Empathy: Developing This Core Leadership Skill in Engineering Students

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Abstract

   In an increasingly complex and interconnected world, empathy is emerging in literature as a vital leadership skill for engineers. Traditionally viewed primarily through a technical lens, engineering roles now demand a more holistic approach that integrates emotional intelligence with technical expertise. Empathy, often overlooked in engineering education, stands as a critical attribute for effective leadership and collaborative problem-solving. Engineers entering the workforce today may find themselves working on diverse teams in multinational companies for customers they have never met in person, and be expected to deliver excellent work under tight deadlines. Under such conditions, they must be prepared and enabled to connect with others who have different backgrounds and experiences than they do, quickly understand perspectives that differ from their own, and solve problems with the end users' and other stakeholders' interests at the forefront of their minds. This paper includes a narrative literature review of research on empathy in engineering leadership education and development. It examines the Zachry Leadership Program at Texas A&M University as a case study of how empathy can be introduced into engineering leadership curriculums, describes the teaching approaches faculty in that program use to help students understand and develop this skill, and identifies ongoing challenges, particularly with assessment. Finally, it presents planned future research in which graduates of the program will be asked about the importance of empathy in both student organization leadership positions and their current professions and roles; which aspects of the course on empathy were most helpful; and whether they felt fully prepared to be empathetic leaders when they graduated.

   This practice paper is aligned with the LEAD division's "design" strategic priority. It will introduce ideas and foster discussion around ways that engineering leadership development programs can integrate empathy as a core leadership skill.

I. Introduction

   Engineers learn technical material not just to gain knowledge, but to improve the lives of others. Their work, whether it be in biomedical device design, food processing, energy sourcing and distribution, power systems, software, system optimization, or any other field, allows humans to be more comfortable, productive, or efficient. Absent this ultimate purpose, engineers would only be creating valueless widgets, physical or otherwise.

   Further, rising to a leadership position in the engineering profession is usually the reward for technical mastery or other process-oriented skills such as problem-solving, project management or innovation. Interpersonal skills are often considered secondarily or not all. In other words, engineers promoted to leadership positions often have technical mastery, but may have little experience or training that will help them lead people.

In response to feedback from undergraduate and graduate programs, industry and government employers of engineers, and professional societies, ABET incorporated leadership in its student outcomes required for accreditation for the first time in 2019 [1]. The new language, shared below, is a move in the right direction, but leaves institutions to figure out how best to teach their students to work together to provide leadership and create a collaborative and inclusive environment.

> *ABET Criterion 3, Student Outcome 5: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.*

Empathy is a skill that institutions can focus on that will help them achieve this outcome. Whether engineering students aspire to be technical experts, leaders in their companies, or entrepreneurs who start their own businesses, awareness of people and leadership skills will be important. However, most engineering curriculums devote few, if any, courses to developing these skills and abilities. Empathy is a core skill that can be learned [2] and can help engineers function effectively on a team in any role and in any environment [3]. Drawing on research in social work, Walther et al. propose a definition of empathy in the context of engineering and propose a model that includes perspective-taking, affective response, cognitive processing, and conscious action [2]. As such, empathy is a critical skill for authentically connecting with others [4] as they work in teams and endeavor to take the perspective of potential users of their work so it is as practical and helpful as possible.

Higher education does more than just teach and train the next generation of professionals; it also prepares people to engage productively with the rest of the world [5]. According to Bairaktarova, "the development of empathy fosters the 'whole-person' education required in the 21st century" [5]. However, the breadth and diversity of conceptions of empathy in the field of engineering makes it challenging to implement in educational settings [2].

In this paper, we provide a review of the growing body of literature concerning the role of empathy in the engineering profession and engineering education; we describe how the Zachry Leadership Program at Texas A&M University integrates empathy into our leadership development curriculum; we present our plan to collect feedback from alumni of the program who learned about, developed, and practiced empathy during their time in the program; and we share our conclusions and possible next steps for researchers and practitioners who desire to incorporate empathy development to help prepare future engineers to make valuable and impactful contributions to their organizations and our broader society.

