Understanding Curricular Approaches to Communication as a Global Competency: An Interdisciplinary Study of the Teaching and Learning of Communication

Citation: White, Christina, Lori Breslow, and Daniel Hastings. "Understanding Curricular Approaches to Communication as a Global Competency: An Interdisciplinary Study of the Teaching and Learning of Communication." ASEE Conferences, 2015. 26.1621.1-26.1621.11.

As Published: http://dx.doi.org/10.18260/p.24957

Publisher: American Society for Engineering Education (ASEE)

Persistent URL: http://hdl.handle.net/1721.1/105809

Version: Original manuscript: author's manuscript prior to formal peer review

Understanding Curricular Approaches to Communication as a Global Competency: An Interdisciplinary Study of the Teaching and Learning of Communication

Introduction

As society grows more global and interconnected, the challenges that must be addressed by the next generation of engineers are becoming more complex [1-2]. Engineers need deep technical expertise, of course, but they also need what have typically been called 21st-century skills, for example, critical thinking, problem solving, teamwork, and communication. Technical knowledge and "soft" skills are complementary, and both are necessary if engineers are to help solve the most serious problems our societies face [3-4]. This call for engineering education to position itself so students can meet modern challenges was laid out by the leaders of the National Academy of Engineering (NAE) in their influential reports, *The Engineer of 2020* [5-6]. There is now a need to reflect on how engineering education has positively changed in the decade since those reports, and to consider what still needs to be tackled.

Our research aligns with one of the key recommendations of *The Engineer of 2020*: to develop engineers whose communication skills will allow them to become successful professionals and, who, in turn, will drive technological and social change. Specifically, we examine how engineering schools are helping students develop four key communication competencies: writing, creating and delivering presentations, developing and employing visual literacy, and participating in teams. The Organization for Economic Co-operation and Development's (OECD) *Definition and Selection of Competencies (DeSeCo) Project* describes "competency" as:

> …more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context. For example, the ability to communicate effectively is a competency that may draw on an individual's knowledge of language, practical IT skills and attitudes towards those with whom he or she is communicating [7].

Engineering schools and departments need to produce diverse leaders for the global workforce and in society. But in order to do that, engineers need strong communication skills that will allow them to interact with a wide-ranging audience, including policy makers, community leaders, and the general public—all of whom do not necessarily have a strong understanding of science and technology.

In this paper, we describe preliminary results of a pilot survey we administered at three universities that asked students to report on their levels of self-efficacy for the four communication competencies listed above. Our study sites include two Asian universities and one university in the U.S. (We will add another U.S. university as the fourth study site; however, at the time the pilot survey was administered, this institution was awaiting IRB approval for the study.) We recognize that communication encompasses a variety of activities undertaken by engineers, including interacting in meetings, talking on the telephone, writing e-mails, creating computer-aided drawings, or producing visual models [8], but we focus on these four skills

because we believe they are the foundation of the communication competencies that engineering graduates need to master. We report on commonalities in students' self-efficacy for these skills, what they perceive their weaknesses to be, and their goals for strengthening their abilities.

These findings will feed into a larger study in which we examine two curricular approaches in which these communication skills are taught: an analysis-centric approach and a design-centric approach. We do not claim that each institution can be placed into a silo of one particular curricular approach, but instead each can be benchmarked on a continuum of pedagogical practices. However, we believe that where these institutions sit on the analysis-design spectrum varies enough that we will see interesting differences in how communication skills are taught, and the impact of those practices on student learning. We believe this attention to understanding the learning ecology of each institution is critical because research clearly demonstrates that the development of communication skills relies heavily on *situated learning*, in which, for example, the context surrounding an assignment can be as important as the assignment itself [9-10].

Eventually, we will use a mix of quantitative and qualitative research methodologies in the study. In addition to the student survey of self-efficacy, which will be given both to first-year and graduating students, we will use four other data collection techniques: (1) an inventory of the types and frequency of communication experiences and assignments given at each institution drawn from course syllabi; (2) a faculty survey to gauge instructors' confidence in their ability to teach communication skills and the value they place on communication; (3) student and faculty focus groups to complement the surveys; and (4) classroom observations.

Methodology

The development of the survey began with a review of the research on teaching engineering students communication skills. We also drew on the classic literature on self-efficacy. According to work most notably by Bandura [11-12], success is not only based on the possession of necessary skills, it also requires the confidence to use these skills effectively. Those individuals who develop a strong sense of self-efficacy are well equipped to educate themselves when they have to rely on their own initiative. One of the goals of teaching communication skills is to develop students who feel competent and confident in the use of those skills [13]. Our student survey is designed to measure the extent to which students at our study sites have developed a sense of self-efficacy for communication.

