

Strengthening Writing (and Reading) Skills in a Senior-Level Lab Course while Reinforcing Life-Long Learning Skills

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Abstract

Engineering faculty typically rely on a summative process to improve students' written communication skills (such as graded written reports, a common part of engineering laboratory courses), but formative exercises may be more effective in actually providing helpful feedback to students. The series of student exercises discussed in this paper were found to be helpful by students in improving their writing skills. The exercises were structured to help students be more aware of new innovations and discoveries in science, business, and technology and consequently, to increase students' awareness of the importance for life-long learning. The student exercises required to students to read and summarize relevant information, and the summaries were reviewed in a classroom setting. Students found the exercises to have improved their writing skills and enhanced their understanding of the importance of life-long learning. Small changes in the process are to be considered in future courses.

Introduction

In addition to the five “hard” skills that primarily emphasize technical expertise, Criterion 3 of the 2013-2014 *ABET Criteria for Accrediting Engineering Program*¹ lists six “professional (or ‘soft’) skills”:

- (d) an ability to function on multidisciplinary teams
- (f) an understanding of professional and ethical responsibility
- (g) an ability to communicate effectively
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) a recognition of the need for, and an ability to engage in life-long learning
- (j) a knowledge of contemporary issues

Oberst and Jones² note the importance of developing these professional skills, which encompass far more than simply mastering the ability to work well in teams or developing good public speaking techniques and management skills. The growing social consciousness around the world makes it imperative that engineering students understand the global implications of their work. Furthermore, an increasing number of engineering graduates never actually practice engineering—many engineers instead choose to enter fields such as business, law, medicine and management.³

Engineering graduates value professional skills, particularly the ability to communicate effectively. In a survey of young (within 10 years of graduation) undergraduate engineering alumni from a large Midwestern university, Passow⁴ ranked the perceived importance of ABET

hard and professional skills to the success of these graduates. Effective communication was ranked in the top statistical cluster of competencies, along with teamwork, the ability to analyze data and problem solving ability. Although the balance of the professional skills statistically ranked overall in the second and bottom clusters, a knowledge of contemporary issues was actually ranked in the top cluster by computer science majors, MDs, those working in the healthcare industry and those working outside of traditional engineering.

Even though professional skills (and especially technical communication) are of utmost importance, our graduating engineers are often inadequately prepared to deliver technical information to diverse audiences. Sageev and Romanowski⁵ cite overwhelming evidence from industry and academic surveys, as well as comments from managers and professors, that our students have poor writing and presentation skills. Sadly, these authors also note that 64 percent of the overall work time of an engineer is spent on some form of communication.

The obvious answer to this problem is to better incorporate professional skills and their use into the everyday engineering classroom. Spinelli,⁶ of Union College, developed a course on the history of electrical engineering, which couples the study of technological developments in American and European civilizations to writing, oral communication and ethics. At the University of Virginia, Richards and Gorman⁷ used case studies to simultaneously teach design and ethics. The International Engineering Program^{8,9} at the University of Rhode Island combines an undergraduate engineering degree with a degree in German, French or Spanish, and also requires students to complete an internship in a country where the foreign language is spoken.

The incorporation of professional skills is not necessarily easy to implement in many engineering courses. For courses involving the development of technical skills, there is always the tension between covering the technical material (and providing experience in its application – homework and problem solving) and including projects that involve written or oral reports. If reports are required, they are typically part of a much larger assignment. The net result is that the students actually receive little practice in technical communication. The emphasis on life-long learning may be more easily included in applications of technology, but there are few engineering course topics that directly appear in daily headlines.

This paper discusses one approach to addressing these issues by giving students practice in writing in a setting that helped them improve their skills, while showing them the importance of keeping up with current events that may very well shape their future.