II. Literature Review

Empathy is increasingly recognized as an essential component in engineering, influencing both educational practices and professional outcomes. The integration of empathy into engineering education and practice enhances the ability of engineers to design solutions that are not only technically sound but also socially responsible and user-centered. Empathy helps engineers understand and address the diverse needs of users, leading to more inclusive and

effective design solutions. This perspective is supported by various studies that highlight the role of empathy in engineering education and practice [2], [5], [6], [7], [8], [9].

Empathy is considered a necessary interpersonal skill for modern engineers, supporting creativity, ethical decision-making, and collaboration. However, perceptions of its importance in pedagogy vary among instructors, indicating a need for broader acceptance and integration [10].

In engineering education, the integration of empathy takes several forms. Incorporating empathy into engineering curricula can shift students' perceptions of their roles as engineers. For instance, empathy modules in first-year engineering courses have been shown to influence students' engineering identity and enhance their understanding of the social and cultural implications of their work [11]. Empathy also plays a crucial role in fostering productive cooperative problem-based learning environments, where it aids in team dynamics and problem-solving [12]. Reflective thinking and social learning frameworks are used to develop empathy in team settings, which is essential for effective collaboration. Programs like the 'Design and Analysis of Experiments for Engineering Innovation' integrate empathy with design thinking to foster innovation and user-centered design, particularly in creating solutions for individuals with disabilities [13]. Empathy can also help students connect with the human experience and develop solutions that are both technically and emotionally resonant [14].

In professional practice, empathy serves multiple functions. It is vital in understanding user needs and creating designs that are accessible and inclusive. Empathic design approaches help engineers develop solutions that consider the emotional and practical needs of users, leading to more effective and user-friendly products [6]. In project management, particularly in contexts like rural road projects, empathy can reduce project failures by addressing the social and emotional needs of the community [15]. Empathy training is suggested as a means to enhance emotional intelligence and project management skills. In software engineering, although under-researched, empathy is seen as a critical skill for understanding end-user needs and improving user interaction with software systems.[16]

The integration of empathy into education and practice faces challenges. These include varying perceptions of its importance among educators and the need for effective pedagogical strategies to teach empathy. Additionally, while empathy is recognized as beneficial, its application in fields like software engineering is still developing, suggesting a need for further research and adaptation of empathy models to fit specific engineering contexts [10], [16].

III. Case Study: Empathy Development in the Zachry Leadership Program

The Zachry Leadership Program at Texas A&M University is a selective, five-semester certificate program designed to develop intrapersonal and interpersonal skills in undergraduate engineering students. Program faculty and staff select a cohort of 32 sophomores to commence the program each year. Students attend a three credit-hour course each semester for five semesters. Courses cover a variety of topics in leadership, business, and service. In particular, each semester features a leadership emphasis. In the first semester, the emphasis is self-awareness; in the second, it is empathy; in the third, creativity; in the fourth, purpose; and in the fifth, it is leading for a lifetime.

Our approach to teaching engineering leadership begins with the belief that leadership is independent of position or role. Leadership is not so much a position that requires authority and technical savvy, but one where developing other people is essential. We know that because someone is in *charge* of an effort does not mean they can *lead people* through this effort. Leadership as an attribute of humanity is intrinsic and individual. Thus, empathy is a necessary skill for leaders regardless of formal title or role.

We guide our students both as a cohort and individually through an exploration of their leadership qualities and values. They learn about their leadership qualities, explore their passion, and define their purpose and values individually, but in the context of a trusted group of likeminded people. Before each of the five semesters, students attend a pre-semester retreat where they are introduced to the theme for the coming semester. The retreats allow students to come together before the semester—and the exams, lab reports, student organization commitments, and other demands for their attention—begin. This affords the time and setting to reflect deeply, engage in meaningful dialogue, and anchor themselves on the theme of the upcoming semester. We introduce empathy at the retreat they attend before the fall semester of their junior year, after they have completed the semester focusing on self-awareness.

