

A Cultural Approach to Teaching Teamwork in Undergraduate Engineering Courses

Joanna G Burchfield

Dr. Joanna Burchfield is an Assistant Professor of Communication for the College of Engineering at the University of South Florida. Her current research interests focus on the links between interpersonal and intercultural communication competency and undergraduate engineering students' professional proficiencies and professional identity development. Specifically, Burchfield's research explores how the application of an interpersonal communication based curriculum impacts undergraduate engineering students' critical and analytical thinking, communication competencies, and their understandings of themselves and their responsibilities as professional engineers, especially as related to ethics, sustainability, teamwork, systems thinking, leadership, global mindset, diversity, and inclusion. Her research at USF is inspired by her broader interest in the current and potential roles of cross-disciplinary communication training in helping to shape a global workforce of ethically-, collaboratively-, and global-minded individuals who seek innovative and equitable solutions to 21st-century challenges. Prior to joining USF's College of Engineering in 2018, Dr. Burchfield's research explored how intersectionality shapes mediated representations of patients in medical texts and how those representations are linked to doctor/patient communication and patient treatment and care at individual and institutional levels.

Olukemi Akintewe (Assistant Professor of Instruction)

Dr. Kemi Akintewe is an Assistant Professor of Instruction in the Department of Medical Engineering and the Director of the First-year Engineering Experiential learning at the University of South Florida (USF). Dr. Akintewe holds a Doctorate in Chemical Engineering from USF, a Masters in Materials Science & Engineering from the Ohio State University, and her Bachelors in Chemical Engineering from the City College of New York. Her research focuses on active learning in engineering education, engineering predictive assessment models that support students' learning, classroom management techniques, and best teaching practices. Dr. Akintewe's teaching, mentoring, and academic efforts have received recognition, including the 2022 Women in Leadership & Philanthropy, Kathleen Moore Faculty Excellence award, the 2021 USF STEER teaching scholars award, and the USF BMES chapter Faculty of the year award. Her mission is to teach, mentor and coach the next generation of students that succeed in STEM fields while promoting learning, diversity, and leadership.

Jamie Chilton (Instructor I)

Jamie Chilton is an Assistant Professor of Instruction in the Department of Industrial and Management Systems Engineering (IMSE) in the College of Engineering (COE) at the University of South Florida (USF). Chilton received her BA in Biochemistry and Molecular Biology from Agnes Scott College (Decatur, GA). Chilton received her PhD in Biomedical Engineering from Georgia Institute of Technology College of Engineering and Emory University School of Medicine (Atlanta, GA) while also earning her graduate certificate in Engineering Entrepreneurship. Chilton has over 20 years of experience in a variety of academic, research, technology, government, consulting, and private industry settings, particularly in biotechnology. Prior to USF, Chilton's previous work in the biotech industry includes developing innovative cell culture systems for disease modeling, drug discovery and toxicity studies for clients ranging from academia and government to large biotech and pharmaceutical companies. Chilton's current teaching interests include economics, sustainability, engineering management, creativity, and technology-based entrepreneurship. Her broader research interests include engineering management, healthcare engineering and security, and education engineering. Chilton's research in education engineering is motivated by her desire to provide improved interpersonal and intercultural communication training to engineering students to help develop an inclusive and systems thinking mindset as they navigate the global workforce and the critical need for sustainable engineering solutions. Chilton currently serves as the ABET Coordinator for USF's Bachelor of Science in Industrial Engineering (BSIE) program, the Faculty Advisor for USF Engineering Student Council (E-Council), and the Career Advisor for USF Society of Women Engineers (SWE).

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 et al, nearly 500 companies and organizations of varying sizes, based both in the US and abroad, that hire engineers were asked to rate the importance and proficiency of their recent entry-level engineers for 26 identified professional competencies (Hirudayaraj, 2021). These 26 professional competencies were compiled from literature with many directly relating to ABET required competencies and ranked in importance and proficiency by employers using a Likert scale of 0 as not important or not proficient to 4 as absolutely essential or absolutely proficient (Hirudayaraj, 2021). According to their findings, the top professional competencies ranked most important for entry-level engineers were: 1) reliability, with an importance rating of 3.93 and proficiency rating of 3.35; 2) ability to work in teams (ABET required competency), with an importance rating of 3.86 and proficiency rating of 3.38; 3) responsibility, with an importance rating of 3.86 and proficiency rating of 3.32; 4) self-motivation, with an importance of 3.85 and a proficiency rating of 3.30; and 5) positive attitude, with an importance rating of 3.82 and proficiency rating of 3.55 (Hirudayaraj, 2021). Since many of these professional competencies relate to individual traits and professional conduct, it is