Implementation

The Ralph E. Martin Department of Chemical Engineering at the University of Arkansas has a required senior level laboratory course that emphasizes mass transfer and reactor design/chemical kinetics. The course develops mass transfer operations through experiments in analytical techniques (standard gas chromatography), vapor/liquid equilibrium (Othmer still), and separation in packed and staged columns. As in most lab courses, report writing is an important element of the course. However, the desire was to have report grades to be more reflective of a student's technical understanding and analysis as opposed to their ability to write

an effective report. (The emphasis on technical analysis was intended to resonate with students who viewed the analysis as more important than the format of a report, for example, and while this may not be entirely true for students after college, it may be easier to learn the reporting format of an organization than it is to freshly learn how to analyze a problem and identify the important aspects of a problem and communicate those to others. The sentiment of students was that they wanted their course grade to be based on important understanding instead of report details.) Clearly, the ability to write an effective report was a primary course objective, so to meet both objectives, report grades were not strongly weighted to communication issues, and an alternative method was used to help students improve their writing skills – the “Pop Quiz.” Students could be required to resubmit reports with writing issues corrected, but this would require additional faculty time. The first attempt to use an approach like the “Pop Quiz” was in CHEG 4332L in spring 2013, and this paper summarizes that effort.

In developing the “Pop Quiz,” the following observations were considered:

- Many upper-level engineering students perceive themselves to be so busy that they ignore the sources of information readily available to them about scientific, technological, and business innovations and changes.
- Engineering students do not typically read good writing. The majority of reading by students may well be text messages! Reading good quality writing will be a positive contributor to improving students’ writing skills.
- When in a professional setting, people rely on others to provide informal feedback on reports, which may not be true of many courses. Furthermore, if you ask a colleague to provide feedback on a report, you will likely be asked to reciprocate, and if your ability to write and communicate is substandard, cooperation of colleagues may not be as helpful as it could be (e.g., “I don’t really have time to look at that now” or simply agreeing to help and then never following through). It will be helpful to develop a network of people who can be helpful in providing mutual assistance.

The “Pop Quiz” was used as follows:

- The weekly “Pop Quiz” was announced at least two days before class. For the particular course where this was implemented, all students in the class met weekly in a drill session on Thursday.
- In the first few “Pop Quizzes,” students were asked to read an article in the New York Times (NYT) Science Section (published every Tuesday) and to write a brief summary of the article to be submitted at the next drill session.
- In the “Pop Quiz” announcement, it was made clear that one or two submissions would be anonymously reviewed during class. (This was accomplished during class by picking out a paper, and putting it on a camera projector with the name of the person obscured.) In the in-class review, all students were invited to provide comments. Since many of the students had read the same article, they could comment on how effective the particular summary was at expressing the most important aspects as well as the accuracy of the account. The most common problem was wordiness.
- All students who came to class and submitted a summary would get full credit for the “Pop Quiz.”

- Student summaries were marked up showing corrections to improve the effectiveness of their writing (in addition to correcting errors) and returned to students before the next “Pop Quiz.”

In the announcement of the “Pop Quizzes,” the observations discussed above were discussed with students. The “Pop Quizzes” are considered formative because students receive credit for participating (as opposed to performance).

After a few “Pop Quizzes,” there were some variations that were tried:

- Materials other than NYT Science Section used, such as the written scripts for TED Talks¹⁰ and the NYT Business Section. Because the “Pop Quiz” was announced a couple of days before it was due, the source of the review could be tailored to what news was available for that week. The TED Talks were limited to various subject areas (such as science or global issues).
- A report of common writing issues was discussed during the next (weekly Drill) class period.
- One week, students were asked to submit one copy of their summary without a name. The nameless summaries were redistributed to students to correct the anonymous paper. Students received full credit on the assignment if they did a reasonable job of noting issues. Students’ original papers were also graded by faculty. The student graded anonymous papers were returned to the graders with faculty comments about their appraisal. This was abandoned after one try because it doubled the amount faculty work.
- Although never implemented, students would only receive full credit if they corrected their summaries based on faculty comments. (This was actually suggested by a student.)

