TEACHING SOFT SKILLS TO ENGINEERING TEHCNOLOGY STUDENTS

Teresa F. Cook[1], Janak Dave[2], James O. Everly[3],

Abstract — *Research shows and accreditation boards require that a successful engineering technology program incorporates the development of soft skills throughout its curriculum. Although most engineering technology students recognize the need to develop their technical proficiency, convincing these students to prioritize communication and management skills can be challenging. An effective approach that emphasizes the importance of soft skills is to design core classes which include technical assignments that stress responsible documentation of research, clear oral, graphical, and written communication, as well as the development of an accurate budget and schedule. Often overlooked, but equally important in producing lifelong learners and effective practitioners, is the collaboration of humanities and engineering technology faculty in the creation and evaluation of these assignments.*

.

Index Terms — Writing in the disciplines, multi-disciplinary teaching, assessment, soft skills

INTRODUCTION

Practicing engineers can attest to the fact that their profession requires them to communicate with diverse audiences through an array of genres, but most engineering technology students choose their major because they have a preference for science and technology fields, and some even admit their choice is in part based on a desire to avoid English classes. Such students often are disappointed as they begin registering for classes and realize that they are required to take a series of English and communication courses. At the University of Cincinnati's College of Applied Science (CAS), these courses include English Composition 101, English Composition 102, and Fundamentals of Speech Communication during their first year, and a minimum of one mid-level writing or technical writing course during their sophomore or junior years. After completion of this mid-level writing course, students can often be heard celebrating that they have finally "finished with writing." Of course this claim belies reality as growing research suggests that communication skills are vitally important to the technology student's future academic and professional success. In preparing students for an increasingly complex and global workforce, Sheppard, Pellegrino and Olds contend that "U.S. engineering education must not only prepare graduates to work in this rapidly changing world, but also engage students in disciplines beyond engineering to make them better engineers and more informed human beings and citizens" [1]. This reality is faced by many graduates as they enter the workplace and recognize they are underprepared for the communication tasks they must complete [2].

ACCREDITATION REQUIREMENTS

In addition to the observations of recent graduates that they need stronger communication skills, the College of Applied Science's industrial advisors consistently stress the need for graduates with better soft skills, such as oral and written communication. This emphasis is strongly echoed by ABET, "the recognized accreditor for college and university programs in applied science, computing, engineering, and technology" in the United States [3]. Accreditation by this organization ensures that a postsecondary program is meeting the quality standards established by professionals in the field [3]. According to Youra, these standards historically have "involved counting up instructional hours and educational experiences within tightly defined categories. Under the new criteria, individual programs must demonstrate that they meet broad aims through a process that includes defining local goals, measuring outcomes, and using that outcome to continuously improve the curriculum" [4]. The ABET 2000 criteria require that engineering and technology programs demonstrate that their graduates possess the following:

a. an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines
b. an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology
c. an ability to conduct, analyze and interpret experiments, and apply experimental results to improve processes
d. an ability to apply creativity in the design of systems, components, or processes appropriate to program educational objectives
e. an ability to function effectively on teams
f. an ability to identify, analyze and solve technical problems
g. an ability to communicate effectively
h. a recognition of the need for, and an ability to engage in lifelong learning
i. an ability to understand professional, ethical and social responsibilities
j. a respect for diversity and a knowledge of contemporary professional, societal and global issues
k. a commitment to quality, timeliness, and continuous improvement [3]

A quantitative assessment of this list might note that only one of the eleven requirements specifies communication or writing skills, but this inaccurate analysis would fail to recognize that inherent to this set of criteria is an inextricable relationship between soft skills and hard skills. Communicating effectively is essential to functioning on a team, and how does one apply the knowledge gained from experimental results or share the solution to a technical problem except through some means of oral, visual, or written communication? Furthermore, ABET stipulates that

[1] Teresa F. Cook, University of Cincinnati College of Applied Science, Cincinnati, Ohio, United States, teresa.f.cook@uc.edu
[2] Janak Dave, University of Cincinnati College of Applied Science, Cincinnati, Ohio, United States, janak.dave@uc.edu
[3] James O. Everly, University of Cincinnati College of Applied Science, Cincinnati, Ohio, United States, james.everly@uc.edu

a program's communications content must develop the ability of graduates to:

a. plan, organize, prepare, and deliver effective technical reports in written, oral, and other formats appropriate to the discipline and goals of the program

b. incorporate communications skills throughout the technical content of the program

c. utilize the appropriate technical literature and use it as a principal means of staying current in their chosen technology

d. utilize the interpersonal skills required to work effectively in teams [3]

These skills are ultimately tested in the capstone design experience, which is one of the most useful course sequences in an engineering technology curriculum.

