

A Cultural Approach to Teaching Engineering Undergraduates Teamwork

Communication in engineering continues to be an important and widely discussed element of engineering education. Meanwhile, the communication competencies of recent engineering graduates continues to be a point of contention for employers, who continue to call on engineering programs to improve students' communication training. While engineering programs and faculty acknowledge the importance of "good" communication, tensions remain regarding the depth of importance, utility, and even relatedness to engineering education. And while some engineering students acknowledge communication as an important part of engineering practice, namely students who already have some work experience, the majority of students – and some faculty – still discount the breadth and depth of the importance of communication across all fields of engineering practice.

According to LinkedIn data prior to the pandemic, the US workforce does not primarily lack technical skills, rather it lacks people who can communicate and connect with other people effectively (Petroni 2018). Communication was the number one proficiency in demand in all 100 major US metro areas assessed by LinkedIn's skills gap analytics (Barret, 2018). With nearly every job looking for professionals with communication competency, the US was short 1.4 million professionals with these proficiencies by LinkedIn's estimates even before the massive resignation and reshuffling of the US workforce following the pandemic (IEEE Innovation at Work n.d.). So valuable are transferable skills like communication and teamwork, that 63% of employers are now willing to hire someone with transferable skills and train them on technical aspects of the job (Smith, 2022).

Unfortunately, engineering students in particular fail to meet engineering employer expectations. Concerns over the communication and teamwork competency of engineering students have been on the rise recently. One study reported that 59% of managers indicated that it was harder to find employees demonstrating competence in non-technical competencies than employees with technical skills (Berger 2016).

In a recent study by Hirudayaraj

of utmost interest that the next top-ranked professional competency by employers is another ABET required competency – the ability to communicate effectively with diverse groups of people, with an importance rating of 3.78 and proficiency rating of 2.89 (Hirudayaraj, 2021). It is of even further importance to note that this specific ABET required competency, the ability to communicate effectively with diverse groups of people, had the greatest difference between the level of proficiency and the level of importance to engineering employers amongst all professional competencies surveyed (Hirudayaraj, 2021).

At the same time, that engineering graduates possess cross-cultural communication proficiencies have quickly become an industry necessity (e.g., Downey, et al., 2006; Rico-García & Fielden Burns, 2020). However, while cultural competency has long been recognized as an essential competency for engineering professionals, and while engineering programs, especially those abroad, have increased their efforts to prepare students to enter global markets, industry reports indicate that, broadly speaking, US efforts have not met industry needs and expectations (Warnick, 2011; Ndubuisi, et al., 2020).

The discrepancies between engineering employer needs and university efforts can be attributed to how teamwork and intercultural communication function in real-world contexts versus how the theory, concepts, and practice of teamwork and intercultural communication are taught in engineering classrooms; in short, they are not. Although engineering programs work toward helping their students develop teamwork competencies, teamwork in engineering classrooms has been largely bereft of direct teaching about the communication-rooted components of teamwork (Kedrowicz & Nelson, 2007), tending instead to focus on the process and organizational elements of teamwork and various levels of assessment, such as peer-assessment and observation (Chowdhry & Murzi, 2019). Intercultural competency in engineering classrooms suffers a similar fate (Warnick, 2011; Ndubuisi, et al., 2020) and is often discussed in essentialist terms

and intercultural communication being taught in the Engineering Economics with Social and Global Implications course.

I. University of South Florida Program Methods/Implementation

- a. Courses
- b. The Foundations of Engineering Lab (EGN 3000L) is a mandatory first-year engineering three-

and Chilton, were included in this study. At the beginning of the semester, prior to working in teams, all students participated in a lecture conducted by the communication professor which emphasized interpersonal communication, especially intercultural competency, and its significance in promoting a healthy team dynamic. As the semester progressed, the communication professor taught additional lectures reinforcing the importance of interpersonal communication, providing additional knowledge and real-world scenarios. At the end of the semester, students completed a self-reflection assignment to describe their experiences in open-ended short essay questions reported in Appendix B. The self-reflection assignment was made available online to all students in the course to complete without any time restrictions. Blinded qualitative thematic assessment was conducted on one of the student self-reflection responses. The authors individually identified emergent themes in student responses and cross-referenced their results. Themes that were agreed to be very similar or referred to the same subject were combined.