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 wherein intercultural competency is framed as overcoming national differences at the individual level (Mahadevan, 2014; Handford, et al., 2017). Meanwhile, students frequently undervalue and resist teamwork activities in the classroom, failing to connect teamwork training with professional competency development and often framing important team tasks such as role setting and team contract writing as busy-work that needs to get done so they can leave. Similarly, students resist the notion that intercultural competency can be learned through reading, lectures, and course work, finding it difficult to understand intercultural competency as a spectrum and believing that the only way to learn how to “overcome” cultural differences is through full immersion via travel to other countries.

However, in university communication departments across the world, intercultural communication courses teach students to understand specific concepts, principles, and practices that ground students’ understanding and move them along the spectrum. Importantly, intercultural communication is not about identifying and “overcoming” cultural differences; rather, the intentional training and practice of intercultural communication teaches us how to locate shared goals, visions, and challenges, to embrace a wide array of perspectives, approaches, and solutions, and to recognize our own preferences and biases; at its heart, intercultural communication is about connection. Similarly, strong teamwork competencies teach students not only that goal setting and team contracts aid in team organization and efficiency, but that teamwork itself is an exercise in finding common ground, embracing new and different

perspectives and ideas, and expanding our individual perspectives in the process. Both Teamwork and Intercultural Communication fall under the broader discipline of Interpersonal Communication (Fig. 1), which encompasses a wide range of topics, including teamwork, intercultural communication, diversity, conflict resolution, listening, and framing. These topics address many of the communication competency-based employer demands outlined above at theoretical, conceptual, and practical levels that aid in helping students understand the what, where, when, why, and how of communication training. Thus, teamwork and intercultural communication pedagogy in engineering classrooms must be grounded in communication discipline-based theories and principles to help students fundamentally understand and practice these competencies.

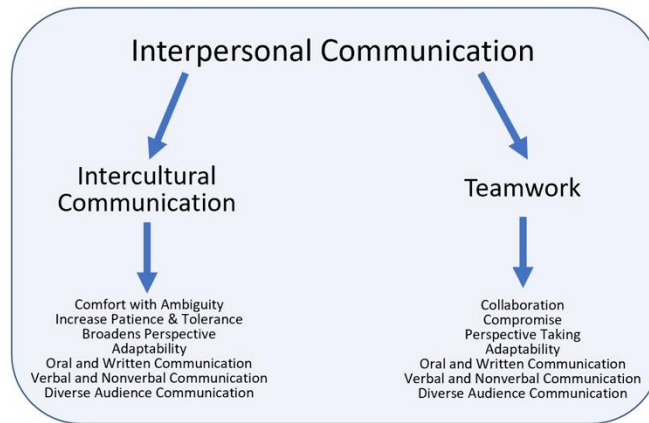


Figure 1: Diagram of Intercultural Communication and Teamwork Competencies

Incorporating communication training into non-communication disciplines is not new. Teaching communication across disciplines (CAD), or across the curriculum (CXC) programs were initially coined “Speaking Across the Curriculum” (SAC) at Center College, Iowa, in 1974 (Dannels & Housely Gaffney, 2009). The “Communication in the Disciplines” (CID) model of teaching communication across disciplines helps foster a “situated” learning experience for students, providing a platform to confront students with realistic engineering tasks that offer students a glimpse of engineering practice, helps students develop transferable professional competencies, and helps students develop professional engineering identities (Paretti, 2008). While the CID model is expanding across disciplines and has been adopted by some engineering programs in universities including MIT, Virginia Tech, Cornell, North Carolina State University, and University of Southern California, CID programs are not prevalent in engineering (Paretti, Eriksson, & Gustafsson, 2019). Rather, The College of Engineering (CoE) at the University of South Florida (USF) determined to develop a CID based integrated communication program that incorporates communication training into existing engineering courses.

CoE Communication faculty Dr. Joanna Burchfield is embedded in a traditional engineering economics course, “Engineering Economics with Social and Global Implications,” a high-enrollment course required for several engineering majors at USF. Burchfield and Engineering faculty Dr. Jamie Chilton teamed up to develop an interpersonal communication approach grounded in situated learning. Although interpersonal communication (IPC) competency, including intercultural communication (ICC), is gaining recognition for the value it brings to engineering education, as far as these authors know, there is not an IPC/ICC based integrated

engineering communication program in the US. An IPC/ICC focus was chosen to meet industry demands, satisfy the “human and cultural diversity” general education student learning outcomes of the course, and better prepare engineering graduates to meet the needs of an increasingly global and interdisciplinary industry. The communication based “Social and Global Implications” (SGI) portion of the course accounts for 20% of course content and assignments and is designed to include professional competencies that students should reasonably expect to need in their future engineering careers. The SGI portion of the course was designed to engage students with realistic professional scenarios and tasks that facilitate students’ abilities to make direct connections between the communication course content and professional engineering and decision making.