For the next step in the pilot, members of the research team met with a total of twenty student volunteers from the participating universities, ten students from the U.S. university and ten from the universities in Asia so we could observe students actually taking the survey. The student volunteers were diverse in multiple ways, including engineering discipline, ethnicity, gender, first language/native tongue, and academic performance. They had the opportunity to use their own device or one of the computers at the research site to take the online survey, and they also had a hard copy of the survey upon which to take notes.

After we explained the study to the students (we developed a script for this introduction so that there would be common protocol at each institution), they went through the survey question by question. They were asked to read each question out loud, tell us what they thought the question was asking, and then give their answer. We checked to see if the wording of the questions was

clear or if any of the individual words or phrases were confusing. The students were also asked to describe their feelings about the options response scale and if it made sense. We wanted to know their opinion about the length of the survey, including if they would be motivated to finish it, and if they felt it was too long, to indicate at what point they began to feel that way. At the end of the session, students were prompted to provide their perspectives on the layout of the survey, and they were asked if they had any additional feedback that might improve the survey. The research team compiled notes about the students' responses and made modifications to the survey based on the insights from this first phase.

In the second phase of the pilot study, the survey was administered to first-year engineering students at the three universities. A total of 523 students responded, including a diverse representation in terms of engineering discipline, ethnicity, gender, and first language/native tongue.

We initially analyzed the data to compare means between universities. To do this, we needed to determine if there were statistically significant differences in the means of the data from each school. Our data sets are independent and are unequal population sizes so we first used an F-test to determine if the variances were equal or unequal. Then, we ran a two-tailed T-test to compare the means to determine those categories that had a low P-value ($p > .05$), indicating that there was a significant difference between the means, thus between the schools. At this initial pilot stage, we are not seeing significant differences between the schools, but an interesting finding from the data is that we are able to identify common areas where students feel the most and least amounts of self-efficacy in communication, which we describe in the next section. We will continue to employ several methods of data analysis, including means comparisons, in the larger study and will report the findings.

Findings

We analyze the data from the first student survey to indicate the level of self-efficacy for communication skills. We include quantitative results and qualitative trends from the survey to report findings that indicate there are categories in communication in which students across universities report the most and least confidence.

The quantitative data from the pilot survey indicate that the two areas in oral communication that students feel most confident in are: 1) developing a presentation that effectively shares the purpose of the message, and 2) providing evidence that supports the main idea, argument, or recommendation. The areas in oral communication that students from across universities feel least confident in are: 1) speaking with few fillers such as "ummm," and 2) using gestures effectively.

Whereas in oral communication there are two areas that students feel most and least confident in across the three universities, in written communication there is only one most confident and one less confident finding. Specifically, students across the three universities feel most confident in their ability to punctuate sentences correctly and least confident in their ability to create a strong introduction in their writing. However, in two out of the three universities, there were three common areas that students ranked being most confident in: 1) using grammar correctly, 2) using formatting effectively to highlight important ideas or to help the audience skim the document,

and 3) providing evidence that supports the main idea, argument, or recommendation. Also in two out of three universities, there are two common areas that students ranked as being least confident: 1) writing concise sentences, and 2) identifying the audience for whom they are writing. (Please note that when we write "in two out of three universities … that the two universities are not necessarily the same.)

The students across the universities feel most confident in two areas of visual literacy: 1) editing images, as necessary, for layout and display, and 2) creating visual media that represents data. In two of the three sites, students indicate they are also highly confident in using titles or captions with visual media to enhance the audiences' understanding of the message. The area that students indicate the least amount of self-efficacy in visual literacy is including source information in citation and statements of credit. In two out of the three universities, students also indicated their lowest perceptions of self-efficacy in: 1) creating visual media that communicates concepts, narratives, or arguments, and 2) in identifying if there are legal restrictions on the use of an image.

When students rank their self-efficacy in communication skills within a team, there are two categories that rank highest across all three universities that are: 1) listening to team members' ideas and points of view respectfully, and 2) interacting with team members to find solutions to problems. The survey results indicate that students in two out of the three universities also ranked a high confidence in providing feedback to other team members respectfully. Areas across the three participating universities that students have the least confidence when communicating in teams are: 1) clarifying the source of problems when they arise, and 2) identifying verbal and non-verbal behaviors that may be due to cultural norms of team members (for example, hand gestures, slang words, eye contact). Students at two of the three universities also describe low self-efficacy in the ability to express ideas clearly to other team members.

