Evaluating the Communication Component of an Engineering Curriculum: A Case Study

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Abstract

This paper describes the evaluation process and findings for teaching and learning of communication skills in the Electrical Engineering Program of the Milwaukee School of Engineering (MSOE). While the teaching of both written and oral communication skills are fostered in a wide variety of courses, only writing can be claimed to be substantially integrated into the curriculum. A wide range of settings for the evaluation of these skills is presented. The evaluation focuses on using reading, writing, speaking, and listening as the four core competencies for effective communications. The findings show that reading and listening skills need strengthening. The belief is that those skills are key to exposing students to influences and thoughts beyond themselves, enlarging the capability to express themselves in their writing and speaking.

The Electrical Engineering Program of MSOE requires communication skills to be stressed in various aspects of the entire curriculum and integrated into the syllabi of courses, including technical courses. In part this is a product of the school's "applications-oriented" educational philosophy, but in part stems also from the goodwill and cooperative dialogue among the faculty of different departments. The team presenting this paper is representative of the Electrical Engineering Program's interdisciplinary approach to integrating communication skills throughout the curriculum. Three of the authors are professors in the Electrical Engineering Program; two are professors in the General Studies Department, with backgrounds in communication, rhetoric, and literature.

Introduction – Background of the Study

The Electrical Engineering Program's greatest strength in integrating communication skills throughout the curriculum is its emphasis on practice and performance. At the core of MSOE's educational philosophy is an "applications-oriented" approach in all classes and laboratories. The process begins in the freshman year, with freshman composition, technical composition, and speech courses. In addition, freshmen take an introductory humanities course that emphasizes interpretation of "texts" (works of literature, film, and fine arts) and written responses to those texts. During the sophomore and junior years, communication practices in science and engineering courses take the form of a variety of reports and some oral presentations. Also, as the students take their humanities and social science electives, they continue to build on the skills of textual interpretation and articulation of a position in response.

The focus on communication skills culminates in the requirements of the yearlong Senior Design sequence, designed to help students make the transition from academe to industry. Communication in this Senior Design sequence is done almost completely in a team environment, with few individual reports or presentations. A major written report (approximately 20-50 pages each) is due every quarter: a feasibility study in Fall Quarter, a design report in Winter Quarter, and a final report in Spring Quarter. In addition to these major reports, teams extensively engage in more informal communication using e-mail and memos. Most routine communication takes the form of team-written memos, with e-mail reserved for very urgent or very casual messages. Students also must prepare an informal oral presentation, two formal oral presentations, a "trade-show" presentation open to the entire campus and the general public, and a single poster presentation of the project. All of these senior team communication requirements involve performance-based skills, primarily speaking and writing. As of the 2002-2003 academic year, however, an additional individual writing project has been assigned. This assignment is a private communication between the team leader and the Senior Design project adviser, in which the team leader reflects upon his or her leadership style, use of motivational techniques, and methods of handling conflict.

Together the courses of the curriculum are intent on setting the standard that *communication occurs in many forms and settings*.

The Electrical Engineering program's stated communication goal is that" its graduates will have demonstrated proficiency in oral and written skills and effective teamwork skills." The issue of communication instruction, particularly in the form of writing-across-the-curriculum (WAC) practices, has been covered extensively. Some articles regarding this topic appear in the bibliography at the end of this paper[1-7]. However, most scholarship in this area has focused primarily on writing as the principal form of communication practice. Our study arose from a desire to better understand the extent to which the current Electrical Engineering curriculum prepares students to meet *all* of the communication challenges they will encounter in the engineering profession, where communication most definitely does occur in many forms and settings. This study, therefore, does not focus on specific student outcome data; rather, it focuses on finding the best framework for analyzing what those outcomes are.

Study Methodology

To evaluate how successfully the Electrical Engineering program is integrating communication skills into the curriculum, a structural rubric was needed to organize all categories of learning activities associated with communication and to provide a method for evaluating both instructional practices and student assessment outcomes.

