

Teaching Effective Communication for Teamwork

Dr. Joanna Tsenn, Texas A&M University

Joanna Tsenn is an Associate Professor of Instruction in the J. Mike Walker '66 Department of Mechanical Engineering at Texas A&M University. She earned her B.S. from the University of Texas at Austin and her Ph.D. from Texas A&M University. She coordinates the mechanical engineering senior capstone design program and teaches senior design lectures and studios. Her research interests include engineering education with an emphasis on capstone design and teamwork.

Jonathan Weaver-Rosen, Texas A&M University

Jonathan Weaver-Rosen is an Instructional Assistant Professor in the Department of Mechanical Engineering at Texas A&M University since August 2021. His research has focused largely on design automation and methodologies – specifically parametric optimization and the design of morphing or otherwise adaptive systems.

Mohammad Waqar Mohiuddin

Possesses a multidisciplinary background in Mechanical Engineering (BS and MS) and cardiovascular physiology (Ph.D.). Currently working as an Instructional Assistant Professor in the J Mike Walker '66 Department of Mechanical Engineering at Texas A&M University. Areas of expertise and interest include biomedical and mechanical system design, electromechanical systems, computer-aided engineering analysis, and mathematical modeling of physiological systems. Before joining Texas A&M, worked in industry settings to develop various biomedical technologies, ranging from acute neonatal care to long-term space exploration.

Dr. Shadi Balawi, Texas A&M University

Dr. Balawi is an Instructional Associate Professor in the Mechanical Engineering department at Texas A&M. He teaches in the areas of materials, manufacturing, and design. His interests are in the areas of Engineering Design for Disciplinary STEM Educational Research, Team Formation and Team Skill Education. Dr. Balawi earned his PhD in Aerospace Engineering from University of Cincinnati with research focus on experimental design and testing of solids for honeycomb core materials.

Dr. Carlos R. Corleto, Texas A&M University

BS, MS, PhD in Mechanical Engineering from Texas A&M University. Experience includes 20 years in industry as a lab director, technical manager and engineering advisor, 8 years of academic experience at the assistant and tenured associate professor level, 5.5 years as a professor of practice, Undergraduate Program Director of the J. M. Walker '66 Department of Mechanical Engineering since June 2022, and active industry consultant. Author and contributing author of 10 patents and multiple publications/presentations at technical and engineering education conferences. Areas of expertise and research interest include Deformation & Failure Mechanisms, Materials Science, Fracture Mechanics, Process-Structure-Property Relationships, Finite Element Stress Analysis Modeling & Failure Analysis, ASME BPV Code Sec VIII Div. 1 & 2, API 579/ASME FFS-1 Code, Materials Testing and Engineering Education. Professionally registered engineer in the State of Texas (PE).

Teaching Effective Communication for Teamwork

This is a Work in Progress paper.

Introduction

Engineering projects are often complex and require collaboration, making teamwork skills critical for engineers. Employers want to hire students with strong professional skills, including the ability to work effectively in a team [1-4]. However, engineering graduates' interaction-related competencies are lower than desired, and these skills must be strengthened earlier [5]. ABET, an accreditation program for the STEM disciplines, aims to “ensure that the next generation of STEM professionals is equipped to help build a world that is safer, more efficient, more inclusive and more sustainable” [6]. To advance this goal, one of the ABET student outcomes for engineering programs is “the ability to function effectively on a team” [7].

Many engineering curricula utilize experiential learning to teach teamwork. Courses have team-based projects to provide students with opportunities to collaborate. However, research has shown that simply being on a team project does not help students learn to be effective team members [8]. A significant challenge is that team members do not communicate effectively to support others [9]. Communication, expectations, and effort issues can lead to negative team experiences. Studies have found that these unfavorable encounters can result in students preferring to work alone despite recognizing the importance of developing teamwork skills [10] or even devaluing teaming altogether [11].

Students need structure and faculty guidance to learn teamwork skills [9]. However, engineering faculty often lack training in teaching teamwork and may not have received that training themselves [11, 12]. There is limited instruction on how to teach teamwork and a lack of systematic focus. Even with the research on teamwork, the focus tends to be on improving the team's effectiveness and outcomes rather than improving an individual's teamwork skills [11].

At Texas A&M University, five mechanical engineering faculty members began the UNdergraduates Improving TEamwork Skills (UNITES) project to help students develop their teamwork skills [13]. We identified three key aspects of teamwork and developed modules around each topic that can be taught during one lecture class. The first module focused on the stages of team formation and the development of a team charter to set expectations at the start of a project. It was first taught in a sophomore-level course in Spring 2022. The second module, the focus of this paper, centered on effective communication, considering cross-cultural communication and different working styles. It was implemented in a junior-level course in Fall 2023. The final module focuses on conflict management and is currently in development, with plans to teach it in a senior-level course in 2024.