Group dialogue underpins our pedagogical approach. Distinct from group discussion, dialogue is both personal and collaborative, and it promotes introspection [17]. We encourage students to actively practice the four principles of dialogue: listening, voicing, suspending, and respecting [18]. The result of this approach is that they not only learn from the teaching faculty and lectures but most importantly, they learn from each other. As they each share their own observations and reflections, they are exposed to diverse ideas, backgrounds and experiences, enriching their learning.

Prior to beginning work on empathy, students have spent a semester learning about and developing self-awareness. By moving through self-awareness curriculum that includes emotional intelligence, personal strengths and blind spots, values, and other topics, students have opportunities to hone their understanding of themselves. This, in turn, provides a foundation to help them better empathize with others.

As we discuss empathy, we focus on perspective taking and practical applications of the skill as a leadership tool, particularly in the context of engineering leadership. We have students reflect on and share their own experiences receiving empathy, as well as times when they did not receive empathy. This allows them to establish, based on their own experiences, the role empathy might play in their leadership skillset. They also do exercises to help stimulate curiosity. These reinforce the need to check their own assumptions and to learn as much as possible before drawing conclusions about why someone acts a certain way.

A listening workshop often receives the most positive student feedback. In this session, students have a conversation with a partner in which they notice how often they get distracted (for most, it happens at least once; for some, it happens several times). Then, we teach them about different levels of listening, ranging from ignoring and pretending to listen to empathetic listening. We also talk about the difference between listening to respond and listening to

understand. Then, they have another conversation with their partner and observe the differences, as both speaker and listener, when the listener really focuses on listening well. Finally, they learn about different ways people demonstrate empathy, based on Michael Ventura's book, Applied Empathy.

Throughout the retreat, we use dialogue, journaling and self-reflection to help them find their own understanding and questions about the subject. The culminating event of the retreat is a service project they do together that allows them to interact with people. For example, one cohort visited a homeless shelter and conversed with clients, learning about their stories and interests. Another cohort visited a community center in a rural town, while a third visited a senior center. In all three cases, students were prompted to use active listening and curiosity to try to understand the perspective of the people they talked to.

During the semester, in classes that meet one time per week for 100 minutes, students explore other topics that pertain to empathy in an engineering leadership context, including overcoming empathy gaps, empathetic accountability, and integrating empathy in the design process. We supplement these topics with assignments that ask them to empathize with others in various ways and reflect on the experiences. We follow up with open dialogues in class. Sample class plans and assignments are included in the appendix.

We do not presently use any independent instrument to assess empathy in students, although we are not opposed to doing so. We rely instead on reflection papers in which they define empathy and describe its effects, as well as how they can use it in their leadership and lives. At the end of the last semester, we bridged to the upcoming semester on creativity and asked them to tell us about the "ingredients" of empathy during a class discussion. Responses included understanding, listening, curiosity, suspension of judgment, heart, attention, and other elements. These responses indicated, anecdotally, that they had developed an understanding of the concept of empathy, what they needed to do to hone it, and how they could apply it. They also wrote an individual final reflective essay in which they answered the following questions.
- How do you define empathy, and how has your understanding of it changed this semester?
- What connections have you discovered between self-awareness and empathy?
- How might empathy affect the influence you have on others?

Responses to these questions also indicated a robust understanding of empathy. One student wrote, "Going into this semester I mainly saw empathy as the ability to simply perceive another human being's state of being, but my definition of what empathy is has expanded to encompass so much more than that simple definition. I now see empathy as a culmination of compassion, vulnerability, and understanding, and the foundation of true connection." Another wrote, "By having empathy, one is open to understanding another to a greater extent, acknowledging differences, ultimately reducing the conflicts that would go unaddressed." A third wrote, "Being empathetic enhances one's ability to influence others by building trust, understanding, and meaningful relationships."