While some students have a well-developed and nuanced understanding of cultural variation, preferences, and influences, Burchfield recognized that many students have little to no intercultural experience and may rely on essentialist stereotypes to aid their understanding. Although a full intercultural communication course cannot be taught as 20% of an engineering course, care is taken to help students avoid developing or leaning on essentialist notions of culture by implementing self-analysis and self-reflection assignments that require students to examine their own cultures through a critical lens at the start of the semester. Additionally, co-cultures such as age/generation and neurodiversity are consistently linked to the broad notion of “culture” to highlight individuals’ multiple, layered, and intersecting cultural identities. Importantly, although Geert Hofstede’s cultural dimensions and Country Comparison Tool are used as part of an assignment, Burchfield directly addresses the essentialist nature of Hofstede’s model and balances it with updated readings from communication textbooks that offer social constructivist perspectives on culture and diversity. Furthermore, course lectures and assignments are designed to encourage students to consider culture at personal and local levels which grounds the otherwise abstract concepts of “culture” and “intercultural communication” in students’ lived experiences and fields of perception.

Overall, students in the Engineering Economics with Social and Global Implications course have responded well to the integrated communication content; however, the 20% of course content and assignments in the SGI portion of the course is currently the only point in the CoE curriculum where students will encounter interpersonal and intercultural communication-based teamwork training. While the SGI assignments are designed specifically to help students develop ABET aligned transferable professional competencies, it is likely that a single encounter over 4 years of study is not enough for students to adequately develop the teamwork competencies and global diversity mindset needed/desired in the engineering field. Rather, we suspect that “communication checkpoints” offering consistent training and messaging throughout the program with 2-4 more substantial engagements, such as in the aforementioned Economics course, would be most beneficial to students. Such “checkpoints” could be structured as guest lectures and/or course modules that focus on specific communication competencies that fit into the structures and lesson plans of existing engineering courses. For example, courses that use teamwork could import teamwork specific modules Dr. Olukemi Akintewe is the Director of the Foundations of Engineering Lab course, which is required for all first-year engineering students. Drs. Akintewe and Burchfield collaborated to investigate how students might be impacted by a short, targeted lecture on intercultural communication and teamwork prior to being assigned to their course project teams. The short lecture was designed based on elements of interpersonal

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-credit hour course offered to all incoming freshmen and transfers in the college. Total enrollment every semester ranges from 500 to 700 (Figure 2). Between seven to eight sections of the course are taught each semester by an interdisciplinary instructional team from each department in the engineering college. Undergraduates who have passed the course with an A+ are hired as learning assistants in subsequent semesters. The course employs a project-based method where students work in teams of up to five to design and manufacture a functional prototype. Each member has a designated team role and responsibilities (Figure 3). As a result, the team dynamic is essential for the successful completion of the project. Due to the outcome experienced in Engineering Economics, a lecture and survey were conducted on Intercultural and Teamwork competencies to foster team collaboration. Only one section of the Foundations Lab course (83 students) was piloted for this study. Before group formation, students participated in the lecture, which discussed the impacts of culture and co-culture on communication. Factual scenarios were provided to support students' understanding of the interplay of intercultural communication and effective teams. Towards the end of the semester, students reported their team experiences in the survey shown in Appendix A. The survey included open-ended, short answers, Likert-type, and multiple-choice questions.
- c. The Engineering Economics with Social and Global Implications is a mandatory three-credit engineering course offered to all engineering majors at any grade level and engineering transfers in the college. Total enrollment every semester ranges from 125 to 350 students (Figure 2). Between two to four sections (both in-person and online) of this course are taught per semester with an interdisciplinary instructional team comprised of CoE faculty including communication professor Dr. Burchfield and engineering professors from the Industrial and Management Systems Engineering Department. An adjunct instructor and graduate engineering students are hired as teaching assistants. In addition to flipped classroom and traditional lecture instructional methods, the course employs a project-based method where engineering students work in teams of up to six students. All students in all sections (both in-person and online) receive the same team assignments. For their projects, student teams are given the same sustainability-based scenario and are introduced to their fictional engineering project manager. Teams are assigned existing local clients (real companies, non-profit organizations, and government entities located in the Tampa Bay area) that are actually engaged in sustainability-based projects. Each student team then designs a novel engineering solution incorporating engineering economics to pitch to their project manager in hopes of hypothetically being selected to lead the client's sustainability project. Student teams self-assign the instructor designated team roles and responsibilities, including team leader. To successfully research their local client and design an appropriate and economical engineering solution, interpersonal communication and teamwork are crucial.

