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Teaching Students Skills to Foster Psychological Safety in a Team Environment

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Teaching students skills to foster psychological safety in a team environment

Abstract:

Psychological safety is a critical component of effective teaming. In engineering education, programs rarely teach effective teaming skills and even fewer teach skills for fostering psychological safety. To address this gap, we developed modules to teach engineering students a framework that promotes psychological safety. We implemented these modules at the beginning of the civil engineering sections of an Introduction to Design course. These modules enabled students to experience and practice effective teaming skills through role-playing. The modules focused on how to act and how to respond to promote psychological safety on design projects. Each module was tailored to a different phase of the design process. The themes of the three modules are (1) treating every idea as having potential to contribute to a positive outcome, (2) questioning an idea to obtain valuable insight, and (3) applying the brake to improve a decision. To explore the impact of the modules, we deployed a post-course survey to measure students' perceptions of psychological safety on their project teams. Compared to control sections of freshman design in other majors, the civil engineering students reported increased psychological safety. Generally, the civil engineering students felt more comfortable in bringing up problems and tough issues, and felt more safe taking risks. These modules are general enough to be applicable to any engineering field, and they are flexible enough to be included in curricula in a variety of ways.

Motivation:

Teamwork is a necessity for engineering education and engineering practice. In his book, Senge argues that when teams are learning, the individual members grow more rapidly than they could have on their own (1990). Therefore, as educators, we put students in teams to enhance their learning. Chowdhury and Murzi (2020) point out that teamwork became an important aspect of engineering practice during the second industrial revolution, which started in the late 19th century. Today, the importance of teamwork skills for engineers is codified in the ABET accreditation requirements (ABET 2021).

Too often, we, as instructors, put students in teams and assume they will learn teamwork skills organically. As a result, the majority of students report at least one type of interpersonal problem on projects and many report reduced learning as a result (Wolfe *et al*. 2016). In most cases, we don't learn about the problems until reading student peer evaluations or we don't learn about them at all. Either way, the opportunity to correct the situations has passed and the damage is done. In these common scenarios, students likely graduate having learned negative coping strategies, or learned to avoid team environments.

"Psychological Safety" is a term first used by Schein and Bennis (1965) to describe how secure and confident an individual is in their ability to manage change. Kahn (1990) later

conceptualized psychological safety as an individual's comfort level to show and employ themselves without fear of negative consequences to self-image, status, or career. Edmonson (1999), however, argued that psychological safety is best viewed as an attribute of team climate. Edmonson defines psychological safety as "a belief that one will not be punished or humiliated for speaking up with ideas, questions, concerns, or mistakes, and that the team is safe for interpersonal risk-taking" (2022).

Ruiz Ulloa and Adams discovered that psychological safety is an essential ingredient for effective teamwork (2004). Therefore, it should be our goal as instructors to get engineering students to create a psychologically safe environment on their teams. The problem is how.

Background:

Previous Studies

Studies in a variety of fields have shown benefits of psychological safety. For example, Sun and Huang found that psychological safety played an important role in unlocking innovative behavior among university teachers (2019). Albritton *et al*. showed a link between psychological safety and successful implementation of quality improvement practices in hospitals (2019). Dodoo *et al.* showed that psychological safety has significant influence on the display of safety citizenship behavior in the mining industry (2021). Singh *et al.* identified that psychological safety is key to employee performance in a racially diverse workplace, especially for minorities (2013).

Some studies were also conducted to explore what creates or fosters an environment of psychological safety. Most of those studies focused on the role of managers or supervisors. For example, Detert and Burris investigated the impact of leadership behaviors on psychological safety in the restaurant industry (2007). Shao *et al.* studied the effect of charismatic leadership from the people in authority positions on creating a psychologically safe climate in the enterprise systems field (2017). Lee and Dahinten explored the relationship between inclusive leadership and psychological safety by nursing managers (2021). Maximo *et al.* investigated the effectiveness of authentic leadership for fostering psychological safety among workers in the mining industry (2019). Ramalho and Porto, while surveying bank employees, concluded that psychological safety is strongly influenced by organizational power (2021). Newman *et al.* performed a systematic review of the literature and concluded that most of the antecedents of psychological safety can be grouped under the heading of having supportive environments (2017).

Although there have been many studies in the medical and business fields, we found no literature on creating a psychologically safe environment in engineering fields. Nor did we find any literature about how to teach students skills to create psychologically safe environments.