Finally, in a post-semester survey, we asked students to rate their understanding of empathy before the semester started and after the semester ended using a five-point Likert scale

(1=Poor, 2=Fair, 3=Satisfactory, 4=Very Good, 5=Excellent). Of the 32 students in the course, 24 completed the survey (n=24) and rated both the before and after understanding. The mean score before the semester was 2.29 (SD=0.75), and the mean score after the semester was 4.21 (SD=0.78). Using a two-tailed paired t-test, this difference is statistically significant at the $p <$ .05 level. While self-assessment has its limitations as an instrument, it does indicate at least increasing levels of self-efficacy concerning understanding and applying empathy in an engineering leadership context.

IV. Future Research

The Zachry Leadership Program within the College of Engineering at Texas A&M University has existed since 2016 and has over 200 alumni amongst its seven graduated cohorts. Alumni of the program have entered sectors including academia, civil service, and private industry in careers related to technical roles, research, management, consulting, sales and more. This alumni base could be a rich source of data about the effectiveness of the program's efforts to help leaders develop empathy.

In the coming months, we plan to ask alumni about the importance of empathy in their work, to tell us which aspects of the curriculum on empathy were most impactful in retrospect, and how confident they are that they can be empathetic leaders in their field. We plan to collect this data via a mix of surveys and focus groups. The focus groups, comprised of alumni from diverse majors—Texas A&M has 24 majors in the College of Engineering—and post-undergraduate careers, allow for the collection of rich qualitative data and discovery of common themes. The surveys will provide quantitative data that we can analyze for trends and significance.

Future research will help explore key curriculum elements that contributed to leaders' growth. Through analysis and reflection upon alumni feedback, program staff can make decisions which refine the depth at which students experience and explore empathy. Below are some potential questions we are working to refine for use in the surveys or focus groups.

1. On a scale of 1-5, how often do you apply empathy in the workplace?
2. How did your participation in the Zachry Leadership Program shape your understanding and practice of empathy?
3. What, if any, differences have you noticed between the empathy taught in the program and how you practice empathy in the workplace?
4. Does empathy impact your approach to leadership? If so, how?
5. Has empathy been helpful in motivating or engaging your coworkers/team? If so, how?
6. What have you learned about empathy since you graduated that you would share with current students who are learning about it?

In summary, our practice and initial research indicate that empathy helps break down barriers that limit creativity, growth, personal connections, and the potential of leading an impactful life. Alumni who are working in a variety of professions and industries may hold valuable feedback that will help us further assess our efforts to equip engineers with the tools—

including empathy—necessary to meet the needs of those around them, see with eyes of compassion, and develop as leaders in their families, workplace, and communities.

V. Conclusion

Empathy is an important skill for the engineers and leaders of the future to develop. It will allow them to connect and collaborate more effectively with their teams, design and build better products and processes, and make a greater number of positive contributions to society. Although it can be difficult to conceptualize with and develop in our students, engineering educators need to continue to think about how we can incorporate empathy into our curriculums, particularly with students who are interested in leadership. Further research on effective interventions and assessment instruments is needed to help members of our division build impactful curriculums.

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Appendix A: Sample Assignment

Assignment Overview

Write

Tell the story of your empathy journey that started in the summer with the retreat and continued through the semester, considering the questions below.

- How do you define empathy, and how has your understanding of it changed this semester?
- What connections have you discovered between self-awareness and empathy?
- How might empathy affect the influence you have on others?

Consider all elements of this assignment and its description as well as any other empathy learning experiences over the summer and semester. Be specific and share relevant examples. This written assignment should be personal and reflective in nature, but should include your thoughts to the book and other materials.

