Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025
Paper ID #45468

# From essential to ridiculous: Exploring instructor perceptions of empathy-focused instruction

**Jennifer Howcroft, University of Waterloo**

Jennifer Howcroft is a Continuing Lecturer in the Department of Systems Design Engineering at the University of Waterloo. Her pedagogical research focuses on engineering design, holistic engineering education, stakeholder interactions, and empathy in engineering education.

**Dr. Kate Mercer, University of Waterloo**

Dr. Kate Mercer graduated with a Master of Information from the University of Toronto, and a PhD in Pharmacy from the University of Waterloo, focusing on communicating health information. Kate is the liaison librarian for Systems Design Engineering and Biomedical Engineering at the University of Waterloo where her job includes collaborating with faculty, staff, and students to effectively provide instruction and support and conduct research. Kate publishes on a rage of topics including information literacy, misinformation, scientific communication, artificial intelligence, and empathy in engineering teaching and learning.

**Ms. Stephanie Mutch, University of Waterloo**

Stephanie Mutch is a STEM Librarian & Instructional Design Specialist at the University of Waterloo. Stephanie holds a BAH in Sociology and an MA in Criminology and Criminal Justice Policy from the University of Guelph, in addition to an MLIS from the University of Western Ontario. Her research interests include information seeking and evaluation, interdisciplinary applications of sociological theory, and critical librarianship.

# From essential to ridiculous: Exploring instructor perceptions of empathy-focused instruction


## Abstract

Empathy skills have been recognized within engineering as beneficial in the context of design, ethics, and professionalism. However, the inclusion and success of empathy-focused instruction is dependent on instructors. This study investigates engineering instructors' perceptions of empathy and empathy-focused instruction by investigating (1) how instructors define, view, and value empathy, and (2) advantages and challenges to teaching empathy in engineering courses. A survey was distributed to instructors teaching engineering courses at one institution. This paper presents a qualitative analysis of open-ended questions. Instructors described different understandings of empathy and opinions regarding empathy-focused instruction. Some described teaching empathy as essential, while others considered it "ridiculous." Key advantages were interpersonal skills, improved professionalism and ethics, and improved learning environment. A lack of knowledge base, practical challenges, and confronting traditional practices were identified as key barriers to empathy-focused instruction in engineering education that will need to be addressed moving forward.


## Introduction

Traditionally, the discipline of engineering has been characterized as being primarily technical in nature, from this perspective, the role of the engineer is to apply their advanced knowledge of math and science to devise solutions to humanity's problems and create products that improve life. Underlying this traditional understanding is the assumption by engineers that, through their education and experience, engineers are the most qualified to determine which of humanity's problems ought to be addressed and the best ways to do so. Contrasting this traditional viewpoint is the growing appreciation for the user's expertise regarding their own situation, wants, and needs. User-centered design approaches like co-design, participatory design, and human-centered design highlight the importance of understanding and valuing user perspectives to create useful products and solutions [1], [2].

Over the past two decades, the term "empathy" has been used with increasing frequency to describe the willingness and ability of engineers to account for the perspectives of their users [3], [4]. This has led to the development of "empathetic design" techniques that recommend using a variety of methods, including contextual inquiry, personas, and empathy maps, to gain a better understanding of the user's perspective [5], [6], [7]. By stepping into the user's shoes to get a clear picture of their wants, needs, and concerns, empathetic designers are able to make design choices with a better understanding of the user's context, yielding designed solutions that are more applicable and useful for user groups. Despite receiving increasing attention in the literature, empathetic design has been criticized for continuing to treat users as sources of data for "expert" engineers to use [8]. In place of "empathic design," Tang (2018) argues for "empathic engineering," which recognizes the role empathy has to play in improving communication and sensitizing engineers to community needs, environmental concerns, and social justice issues, in addition to user needs.

Empathy skills are also essential to an engineer's ability to fulfill their ethical and professional duties. In the North American context, engineering societies and regulators, such as the National Society of Professional Engineers (NSPE), Engineers Canada (EC), and Professional Engineers Ontario (PEO), outline the conduct that is expected of professional engineers (EC, 2016; Professional Engineers Act, 2014; NSPE, 2019). Although there are differences among them, each of these codes of conduct stress an engineer's ethical obligation to protect public welfare and act in society's best interest, foundational ethical duties shared by many international Engineering Societies as well (see for example: Engineering Council & Royal Academy of Engineering [12] and Engineers Europe [13]). Engineers with empathy, who take the time to consider and truly understand how their work impacts users, communities, and the environment around them, are better prepared to account for concerns relating to safety, usability, social and cultural variables, and sustainability. In this way, empathy improves engineers' ability to make ethical decisions and adhere to professional codes of conduct [14].

In the field, practicing engineers acknowledge the impact empathy has on their day-to-day work, noting that it improves communication and interpersonal skills, helps them to understand the wants and needs of clients, stakeholders, and colleagues, and leads them to consider the broader impact of their work [3], [15], [16]. Surveying practicing engineers from across specializations, Hess et al. [16] found the longer an engineer had been working in the field, the more they came to view empathy as an important element of their work. More experienced engineers were also found to be more aware of the different ways empathy contributed to and improved engineering work. This increased awareness is noteworthy given that previous studies assessing how professional engineers view empathy have found practicing engineers define empathy in a variety of different ways and are occasionally uncomfortable providing their own definition of the term [3], [15].

### 1.1 Defining empathy

Although the use of the term "empathy" in engineering circles has been steadily increasing [4], reviews of the literature and interviews with practicing engineers suggest that this terminology is used infrequently in the discipline of engineering [3], [15]. Rather than discussing "empathy" as such, engineers may discuss respect for others, ethics, communication skills, or teamwork, for example. When empathy is explicitly discussed in the engineering literature, authors may fail to operationalize or adequately define the concept, leaving readers to interpret what exactly "empathy" entails on their own [8], [17]. The lack of a fully realized definition of what "empathy" means in an engineering context, often leaves engineering education researchers to search for answers in the literature of other disciplines.

Both within and outside of engineering, there remains a marked lack of consensus regarding the definition of the term "empathy" [1], [18], [19], [20], [21], [22]. While there is much debate in the field of psychology regarding what internal processes are involved when one feels and shows empathy, a common distinction is made between affective and cognitive empathy. Affective empathy refers to the emotional response one feels, often automatically, in response to another's situation, whereas cognitive empathy involves "intellectually taking the role or perspective of another person" [23, p. 442]. An advanced empathic response typically involves both affective and cognitive empathy working together.