Teamwork at Rose-Hulman

Students at Rose-Hulman Institute of Technology are assigned to work in teams as part of the learning process in courses throughout the curriculum (Table 1). The lifespan of the team varies depending on the course. Some teams are formed to conduct one lab and write the report, so they have a lifespan of only a few days. For the capstone course sequence, teams work together for the entire academic year.

Table 1. Team Experiences Throughout the Curriculum

Term	Course	Team Experience
Y1, Fa	Engineering Surveying	In-class and HW assignments
Y1, Sp	Introduction to Design	Term project
Y2, Wi	Mechanics of Materials	Mini-project
Y2, Sp	Fluid Mechanics	Lab experiments and reports
Y2, Sp	Civil Engineering Materials	Lab experiments and reports
Y3, Fa	Soil Mechanics	Lab experiments and reports
Y3, Wi	Water Resources Engineering	Term project
Y3, Sp	Environmental Engineering Lab	Lab experiments and reports
Y4, Fa	Civil Engr Design & Synthesis I	Full-year project
Y4, Wi	Civil Engr Design & Synthesis III	Full-year project
Y4, Sp	Civil Engr Design & Synthesis III	Full-year project

This project took place in the Introduction to Design course during the spring of the freshman year. The course is built around team projects. Students are randomly assigned to teams of 3-4 students to work on projects for real clients. Example design projects include a playground for a county park, site layout for an expanding company, and a handicap accessibility plan for an older building. Teams meet with the client to develop an understanding of the client's goals, develop options to meet those goals, rationally assess the options to choose the best one for the situation, develop a design for the chosen option, and create a report for the client that includes details of the design and a cost estimate. The course meets once per week for three hours. Because of the quarter system, the course meets for ten weeks.

Intervention:

There are a multitude of published ways to promote psychological safety according to authors and consultants, and these ways tend to be focused on certain environments or roles. For example, many suggestions are specifically for the person who carries actual authority and responsibility for the team, which is a situation students rarely encounter with class projects. A student might carry the title of Project Manager for a class assignment, but the student does not actually have authority over the other students on the team. Therefore, we focused on identifying ways that peers can promote psychological safety. We developed interventions that help student teams develop psychological safety when 1) developing design options, 2) evaluating design options, and 3) executing the chosen design option.

Knowing what the skills are and why they are effective is working in the cognitive domain. Embracing the skills and making them a habit is working in the affective domain, which tends to be more challenging to impact and assess. Our goal as instructors was to drive changes in the affective domain; therefore, we focused on teaching one skill for each targeted phase of design projects. Training on each skill included how to *act* to promote psychological safety and how to *react* to promote psychological safety. We conducted the training during the first meeting of the Introduction to Design course, just moments after the team assignments were revealed.

Skill 1: Treating every idea as having potential to contribute to a positive outcome
When a team is developing design options, the objective is to develop as many ideas as possible. Crazy, off-the-wall ideas can actually provide the nucleus for a great solution, but students are often hesitant to speak up with ideas that might be criticized as "dumb" or "silly". Students are also hesitant to share ideas when they think a "good" idea has already been presented, or when their idea might be perceived as contradicting another person's idea. To help students overcome these concerns, the first skill we taught the students was to treat every idea as having potential to contribute to a positive outcome.

All team members are empowered to act this way, not just the "Team Leader" or "Project Manager". We discussed how to foster psychological safety by asking for input:

- Ask for input from everyone.
- Encourage multiple ideas from people.
- Encourage out-of-the-box ideas.

We also discussed how to foster psychological safety in how a person responds to team members' contributions:

- Affirm the value of contributions as they are made.
- Reflect back the potential value of an idea.

To practice this skill, the students undertook a brainstorming activity with their newly-formed project teams. We put two words on the board--coffee and camera--and the teams had 90 seconds to identify as many ways as possible that the two words could be related. Even though the teams had only been formed a few minutes prior, students were very engaged in the exercise.

During the debrief, the team spokesperson reported out their favorite response. They were also asked to report a good example of soliciting input and a good example of responding to contributions. The final debrief question was "When a team uses these techniques to solicit input and respond to input, why does it make people more likely to contribute?"

Skill 2: Questioning an idea to obtain valuable insight
When a team is evaluating design options, the objective is to select the best option to maximize positive outcomes while minimizing negative consequences. A challenge for most

teams is recognizing the broad range of potential outcomes and consequences, and the magnitudes of those impacts. Questioning helps students discover things they missed. Even once the team members have identified the potential outcomes and consequences, they often struggle to develop a consensus of what is "best". In this case, asking questions helps the team members discover the underlying values informing each student's assessment of the impacts.