UNITES Module 2 Workshop

Module 2 was taught in MEEN 357 Engineering Analysis for Mechanical Engineers, a 75-minute junior-level numerical methods course. The MEEN 357 instructors presented it in early

September after the semester-long project teams were assigned. A workshop-style format was used to engage the students and encourage individual reflection.

The students sat with their project teams, and the workshop began with a Lost at Sea activity [14]. The teams imagined that their ship capsized and they could only save fifteen items. In the ten-minute activity, the students first individually ranked their resources in priority order and then worked as teams of 4-6 students to merge their rankings into a team consensus. The team result was then compared to an expert's (Coast Guard) rankings and scored. This exercise required students to communicate and make decisions under time constraints. While the activity was low-stakes, there was pressure to complete it quickly, so there was not enough time to debate each item thoroughly. This activity provided a platform for students to understand how they communicate under pressure and laid the groundwork for the workshop material.

Two instructional videos were developed for Module 2. We found videos to be an effective and efficient way to share material that would allow any instructor to teach the module with limited training. The first video was a short summary of Module 1 outlining teamwork skills, the stages of team formation, and a team charter. The video helped students recall the information they learned the previous year and linked it to Module 2.

Before the second video, the class engaged in a discussion prompted by the question: "What factors affect effective team communication?" This encouraged individual reflection and primed the students to learn more about communication. The ten-minute video developed by Dr. Carlos Corleto, a member of our team, was then shown. Dr. Corleto shared that the number one reason teams fail is poor communication [15], and he provided Nokia [16] and the Costa Concordia cruise ship disaster [17] as case studies of how communication issues can lead to failure. While referencing Dr. Daisy Lovelace's Communication within Teams LinkedIn course [18], our video emphasized three key elements important to our students: trust, cross-cultural communication, and conflict management. Team members need to be able to trust each other to follow through, and they need to communicate when issues arise. Diverse teams need to recognize that language proficiency is not related to ability, that low-context and high-context cultures may communicate differently, that religious practices may affect when and where work can be done, and that cultural traditions may differ (for example, time is more fluid in some cultures while others feel that "on time is late"). Finally, the video briefly discussed that conflicts will likely arise due to different personal experiences, perspectives, and working styles. The important thing is to recognize when there are issues and to manage them through open communication.

Leading into the next workshop activity, the MEEN 357 instructor asked, "What types of personality and working style differences have you experienced?" We provided the instructors with some initial talking points such as the preference for big picture or details, preference for chitchat or getting straight to the point, preference for telling others what to do or being told what to do. The intention was to have the students begin considering other perspectives and approaches.

Each student was then given twenty minutes to complete the UBT Working Styles Assessment to determine if they had more of an Analytical, Driver, Amiable, or Expressive style [19]. This assessment was selected because it not only included the characteristics of each working style

but also provided a matrix describing how each style can best communicate with the others. Students were asked to consider what others need to know to work effectively with them and what particular challenges they may have working with different styles. While it is interesting to learn about one's working style, our goal was to bring the students awareness of different styles and encourage self-reflection. The activity ended with a reminder that people do not have purely one working style. While one may be dominant, they should all be considered, and people may need to adjust their working style based on a particular situation or their role on a team.

The workshop closed with a final reflection, asking the students to think back to the initial Lost at Sea activity. Studies have shown that reflection activities can help students build their teamwork competencies [8, 11, 20]. The students were directed to use what they learned in the workshop to consider how they could have improved their team communication during the Lost at Sea activity and how they could communicate more effectively with teams in the future.

Assessment

The MEEN 357 instructors assigned an informal 3-2-1 reflection after the module was presented. Students identified 3 things they learned or found interesting, 2 questions they still have, and 1 thing they would implement or do differently going forward.

A formal, quantitative team experience survey was given at the end of the semester as the teams completed their projects. The survey was adapted from Ullman's The Mechanical Design Process textbook [21] and consisted of eleven Likert-scale questions scored from 1 (strongly disagree) to 5 (strongly agree). Questions 4-6 best represent the material taught in Module 2.

Please answer based on your perception of your team.

1. Team mission and purpose are clear, consistent, and attainable to everyone on the team.
2. The roles and work assignments are clear to everyone on the team.
3. When any member of the team says they are going to do something, the team can count on it being done.
4. Respect has been built within the entire team for diverse points of view.
5. Team takes time to develop consensus by discussing the concerns of all members to arrive at an acceptable solution
6. Decisions are made with input from all in a collaborative environment.
7. Conflicts within the team are aired and worked to resolution.
8. Dysfunctional behavior is dealt with in an appropriate manner.
9. I feel that I am part of a team.
10. I feel good about the team's progress.
11. Overall, how satisfied are you with your team experience? [1 very dissatisfied to 5 very satisfied]

Initial Feedback, Results, and Discussion

In Fall 2023, Module 2 was taught in four MEEN 357 lecture sections, each led by a different instructor. Feedback from the course instructors indicated that the students were engaged, and the Lost at Sea activity was very interactive. The students appreciated the brief Module 1 review video but lost interest during the ten-minute Module 2 video. To enhance engagement, we are exploring strategies such as splitting the video into two sections with a class discussion between

them or incorporating interactive polls into the video. One instructor noted that their class had so much discussion that they could not complete the working styles assessment and final reflection, so we may need to reconsider the timeline as well.