The rubric chosen was a framework of the four verbal arts: reading, writing, speaking, and listening. This simple taxonomy is capable of overarching the entire Electrical Engineering curriculum, from humanities courses to highly technical engineering courses, and therefore provides a comprehensive methodology for determining whether communication learning is integrated as fully as possible into the EE curriculum at MSOE. By placing all student communication activities into these four categories and then examining each area's contribution in terms of instruction, skill performance, evaluation/feedback, and student self-

assessment/reflection, it is possible to determine the curriculum's strengths and weaknesses in course design and/or student outcomes.

Study Findings, Part 1 – The Good

In writing, the Electrical Engineering curriculum is very strong. Every student takes a freshman composition course, a technical composition course, and a writing-intensive introductory humanities course. In each of these classes students receive instruction on writing well, including communication theory (such as Aristotle's communication triangle and the concepts of ethos, pathos, and logos) and widely used heuristic strategies (such as free-writing and mapping). Ethical issues in communication are also addressed. In addition to strategies for generating ideas and structuring information, students are taught the importance of using evidence to support their opinions and conclusions. There are ample opportunities to practice writing in these courses. Three essays (each with multiple drafts) are required in EN-131 Composition. Several letters and memos are required in EN-132 Technical Composition, in addition to a short report and a formal report. Several short papers, a 5-12 page position paper, and midterm and final essay exams are required in HU-100 Contemporary Issues in the Humanities.

Instructors provide evaluation and feedback on writing in all of these writing-intensive courses. In EN-131 Composition, instructor feedback is supplemented (and amplified) by evaluation and feedback provided by other students through peer critiques generated in small-group writing workshops. EN-131 students are then required to implement that feedback through revision of multiple drafts. During the peer-review process, students also engage in self-assessment and reflection on their own writing, albeit somewhat obliquely. Critiquing other students' work helps to develop the editing skills and awareness of quality standards necessary for students to evaluate their own work, and the multiple-draft writing process encourages continual self-reflection and assessment of those texts against the quality standards that are continually being internalized.

In speaking, the Electrical Engineering curriculum is also very strong. All students give presentations of technical subjects in the freshman-year technical composition course. A performance-based speech class (EN-241 Speech) is also required of all freshmen in the program. In EN-241, students receive instruction in communication theory, including review of Aristotle's triangle and the transactional model of communication. Communication is presented as a continuous process of simultaneous interaction between speaker and listener within the specific context of their transaction. Nonverbal cues are discussed, as well as a broader awareness of the speaking situation and the importance of controlling environmental factors such as lighting, room temperature, seating arrangement, equipment availability, and sound levels. Students view video clips of famous speeches and discuss what makes these speakers' performances effective. Ethical issues in public speaking are addressed. In addition, students in EN-132 Technical Composition and EN-241 Speech receive instruction regarding strategies for presenting visual information, including use of PowerPoint.

Ample opportunities for performance exist. Students deliver at least five speeches in the ten-week quarter covered by EN-241 Speech. In addition, short oral presentations are required in several electrical engineering and computer science courses. These presentations are graded (the

grade is equal to one homework or lab experiment grade) and videotaped, with the tapes available to students for viewing. In addition to these presentations in various courses, students polish their speaking skills to a professional sheen during the yearlong Senior Design sequence. At this point, students must learn to deliver team presentations, as Senior Design is a team-centered project. Student design teams deliver an informal oral presentation, two formal oral presentations, a "trade-show" presentation open to the entire campus and the general public (includes posters, etc.), and a single poster presentation of the project.

Evaluation and feedback is built into all speaking performances, although not every classroom presentation is graded. Students in EN-241 Speech receive evaluation and feedback from both instructor and peers. As in EN-131 Composition, the requirement that students critique each other's work not only provides feedback to the students being critiqued but also develops each critiquing student's own internal sense of quality standards. EN-241 students are required to review the videotape of at least one of their speeches and write a self-evaluation. In certain EE courses and in Senior Design, the students are provided the results and instructor's comments of their oral presentation for self-evaluation; they are encouraged to discuss the results with the instructor for improvements.