Only the four sections of the course over two semesters (219 students) in which both the communication and engineering economics instructor authors were involved, Drs. Burchfield

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.

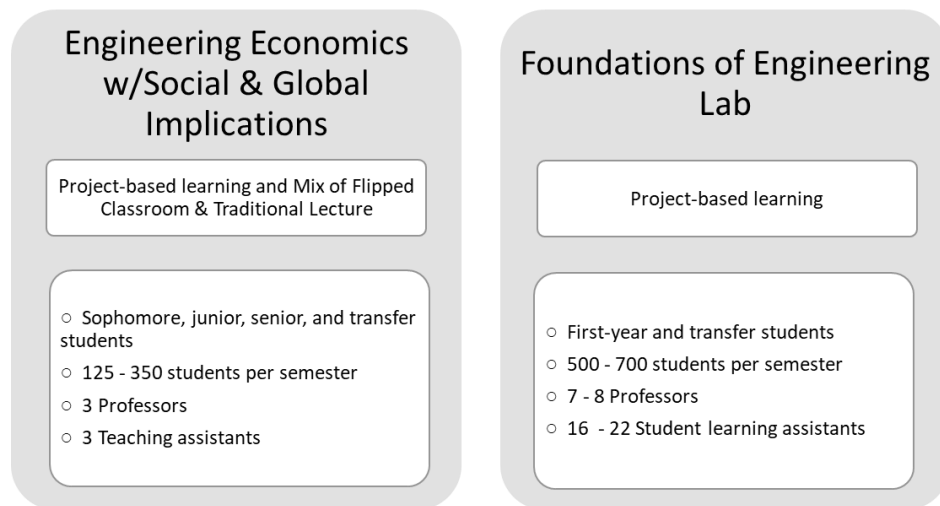


Figure 2: Description of the Surveyed Engineering Courses

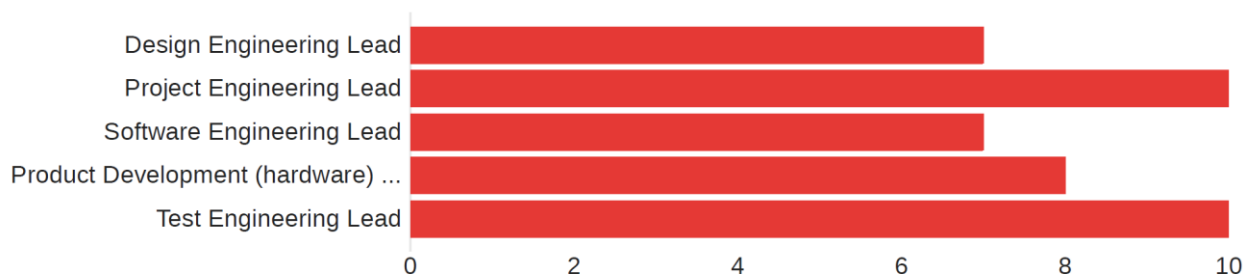


Figure 3: Distribution of Team Roles in Foundations of Engineering Lab Course.

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.

Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Your impression of the first team meeting	21	100	77	19	344	39
What you think your team's general impression of you was at the first meeting	0	100	72	21	445	39

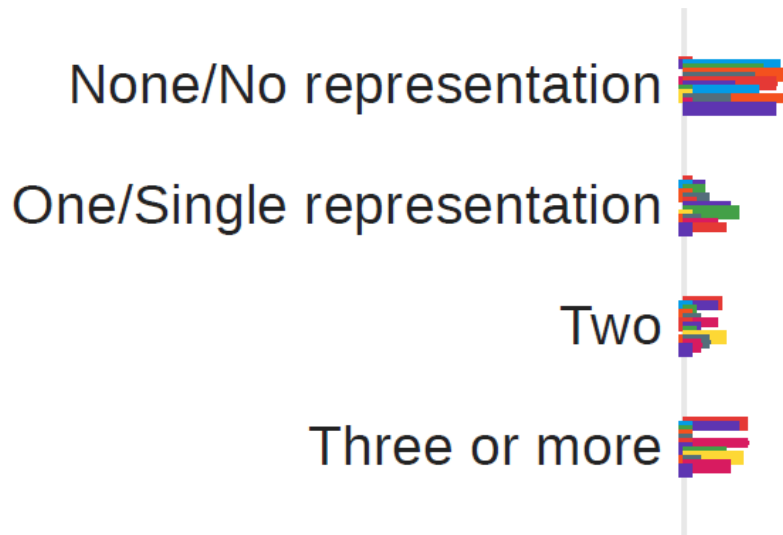
Students who previously took Engineering Economics with Social and Global Implications (EGN3615), had a unique job experience, or participated in sports teams were knowledgeable of the value of intercultural communication and said they hope others learned about effective leadership and teamwork. The 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.