Empathy is also commonly defined in comparison to the related subjective experiences of "sympathy" and "care." Although like empathy, there is no widespread consensus regarding the exact definitions of sympathy and care, positioning these terms in relation to one another remains a useful way to differentiate between similar internal processes that are often easily confused [3], [18], [21], [24], [25]. Acknowledging the varying degrees of empathetic skill and understanding an individual may possess, we see empathy as existing on a spectrum (as seen in Figure 1) that ranges from sympathy to empathy, to care.

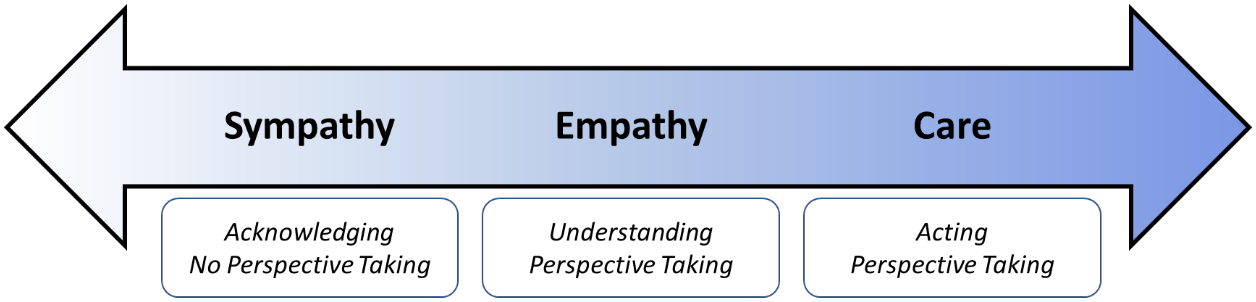


***Figure 1: The Empathy Spectrum from sympathy to empathy to care.***

In our conception of the empathy spectrum, we adopt Darwall's definition of sympathy as concern or feeling for someone else's sake [24]. Here "sympathy" is understood as having an awareness of the situation and an emotional response that may, or may not be automatic, and is felt from the position of the observer. In contrast, our conception of "empathy" goes beyond "sympathy" in that the observer takes on the perspective of the other person instead of feeling an emotional response from their own perspective and position. This perspective taking can reside solely in the cognitive domain of empathy but typically also includes the affective domain [18], [23], [24]. In addition to the affective and cognitive domains of empathy, the ability to regulate one's emotions and self/other-awareness have also been identified as key to empathy [26]. Finally, while care has been defined in many ways, it is often depicted as empathy that elicits a behavioral response. In other words acting on the empathetic response in a manner intended to improve the situation of the other person [3], [8], [15], [27]. Similar to Valente's [25] description of Empathetic Affect, Cognition, and Behavior, we see the progression from sympathy, to empathy, to care as requiring increasingly sophisticated empathetic engagement, understanding, and skill.

### 1.2 Teaching empathy

In our view, the goal of empathy-focused instruction is to improve students' empathy skills, helping them to move further along the empathetic spectrum. In the context of engineering, moving from awareness (sympathy) to understanding (empathy) could have a significant impact on students' ability to identify the nuances of a design problem, appreciate the context surrounding the problem and potential users, identify pertinent ethical considerations, and meaningfully communicate with users, stakeholders, and their own teams [1], [14], [15], [17], [28], [29]. While technical skills are indeed important, modern engineers require a broader skillset that helps them to navigate the interpersonal, ethical, and user-oriented aspects of their work. Particularly in the case of wicked problems, engineering work is sociotechnical in nature, requiring engineers to assess more than just the technical elements of a problem to present applicable, useful solutions of value [17].

In other disciplines that acknowledge empathy as an important professional characteristic, empathy is widely understood to be a teachable skill. It is common for doctors, nurses, social workers, educators, and counsellors to receive some form of empathy-focused instruction as part of their post-secondary training [19], [22], [29], [30]. A growing number of engineering educators are noticing the empathy-focused instruction strategies used in these fields and are working to adapt them for an engineering context [23], [29], [31]. For example, role playing exercises that help social workers and healthcare providers understand the client perspective have been successfully used to help engineering students understand user concerns and social justice issues [1], [4], [23]. Drawing on neurobiological findings showing human brains are unable to empathize and analyze at the same time [32], Walther and colleagues suggest engineering students would benefit from learning "mode switching," a problem-solving technique that explicitly allocates time for empathic considerations, before switching to more technical, analytic considerations [29]. This is similar to Kouprie and Visser's [23] strategy of "stepping into and out of the user's life" to understand the problem from the user perspective before returning to the engineer's perspective to create empathy-informed, responsive designs. While engineering educators may find it helpful to draw on other fields for inspiration, successfully integrating empathy-focused instruction in engineering education will often require appropriate modifications to these techniques to ensure they are relevant to the pedagogical needs and professional context of engineers.

Including empathy-focused instruction as part of the engineering curriculum can also help engineering programs to meet the requirements of accreditation boards like the Accreditation Board for Engineering Technology (ABET) and the Canadian Engineering Accreditation Board (CEAB). More specifically, both the ABET [33] student outcomes and CEAB [34] graduate attributes outline a number of skills and abilities expected of engineering graduates that require or are significantly improved by a strong empathy skillset. For example, CEAB expects graduates to be able to create engineering designs that consider "health and safety, sustainability, environmental, ethical, security, economic, aesthetics, and human factors,"(CEAB, 2022, p. 7). This is similar in many ways to the ABET student outcome #2, that requires "an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, an societal contexts" (ABET, 2021, p. 8). Both ABET's student outcomes (s/o) and CEAB's graduate attributes (g/a) also require graduating students to have the ability to communicate well with colleagues as well as non-engineers (ABET s/o 3, CEAB g/a 7), possess effective teamwork and leadership skills (ABET s/o 5, CEAB g/a 6), be able to appreciate the impact of their work on society and the environment (ABET s/o 4, CEAB g/a 9), and make decisions that reflect the ethical requirements of the profession (ABET s/o 4, CEAB g/a 8,10)(ABET, 2021; CEAB, 2022). The presence of user-focused, interpersonal, and ethically mindful criteria in over half of ABET's student outcomes and CEAB's graduate attributes confirms the profession's desire for newly minted engineers to possess a variety of social and interpersonal skills to complement their technical abilities.

Successful empathy-focused instruction requires engineering educators to understand how and why empathy is important to engineering work and commit to guiding and supporting students as they develop these skills. In addition to adopting new pedagogies that they are unfamiliar with or that may feel uncomfortable to them, instructors must support and guide students as they work through material that may challenge their preconceived notions about what it means to be an engineer [4], [35], [36]. Students often enter post-secondary education with the perception that engineers are technical experts, and may see social, interpersonal, or "soft" skills as having little value to engineering work [4], [28], [30], [31]. Challenging these beliefs can be difficult for students and requires instructors who not only see the value in empathy-focused instruction but are committed to helping their students see this as well. Instructors teaching empathy skills in the classroom should also be willing to model empathy through their interactions with their students. Modelling empathy helps to create an open and respectful learning environment where students can feel safe confronting their own assumptions [31].