Study Findings, Part 2 – The Bad

While writing and speaking are strongly integrated into the Electrical Engineering curriculum, the same cannot be said of reading and listening.

Some instruction in reading does occur, but it is minimal. All students are required to take EN-131 Composition and HU-100 Contemporary Issues, the introductory humanities course, during their freshman year. In the composition course, students read several essays included in the course reader. While class discussion primarily centers on how students can use these essays as models for their own writing, the very nature of this focused reading also gives students a deeper understanding of how texts are structured and how certain literary devices (i.e., foreshadowing and metaphor) carry meaning. The introductory humanities course teaches close reading and interpretation of texts—including "texts" such as film and fine arts. Students' interpretative skills are put into practice during class discussion and in several written assignments, including a fine-arts experience paper, a position paper, and midterm and final essay exams. Students receive evaluation and feedback on their interpretive skills through feedback in discussion and on their written work. Student self-assessment of and reflection on reading skills are not institutionalized in the curriculum at this point.

Almost no instruction in listening skills occurs. In fact, listening may be the weakest component of the communication curriculum in Electrical Engineering. Students do receive some instruction on listening in EN-241 Speech. Strategies for mentally organizing and retaining information are discussed, and ethical issues in listening (such as keeping an open mind) are addressed. However, this is the only instruction on listening skills that students receive. One promising development in the listening category, however, is the new requirement in Senior Design for the team leader of each group to write a memo reflecting on his or her leadership style. This assignment may provide a place where self-assessment of listening skills occurs.

Additionally, one of this study's authors has replaced student presentations in his classes with one-on-one conversations in which students must listen to the professor's questions and respond orally. Conventionally, oral class project presentation is conducted by requiring the student to present his/her project or a portion of the project to the class before or at the end of the project checkout session. The student is informed of the requirements in advance and is usually well prepared for the presentation (including the answers for possible questions). Using the new format, the student explains his/her project to the professor individually (with no electronic presentation aids such as PowerPoint). The questions are usually directly related to the project (theoretically and implementation). The purpose of this method is to provide the student with oral presentation skill in a semiformal atmosphere and "on his/her feet." The question session usually lasts about 5-10 minutes and covers about 3-5 questions. This format emulates a situation that the student may encounter during a job technical interview at the company (second interview, plant trip). This format does not replace the formal oral presentation that student must conduct for his/her senior design project. It also may not apply to all courses

Study Findings, Part 3 – The Ugly

Despite the extensive instruction and feedback students receive in writing and speaking, the study reveals two chronic patterns of weakness in student performance: 1) a difficulty in distinguishing and articulating a hierarchy of importance or some other organizing principle among multiple data points and 2) a lack of balance in the give and take of communication with other people.

First, engineering students generally seem to be serial writers, preferring to write about events as they occurred in time. This makes for a great challenge in writing abstracts or summaries, both of which require writers to focus only on the most essential points. Giving shape to a report narrative means replacing the chronological organization of data with another pattern. Writing from the perspective of beginning with what is most important appears to be very difficult. There is a preference for details. Engineering students are very good, therefore, when writing the body of a report. They do know the details extremely well. But they have difficulty stepping back from the details and seeing the "bigger" picture. Three areas are seen as needing major reinforcement: Executive Summaries, Introductions, and Conclusions. These areas are where "big picture" perspectives are most needed.

Second, there is a disconnect between the "incoming" and "outgoing" verbal skills that not only marginalizes the "incoming" skills but also shortchanges the "outgoing" skills. Skills in reading (incoming) and writing (outgoing) are strongly linked, but unfortunately, reading is not accentuated strongly throughout the curriculum. Students are advised again and again, read what you write, edit what you write. Worst case scenarios are often seen in email. Emails have developed a culture and writing syntax that are often strongly at odds with conventional communication norms. Students have the impression and belief that "bad writing" can be turned on and off, as the occasion demands. Our observations are that it is "on" all too often.