These students mentioned that the lecture helped reinforce core values, created an open mindset, provided better connection, and informed mindfulness of their cultural differences, even the non-verbal communication. Students said they were more cognizant of their choice of words, language, and how it might be perceived, so they consciously did not dismiss others or want to sound offensive. Likewise, evaluation on how the lecture might have impacted how their team members perceived, interacted with, or treated them in the first team meeting was positive. By the end, students thought the lecture made others more accepting, patient, and tolerant of different ideas and fostered a positive environment. However, less than 7% of the students experienced extreme profiling by their teammates due to their race, gender or identity. In general, the lecture made students respect and understand their peers; therefore, they became accommodating and accepting of other team members' ideas.

Narrowing to the impact of the culture and co-culture memberships on conducted meetings and how the team worked on project work, some students devised strategies to work with non-native English speakers so that they could fully participate or carry them along. In contrast, some teams used diverse backgrounds to generate creative and novel ideas. Almost half of the students (46%)

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.



- Countries/Culture...
- Languages spoken
- Team members who ...
- Team members who ...
- Caretakers, eithe...
- Nontraditional ag...
- Generation
- Race/Ethnicity
- Military
- Full- or part-tim...
- Professional Expe...
- Female identifyin...
- Male identifying:...
- Nonbinary identif...
- From large city
- From suburban area
- From rural area/s...
- Other (describe b...

Full description of each category:

Countries/Cultures represented	Generation	
Languages spoken	Race/Ethnicity	
Team members who identified as neurodivergent	Military	
Team members who identified as LGBTQ+	Full- or part-time student while working	From large city
Caretakers, either of children or adults	Professional Experience	From suburban area
Nontraditional age (older than 24)	Female identifying: she/her/hers	From rural area/small town
	Male identifying: he/him/his	Other (describe below)
	Nonbinary identifying: they/them/theirs	

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

b. Faculty Reflections

Upon completing the Foundations pilot study, the lecture and students' experience of the interdisciplinary faculty outlook were positive. The number of dysfunctional teams was minimal compared to previous semesters where students had no exposure to knowledge of intercultural communication. The lecture helped strengthen the majority of students' expectations of teamwork prior to embarking on their project. In addition, the classroom discussion provided students with tools of operation. The effect of an interdisciplinary instructional team benefited students. The expertise of a communications instructor infused a social perspective lacking in engineering. At the same time, the engineering instructor contextualizes the importance of working in teams on different projects in the field. Thus, we believe integrating communication concepts into this course taught our students essential competencies that promote lifelong learning for successful careers in engineering or any related field. We recommend this lecture and related activities for other project-based learning courses as we advance.

III. Engineering Economics with Social and Global Implications Reflections

a. Summary of Self-Reflection responses

At the end of the semester, students were asked to complete a Self-Reflection assignment to describe their experiences in their respective teamwork and process the impact that the interpersonal and intercultural communication lecture workshops with the communication professor had on their team dynamics over the course of the semester and the way they considered and solved engineering economics problems. In particular, students were asked about their greatest/most impactful take-away from the communication (Social and Global Implications) portion of the course and how they would use what they learned from this insight. 97.58% of all students completed the self-reflection assignment. Student responses to the self-reflection assignment were blinded and qualitatively coded and analyzed for the emergence of broad themes and theme subcategories describing the students' experiences and insight.

Of those students who completed the self-reflection assignment, 86.78% of responses demonstrated obvious effort on the part of the student and indications of metacognition. The remaining 13.22% of student responses were eliminated from the analysis, as they did not correctly answer the question or contributed a simple generic statement or definition lacking any self-reflection. An example of a statement omitted from the analysis was: "This course taught me the benefit of the different types of communication. I will use this in the workforce."