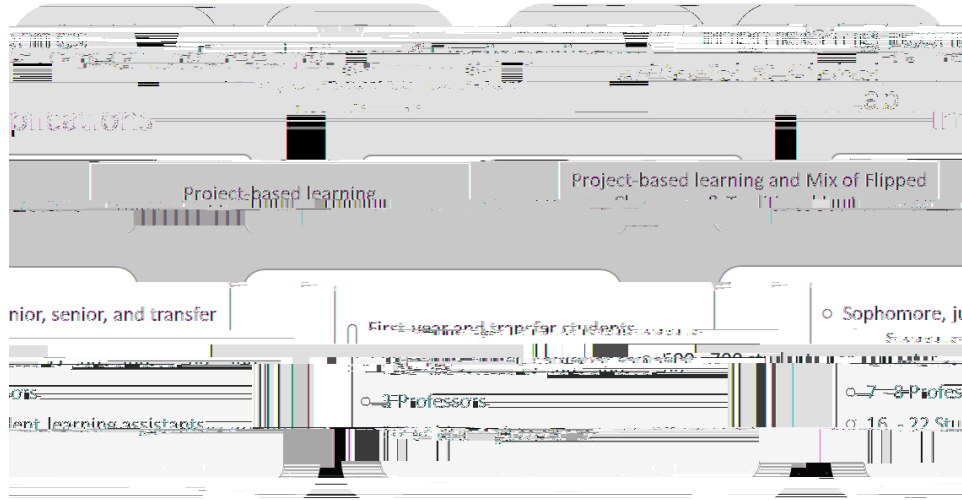


Figure 2: Description of the Surveyed Engineering Courses



Figure 3: Distribution of Team Roles in Foundations of Engineering Lab Course.

II. Foundations of Engineering Lab Reflections

a. Summary of Survey responses

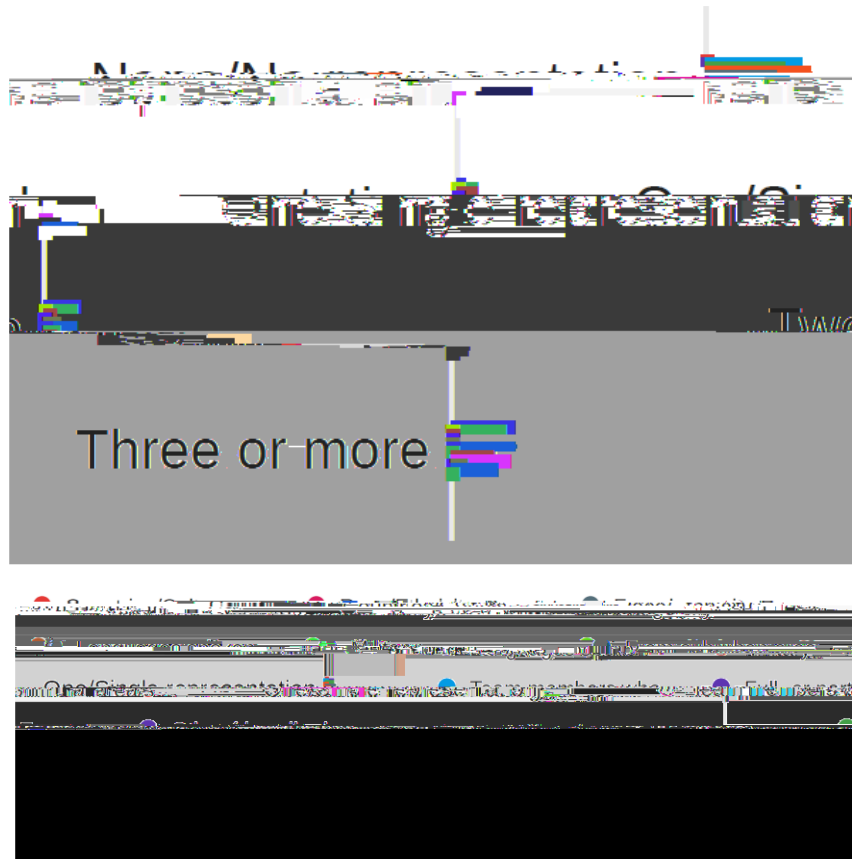
Responses to the survey were collated to assess students' experience in their respective teamwork and document the impact of the semester's lecture. The majority of the students (77%) who responded to the survey questions (Appendix A) had a positive impression of the first team meeting, Table 1. The survey captured the diversity attributes of each team, as shown in figure 4. The representation of the culture and co-culture attributes show that most groups had three or more culture diversities represented, especially on race, countries/culture represented, and languages spoken.

Table 1: Student response rate and Impression of the first meeting.

Students who previously took Engineering Economics with Social and Global Implications (EGN3615), had a unique job experience, or participated in sports teams were knowledgeable of the value of intercultural communication and said they hope others learned about effective leadership and teamwork. The intercultural communication lecture prepared students to have an open mindset before working in groups. The provided examples helped set a precedent for practicing effective communication in a team. Students noticed the difference in the team members who missed the lecture. Most students (72%) had positive responses and demonstrated how the lecture impacted their interactions with team members during the first meeting.

did not think culture affected how the team operated though they respected each other. Overall, there were mixed feelings on how cultural diversity affected meetings and project work.

Intercultural awareness impacted students' actions and behavior towards others. Students shared how the lecture provided strategies on treating others with respect, listening before speaking, and being careful with the choice and tone of voice. Tolerance, respect, understanding, patience, open-mindedness, and self-awareness were the attributes students mentioned that they consciously demonstrated.



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Figure 4: The representation of the culture and co-culture attributes of the teams

“There was not any hint of “social and global implications” throughout the semester project, which I was disappointed,”

“That may not be the most culturally competent thing to say but as I approach my thirty’s already having 2 degrees and 2 tours in the United States Navy, I can say I’ve seen and done more than most of my cohort.”