To motivate the skill, we shared the story of Citicorp Center (Morgenstern 1995): A question from an architecture student prompted the lead structural engineer, William LeMessurier, to perform additional calculations which identified a potentially serious weakness in the structure.

Our instruction to help the teams create psychologically safe environments centered on delivering questions in a friendly, open-minded way:

- Ask in order to learn.
- Presume that there is a thought-out reason.
- Choose a tone of voice that is cordial and inquisitive.

Our instruction also covered how to respond to questions in a way that promotes psychological safety:

- Respond in a welcoming, appreciative way.
- Articulate back the potential positive outcome of the question.
- Invite questions about one's own ideas.

To practice this skill, we shared a cartoon drawing of a poorly designed swing set. Each team was directed to develop questions they would ask to help the instructor, serving as the developer of the design, to discover potential problems with the design. As teams shared their questions, the instructor demonstrated the responding techniques. For example, "Thank you for bringing that to my attention."

To practice asking and responding, the second exercise was a different poorly designed swing set. We randomly selected a lead designer for each team. We instructed the team members to develop and deliver questions to help improve the design. We instructed the lead designer to respond in a way that promotes psychological safety. After the exercise, each team shared one question and one response that they believed promoted psychological safety. While observing the exercise, we noted that the students playing the role of lead designer routinely responded to team members' questions by defending the design decision. This natural tendency is something that students must learn to control to promote psychological safety.

Skill 3: Applying the brake to improve a decision

There are times when the chosen design either fails to meet the design requirements or will have undesirable outcomes. When a team is headed in that direction, all it should take is one

person to stop the trajectory. Empowering all team members to fill that role decreases the likelihood of a poor outcome.

To provide motivation to develop this skill, we shared three scenarios that demonstrated common reasons people choose to not speak up when they believe there is a problem: 1) deferring to seniority or status, 2) being new to a group, and 3) fearing the cost of pausing the team. Each scenario showed how the team's decision making could have been improved if the person requested a pause to review a decision.

Our instruction described how to act to promote psychological safety when stopping the team:

- Recognize when others have a concern.
- Acknowledge the potential impact of stopping as you request the pause.

Our instruction also described how to respond to a team member in a way that promotes psychological safety:

- Listen to the concern.
- Address the concern.
- Articulate back a potential positive outcome of pausing to consider the concern.

To practice these techniques, teams participated in two role-playing vignettes. For the first vignette, one member of the team was designated the "Team Leader" and one was designated the "Summer Intern". All other people on the team had the role of "Observer". We provided unique instructions and partial scripts to each person based on their role. For this vignette, the Summer Intern requests the pause to review a decision and the Team Leader was instructed to respond in a way that destroys psychological safety. The students playing the role of Team Leader were very adept at destroying psychological safety, which suggests that students have all seen poor examples on teams.

Students changed roles for the second vignette, a capstone design scenario. One student was designated the "Team Leader", one the "Team Member", and the rest were "Observers". In this vignette, the Team Member was to express concerns about calculation results, and the Team Leader was to respond in a such a way as to promote psychological safety. During the debrief for each vignette, the Observers led the discussion by sharing what they saw that promoted psychological safety and what they saw that hindered or removed it.

Methods:

This project was predicated on the research question: Does teaching psychological safety improve teaming experiences for first-year students?

We hypothesized that we could improve students' team interactions by directly teaching tangible skills to first-year Introduction to Design student teams. To test our hypothesis, we

implemented the modules in EM103, Introduction to Design in civil engineering (CE). While this course is taught across the institution, there are differences between sections from department to department, because each department focuses the course for the needs of their discipline. In spring of 2021, the intervention was taught in the two CE sections of the course to a total of 40 students.

To assess our intervention, we surveyed students using an existing post-experience survey (Edmonson 1999). The survey asked students to identify how true they felt seven statements were based on a seven-point Likert scale from "very inaccurate" to "very accurate" (Table 2). To determine if students in the intervention group had better teaming experiences because of the intervention, we also surveyed five additional sections of the Introduction to Design course. We surveyed three sections of the course taught in chemical engineering (37 students) and two sections taught in mechanical engineering (43 students). The survey was disseminated in our learning management system, following an approved, exempt IRB protocol.

Table 2. Post-course survey statements, based on Edmondson et al. (1999).