Therefore, a total of 149 unique response statements were analyzed. Seven Broad Theme categories were identified, with each Broad Theme comprised of several subcategories of themes. All broad themes and theme subcategories identified in student responses are listed in Table 2. Some unique response statements reflected more than one theme subcategory. The overwhelming majority of the students whose responses were analyzed (97.32%) identified the value of communication competency in a positive way. Only 2.68% of responses analyzed indicated repetitive, negative, or indifferent statements. Examples of such statements include:

“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.”

“You must always be mindful of the different backgrounds and experiences your audience may have, and that you may need to alter the way in which you present your thoughts in order to make a connection with the audience. Often, we become comfortable with the way in which we conduct our daily relationships and how we normally speak with people, and we do not consider the fact that others might not connect with the way we present ourselves and our thoughts, so we need to be considerate of that. It is about finding a balance in your relationships and with your audiences that works well for everyone involved and creates a comfortable and engaging atmosphere. That way, the thoughts and ideas that you present can be most effective and allow for a greater link between people.”

Results for the theme subcategory (4.02%) that communication is broader than expected revealed that students were surprised with what they learned about the complexity of communication across the globe. Selected responses include:

“You never realize how many factors actually come into play when participating in any form of communication. I know I did not.”

“I never understood how important gestures and non-verbal communication was across the globe. It comes as a bit of a culture shock how many different places have different meanings for the same gestures and hand signs.”

Student responses (6.04%) also centered directly on the concept of teamwork, with students indicating that increased knowledge and application of communication concepts would improve team dynamics and effectiveness. Selected responses include:

“My greatest takeaway from this course is how communication differences can strengthen a team if used advantageously. People will have differing communications styles (usually direct and indirect), which can lead to barriers in communication from people not realizing those differences occur. By educating ourselves about these differences not only do we prevent these barriers from stopping work productivity, but they also strengthen a team. This is because group members can learn from each other’s unique communication styles and apply it when necessary.”

“Being able to actually recognize and utilize these concepts in a team project was the most impactful part of this course for me.”

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 technical/economic and communication/social & global Preconceived notions of engineering and engineering education
Broader Impacts	Trust Diversity Engineering Ethics Context Situational awareness
Types of Communication	Persuasion Professional communication Professional competencies Audience centered Intercultural/cultural communication Comm competencies as intercultural comm Interpersonal communication Virtual communication Listening Comm, Verbal/Nonverbal communication Client needs Client understanding
Self-reflection, Perspective, and Growth	Open minded Other-centeredness Self-reflection Growth Perspective Cultural biases Confidence Personal organization/strategy/detail
Resources	Hofstede Hofstede/Chapter Chapter
Repetitive, Negative, or Indifferent	Lacking/disappointment Already experienced Ethnocentrism Stereotyping

b. Faculty Reflections

Upon completing the thematic analysis for the Engineering Economics with Social and Global Implications summer and fall sections, it became clear that many students in both semesters were particularly struck by the notion of audience-centered communication. Burchfield used the

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. This was intended to help students make deeper and more meaningful connections between their projects and the communities their projects would impact. Additionally, the instructors made a point to more strongly link culture and the professional competencies with diversity, equity, and inclusion (DEI), and added additional discussion about cocultures and the impacts of DEI on innovation and teamwork. The instructors used examples, including Microsoft’s Minecraft interviewing strategy and a local issue of pedestrian, vehicular injuries, and deaths on a road close to campus. These examples highlighted the importance of DEI in team building, problem-solving, and decision making and seemed to provide additional insight to students. Exclusively in the F21 reflections, students expressed heightened situational awareness, increased consideration of others, increased desire to be inclusive, increased self-reflective tendencies, increased awareness of engineering’s impact on whole systems, and a stronger sense of global citizenship and responsibility. Additionally, several students specifically pointed to the importance of diversity in engineering and teamwork, and although the communication instructor did not focus on or discuss engineering ethics, several students made direct connections to ethical professional behavior or alluded to professional ethics using different verbiage. This correlation will be explored in more detail.

V. Future Directions

A future iteration of the Foundations Lab course includes restructuring the survey questions. The cultural identity questions would be stated upfront to consider this in their responses to its impact. Integration of teamwork practices for other engineering courses is vital for students to learn engineering concepts in groups and work effectively as part of a team. Implementation of other factors that affect team effectiveness apart from intercultural and teamwork competencies

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 Global Implications.

Additionally, the instructors will continue to specifically engage DEI topics and examples in communication lectures in future semesters and will mindfully focus on guiding students through making connections between the demographic elements related to their mock project proposals and engagement with DEI thinking and decision making in Engineering Economics with Social and Global Implications. These elements will also be integrated into future lectures and communication modules developed for the Foundations of Engineering Lab course.