The class's reflection assignment showed promising results. When considering what to implement, many students considered their personal weaknesses and identified strategies to improve as team members. Responses included, "I plan to be more decisive and set my goals early to be more productive", "I plan to try to avoid being too strict with specific criteria and self created deadlines, compared to in the past where I maintained a strict schedule and became annoyed if it wasn't maintained", and "I tend to procrastinate my work, especially if it's a difficult task, so I will try to start my work early and be more considerate of my team members." Some students also identified that they should be more open-minded with comments like, "Be more open to people's opinion and try to hear out what they think we should do", "I will adapt to working with and listening to a group more. I normally see myself as being more efficient with improved work when I do things individually, but when the group score [for the Lost at Sea activity] ended up being better than the individual score, it made me realize that working in groups and getting other people's opinions and points of view is very important in completing a task", and "I plan to keep a more open mind when working with others. I tend to get frustrated with people easily, but understanding the different working styles has given me a new perspective on the matter." Finally, students realized they needed to establish trust amongst the team with "I plan on being better friends with my teammates, I believe that it helps bring comfort, trust, and it makes it easier to communicate with each other" and "I think we need to establish firm expectations and a plan of how the project is going to be attacked. This would help my trust in the other group members and not feel the need to micro-manage everyone because I will have trust that they are going to get their work done."

The quantitative team experience survey was given in MEEN 357 in multiple semesters. The Fall 2022 group did not receive teamwork training, and their 120 responses were used as a baseline. The Fall 2023 group received the Module 2 training and had 189 responses. Two-sample t-tests with equal variances were conducted for each survey question between the baseline group and the group that received the training. We hypothesized that the quantitative scores would increase after receiving teamwork training. In particular, we thought that the scores for questions 4-6 would improve because they were directly related to the material taught in Module 2. However, the only statistically significant difference was for Question 2 ("The roles and work assignments are clear to everyone on the team"), and the trained Fall 2023 group rated themselves lower (Table 1). While the rest of the questions did not have a statistically significant difference, the trained group's average scores were lower for every question.

We confirmed with the MEEN 357 instructors that there were no major changes to the course, project, or team selection process. The lower post-training scores may be because this was a different group of students that had different team interaction experiences. Alternatively, the training may have provided new awareness of teamwork and communication, prompting students to evaluate their experiences more critically. In addition, students may need more time to implement and refine changes to their team interactions. We are considering if we need to adjust the assessment process and survey.

Table 1. Team experience question means and standard deviations for the Fall 2022 baseline class compared to the Fall 2023 class that received the Module 2 training with independent samples t-test results.

	Fall 2022 (Baseline)		Fall 2023 (Trained)		t-test	
	M	SD	M	SD	t-value	p-value
Q1 Mission	4.53	0.64	4.43	0.67	1.19	0.235
Q2 Roles	4.57	0.71	4.30	0.84	2.94	0.004
Q3 Reliability	4.40	0.90	4.35	0.92	0.46	0.646
Q4 Respect	4.51	0.84	4.42	0.77	0.97	0.333
Q5 Consensus	4.37	0.84	4.32	0.83	0.48	0.632
Q6 Decisions	4.48	0.82	4.38	0.85	1.01	0.311
Q7 Conflicts	4.54	0.78	4.45	0.83	0.93	0.353
Q8 Dysfunction	4.55	0.76	4.39	0.87	1.60	0.110
Q9 Team	4.58	0.76	4.50	0.86	0.92	0.358
Q10 Progress	4.58	0.77	4.55	0.74	0.38	0.707
Q11 Satisfaction	4.47	0.78	4.43	0.84	0.35	0.731

Conclusions and Future Work

The UNITES project aims to teach our undergraduate students the foundations of teamwork to be more effective team members. The first module on team formation was developed and taught to sophomore-level students. This paper focused on the second module, where effective communication was taught to junior-level students. The third module is in development and will be introduced in 2024 to senior-level students.

In the Module 2 workshop, the students engaged in a team-based activity, watched prepared videos, completed a working styles assessment, and reflected on their learning. Although the students were engaged and an informal activity indicated that they applied the material to consider how to improve as team members, the quantitative survey results found that their team experience scores were lower than those that did not receive teamwork training. The decrease may be due to a heightened awareness of effective communication and teamwork or the need for more time and practice to implement changes. The survey questions will be revisited, and alternative methods to evaluate the students will be explored.