The efforts of individual instructors to bring empathy training into the engineering curriculum can be undermined by unsupportive faculties and departments. In their study of undergraduate engineering students, Guanes et al. [28] found that even when students could identify the importance of empathy to engineering work, they prioritized personal goals over empathetic choices. This disconnect reflects students' struggle to meaningfully integrate empathy into their professional epistemology. To shift students' view of what it means to be an engineer and how engineering work is done, empathy must be well integrated and effectively modelled throughout their post-secondary training [4], [28], [31], [37]. While technical skills are important, when the primary focus of an engineering program is technical content, students learn that technical expertise is the most important part of being an engineer. This can create what Cech [37] calls a "culture of disengagement," where students devalue the non-technical skills that are essential to ethical decision making and the consideration of public welfare.

Despite the importance of instructor and departmental buy-in to the development of empathy skills and professional decision making among students, instructor opinions and perceptions of empathy-focused instruction remain poorly understood. In one of the few studies addressing this topic, Strobel et al. [3] found engineering faculty were not in favor of adding empathy-focused instruction to the engineering curriculum. Although many agreed that empathy was an important trait for engineers to have, they felt it was already taught indirectly in different ways and did not believe there was room in the curriculum to add empathy-focused content. Since Strobel and colleagues' work was published over a decade ago, empathy has continued to gain attention in the engineering education literature, but it is unclear what, if any, impact this has had on instructor opinions and attitudes. Our research presents a current understanding of how engineering instructors view empathy and empathy-focused instruction. More specifically, we looked to answer the following questions:

1) *Given that lack of consensus regarding defining empathy, how do engineering instructors define this term?*
2) *What, if any, role do engineering instructors see for empathy in engineering education and what are barriers to including empathy-focused pedagogies?*

## 2.0 Methods

### 2.1 Study design

To gather information about how instructors teaching engineering courses at the University of Waterloo view empathy and empathy informed pedagogies, an online survey was administered using Qualtrics software and the Faculty of Engineering's internal email listserv.

The qualitative data we focus on in this paper was collected using the following open-ended questions and prompts:

1. Provide your own definition of the term 'empathy.'
2. Describe what, if any, value you see in empathy as an engineering or architecture skill.
3. Where do you see empathy playing a role in engineering work? If you do not think it plays a role, please state this.
4. What advantages do you see to including empathy instruction in engineering or architecture courses?
5. What challenges do you see to including empathy instruction in engineering or architecture courses?
6. What was your rationale for including empathy-focused instruction in your course(s)? If you did not include empathy-focused instruction in any course, please write 'not applicable.'
7. What was your rationale for not including empathy-focused instruction in your course(s)? If you include empathy-focused instruction in all your courses, please write 'not applicable.'

Reponses to these questions were analyzed using reflexive thematic analysis to identify shared patterns of meaning expressed by the instructors surveyed. Reflexive thematic analysis (RTA) was used due to its accessible and flexible approach to interpreting qualitative data. Themes were not previously hypothesized but were developed following initial data analysis. This method was also chosen to allow for the researcher's active role in knowledge production, as per Braun and Clarke's 2019 paper [38]. RTA was chosen for analysis as it is suited to both experiential and critical framings. This research, while largely emergent, is very grounded in experiential learning , and specifically is empathy in engineering through "...existing research and theory provide the lens through which we analyze and interpret data" [39]. The study received ethics approval from the University of Waterloo Office or Research Ethics (ORE#: 43729).

**2.2 Participants and data collection**

Of the 40 participants responding to this survey, 33 provided responses to the open-ended questions. Given that the current faculty complement within the Faculty of Engineering at the University of Waterloo is around 330, this represents a 10% response rate. These 33 respondents ranged in age from 32-70 years, with 61% identifying as male, 36% as female, and 3% preferring not to disclose their gender. The majority had completed a PhD (70%) and just under half (48%) were licensed professional engineers (P.Eng.). The sample size for individual questions ranges from 16 to 30. Smaller response rates (n = 16) were elicited for questions 6 and 7 as survey respondents typically only answered one of these two questions based on whether they do or do not include empathy-focused instruction in their courses.

The University of Waterloo's Faculty of Engineering covers 14 professional engineering degree areas as well as the School of Architecture. Although it is not always commonplace for post-secondary institutions to group Architecture within the Faculty of Engineering, we chose to include these instructors in our sample because they often do teach engineering students, particularly those enrolled in the Architectural Engineering program. Participants providing the qualitative data for this study reported teaching across a variety of different engineering and architectural specialties and topics.

Before beginning the survey, all participants were asked to review a confidentiality statement and to provide consent to take part in this study. Participants had the option to limit consent to data collection alone, or to also consent to having quotations of their responses used in publications resulting from this research.

**2.3 Data analysis**

To gain a better understanding of instructors' attitudes, opinions, beliefs, and perspectives, the data were analyzed using Braun and Clarke's [40], [41] RTA. Unlike codebook and coding reliability methods of thematic analysis, RTA requires the researcher to adopt a truly qualitative orientation that focuses on producing deeply meaningful codes rather than focusing on codes that are widely agreed upon [39]. To avoid questionable objectivity claims, RTA embraces the important role a researcher's background knowledge, theoretical assumptions, and perspective play in how they interpret the data. Specifically, the authors come from a professional engineering background, a critical theory background, and a STEM information background. Each author brings their lived experience of being women in STEM and information into the experience of discussing empathy, and it is important that these backgrounds are not lost during the analysis process. Taking a reflexive approach by continually reflecting on one's own views and beliefs allows researchers to complete stronger, theoretically situated, and self-aware qualitative analyses [38].

The qualitative analysis presented here was undergirded by the constructionist assumption that individual realities and beliefs are created through a complex process of meaning making. Seeking to locate and understand these beliefs, the analysis was conducted using an experiential orientation that focused on exploring individual perspectives and attitudes, rather than larger scale social phenomena [41], [42]. The data were coded by one member of the research team, in consultation with the other members. Consistent with Braun and Clarke's [39], [41], [43] recommendations, the purpose of team consultation on codes, and later themes, was not to arrive at a consensus, but to allow for new insights and subjective viewpoints to further enrich the analysis.