In contrast, 14.09% of student response statements were coded under the broad theme of Collaboration/Sharing, 6.04% under Broader Impacts, 9.40% under Realizations/Connections, 6.04% under Resources, 48.99% under Types of Communication, 37.58% under Self-Reflection/Perspective/Growth.

Of all the theme subcategories, the most prevalent in student responses (18.12%) focused on audience-centered communication. The concept of audience-centered communication resonated with students with the highest level of recall, with many students making the connection of how it would affect their future professional careers when relating to other stakeholders and clients and making presentations.

Selected responses include:

“I have learned a lot of things that can help me in my future and most importantly is communicating in a professional way with my surroundings as my boss, customers and teammates. I learned that audience centered communication is to know how to explain my message in a professional way and to know the way the audience would understand my message in a professional and easy way. I will use these communication tips in my current and future career because it will always help me in my work life and my everyday life, because knowing the audience is the first thing a speaker should know before starting their speech or their way of communicating to communicate in the right way.”

“I liked a lot the part in which we got to do the interviews because we get involved a lot on how to communicate to someone who has an important position in a company, so we must do some research on the person to adapt our communication. In the future, I see myself using some of the tools learned in the communications part of the course to address some situations to my superiors or my employer.”

“My most important take-away from the “with Social and Global Implications” is the idea of audience centered communication, as this seems like a very useful concept in showing respect to your audience, and providing information in an appropriate and useful manner. In moving forward, I hope to use this takeaway in presentations, messages, and face-to-face communication. I also hope to recognize errors in communication when I fail to follow this concept, so I can thus correct myself. This would keep my presentation on track, and would benefit me, as I would be able to passively follow this concept in doing my academic and professional work.”

“Before this course, I had never really thought about who my audience is or the importance of knowing who they are. It makes so much sense to know your audience and tailor a presentation to that specific audience.”

Table 2: Thematic analysis broad themes and subcategories

Themes	
Broad Themes	Subcategories
Collaboration/Sharing	Teamwork Team leader Leadership Global collaboration Sharing ideas
Realizations/Connections	Communication is broader than expected Beyond technical skills Connections between n cn-5(a)7(mi)7(n)-icyoned

phrase “Audience Centered Communication” in two of her three lectures and in the title of an assignment. Additionally, throughout both semesters students were specifically instructed as part of assignment instructions who their direct audiences were, as well as what potential indirect audiences they could reasonably expect to see their work. In these ways, students were reminded to consider their intended and potential audiences throughout the semester, which is something students noted they had not previously put much, if any, thought into. However, it is important to note here that students were also regularly reminded that an “audience” is any person or group of people who pay attention to what they communicate (written, verbal, or nonverbal), including team members. Thus, although “audience centered communication” was most frequently applied to communication with students’ fictional project manager and potential client, it was also specifically stated throughout the semester that their team members were also audiences, and that they were audiences for their team members.

Although the specific topics of leadership and trust were not directly discussed as part of the communication/SGI portion of the course, some students drew connections themselves between communication competency and leadership and communication and trust among peers, coworkers, and superiors.

The F21 section provided some unexpected and encouraging results. Although the readings remained the same, a small change was made in the SGI proposal assignment wherein instead of being asked to discuss several demographic factors related to their project, which was found to cause a kind of “glossing over” effect in students’ presentations, teams were asked to focus on a single demographic factor that they felt was the highest impact factor related to their project.

would be explored. We would create a communication module covering social competencies, time management, and team bonding exercises. This module would be taught across all sections of the Foundations of Engineering Lab course and Engineering Economics with Social and Glo

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“My group specifically consisted of multiple genders, ethnicities, sexualities, nationalities, races and religions. I feel as though if we didn’t have this talk that my teammates still would have treated each other

“It made me understand that our team interactions might be a little different, and may be affected by others around me.”

“It gave the expectation that intercultural communication can be an asset in the design process and working through problems due to the different perspectives.”

“It did not affect my expectations because we did not have the time to understand and learn each others backgrounds.”

“I feel that it helped to understand that everyone would have different opinions that needed to be respected in the process.”

Q16. Did the Intercultural Communication lecture with Dr. Burchfield change or strengthen your perspective on teamwork or yourself as a team member in any way? How/why or why not?

The lecture was effectful in strengthen X students perspective on teamwork while 8X said minimal impact was made based on their previous knowledge and how well they already work in teams.

“Listen to everyone no matter who they are, and communicate what you want to see everyone do if nothing is being done.”

“It makes me more understanding and patient with people who are unaware about certain aspects of engineering.”

Q21: As a student, what kind of guidance and experiences do you think would be helpful to teach engineering and computer science students how to work effectively as part of a team?.

“More experience in an actual engineering environment”

“I think that the issue isn’t really the differences in culture from what I’ve experienced they all seem to be accepting I think that the issue just is on a social level for some students who just dont want to talk and its pretty hard to teach people how to talk”

“Group work is definitely a good wa