SENIOR CAPSTONE PROJECTS

In a year long senior design project, CAS students must solve "real world," open-ended design problems by synthesizing knowledge obtained through their years in the program. In addition to satisfying ABET capstone requirements, this allows students to design, build and test their products. At the successful completion of their projects, students have acquired the following necessary skills which they will apply in their careers:

- Synthesizing knowledge from earlier courses
- Going from concept to a working prototype
- Project management
- Time management
- Dealing with vendors
- Oral communication to technical and non-technical audiences
- Written reports [5]

The successful acquisition of these skills is independently documented in a number of formats. For example, students write weekly reports that describe activities and results obtained during that week as well as plan for the following week and assess of the progress they have made towards completion of their project. Ultimately, a comprehensive, professionally written design report is submitted which includes the following elements:

- Project description
- Assumptions
- Patent search
- Literature search
- Customer surveys
- Quality function deployment/house of quality
- Technical specifications
- Design alternatives
- Selection of best design
- All pertinent analyses
- Schedule/Gantt chart
- Proof of design document
- Drawings
- Bill of materials [6]

In addition to writing the design report, students are responsible for fabricating the device, testing the device, projecting its production and manufacturing costs, graphically depicting the project in a poster presentation, and delivering a 15-minute oral presentation describing all aspects of their senior capstone project to a technical audience. Students also must answer questions from practicing engineers who judge every senior project at the college's annual Technical Exposition. As the exposition is open to the public, seniors must explain their projects to a non technical audience as well. The complexity of these capstone projects is difficult to overstate, and it should not be surprising that many students struggle to manage the myriad technical and communication tasks required of them.

Close contact between students and their faculty advisors helps students to address the challenges they encounter in the technical aspects of their projects, but students flounder frequently in producing the required communication elements. In response to these struggles, some CAS degree programs require a senior project communication course offered through the Humanities Department. The course is designed to assist students in transferring many of the humanities skills they have learned throughout their curriculum to a project in their major in the same way that the capstone course sequence has them pull together the many technical skills learned throughout their degree program.

This course is best taught in close conjunction and cooperation with faculty from the students' major, an approach that has been independently confirmed by numerous studies suggesting that students respond best when the importance of writing instruction is stressed by professors from a diversity of backgrounds [7]. Unfortunately this single example of interdisciplinary cooperation at the close of a student's academic career cannot erase the longstanding misconception that humanities courses are of little importance, nor can it fill the vacuum created by only a single quarter of writing instruction between the end of a student's freshman year and the end of his or her senior year. Course evaluation comments from students who have taken the senior communication course often share this sentiment, as one student noted,

> "This was a very useful course and the feedback I received was a tremendous help in completing my Senior Design Report and Presentation. I

mentioned this point while serving on the HMCS Department Head Search Committee but I just wanted to reiterate my belief that Technical Writing I & II should be included as mandatory courses somewhere in the curriculum. These two courses were undoubtedly the two most useful courses when it came time to write my Senior Design Report and Presentation."

Although the student's suggestion to add more writing courses to the degree program requirements seems an appropriate response, it fails to acknowledge the curriculum crunch faced by most engineering technology programs or the often tenuous relationship between engineering and humanities faculty that has erupted in constant negotiations between the cultural and utilitarian value of humanities courses. An historical study of the country's engineering programs shows that these negotiations have resulted in a continual shifting in the emphasis and requirement for humanities courses within engineering and technology programs [8]. The current status and role of humanities courses in engineering programs is widely debated and is sure to vary from program to program, but the demand for better writing skills in engineering graduates remains constant.

A Junior Capstone

In one approach to bridging the chasm between writing instruction and engineering courses, CAS faculty members from the Humanities and the Electrical and Computer Engineering Technology departments teamed together to teach a junior level Applied Design course. Instead of proposing and creating a unique project, as in senior design, this course allowed students to reverse engineer the major communication assignments of a pre-selected project. According to Wilson and Everly, "This allows the students the time and creativity to master the skills needed to present the findings of their projects and tie all of the threads from their coursework together without the pressure of innovation"[9]. Students began with the final paper, and then created their own version of the major assignments that would have led to the writing of this paper: a project poster, PowerPoint presentation, abstract, annotated bibliography and project notebook. Students responded positively to this cooperative learning experience with comments such as

> "…by requiring us to submit abstract, proposals, annotated bibliographies, etc. allowed us to preview and prepare for Senior Design. With this when we are required to prepare such things for our Senior Capstone Project they will be something we have seen before and have had experience with, hopefully making our Senior Capstone Experience that much better." [9]

The success of this course and other collaborative efforts between faculty members from humanities and engineering technology departments has led to important realizations.