Likewise, skills in listening (incoming) and speaking (outgoing) are strongly linked, yet listening instruction and practice is scarcely to be found in the curriculum. Nowhere is this disconnect more clearly represented than in the Senior Design teams. Generally everyone wants to present

his point of view—and can do so forcefully—but has great difficulty in listening to and accepting the ideas of others. Communication falters among team members as a result, no matter how clearly individuals articulate their positions.

Conclusion

Overall, the students in the electrical engineering program at MSOE develop very substantial communication skills. But as expected, upon the cooperative analysis by the joint faculty from the Electrical Engineering Program and the General Studies Department, areas were identified that should be addressed for improvement.

Because of its applications-oriented mission, MSOE's Electrical Engineering program has a very output-oriented curriculum. Student performances in writing and speaking do tend to be very strong, despite the patterns of weakness noted. We have a sound program in a traditional context. However, we are in a changing world. As our graduates adjust to this global workplace environment, "outgoing" communication skills are not enough. With the rapidity of change that accompanies globalization, traditional ideas of communication proficiency are insufficient. Therefore, it is necessary to rethink student outcomes associated with the Electrical Engineering program's Goal No. 4, which states that its graduates will have "demonstrated proficiency in oral and written communication skills and effective teamwork skills." The weaknesses noted earlier must be corrected.

Recommended Solutions

The weaknesses noted in students' big-picture organizational skills and imbalanced communications should be addressed in ways that confront the problems at several points in the curriculum.

First, more emphasis should be placed on helping students understand not only the commonalities shared by all well-written texts but also the differences between texts of various genres in terms of structure, format, and reader expectations. Essays are literary texts meant to entertain or enlighten readers, for example, while reports are transactional texts meant to document processes and provide readers with easy access to information. Yet good writing in both genres is marked by clear purpose, logical structure or syntax, and stylistically appropriate prose. Instructors in all courses involving writing or speaking should emphasize these big-picture elements, with particular focus on how to summarize the main point of any message or text. More specifically, special focus on Executive Summaries and Conclusions must occur throughout the curriculum. Technical communications are "front-loaded" messages. A report summarizes its main point in the first sentence and then follows up with background information—completely opposite to the strategy commonly used in a freshman composition essay, which usually employs a general-to-specific organizational pattern. In addition to increased emphasis on purpose and structure, students should also be guided in the use of stylistically appropriate prose by attempting to inject nuances in cover letters and resumes, where choice of words can have a greater impact than in technical reports.

Second, changes to Senior Design should be implemented that will provide students with additional opportunities to practice skills in listening and reading. Senior Design team/advisor sessions should be held that will engage the students in discussion and require greater participation from all members in listening for meaning and enlarging their understanding. Also, Senior Design presentations should be made to audiences of peers, whose grades are influenced by their participation in asking questions of the presenters, again focusing on the active, critical listening skills of all participants. Finally, a student majoring in Technical Communication should be assigned to each design team as a consultant to critique the report writing and facilitate other aspects of communication that may be problematic: issues of interpersonal communication and group dynamics, strategies for improving the stand-alone, narrative quality of graphical representations of data, and techniques for visual storytelling that would enhance the poster-session display board, for example.

Addressing these weaknesses may also strengthen student outcomes under two other stated goals of the program: ethics and lifelong learning. The findings show that reading and listening skills need strengthening. The belief is that those skills are key to exposing students to influences and thoughts beyond themselves, which, in turn, should strengthen both ethics, through greater empathy for others and a big-picture understanding of the broader implications their actions may have, and lifelong learning, through an increased awareness of the world outside the immediate context of the engineering field and an ability to make meaningful connections among the chaos of detail.

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