Following the six-phases of RTA (see Braun & Clarke, 2006, 2022, and Byrne, 2022), the primary coder began by immersing herself in the data to become familiar with the contents of the dataset. Responses to each of the open-ended survey questions were coded separately to identify shared meanings expressed in response to specific prompts. The coding process was largely inductive and made use of both semantic and latent codes. Codes were then used to generate themes capturing patterns of shared opinions, beliefs, and concerns. The research team met to review and refine initial themes, and related themes were combined across questions where appropriate. While some recoding was required at various stages throughout the analysis, this was expected and is reflective of the iterative nature of qualitative thematic analysis.

**3.0 Results**

The qualitative data collected through open-ended survey questions showed understandings, attitudes, and opinions of empathy and empathy-focused instruction vary widely across the University of Waterloo's engineering instructors. While some instructors demonstrated an advanced understanding of empathy and were highly supportive of empathy-focused instruction, others questioned whether empathy is something that can be taught at all and were doubtful of its relevance to engineering. Although themes were originally generated for each of the seven questions, combining similar themes across related questions resulted in the following four topic areas: 1) empathy definitions, 2) role and value of empathy, 3) advantages and reasons for teaching, and 4) challenges and reasons for not teaching. These categories help to organize themes and tell the story of the data but should not be considered themes themselves.

### 3.1 Empathy definitions

When asked to provide their own definition of the term empathy, instructors described subjective experiences and behaviors falling across the empathy spectrum (see Table 1, below for theme descriptions).

***Table 1: Themes in empathy definitions***

| **Theme** | Sympathy | Empathy | Care |
|---|---|---|---|
| **Description** | A sense or awareness of emotions or experiences. May or may not involve sharing those emotions with the person(s) observed. | Process of considering or working to understand the perspective of others. | Involves a behavioral response or willingness to act on behalf of the observed other. |

Despite this variation, the majority of definitions given by instructors expressed the requirement for empathy to move beyond awareness, to include perspective taking and working to understand where someone else was coming from. This was often communicated using the phrase "putting yourself in someone else's shoes," but some participants did include more detail in their answers.

*"The ability to understand the experiences, emotions, and values of others in a vicarious way."*

While most of these responses discussed empathy in relation to a general "other," some were more specific:

*"Understanding someone else's perspective/feelings whose experience/positionality you don't share."*

This response shows a particularly advanced understanding of empathy, as it is often more difficult for individuals to empathize with those who are different from themselves [25].

The next most commonly shared understanding of empathy resembled our definition of sympathy, in that these definitions often described observing others rather than working to see or understand a situation from the perspective of the other.

*"Awareness/perception of emotions/feelings/mood of other persons"*

*"The consideration of others' thoughts and feelings."*

Finally, a small number of respondents saw empathy as including the inclination or desire to act in response to empathic feelings that aligns with care on the empathy spectrum.

*"Relating with compassion to the experience of others and acting with that understanding."*

*"Having a sense of what the other might be experiencing and adapting to it."*

**3.2 Role and value of empathy**

Many participants offered similar answers to questions related to the professional role and value of empathy that yielded several related themes:

- Improved "soft" (interpersonal) skills,
- Improved engineering/architectural outcomes,
- Enhances ethical decision making and awareness of impact, and
- Helps instructors support students.

Interestingly, these themes encompass diverse perspectives on the role of empathy in engineering education. The first theme aligns with the literature where empathy is viewed as being predominantly related to "soft" or interpersonal skill development [3], [15], [29], [44]. The second and third themes suggest a role for empathy in the work of engineering and associated outcomes. The fourth theme focuses on instructor-student relationships separate from the specific content being taught.

Instructors were able to clearly articulate the role empathy plays in improving engineering and architecture outcomes. Some respondents connected this to design outcomes by identifying empathy as a valuable trait that helped to improve design work through helping engineers to better understand human factors, user needs, and stakeholder interests.

*"Empathy helps us to better understand our users, particularly when the users are diverse, and integrate their needs and wants into our designs. It helps us ensure that our design solutions will be useful to our users."*

*"At a broader level, empathy informs all design decisions. Buildings are not machines, they accommodate and support the action and lives of the people who occupy them. The sense of empathy must extend to all users."*

Some instructors also noted the essential role empathy plays in successful interpersonal interactions and communication. These skills are sometimes referred to as “soft skills,” differentiating them from technical or “hard skills.”

*“It is a soft skill that is absolutely essential in understanding how to work and collaborate in groups.”*

*“Engineering requires trust relationships with customers, employers, and society and these need emotional connection.”*

*“It’s a personal or interpersonal skill not an engineering skill.”*

Empathy’s role in ethical decision making and an engineer’s ability to remain cognizant of their impact on the world around them was also expressed by instructors.

*“Empathy underpins ethical decision making and action. If we can’t do engineering ethically, we shouldn’t do it.”*

*“I think empathy plays a role in the two most important priorities in engineering practice, safety and protection of the environment.”*

*“Engineers are human beings first. If not able to view any problem etc. through an empathic lens, they might go do something crazy like work for a large company that works with repressive governments to create technology that surveils their citizens.”*

Instructors also mentioned empathy’s role in the classroom, helping them to create better courses and a more supportive atmosphere for students.

*“In design projects, developing projects, in course development and course activities, in assessment, etc.”*

*“Most profs were excellent students, so we need to imagine the struggles faced by the more average students. Also, we tend to act like our course is the only or most important course the students are taking, so we need to adjust our expectations of what the students can realistically accomplish in a semester full of other demands.”*

No negative themes, or themes reflecting the belief that empathy has no value or role in professional practice, were generated from this data. This is consistent with quantitative data collected as part of this survey, where all participants ranked empathy as at least moderately important as a professional skill in engineering [45].

### 3.3 Advantages and reasons for teaching

The results of this section were very similar to the prior section related to the professional role and value of empathy:

- Improves "soft" (interpersonal) skills,
- Improves engineering and architectural outcomes,
- Improves understanding of professional role and ethical expectations, and
- Improves the learning environment.

The alignment of the two themes is interesting to note and leads to an interesting angle to dig further into future research. The differences emerged as they relate specifically to learning environment specifically noting the importance of training to help students *become* engineers. Again, instructors noted the importance of empathy to different elements of engineering work and improving engineering outcomes. Those who taught empathy in their courses often did so because they felt it helped students to understand users, consider appropriate human factors, prioritize safety and ultimately develop better designs and problem solutions. These reasons were also listed by many instructors as advantages of empathy instruction.

*"Designing for safety requires the consideration of human behavior."*

*"Empathy wasn't explicitly identified as a teaching item in the course. It is intrinsic to the design process, and therefore is part of the subject matter regardless of whether or not it is defined expressly in the course."*

While it was common for instructors to discuss empathy's role in design courses, one participant described how they integrate empathy instruction into their Computational Design course. In addition to being unique, this response is particularly interesting given the common assumption that empathy instruction does not have a role to play in courses covering highly technical content.