Guidelines

Your assignment submission should be about 600 - 1000 words in length. You can include photos or graphics, if you'd like. Your answers will be reviewed for depth and clarity. Please consult the attached rubric.

Appendix B: Listening Workshop

3:30-3:40	Introduction, safety moment
	- Safety moment apart of culture at Zachry - Orbiter: small mistake with a big price - The spacecraft encountered Mars on a trajectory that brought it too close to the planet, and it was destroyed. NASA was using metric system and a component made by Lockheed was using imperial system. The systems were using different "languages". They thought they understand each other, but each system had its own frame of reference.
3:40-3:55	Have people in pairs to do part 1 listening exercise - Like "Dug" from the movie "up", introduce squirrel activity. Maybe play the squirrel video https://www.youtube.com/watch?v=xrAIGLkSMls - One person talks about a story from their summer, one listens. When the listener is distracted and they realize it, they hold up the picture of Dug. Switch roles after 2 minutes. - Tell them it is okay to hold up the picture, it is okay if you show that you are distracted, the other person won't be offended, we are all here to learn and grow.

3:55-4:05	Group discussion
	- How did it feel when your partner held up Dug?
	- How did it feel when you held Dug?
	- What causes us to be so distracted?
	- What are ways we can limit our distractions?
	- Why do you think it's so important to listen to other people?
	
	The fundamental unit of work for a lot of us is a conversation. Yet, so often our conversations go awry.
	What we say isn't what is heard.
	    What we hear isn't what is said.
	    We make assumptions about a lot of things in our conversations or leave things unclear.
	    Clear communication takes work. We must listen to what's being said, repeat what we heard and ask if it is correct or complete, ask clarifying questions, double check our assumptions, recognize when we've shut down our listening, name what arises in us based on what we hear, ask more open honest questions to get more context or understanding.

4:05-4:15	5 levels of listening - Stephen Covey: author, professional speaker, 7 Habits of Highly Effective People - "Most people do not listen with the intent to understand; they listen with the intent to reply"

	- Go through 5 levels and provide examples of each - Ask the students what they think each means and if they have experience with each level of listening. 1. Ignoring: It happens all the time. We get distracted and effectively exit the conversation. It is obvious to other person. 2. Pretending to listen: Verbally or non-verbally encouraging, but in inappropriate moments. Also, maybe someone just waits for us to stop talking to interject their own idea. When we find ourselves in level 1 and 2 it's better to be open and say I'm sorry, I have something else on my mind, give me 5-30 minutes. It is good to ask for permission to be unavailable rather than ignore or pretend. 3. Selective: Swiss cheese listening. Confirmation bias, massive filtering, just the basics. I am missing all of the subtext and some of the text and usually confirms what I already know. Running our lists of assumption. We are not fully engaged. 4. Attentive listening. This is where we start listening. We are engaged, have questions to ask, decide if we agree or disagree, hone in on the areas where we lack clarity. When we are in decision-making mode it is good to be in level 4. You can catch little cues of misalignment, or spot lack of information. It is productive and focused. Keenly aware of what is happening in the room, sense of presence, tracking different people. 5. Empathic listening: Generative listening. I am suspending my opinions, I am letting go of what matters to me. My sole focus is understanding the other person. I am tuning into what is underneath their words, I am sensing their emotions. I can differentiate if someone is asking me for permission or input. I have a good sense of what the other person is needing from the conversation. Level 5 is giving the other person so much space that they can do a terrible job articulating their thoughts and I will still pick up on what they really trying to get across. It is a gift to people. Speakers gain clarity and can organize their thoughts better in the presence of a level 5 listener. So not only the listener is gaining more information, the speaker is also gaining insights.
4:15 – 4:25	Activity part 2 - Repeat the exercise with the same pair about a childhood story. Maybe your favorite place to visit as a child.
4:25 - 4:30	Practical tools - Ask students how they might practice level 4 and 5 listening - The goal is to be aware when we are not listening and either refocus our attention or ask for permission to regroup later.