Thinking about your experience on a team in this class, select the response that best fits how you feel about the following statements:
S1. If I make a mistake on this team, it is often held against me. [Reverse scored]
S2. Members of this team are able to bring up problems and tough issues.
S3. People on this team sometimes reject others for being different. [Reverse scored]
S4. It is safe to take a risk on this team.
S5. It is difficult to ask other members of this team for help. [Reverse scored]
S6. No one on this team would deliberately act in a way that undermines my efforts.
S7. Working with members of this team, my unique skills and talents are valued and utilized.

To analyze the results, median values from each statement were compared using the Whitney-Mann U (Wilcoxon Rank Sum) nonparametric test. Comparing U to the null hypothesis allows us to determine if the populations (intervention and control sections of Introduction to Design) are equal or are statistically different from each other.

Results:

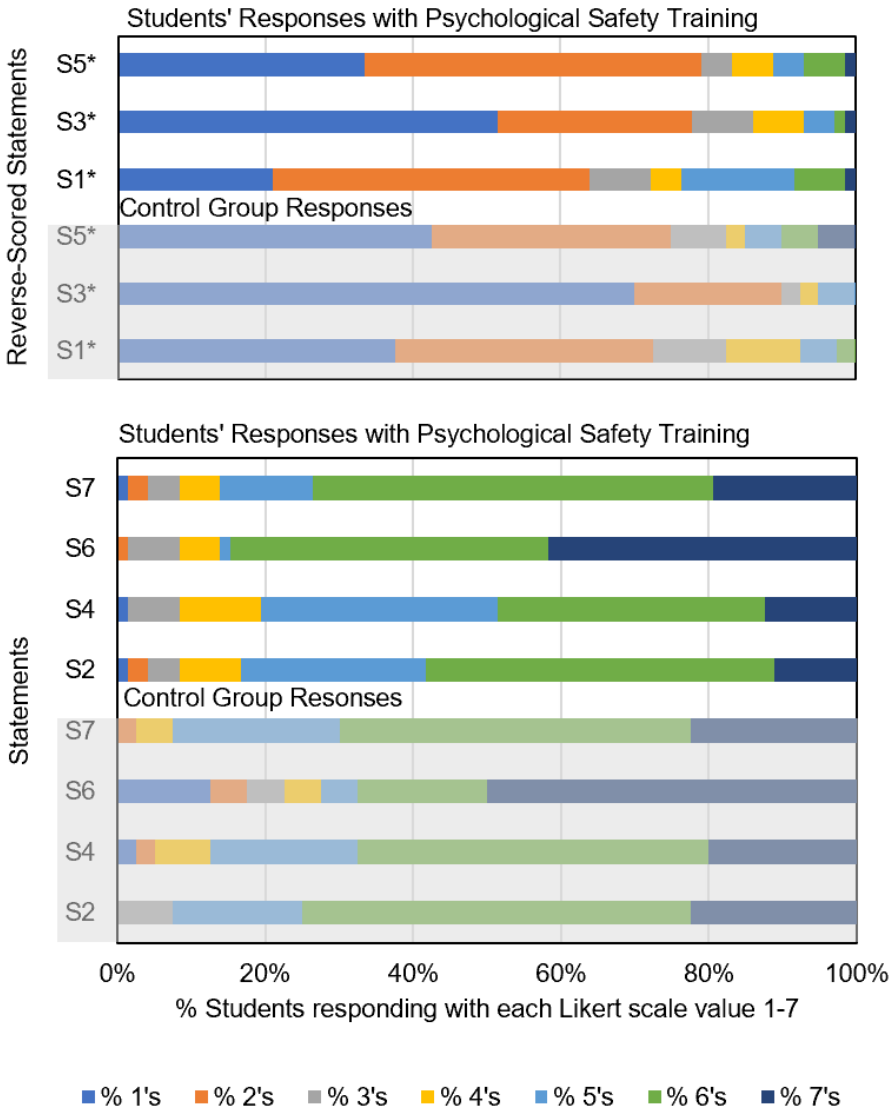
Likert responses between the intervention students (CE Introduction to Design) and control students (other Introduction to Design classes) indicate that the intervention may have allowed students to foster and experience team environments that were more psychologically safe. Comparing the distribution of student responses between the two groups, the intervention students were more likely to score their experiences as psychologically safe (Figure 1).

Overall there was a shift towards positive responses when comparing the intervention group to the control gropu, and the shift was significant for the first four questions based on p-values being less than 0.1 (Table 3). These responses relate to being able to make mistakes, bring up tough issues, not be rejected for being different, and feel safe taking a risk. While no questions indicated highly significantly different medians, our results indicate the psychological safety training we have developed for engineering students is beneficial and certainly not harmful.