Our final goal is to produce teamwork training modules that can be shared with and taught by other instructors. As the modules evolve based on instructor and student feedback, the slides, videos, surveys, notes, and additional resources will be shared through our UNITES project website (<https://unites.engr.tamu.edu/>).

Acknowledgment

This work is supported by the National Science Foundation Grant EEC-2022275 to create opportunities for revolutionizing the preparation of students.

References

- [1] T. W. Hissey, "Education and careers 2000. Enhanced skills for engineers," *Proceedings of the IEEE*, vol. 88, no. 8, pp. 1367-1370, 2000.
- [2] L. Small, K. Shacklock, and T. Marchant, "Employability: a contemporary review for higher education stakeholders," *Journal of Vocational Education & Training*, vol. 70, no. 1, pp. 148-166, 2018.
- [3] R. J. Marandi, B. K. Smith, R. F. Burch, and S. C. Vick, "Engineering soft skills vs. engineering entrepreneurial skills," *The International Journal of Engineering Education*, vol. 35, no. 4, pp. 988-998, 2019.
- [4] H. Jang, "Identifying 21st century STEM competencies using workplace data," *Journal of Science Education and Technology*, vol. 25, pp. 284-301, 2016.
- [5] L. Ballesteros-Sanchez, I. Ortiz-Marcos, and R. Rodriguez-Rivero, "Investigating the Gap Between Engineering Graduates and Practicing Project Managers," *International Journal of Engineering Education*, vol. 37, no. 1, pp. 31-43, 2021.
- [6] ABET. "ABET Home Page." <https://www.abet.org/> (accessed January 27, 2024).
- [7] ABET. "Criteria for Accrediting Engineering Programs, 2024 – 2025." <https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2024-2025/> (accessed January 27, 2024).
- [8] P. L. Hirsch and A. F. McKenna, "Using reflection to promote teamwork understanding in engineering design education," *International Journal of Engineering Education*, vol. 24, no. 2, p. 377, 2008.
- [9] R. Lingard and S. Barkataki, "Teaching teamwork in engineering and computer science," in *2011 Frontiers in Education Conference (FIE)*, 2011: IEEE, pp. F1C-1-F1C-5.
- [10] D. E. McCorkle, J. Reardon, J. F. Alexander, N. D. Kling, R. C. Harris, and R. V. Iyer, "Undergraduate marketing students, group projects, and teamwork: The good, the bad, and the ugly?," *Journal of Marketing Education*, vol. 21, no. 2, pp. 106-117, 1999.
- [11] P. Lewis, D. Aldridge, and P. M. Swamidass, "Assessing teaming skills acquisition on undergraduate project teams," *Journal of Engineering Education*, vol. 87, no. 2, pp. 149-155, 1998.
- [12] T. Chowdhury and H. Murzi, "Literature review: Exploring teamwork in engineering education," in *Proceedings of the Conference: Research in Engineering Education Symposium*, Cape Town, South Africa, 2019, pp. 10-12.
- [13] M. W. Mohiuddin, J. Tsenn, S. Balawi, C. R. Corleto, and J. Weaver-Rosen, "Vertical Integration of Teamwork Skills from Sophomore to Senior and Beyond!," in *2023 ASEE Annual Conference & Exposition*, 2023.
- [14] E. Biech, *The Pfeiffer book of successful team-building tools: Best of the annuals*. John Wiley & Sons, 2007.
- [15] J. Brox. "The Results Are In: Poor Communication Number One Reason Teamwork Fails." <https://www.refreshleadership.com/index.php/2015/09/results-poor-communication-number-reason-teamwork-fails/> (accessed February 10, 2023).
- [16] B. Groysberg and M. Slind. "The Silent Killer of Big Companies." Harvard Business Review. <https://hbr.org/2012/10/the-silent-killer-of-big-companies> (accessed October 25, 2022).
- [17] S. Tannenbaum and E. Salas, *Teams that work: the seven drivers of team effectiveness*. Oxford University Press, 2020.

- [18] D. Lovelace, "Communication within Teams," ed. LinkedIn Learning, 2021, p. <https://www.linkedin.com/learning/>.
- [19] "Working Styles Assessment." https://oml.eular.org/sysModules/obxOml/docs/ID_103/01_Working-Styles-Assessment.pdf (accessed October 15, 2021).
- [20] S. H. Bhavnani and M. D. Aldridge, "Teamwork across disciplinary borders: A bridge between college and the work place," *Journal of Engineering Education*, vol. 89, no. 1, pp. 13-16, 2000.
- [21] D. G. Ullman, *The Mechanical Design Process*, Fourth ed. McGraw-Hill, 2010.