The qualitative data complement the quantitative results of the survey. Student participants are prompted to respond to three open-ended questions to tell their own perspectives about: 1) personal communication strengths, 2) personal communication areas for growth, and 3) communication skills that engineers need. We also analyzed the qualitative data to identify trends across all three universities by coding responses to see the themes that emerged.

Across the three universities, some students mentioned they wanted to improve their writing, but most felt more confident in the strength of their written communication than in their oral presentation skills. Interestingly, students reported one of their greatest strengths in communication is their ability to listen.

In responding to the open-ended questions about areas of growth, students at all three universities noted they wanted to develop confidence in public speaking. For example, students stated that, "I want to be able to talk in front of different audiences without showing my discomfort" and "I have a lot of nervous habits while speaking. Though I feel comfortable, I will make long pauses or pace a lot." Students also indicated that they wanted to learn to avoid fillers (such as umm) and to be more assertive in sharing ideas. One student wrote, for example, "in working in groups, I tend to get lost in the background" and another that, "I would like to improve the way that I communicate with my team members in a group setting. I often don't

communicate my ideas or worries clearly or effectively which can add stress to a stressful situation when a problem arises."

The students across universities identified the many communication skills they felt engineers needed, including: 1) being concise, 2) tailoring the engineering message to diverse audiences, 3) communicating concepts to audiences with various levels of engineering and technical backgrounds, 4) simplifying complex ideas, and 5) working in a team. For example, one student responded to the open-ended question by writing, "If we come up with a new product or idea that could be crucial to society, we need to be able to present it, make a display, write papers, etc. in order to allow more people to know about it . . ., " and another wrote, "I think that engineers should be able to explain concepts to audiences with varying backgrounds and levels of expertise." The ability to communicate in a team resonated with students at all of the universities as one of the most important skills for an engineer to have. One student reported that "cooperation as a team is the most important skill because it lays the foundation of achieving an objective and making progress in our field; it is what starts the ball rolling and is the first step in a chain of communication in the whole execution of a project." Another student mentioned that "the majority of engineering work happens in a group setting, so the members must be capable of accessing and improving an idea in a constructive and cooperative way."

An interesting preliminary finding comes from comparing the U.S.-based university to the two in Asia; this may provide insights into cultural aspects of communication development that can be addressed with pedagogical approaches to facilitating cross-cultural teamwork in engineering courses. Several of the U.S. students indicated they wanted to learn to be better listeners without dominating the conversation, however, the students from the Asian-based universities indicated that listening respectfully and wanting to hear others' ideas were key parts of their communication styles. For example, a U.S. student stated, "I'd like to learn to lead without dominating others," another shared, "I sometimes dominate a conversation without noticing," and the same message is heard as a student reports, "I need more self-control so that I don't dominate conversations." Whereas talking too much is a common observation that many of the U.S.-based students make, we hear the opposite from the Asian-based students. This student quote is representative of what many other Asian-based students described when s/he wrote that, "I am a very observant person and I don't speak unless I am certain of what I am saying. I don't interrupt others while they are talking and wait for others to finish sharing their ideas before interjecting my own."

Discussion

One of the benefits of conducting this pilot survey is to use the analysis as a springboard to develop our focus group topics, course observations, and guide our curriculum review. By conducting a preliminary analysis of the skills that students at three universities identified as being the most and least confident in, we are able to begin to see patterns that will guide the full study. As we continue our more comprehensive study, we hope to include in the analysis the correlations, if any, between communication skills and curricular approaches. We also will explore the differences, if any, between communication skills in students from two different cultures, broadly speaking.. As we have the opportunity to continue the research and disaggregate data, we may be able to identify cultural aspects that impact self-efficacy in different areas of communication, including ways that students interact in teams.

From the qualitative results, it is clear that students perceive that all four areas of communication are relevant skills for engineers to hone. There is overlap in the data in that some of the most frequent skills that students identified as areas for growth are also indicated as important abilities for engineers to have, as, for example, i the ability to clearly and concisely convey engineering information to people who do not have a technical or engineering background. This aligns with the goal of *The Engineer of 2020* and is important to consider in curriculum development in engineering across pedagogical approaches. Similarly, the key areas that students feel least confident in can be considered opportunities to help them learn. For example, we found the students do not feel confident in identifying the audience for whom they are writing expressing ideas clearly to other, clarifying the source of problems on teams when they arise, identifying verbal and non-verbal behaviors that may be due to cultural norms of team members, and creating visual media that communicates concepts, narratives, or arguments.