Specifically, when asked if mistakes are held against them (Statement 1, reverse scored), more students with training in creating psychological safety provided a response indicative of having improved psychological safety in their teams as compared to the control students (38% versus 21% answered very inaccurate). Similarly, when asked about rejection for being different (Statement 3, reverse scored), the intervention students were less likely to feel this way as compared to the control students (70% versus 51% answered very inaccurate). While less strongly differentiated, the trend of the intervention group feeling more comfortable with asking for help (Statement 5, reverse scored) was still evident in students responding that they more often felt this way versus the control group(43% versus 33% answered very inaccurate).

Additionally, when asked if team members can bring up problems and tough issues (Statement 2), no students from the intervention group answered with very inaccurate or inaccurate. Similarly, when asked if team members would *not* undermine efforts (Statement 6), more students in the intervention group responded to the statement with “very inaccurate” (13%) compared to zero students in the control group. In addition, more intervention students reported “very accurate” (50%) to this statement versus the control group (42%).

When students were asked if they felt safe to take risks on their team (Statement 4), more students in the intervention group reported the statement as very accurate (20%) versus the control group (13%). When students were asked about how their unique skills and talents were valued and utilized (Statement 7), students from the intervention group were less likely to answer in a strongly negative way (3% answered inaccurate; 0% answered very inaccurate and somewhat inaccurate) as compared to the control group where 1-4% of students selected these responses.



* Denotes reverse-scored statements.

Figure 1. Raw data summary of percent of students choosing Likert scale responses of 1 (very inaccurate) to 7 (very accurate) for each of the seven statements of the survey, grouped according to if the state was reverse-scored or not. Intervention and control group (shaded) responses are compared for each set of statements.

Table 3. Average response values for the intervention students and control students and the significance. ($p<0.05$ likely different, $p<0.1$ possibly different, $p\geq0.1$ not different)

Statement	Average Intervention	Average Control	p	Significance
S1. If I make a mistake on this team, it is often held against me.*	2.18	2.76	0.068	possibly different
S2. Members of this team are able to bring up problems and tough issues.	5.83	5.39	0.052	possibly different
S3. People on this team sometimes reject others for being different.*	1.53	1.96	0.079	possibly different
S4. It is safe to take a risk on this team.	5.63	5.31	0.083	possibly different
S5. It is difficult to ask other members of this team for help.*	2.30	2.24	0.716	not different
S6. No one on this team would deliberately act in a way that undermines my efforts.	5.38	6.03	0.673	not different
S7. Working with members of this team, my unique skills and talents are valued and utilized.	5.80	5.65	0.879	not different

* Denotes reverse-scored statements.

Discussion:

Lessons Learned

The original training included about 10 minutes of introduction and motivation, plus it included two iterations of the brainstorming activity for Skill 1 and a third iteration of the questioning activity for Skill 2. The resulting training was a bit longer than two hours. Although the students were animated in their exercises, we observed that two hours straight was a bit long for the students to stay engaged mentally. By removing that extra material, the modules are now about 30 minutes each. Therefore, the instruction can be spread out across three days in 30-min segments or covered in 90 minutes total.

As noted in Skill 2, the students serving as the “lead designer” frequently defaulted to defending their design. Therefore, we recommend adding a caution in the instructions to the lead designer to be aware of that tendency and intentionally avoid that type of response.

Plan for Future

We anticipate that the limited impact of the training might be due to having only one touchpoint. Therefore, for the next iteration, we plan to provide email reminders to the students at key times during the course. Each reminder will highlight the skill that is most likely relevant at that stage of the project.

We have also begun looking at this as a longitudinal study. We are gathering data from seniors who did not have this training to serve as a control group, and we will survey the trained students again when they reach their senior year. Additionally, we plan to investigate if there are differences in students' responses based on demographic groupings.

Conclusion:

To improve student teaming experiences, we developed modules to teach psychological safety using role-play and deployed them in a freshman-level Introduction to Design course. The modules focused on *how to act* and *how to respond* to promote psychological safety on design projects. These exercises allowed students to practice good teamwork skills that promote psychological safety. Overall, students in the intervention group reported better team experiences than students in the control group. However, the students reported that their team experiences could have been more psychologically safe. Going forward, our goal is to help students become more proficient at creating psychologically safe team environments.

Invitation:

If you would like to try adopting this approach, contact us and we will happily share the materials: Michelle Marincel Payne, marincel@rose-hulman.edu, and Jim Hanson, hanson@rose-hulman.edu.

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