Finally, the authors of this paper are deeply interested in examining the connections between communication training and engineering ethics. Preliminary analysis indicates that direct engagement with topics of diversity, equity, and inclusion as related to communication, teamwork, and IPC/ICC communication principles evokes stronger individual student identification with themes of DEI, engineering ethics, global citizenship, and engineering responsibility for sustainable development and innovation. Future course design, assignment, lecture, and module development for both Engineering Economics with Social and Global Implications and Foundations of Engineering Lab courses will be especially cognizant of these relationships.

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Appendix A: Foundations of Engineering Lab Survey Instrument and selected student responses

[Insert the cultural attributes questionnaire]

Q9: In what ways did the Intercultural Communication lecture with Dr. Burchfield impact how you thought about and interacted with your team members during the first team meeting?

Students who took EGN3615 were already aware of the value of intercultural communication and said they hope others learned about effective leadership and teamwork. Two students noticed the differences in the team members who missed the lecture.

Of the 39 students who responded: 4X said it had no impact. 5X mentioned that they were already aware from either taken a previous course or from experiences leading to 72% positive responses.

Majority of the students mentioned it helped reinforced values, created an open mindset, provided better connection and informed mindfulness of their cultural differences even the non-verbal communication.

Students said they were more cognizant of their choice of words, language and how it might be perceived so they consciously did not dismissive others or want to sound offensive. Overall, students said the lecture made them respectful and understanding of their peers thus they became accommodating and accepting of other team members ideas.

Selected Student Responses

“It helped me better understand the fact that everyone comes from a different culture and background so I should be understanding about those differences and not judge especially with language barriers.”

“It impacted me by reminding me that this won’t be the last of group projects in my future. Also, to play with others and not bash on what they say all the time.”

“I made sure to really listen and not make judgements about anyone in my group before really getting to know them.”

“It was a reminder that everyone comes from different backgrounds and have different ways of learning and that it is okay to express how you feel about any idea in a polite manner. It reminded me to have patience and try to open up more.”

“I think it was very useful as it introduced me [sid] to some differences we might have had and how to respect and cater to them in order to work cohesively.”

Q10: How do you think the Intercultural Communication lecture with Dr. Burchfield might have impacted how your team members perceived, interacted with, or treated you in the first team meeting?

Evaluation of the impact on intercultural awareness on other team members were mixed.

Of the 39 students who responded: 3X said it had no impact. X mentioned that their group already had good communication and did not see a major difference.

By the end of week 13, students thought the lecture made other students more accepting, patient, and tolerant of others ideas and enabled a positive perspective. However responses from a few students revealed other contributing factors aside from intercultural differences that should be addressed in the future. Some students experienced extreme profiling by their team mates due to their gender, race or sexual identity.

Selected Student Responses

“It created better communication between group members and brought our group closer which helps communication in the future”

“I think everyone appreciated the reminder to display themselves in a positive manner.”

“Helped all of us be open to other ideas and remove some of the hesitancy to communicate”

“As a cis gendered straight white male I felt extremely profiled by my group members.”

“I don’t think that it changed much about how my group interacted with me.”

“They probably treated me better than before, one team member was especially rude when interacting with me but all the others were good”

“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 with respect but the talk caused us to actively remember to do so”

“I think they showed me the same amount of respect and open-mindedness that I showed them”

“I was the only woman on my team and I felt that my male colleagues were a lot less forthcoming with ideas and required a lot of steering to maintain focus on the project plan. They were not disrespectful but their communication still needs work.”

Q12: In what ways did your team members’ cultural and co-cultural memberships affect how your team conducted meetings and worked on your project?

Narrowing the impact on aspects of the team dynamics in the area of conducted meetings and project work, students experienced X. 18 students said culture did not affect how the team operated though they respected each other. were so e areas. Students mentioned that they devised strategies to work with non-native English speakers so that they could fully participate or carry them along. However, some groups took advantage of the diverse background present in the team. Gender may have played a role is effective teamwork. Overall, there were mixed feelings on how cultural diversity affected meetings and project work.

Selected Student Responses

“Sometimes there was a language barrier with one of our teammates so it took a little more to explain everything better but we made sure to take up more time in order for everyone to understand.”

“It impacted our team meetings as someone did not speak the best English so sometimes it was hard.”

“We all had different ideas about how to approach challenges because of our diverse backgrounds”

“The culture of the members in the group did not change how they acted nor how they spoke to others in the group.”