The “Pop Quizzes” emphasized the importance of staying up to date with current developments (the importance of life-long learning).

Results and Discussion

As would be hoped, the number of corrections on each “Pop Quiz” went down over the course of the semester, but no data about the number or type of corrections on papers were collected. In an attempt to determine the effectiveness of this approach, an anonymous student survey was conducted. Seventeen students were surveyed, and the results are shown in Table 1. All students in CHEG 4332L in spring 2013 participated in the survey. The survey was distributed at the final Drill session, and students were given the entire class time to complete it.

Table 1. Feedback from the student survey (N = 17)

Question	Response	Selected Comments
How much time have you spent on these “Pop Quizzes”? (average time per quiz)	30 to 45 min (29%) 45 min (29%) 45 min to 1.5 hr (42%)	
How much do you think your writing has improved because of the “Pop Quizzes”? (options were “A lot,”	Both “A lot” and “Some” (12%) “Some” (88%)	

“Some,” and “No real Change”)		
Do you think these lessons will stick with you in other classes? After school?	Yes (100%)	Yes, I believe what I have practiced and learned about my writing will carry over into other aspects of my life. Writing aside, I believe those pop quizzes have helped me stay connected with what is going on in the world.”
Do you think it has been effective to just grade the “Pop Quizzes” as Pass/Fail (didn’t turn one in)? Why?	Yes (82%) Split (Yes/No) (12%) No (6%)	<p>a) As long as we continue to anonymously critique a single one so that each week I’m not tempted to turn in a sorry excuse for a summary.</p> <p>b) To be honest they may need to be graded. “Senioritis” has set in for many students. Symptoms are laziness and lack of effort.</p> <p>c) I think it’s helpful to get into the habit of writing. Pass/Fail might not be motivating for some students, but it works for me. I do think it might be helpful that instead of correcting each mistake, give us a chance to recognize the mistakes in our writing and correct it. I think that it’s helpful to look over your comments, but if I actually rewrote/corrected a paper/memo, you found unsatisfactory, it might stick a little more. Maybe do pass/fail if I fail then I have to redo it?</p>

In general, the “Pop Quiz” approach seems to have been successful. In particular,

- The exercises did not take an excessive amount of faculty time.
- The exercises involved giving students practice at reading, summarizing information, and writing.

- Students actively participated in the in-class anonymous critique process. There were no issues with students being upset by critiques of colleagues probably because the identity of the student was carefully kept from the group during the process.
- The importance of life-long learning was tangibly emphasized. (The start of the class discussion began with: So what did you all find interesting the Science Section this week? Many if not most of the students had read several of the articles.)

Senior-level students can become indifferent to the usual motivation of making a good grade on an assignment or in a course, particularly if they are near graduation and have accepted a job offer. The "Pop Quiz" exercises seemed to have motivated students in a different way by appealing to their sense of their own professional pride. Consequently, students were engaged in the classroom discussion and did focus on what they wrote. The success of the "Pop Quiz" was probably also linked to the fact that these assignments were not long, and feedback came quickly. Because of the success of the students and the changes that they saw in their own writing, the lessons learned in the "Pop Quizzes" seem to have a better than average probability of positively influencing the students in the future.

Future Work

In our opinion, one of the reasons this approach was successful was that students understood why the "Pop Quizzes" were being used in conjunction with the lab reports in determining their course grade. The in-class anonymous evaluation process was also important because students went through the process of critically evaluating writing with immediate feedback from peers (when students disagreed about feedback in class this gave the instructor the opportunity to weigh in and explain the good and not-so-good aspects of student's opinions).

The "Pop Quizzes" will be used again. The original approach proved quite effective, but the student suggestion of making corrections for full credit was excellent and will be incorporated when the approach is used again. The efficacy of the exercise was improved by discussion of issues with the Faculty Coaches Group in the Ralph E. Martin Department of Chemical Engineering.¹¹

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