*"A tenant of "modern" programming is that you are writing code less for the computer and more for others and that should consider the impact of your coding choices on those others."*

Soft skill development was noted as an advantage of empathy instruction. Some respondents chose to include empathy in their courses to improve students' teamwork and interpersonal communication skills.

*"It will help students to better understand their users. It can help the students better understand each other, thus improving teamwork."*

*"It is a "soft skill" that can be beneficial to a career (particularly in management roles)."*

A number of instructors saw empathy instruction as one way to help students gain a better understanding of the role and ethical obligations of a professional engineer.

> *"Many of our students come to us with the misunderstanding that engineering is about calculations and modelling the world. It isn't, it is about helping people. By teaching empathy we explicitly state that understanding people is important to engineering practice, and hopefully students will be able to reframe how they see their role as professional engineers, which will improve their overall effectiveness at work."*
>
> *"It will make the work they do contribute better to social good."*
>
> *"Without it, we design robots to design robots."*

Using empathy in the classroom to improve learning environments and support students was also a sentiment expressed by instructors. Even those who rejected the idea of teaching empathy directly noted the importance of using empathy to inform one's teaching style and relationship with students.

> *"Improve learner to learner communication, improve instructor-learner communication. Get students, and instructors close to each other, creating an EDI environment where everyone feels equal."*
>
> *"Have empathy as an instructor is something we should be pushing for, but teaching it sounds ridiculous."*

### 3.4 Challenges and reasons for not teaching

When asked to consider challenges and reasons for not teaching empathy, the following themes emerged:

- Determining how to integrate empathy into courses and curriculum,
- Determining how to navigate this content as an instructor,
- Confronting traditional practices and cultural norms in engineering, and
- Empathy-focused instruction does not belong in my course or the engineering curriculum.

Despite the many positive attitudes toward empathy-focused instruction shared throughout this survey, instructors also expressed concerns regarding how to practically integrate this type of instruction into their courses and the curriculum. Respondents expressed concerns relating to their own or their colleagues' ability to teach empathy. Other complications instructors could face when teaching empathy-focused content were also mentioned, including being required to model empathy and establishing boundaries.

*"I'm not qualified to teach empathy. That activity might have a place in a design course but I fail to see how it belongs as content in a physics or math course for example."*

*"We may not have familiarity with these topics and therefore feel uncomfortable teaching them. If we are expecting empathy from our students, they will expect it from us."*

*"Boundaries are important, becoming too personally emotionally invested may lose perspective."*

Instructors also described a variety of challenges relating to how empathy might be embedded at the course and curriculum level more broadly, noting that it would be important to ensure consistency across courses and years, and that some teaching formats may be inappropriate for this type of instruction. Course and curriculum concerns were reasons respondents gave for not including empathy instruction in their courses.

*"Challenges – who to do it, how to do it, how to measure it, and where in the curriculum (the perpetual space problem)."*

*"Empathy instruction may take place via a computer module (!!) or an instructor who is not empathic, even if empathy bumped into them (!!!)"*

In addition to these concerns, respondents discussed the challenge of integrating empathy instruction into an engineering culture that has traditionally devalued non-technical skills. While some responses discussed this challenge in relation to the profession, others focused on the probability that other faculty and students would be more interested in technical content.

*"The fact that engineering culture does not value this trait. Engineers see only the technical and things that can be quantified."*

*"Students and faculty expect mostly technical content."*

The perception that their colleagues may not be receptive to empathy-focused instruction was confirmed by other responses that strongly rejected empathy as a teachable subject, or one that ought to be taught in engineering at all.

*"Engineering is a technical degree. People study for nursing, counselling, or other human-facing jobs probably have explicit modules in this, but I don't see this happening in Engineering."*

*"As a topic in the engineering sciences it quite simply does not belong in the courses I teach."*

*"[The main challenge of empathy-focused instruction is] the ridiculousness of it. Also, it's too late. The students' personalities were set in stone long before they got to U of W."*

Even instructors who did see the value of teaching empathy skills in engineering courses had some difficulty seeing how it would fit into their courses, specifically. When asked why they had not included empathy-focused instruction in their courses, instructors commonly noted empathy was not compatible with their, often highly technical, course content.

*"My graduate level and upper courses were purely technical."*

*"Did not think of it. Much of what I teach is factual and not behavioral."*

**4.0 Discussion**

This study provides a timely overview of instructor perspectives of empathy that demonstrates a shift in perspective since Strobel et al.'s [3] survey of engineering faculty a decade ago. While Strobel et al.'s [3] found that engineering faculty were not in favor of adding empathy-focused instruction to the engineering curriculum, this work demonstrates that a wider diversity of viewpoints now exist. In our study there are still engineering instructors who do not see a place for empathy in engineering education, others have explicitly stated that they have integrated empathy into their teaching. Some instructors noted the potential value of empathy in engineering education, but in parallel identified important barriers to its inclusion. This wider diversity of perspectives aligns with the increased attention that has been placed on empathetic pedagogies in the past decade, including Walther's work in this area [4], [29] among others.

This diversity of perspectives extends beyond the role of empathy in engineering education and extends to the foundation of defining empathy in the context of engineering. There is a lack of consensus regarding the definition of the term "empathy" in the literature [1], [18], [19], [20], [21], [22]. In our study, we asked participants to provide their own definition of empathy and their responses mirrored the literature in that they lacked consensus and spanned the empathy spectrum, including sympathy, empathy, and care. While definitions related to perspective taking and cognitive and affective domains of empathy were the most common from respondents, it is important to note that several respondents gave definitions that aligned with *sympathy* rather than empathy. This misconception could represent a barrier to the integration of empathy in engineering education and represents an important area of future work and study.

Four key roles empathy in engineering education could hold, as identified by respondents, were: (1) improved "soft" (interpersonal) skills, (2) improved engineering/architectural outcomes, (3) enhanced ethical decision making and impact awareness, and (4) supported instructor-student interactions. The themes demonstrate diverse perspectives on the role of empathy in engineering education and suggest that instructors interpreted this question in differing ways based on their own preconceived notions of empathy and its role in an engineering classroom. The theme of supporting instructor-student interactions aligns with "teacher empathy" [46] and appears to be a long-standing viewpoint of engineering faculty [3].