“Knowing from where each member comes from gave the team a better sense of how we should treat and interact with others in a way the won’t be offensive to the individual.”

“I think because we had all different racial backgrounds, yet were all female, our differences really brought us together and different perspectives to the table. I think because we were all female, it was easier to communicate to each other.”

“Coming from diverse backgrounds helped builds a communication and more to talk about.”

“It helped us get different perspectives coming from all different backgrounds”

“I believe that the diversity helped our team make good ideas on what to do with the project.”

Q15. In what ways did the Intercultural Communication lecture with Dr. Burchfield help set your expectations for how team members’ different perspectives might impact team interactions?

The intercultural communication lecture prepared students to have an open mindset before working in groups. Some mentioned that the lecture set a precedent on how to practice effective communication with provided realistic examples and respect.

Selected Student Responses

“It set expectations a little higher because there would be little to no excuses for poor communication after the lecture”

“He showed me that I will not always get the best team, but not the worst because it is what you make of the team. To make the team a comfortable environment everyone has to be comfortable with everyone else.”

“It made me look forward to how each one’s unique perspective would help us come up with more ideas.”

“It set up the standard that we should all be good people and treat each other respectfully.”

“It set the stage for healthy communication and what that is supposed to look like”

“It helped me communicate as a non native speaker.”

“I was more accepting.”

“It made me realize that despite our different backgrounds, we can still come up with similar ideas.”

“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.

Selected Student Responses

“Strengthen, we all picked up the slack when needed”

“Not really because I think I was already decent at teamwork and at least a nice person”

“It made me enjoy teamwork more, I already knew it was beneficial but it reaffirmed myself.”

“It made me more aware of how I am perceived and what I could be doing better to not be received in a negative manner.”

“It strengthened my perspective on everyone by showing everyone will pull their weight if everyone wants the same thing.”

“It didn’t impacted me that much but did reinforce some core ideas about working with others.”

“Most of it acted as a reminder than something new I was learning so I just had to make sure I was actually applying the ideas on teamwork in a beneficial way”

“I understood that I should make my claims very clear to avoid confusion.”

“Strengthen, I was prepared that I might have to communicate with persons of various backgrounds”

“Yes. It showed me that including intersiplinary/ intercultural perspectives allows a broader view and hence a better end result”

“Yes, I realize how important it is to play your assigned role in the team and we do not want to drag the whole team behind and making them suffer due to our lack of attentiveness or lack of efforts”

“Yes it changed my perspective because it meant that I had to be very accommodating to my group members, and had to be very nice to to all my group mates”

“It improved my perspective on teamwork because it made me realize how little me and my group were talking and i tried to make us interact a little more.”

Q20. How does intercultural awareness impact your actions and behaviors towards others?

Students shared how intercultural awareness provided strategies on how to treat others with respect, listen before speaking, 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 had to demonstrate.

Selected Student Responses

“I need to watch what I say because you never know what will offend someone, and I’m not used to being around so many diverse people, so I’m actively learning. I also can appreciate these varied cultures much more.”

“Knowing how time, space, and culture impact people differently can give a sense of patience and understanding that ideas, approaches, and actions will be different.”

“It impacts my actions by not pointing out anything different unless they are comfortable talking about it, and I treat everyone the same way no matter who they are.”

“I encourage the voices of people from other cultures in the group setting.”

“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 way to build professional teamwork skills.”

“Group projects with multiple different groups that are centered around building teamwork and leadership”

“Encouraging the amplification of quieter voices by the louder ones. The people who are loud will always get their ideas out, and they can sometimes cover up the quieter voices.”” First teaching them time management and being respectful of others time, then basic skills so they wont be so inexperienced doing mechanical things”

“I think a module on communicating effectively would be useful”

“I think it would be important if the classes included team bonding events the first time the teams meet in class”

“i believe that group projects in class are really effective on teaching teamwork and makes people more comfortable to work with one another.”

“Having consistent group work throughout all levels of education is important but I have always had peers who refused to improve their cooperative skills, so I don’t know how best these abilities can be taught.”

“I think that the communication lecture by Dr. Burchfield would be helpful to those taking this course in the future.”

Appendix B: Engineering Economics with Social and Global Implications

Self-Reflection Instrument and selected student responses

[Insert the Self-Reflection]

Q6 “Greatest Take-away” (~1 paragraph): What was your greatest/most impactful take-away from the “with Social and Global Implications” portion of the course? Moving forward, what will you do with this take-away? In other words, how will you use what you learned from this insight?