A potential to improve the self-efficacy in all of these areas is to include explicit learning experiences. For example, when students are responsible for working in a team, the instructor can challenge them to communicate the solution to engineering problem to a diverse audience, including people without an engineering background. Ideally, the learning experience would include explicit instruction that includes best practices in the communication skills, scaffolding to support students' communication development, meaningful feedback, and opportunities for reflection. The goal is to foster self-efficacy and ultimately meet the goal of developing the communication skills that the *Engineer of 2020* needs.

Conclusion

Engineering education across all types of curricular approaches must provide students with more than deep technical and analytical skills to meet society's complex challenges. Engineers need to communicate effectively across cultures and situations to design viable, feasible, and desirable solutions to today's problems. This research provides insight into current educational practices that are addressing the goals in seminal reports like *The Engineer of 2020* [2]. It provides an opportunity for engineering faculty across institutions and internationally to compare effective pedagogical practices that will lead to strengthening the communication skills of future engineers [3-6, 14-15].

Bibliography:

[1] ABET Engineering Accreditation Commission. (2005). *Criteria for accrediting engineering programs.* Baltimore, MD: ABET, Inc.

[2] National Academy of Engineering. (2004-2005). *The engineer of 2020: Visions of engineering in the new century.* Washington, DC: The National Academies Press.

[3] Sageev, P. & Romanowski, C. (2001). A message from recent graduates in the workplace: Results of a survey on technical communication skills. *Journal of Engineering Education, 90*(4), 685-693.

[4] Williams, J. (2002). The engineering portfolio: Communication, reflection, and student learning outcomes assessment. *International Journal of Engineering Education, 18* (2), 199–207.

[5] Bandura, A. (1977). Self-efficacy: towards a unifying theory of behavioral change. *American Psychologist, 33,* 344-358.

[6] Boiarsky, C. (2004). Teaching engineering students to communicate effectively: A metacognitive approach.

International Journal of Engineering Education, 20 (2), 251–60.
[7] Organization for Economic Co-operation and Development (2005). *Definition and Selection of Competencies (DeSeCo) Project. http://www.oecd.org/education/skills-beyond-school/41529556.pdf*
[8] Gömleksiz, M.N. (2007). Effectiveness of cooperative learning (jigsaw II) method in teaching english as a foreign language to engineering students (Case of Firat University, Turkey). *European journal of engineering education*.
[9] Paretti, Marie C., and Christine B. Burgoyne. (2005). Integrating engineering and communication: A study of capstone design courses. In Web proceedings, ASEE/IEEE Frontiers in Education Conference, http://fie. engrng.pitt.edu/fie2005/papers/1205.pdf, pp. F4D.23–F4D.28. L (February 8, 2014)
[10] Leander, K., and Paul P. (2004). Speaking and writing: How talk and text interact in situated practices. In C. Bazerman and P. Prior. Mahwah [Eds.] *What writing does and how it does it: An introduction to analyzing texts and textual practices*. NJ: Lawrence Erlbaum.
[11] Bandura, A. (1986), Social foundations of thought and action: A social cognitive theory, In Prentice Hall, Englewood Cliffs, NJ. Koul, R. and Rubba, P. [Eds.] *An analysis of the reliability and validity of personal internet teaching efficacy beliefs scale*, Electronic Journal of Science Education, September, available at: http://unr.edu/homepage/crowther/ejse/koulrubba.html (January 29, 2014)
[12] Bandura, A. (2006). Guide for constructing self-efficacy measures, in F. Pajares & T. Urdan [Eds.] *Self-Efficacy beliefs of adolescents.* Charlotte, NC: Information Age Publishing
[13] Kear, M. (2000). Concept analysis of self-efficacy. *Graduate Research in Nursing*, available at: http://graduateresearch.com/Kear.htm
[14] Davis, D. & Beyerlein, S. (2005). Development and use of an engineer profile. Proceedings of the *American Society for Engineering Education*.
[15] Kaewpet, C. & Sukamolson, S. (2011). A sociolinguistic approach to oral and written communication for engineering students. *Asian Social Science, 7*(10).