to seek "another pair of eyes" for their writing whenever possible. Students should also become accustomed to considering their writing products as works in progress that go through several iterations before they are final.

In terms of grammar and punctuation, students generally need a lot of work in this area. Unfortunately, if they have gotten to upper division status, it means they have also managed to limp through the lower division writing remediation process without that process accomplishing its goal of having all students write at freshman competency level. The focus of an upper division writing class or a senior design class certainly should not be to teach students the basic rules of grammar and punctuation—there is too much other vital information that students need to focus on to grasp the basics of writing for engineering-specific fields. Nonetheless, students need to be held accountable for competency in the basic rules of grammar and punctuation and should be penalized accordingly for lack of competency. Here again, it is important for students

to work through several drafts of their reports, and to seek help on grammar and punctuation at some stage of their writing process if they need such help. One thing that stood out in this area is that students could have greatly improved if they'd simply paid attention to the MS Word spell-checker and grammar-checker. Students need to be coached to use these programs. Spell-checker would have caught mistakes like "nealing" for "kneeling" and "aquard" for "awkward," and in the first case at least would have pointed to the correct spelling. Common ESL issues with verb tense, subject/verb agreement, and adjectival or adverbial endings would have been pointed out by the grammar-checker. Errors are prolific in this area—"the wide of the channel," "the product was design to …" "hazardous if not using properly," "these new technologies allows," "a sophisticate plan," etc.

In terms of understanding documentation conventions for professional reporting, students need specific training in this area. Classroom time needs to be briefly devoted to conventions of citation and referencing, numbering of figures and tables, appendixes, and conventions for callouts and captions. It was common to see figures unnumbered or untitled as well as unreferenced in the text. Another common error was listing a bibliography that was unreferenced in the text. Indeed, it was clear that all students could have benefited from a review of citation conventions, although this too should have been covered in their lower division writing instruction. However, since this convention is closely tied to ethical professionalism, it should be remediated, in my opinion. While poor grammar and punctuation skills may reflect poorly on a student's credibility once he or she reaches the workplace, failing to give proper credit for another's ideas could get him or her fired.

Recommended Teaching Approaches

In general, I believe that three pedagogical approaches can bring significant improvements to the writing products produced by engineering students.

First, consider group-written assignments aimed at an audience of professional peers, rather than written for the teacher. The most successful set of documents I reviewed belonged to the civil engineering students, who worked in groups to produce a proposal for a land development project. These students now have a writing product that they can show to potential employers as evidence that they know the documentation conventions of their field. It has been well argued by teachers of professional writing that students have lots of experience writing for the teacher, but next to none writing for an audience of their soon-to-be professional peers. They need to be given an opportunity to role-play an engineer documenting a professional argument in the form of a proposal or tradeoff study aimed at a decision-maker. Along with a peer-based assignment, clear guidelines should be given for content and persuasive strategy, as well as a detailed set of evaluation criteria, and ideally a template and model example. I also suggest that a letter of transmittal be required in order to give students practice in this crucial business format as well.

Second, train students on documentation conventions for professional reports. Ironically, students showed impressive proficiency in computer-based documentation programs, including automatic Table of Contents generation, formatting, cutting and pasting of graphics, tabulation, CAD, etc., but need training on other documentation basics, including the following:

- Figure and table numbering and captioning conventions
- Conventions for landscape page orientation
- Conventions for numbering of appendixes
- Decimal and alphanumeric numbering conventions
- Text citation, figure/table citation, and bibliographic conventions
- Business letter conventions
- Conventions for units of measure, disciplinary symbols, and acronyms

Third, require students to outline, draft early and work iteratively, and serve as peer reviewers for each other's work. While we cannot turn students into professional writers in one school term, we can "condition" them to seek help from others as writers writing throughout their professional life. Students will learn that writing is a social process and a lifelong learning practice if we model these practices in the classroom. Peer coaching of ESL students in particular can help them avoid culturally embarrassing errors such as "blue colored workers" or "physical disable people." The peer review process needs to be coached, and students need to be held accountable for helping each other, particularly in terms of proofreading and catching grammatical errors. Poorly edited or poorly proofread final reports need to be penalized accordingly. Coaching students in these areas would also offer the opportunity to quickly review the most common grammar problems (which happily, do not include many sentence fragments or run-ons!). From my analysis, the most common problem areas are the following:

- Use of commas, semicolons, and colons.
- Plural vs. possessive
- Missing articles
- Awkward constructions: well recommended for highly recommended
- Verb tense
- Subject/verb agreement
- Which/that, to/too, lead/led
- Adverbial and adjectival endings
- Capitalization

Students could also be trained as peer reviewers by having them correct examples from prior reports. Here are a couple of examples:

> *The product was design thinking in the need of physical disable people to lift the water bottle without making a person to do much work.*
>
> *The pressure at the water main is 15 psi, that gives a 34 feet head.*
>
> *The rear casters have breaking system thus when the machine is at the dispenser the rear casters are locked and the machine is a non moving structure thus use of ones second hand is unnecessary.*

LEDS are special kind of diodes that radiate light when the energy levels in the semiconductor layers changes.

For reports other than design studies, such as reports written by Electrical and Computer Engineering students, consider having students do a tradeoff study where they compare two technologies or products and recommend one alternative, backing up their recommendations with a clear set of evaluation criteria. Also, a progress report could be assigned, framed in the context of having a supervisor assign them the task of advocating and justifying incorporation of a new technology to an organization's decision-makers. Generally the research reports I examined seemed rushed and poorly documented in terms of sources. They contained almost no organizational structure and information was presented in a convoluted manner with crucial explanations missing. Requiring an outline as well as providing a report template might help, and enforcing peer review of drafts seems important.

Design project reports, such as those written by Mechanical Engineering students, could be written as proposals, so that students actually argue for going forward with the design to a decision-maker. Design reports that are structured like a technical research paper (introduction, objective, problem, description, discussion, conclusion) cause students to struggle with this format, with the result that content often won't match titles. For example, in the papers I surveyed, when the instructor wanted design requirements he often got a narrative about how the project was carried out or an evaluation of the assignment itself. The discussion and conclusions sections were often a needless repeat of the design description. A proposal format would help students to organize information and make stronger arguments for their design choices. The proposal should include a project timelime. There seemed to be confusion as well between features and components—a proposal format would help here by forcing students to argue for the benefits of each feature rather writing a useless narrative about product components.

For Civil Engineering students, a sense of what is important to stress in terms of the benefits of the design choices could be enhanced if the audience was specified as a city or a client, and if the report was done as a proposal to these decision-makers. The reports I reviewed were not focused on their audience enough. They are still "writerly" rather than "readerly." That is, the writer is focused on expressing his or her ideas, not on writing for the reader's ease of understanding.

Finally, in providing feedback on engineering student reports, instructors should emphasize presentation competency as instead of just technical content. Students need to understand that clarity and completeness of technical ideas are just as important as the ideas themselves.

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