A Call for More Collaboration

Although students are often criticized for their lack of audience awareness and their poor recognition of rhetorical situations, they sometimes are more adept at these skills than one would ascertain from an examination of their writing in major courses. In the study of a mechanical engineering course that constructed a real world problem and a specific industry customer, the instructor was surprised to hear students complicating and extending the audience to ultimately include the course instructor [10]. Extrapolating from this situation leads back to the importance of collaboration between faculty members from engineering technology and humanities departments. Students will only play the rhetorical game constructed for them if they can see a tangible value. Consequently, if a humanities' faculty member constructs an assignment and specifies that students should assume a technical audience, students will likely fail to take this audience seriously when they know that the sole evaluator will be their English teacher. Similarly when engineering technology faculty invite an English teacher into their classroom for a one-day seminar on writing lab reports, students will not treat the written assignments for that course with the same attention they would an assignment for their English course. Students almost single mindedly focus on the boundaries separating their courses instead of their areas of convergence. Deconstructing these artificial barriers will take faculty collaboration on a scale beyond what has been traditionally attempted in engineering and technology programs.

The successful outcomes of collaborative efforts like the CAS senior and junior capstone experiences suggest an ideal scenario would require that all technical classes that include communication assignments have humanities and technical instructors working together, reinforcing the importance of good writing and communication skills for a student's academic and professional success. The likelihood of garnering administrative support and the financial viability of such an approach most assuredly make this goal untenable, but a number of less daunting strategies can be implemented.

First of all, regular meetings and the sharing of resources between faculty members from humanities and technical departments would create a discourse community with a shared purpose and language. In 2008, a CAS learning community established to study writing in the disciplines came to recognize that often times, instructors are asking students to complete similar writing tasks, but the language they are using differs markedly. An illustrative example arose during a collaborative review of assignment sheets. "In Technical Writing II (a 300-level writing course), students study and are asked to complete their own *process description*. In Programmable Logic Controllers Lab, a mid-level course offering in the ECET department, students are asked to *explain a procedure*"[11]. The faculty's initial failure to recognize the commonalities of these assignments made it quite apparent that without help, students might miss the connection obscured by discipline specific language variances. This scenario does not suggest that technical faculty or humanities faculty abandon their discipline specific vocabulary, which would certainly not serve the student's long term needs in the workforce, but that faculty members instead expand their vocabulary in an effort to make the transference of skills from one course to another more apparent for their students.

In addition to this interdisciplinary cooperation, it is important that technical faculty enforce their expectations for written assignments with the currency that is best understood by students—their grades. When technical faculty complain about the quality of writing in student lab reports but continue to award students Bs for getting the calculations correct, many students will ignore their complaints. This action might be seen as indifference, but it is just as likely that students believe that their professor must be talking about someone else. After all, they "earned" a "B." Perhaps students are rhetorically analyzing the actions of their audience members rather than simply heeding their words.

REFERENCES

[1] S. D. Sheppard, J.W. Pellegrino, and B.M. Olds, "On becoming a 21st century engineer," *Journal of Engineering Education,* vol. 24, pp. 231-234, July 2008.

[2] A. Beck, "Adventures in team teaching: integrating communications into an engineering curriculum," *TETYC*, vol. 34, pp. 59-69, Sept. 2006.

[3] ABET. November 2009,http://www.abet.org/accredited_programs.Shtml.

[4] S.Youra, "Communication across the curriculum," *Language and Learning Across the Disciplines,* vol. 3, pp. 1-12, July 1999.

[5] J. Dave and T. G. Boronkay, "Creation, development, and approval of design, build, and test senior design projects," in *Proceedings of ASME International Mechanical Engineering Congress and Exposition (IMECE)*, November 2001.

[6] J. Dave and T.G. Boronkay, "Design-build-test senior design project," in *Proceedings of ASME International Mechanical Engineering Congress and Exposition (IMECE)*, November 2001.

[7] S. Lord, "Effective 'Writing to communicate' experiences in electrical engineering courses," Presented at the 2007 Annual Conference of the American Society for Engineering Education, Honolulu, HI, June 2007.

[8] J. Leydens and J. Schneider, "Innovation in composition programs that educate engineers: drivers, opportunities, and challenges," *Journal of Engineering Education,* vol. 25, pp. 255-272, July 2009.

[9] L. Wilson, and J. Everly, "Weaving the capstone tapestry" in *Proceedings of the Annual Conference of the American Society for Engineering Education*, June 2007.

[10] D. P. Dannels, "Learning to be professional: technical classroom discourse, practice and professional identity construction," *Journal of Technical and Business Communication*, vol.14, pp. 1-34, 2000.

[11] L. Wilson, T. F. Cook, J. Thompson, and J. Everly, "Developing a writing in the disciplines program in an engineering technology college," in *Proceedings of the Annual Conference of the American Society for Engineering Education*, June 2007.