Theme 1 – *improved "soft" (interpersonal) skills* and theme 3 – *enhanced ethical decision making and impact awareness* align well with professional expectations as outlined by engineering societies and regulatory bodies. Empathy's role as essential to ethical decision making and impact awareness has clear connections with expected engineering responsibilities of managing safety risks, considering environmental impacts, and protecting the wellbeing of clients and communities. These responsibilities are laid out in an engineer's fundamental duty to "1. Hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace" [9, p. 3]. Instructors also identified empathy as playing a key role in a variety of "soft skills," like teamwork, communication, managerial skills, and the promotion of safe and respectful workplaces. The importance of these interpersonal skills to engineering practice is highlighted by professional codes of conduct. Professional Engineers Ontario's Code of Ethics [10] specifically outlines the expectation that engineers will "co-operate in working with other professionals"(s. 77.6) and "act toward other practitioners with courtesy and good faith" (s. 77.7(i)) illustrating the significance of interpersonal skills and collaboration in engineering work. Engineers Canada's [9] code of ethics also expects engineers to "5. Conduct themselves with integrity, equity, fairness, courtesy and good faith towards clients, colleagues and others, give credit where it is due, and accept, as well as give, honest and fair professional criticism" (p.3), all activities that require or are enhanced by a strong sense of ethics and interpersonal skills. For a more in-depth discussion of empathy's relationship to ethics and professional codes of conduct, see [14].

Many of the engineering skills and abilities participants believed empathy could improve have also been explicitly identified as important outcomes of an engineer's post-secondary training. Like the professional codes of ethics outlined above, ABET [33] and CEAB [34] accreditation criteria for engineering programs expect graduating students to have the ability to make ethical decisions that reflect the values of their profession and to consider the impact of their work on the environment and communities it touches. ABET and CEAB accreditation criteria also require engineering graduates to have developed communication, teamwork, and leadership skills by the time they graduate. As previously noted, respondents frequently identified empathy as playing an important role in engineers' ability to make ethical decisions, reflect on the impact of their work, communicate, collaborate, and manage others. This appeared in both the instructor open-ended responses and in closed-ended question where instructors identified teamwork most frequently as the CEAB graduate attribute that would be supported by empathy instruction [45]. Participants also noted empathy's role in creating designs that are more reflective of user wants and needs, another skill ABET [33] and CEAB [34] expect engineering graduates to have developed as part of their post-secondary training.

Although participants acknowledged the role empathy plays in many of the same skills and abilities identified by professional societies and accreditation boards as important to engineering practice, they were not always supportive, and in some cases explicitly rejected the inclusion of empathy-focused instruction in the engineering curriculum. In some cases, instructors who rejected empathy as an engineering skill, still acknowledged that it could improve relationships within the classroom.  It is possible that this disconnect reflects traditional views within engineering culture that frame technical work as the highest form of engineering. Viewing empathy as a non-technical "soft skill," instructors holding more traditional views may find it difficult to acknowledge empathy's use in engineering, even if they are able to see its value in improving class dynamics. This rejection of empathy as a teachable engineering skill were also expressed in response to this study's quantitative survey questions, where all participants ranked empathy as at least "moderately important" as a professional skill in engineering. However, when asked how important it is to teach empathy in an engineering undergraduate program, responses ranged from "extremely important" to "not at all important" [45]. While those who did not support teaching empathy in engineering courses were outnumbered by participants that were in favor of exploring empathy-focused instruction, the resistance to teaching empathy amongst a subset of engineering instructors is important to acknowledge. It is also important to note that the nature of the survey itself with an explicit focus on empathy may have yielded a response bias where instructors were more likely to complete the survey if they felt empathy had a place in engineering education and that there may be more resistance to teaching empathy amongst instructors than was captured.

Respondents explicitly discussed traditional values in engineering as a barrier to including empathy-focused instruction in their courses and the curriculum. Many instructors believed these views were held by their colleagues, while others felt students also preferred technical content. Some responses presented strong views that empathy-focused instruction has no place in engineering, often due to their belief that engineering is a primarily technical degree. This confirms that faculty resistance and traditional engineering values may indeed represent a challenge to the widespread implementation of empathy-focused instruction. Engineering programs that encourage students to prioritize technical proficiencies at the expense of non-technical skills risk encouraging a culture of disengagement which may cause students to lose sight of important non-technical considerations like public welfare, ethics, user wants and needs, and safety [37] and does not afford students the opportunity to practice the "mode switching" recommended by Walther et al. (2017). The inclusion of empathy-focused instruction in the engineering curriculum is one powerful way engineering educators can combat the culture of disengagement. Empathy instruction not only helps students to understand the utility of non-technical skills in engineering work, but directly addresses problematic outcomes of a culture of disengagement. Through improving students' ability to consider user perspectives and encouraging them to reflect on the impact of their work on the communities and environments it touches, empathy-focused instruction can help students to refocus on ethical considerations and the protection of public welfare.

While some instructors discussed engineering's traditional cultural beliefs as a challenge to implementing empathy-focused instruction, others focused on practical challenges related to how empathy would be taught and effectively implemented in engineering courses and across the curriculum. The overarching sentiment expressed by respondents was if empathy were to be taught, it ought to be taught effectively. Instructors worried their colleagues may be disinterested in the topic or lack empathy skills themselves, resulting in poor teaching. Instructors also expressed their own discomfort with teaching empathy, describing themselves as "not qualified to teach empathy" or stating that they are "not sure how one teaches empathy." Although pedagogical techniques for developing empathy skills in engineering students are gaining popularity in the literature, there still appears to be a lack of awareness among instructors as to what exactly empathy-focused instruction entails and a lack of published best practices on embedding this type of instruction in a course, particularly in the case of highly technical courses.

In addition to instructor-level concerns, respondents also described broader practical challenges to implementing empathy instruction at the course and curriculum level. Instructors identified the importance of teaching empathy consistently across different courses and years of study and acknowledge achieving this in a consistent and progressive manner as a challenge. Respondents also noted the mode of instruction would be important to effective teaching, expressing concern that empathy-focused instruction would be less effective if taught through online learning modules. The most commonly discussed course and curriculum level challenge, however, involved finding the time within content heavy courses and an overcrowded curriculum to incorporate additional content. Seeing time as a valuable and limited resource, instructors may be unlikely to consider the addition of new content to their courses and the curriculum unless they are highly motivated to make the time to cover this material. This may be particularly true in the case of empathy-focused instruction, given that many engineering instructors are unfamiliar with how this content is typically taught in an engineering context. This barrier is long standing, having been expressed by engineering faculty members interviewed by Strobel and colleagues nearly a decade ago [3]. However, it has increased import given the increasing focus on student well-being, mental health, and work-life balance in engineering undergraduate programs [47], [48].

## 5.0 Limitations & Next Steps

The primary goal of this study was to explore how engineering instructors understand empathy and its place in engineering, and their opinions and perceptions of empathy-focused instruction. As an exploratory first step, this research focused on determining what opinions and attitudes instructors held, and while some respondents did provide insight into why they viewed empathy and empathy-focused instruction as they did, it is difficult to draw rich, meaningful, well-informed conclusions based solely on open-ended survey responses. An important next step will be to conduct in-depth interviews and open-ended conversations with instructors to gain a better understanding of their viewpoints and expand on these initial findings.

This study focused exclusively on exploring the opinions and attitudes of instructors teaching at the University of Waterloo. Although this has helped us to better understand our own faculty, institutional and departmental cultures often vary significantly across institutions, limiting the generalizability of our findings. Future studies would benefit from a multi-institutional focus that allows for larger sample sizes and a broader picture of how engineering instructors view empathy and empathy-focused instruction.

As previously noted, the results presented here may be influenced by self-selection bias. While survey invitations were sent to all instructors in the Faculty of Engineering, participation in the survey was voluntary. It is possible that instructors with strong feelings for or against empathy-focused instruction were more likely to complete the survey which may have impacted the accuracy of these results.

## 6.0 Conclusions

This study's findings demonstrate that engineering instructors have varied understandings of the meaning of “empathy” that span the empathy spectrum from “sympathy” to “empathy” to “care”.

These diverse opinions of "empathy" also extend to empathy's place within engineering education with some instructors rejecting empathy in engineering education and others seeing positive roles for empathy. These varied roles include facilitating student-instructor interactions, supporting "soft" skill development, and improving academic outcomes related to engineering work and ethical decision making. Instructor-identified barriers to including empathy instruction in engineering education included a focus on traditional, technical instruction, insufficient time or place in the course and curriculum, lack of instructor knowledge, discomfort teaching empathy, and insufficient support within the institution and literature to implement empathy instruction. Important areas of future work include expanding this study to engineering instructors beyond the University of Waterloo, eliciting deeper insights from participants through interviews and conversations, and further exploring the identified barriers with the aim of developing mitigation strategies.

**Acknowledgements**

The authors would like to thank the instructors who took the time to complete our survey and share their honest thoughts and opinions with us. This research was supported by LITE Seed Grant funding at the University of Waterloo.

**References**

[1] V. Barnes and V. D. Preez, "Mapping empathy and ethics in the design process," in *7th International DEFSA Conference Proceedings*, Design Education Forum of South Africa, 2015, pp. 1–11.

[2] P. Seshadri, T. Reid, and J. Booth, "A framework for fostering compassionate design thinking during the design process," in *2014 ASEE Annual Conference & Exposition Proceedings*, Indianapolis, Indiana: ASEE Conferences, Jun. 2014, p. 24.51.1-24.51.20. doi: 10.18260/1-2--19943.

[3] J. Strobel, J. Hess, R. Pan, and C. A. Wachter Morris, "Empathy and care within engineering: Qualitative perspectives from engineering faculty and practicing engineers," *Engineering Studies*, vol. 5, no. 2, pp. 137–159, Aug. 2013, doi: 10.1080/19378629.2013.814136.

[4] J. Walther, M. A. Brewer, N. W. Sochacka, and S. E. Miller, "Empathy and engineering formation," *J. Eng. Educ.*, vol. 109, no. 1, pp. 11–33, Jan. 2020, doi: 10.1002/jee.20301.

[5] J. D. Lee, C. D. Wickens, Y. Liu, and L. N. Boyle, *Designing for People: An Introduction to Human Factors Engineering*, 3rd edition. Charleston, SC: CreateSpace Independent Publishing Platform, 2017.

[6] D. Leonard and J. F. Rayport, "Spark innovation through empathic design," *Harvard Business Review*, vol. 75, no. 6, pp. 102–113, Dec. 1997.

[7] M. Lewrick, P. Link, and L. Leifer, *The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods*, 1st edition. Hoboken, New Jersey: Wiley, 2020.

[8] X. Tang, "From 'empathic design' to 'empathic engineering': Toward a genealogy of empathy in engineering education," in *2018 ASEE Annual Conference & Exposition Proceedings*, Salt Lake City, Utah: ASEE Conferences, Jun. 2018, p. 30538. doi: 10.18260/1-2--30538.

[9] Engineers Canada, “Public guideline on the code of ethics,” Engineers Canada. Accessed: May 17, 2023. [Online]. Available: https://engineerscanada.ca/publications/public-guideline-on-the-code-of-ethics
[10] Government of Ontario, *Professional Engineers Act*. 2014. Accessed: May 17, 2023. [Online]. Available: https://www.ontario.ca/laws/view
[11] National Society of Professional Engineers, “NSPE code of ethics for engineers,” National Society of Professional Engineers. Accessed: May 17, 2023. [Online]. Available: https://www.nspe.org/resources/ethics/code-ethics
[12] Engineering Council and Royal Academy of Engineering, “Statement of ethical principles for the engineering profession,” Engineering Council. Accessed: May 17, 2023. [Online]. Available: https://www.engc.org.uk/standards-guidance/guidance/statement-of-ethical-principles/
[13] ENGINEERS EUROPE, “ENGINEERS EUROPE position paper on code of conduct: Ethics and conduct of professional engineers.” European Federation of National Engineering Associations, Jul. 10, 2022. [Online]. Available: https://www.engineerseurope.com/sites/default/files/Code_of_Conduct_ENGINEERS_EUROPE.pdf
[14] J. Howcroft, K. Mercer, and J. Boger, “Developing ethical engineers with empathy,” in *Proceedings of the Canadian Engineering Education Association (CEEA)*, Charlottetown, PEI: Canadian Engineering Education Association, Jun. 2021. doi: 10.24908/pceea.vi0.14856.
[15] J. L. Hess, J. Strobel, and R. (Celia) Pan, “Voices from the workplace: Practitioners’ perspectives on the role of empathy and care within engineering,” *Engineering Studies*, vol. 8, no. 3, pp. 212–242, Sep. 2016, doi: 10.1080/19378629.2016.1241787.
[16] J. L. Hess, J. Strobel, R. (Celia) Pan, and C. A. Wachter Morris, “Insights from industry: A quantitative analysis of engineers’ perceptions of empathy and care within their practice,” *European Journal of Engineering Education*, vol. 42, no. 6, pp. 1128–1153, Nov. 2017, doi: 10.1080/03043797.2016.1267717.
[17] E. Wilson and P. Mukhopadhyaya, “Role of empathy in engineering education and practice in north america,” *Education Sciences*, vol. 12, no. 6, pp. 420–432, Jun. 2022, doi: 10.3390/educsci12060420.
[18] C. D. Batson, “These things called empathy: Eight related but distinct phenomena,” in *The Social Neuroscience of Empathy*, J. Decety and W. Ickes, Eds., The MIT Press, 2009, pp. 3–16. doi: 10.7551/mitpress/9780262012973.003.0002.
[19] J. Strobel, C. A. Wachter Morris, L. Klingler, R. (Celia) Pan, M. Dyehouse, and N. Weber, “Engineering as a caring and empathetic discipline: Conceptualizations and comparisons,” in *Proceedings of Research in Engineering Education Symposium*, Madrid, Spain, Oct. 2011, pp. 603–616. Accessed: Apr. 14, 2023. [Online]. Available: https://www.researchgate.net/profile/Johannes-Strobel/publication/288398464_Engineering_as_a_caring_and_empathetic_discipline_Conceptualizations_and_comparisons/links/574d0d1708ae82d2c6bc8c47/Engineering-as-a-caring-and-empathetic-discipline-Conceptualizations-and-comparisons.pdf
[20] J. A. Hall and R. Schwartz, “Empathy, an important but problematic concept,” *The Journal of Social Psychology*, vol. 162, no. 1, pp. 1–6, Jan. 2022, doi: 10.1080/00224545.2021.2004670.

[21] D. Jeffrey, “Empathy, sympathy and compassion in healthcare: Is there a problem? Is there a difference? Does it matter?,” *J R Soc Med*, vol. 109, no. 12, pp. 446–452, Dec. 2016, doi: 10.1177/0141076816680120.
[22] Y. Zhao, L. Fuller, and K. K. Daugherty, “Evaluating pharmacy faculty perceptions of empathy in education: A qualitative study,” *Currents in Pharmacy Teaching and Learning*, vol. 13, no. 8, pp. 975–981, Aug. 2021, doi: 10.1016/j.cptl.2021.06.014.
[23] M. Kouprie and F. S. Visser, “A framework for empathy in design: Stepping into and out of the user’s life,” *Journal of Engineering Design*, vol. 20, no. 5, pp. 437–448, Oct. 2009, doi: 10.1080/09544820902875033.
[24] S. Darwall, “Empathy, sympathy, care,” *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, vol. 89, no. 2/3, pp. 261–282, 1998.
[25] F. Valente, “Empathy and communication: A model of empathy development,” *Journal of New Media and Mass Communication*, vol. 3, no. 1, pp. 1–24, 2016, doi: 10.18488/journal.91/2016.3.1/91.1.1.24.
[26] K. E. Gerdes, E. A. Segal, K. F. Jackson, and J. L. Mullins, “Teaching Empathy: A Framework Rooted in Social Cognitive Neuroscience and Social Justice,” *Journal of Social Work Education*, vol. 47, no. 1, pp. 109–131, Jan. 2011, doi: 10.5175/JSWE.2011.200900085.
[27] J. L. Hess and N. Fila, “The development and growth of empathy among engineering students,” in *2016 ASEE Annual Conference & Exposition Proceedings*, New Orleans, Louisiana: ASEE Conferences, Jun. 2016, p. 26120. doi: 10.18260/p.26120.
[28] G. Guanes, L. Wang, D. A. Delaine, and E. Dringenberg, “Empathic approaches in engineering capstone design projects: Student beliefs and reported behaviour,” *European Journal of Engineering Education*, vol. 47, no. 3, pp. 429–445, May 2022, doi: 10.1080/03043797.2021.1927989.
[29] J. Walther, S. E. Miller, and N. W. Sochacka, “A model of empathy in engineering as a core skill, practice orientation, and professional way of being: A model of empathy in engineering,” *J. Eng. Educ.*, vol. 106, no. 1, pp. 123–148, Jan. 2017, doi: 10.1002/jee.20159.
[30] R. C. Campbell, K. Yasuhara, and D. Wilson, “Care ethics in engineering education: Undergraduate student perceptions of responsibility,” in *2012 Frontiers in Education Conference Proceedings*, Oct. 2012, pp. 1–6. doi: 10.1109/FIE.2012.6462370.
[31] N. W. Sochacka, K. M. Youngblood, J. Walther, and S. E. Miller, “A qualitative study of how mental models impact engineering students’ engagement with empathic communication exercises,” *Australasian Journal of Engineering Education*, vol. 25, no. 2, pp. 121–132, Jul. 2020, doi: 10.1080/22054952.2020.1832726.
[32] A. I. Jack *et al.*, “fMRI reveals reciprocal inhibition between social and physical cognitive domains,” *NeuroImage*, vol. 66, pp. 385–401, Feb. 2013, doi: 10.1016/j.neuroimage.2012.10.061.
[33] Accreditation Board for Engineering and Technology, “2022-2023 criteria for accrediting engineering programs.” ABET, 2021. Accessed: May 30, 2023. [Online]. Available: https://www.abet.org/wp-content/uploads/2022/01/2022-23-EAC-Criteria.pdf
[34] Canadian Engineering Accreditation Board, “2022 accreditation criteria and procedures,” Engineers Canada. [Online]. Available: https://engineerscanada.ca/sites/default/files/2022-11/Accreditation_Criteria_Procedures_2022.pdf

[35] T. Shepard, "Empathy lesson as a means of shifting student perception on role of engineer," in *2022 ASEE Annual Conference & Exhibition*, Minneapolis, MN: American Society for Engineering Education, Aug. 2022. [Online]. Available: https://peer.asee.org/40780

[36] S. Secules, N. W. Sochacka, J. L. Huff, and J. Walther, "The social construction of professional shame for undergraduate engineering students," *J Eng Educ*, vol. 110, no. 4, pp. 861–884, Oct. 2021, doi: 10.1002/jee.20419.

[37] E. A. Cech, "Culture of disengagement in engineering education?," *Science, Technology, & Human Values*, vol. 39, no. 1, pp. 42–72, Jan. 2014, doi: 10.1177/0162243913504305.

[38] V. Braun and V. Clarke, "Reflecting on reflexive thematic analysis," *Qualitative Research in Sport, Exercise and Health*, vol. 11, no. 4, pp. 589–597, Aug. 2019, doi: 10.1080/2159676X.2019.1628806.

[39] V. Braun and V. Clarke, "One size fits all? What counts as quality practice in (reflexive) thematic analysis?," *Qualitative Research in Psychology*, vol. 18, no. 3, pp. 328–352, Jul. 2021, doi: 10.1080/14780887.2020.1769238.

[40] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101, Jan. 2006, doi: 10.1191/1478088706qp063oa.

[41] V. Braun and V. Clarke, *Thematic analysis: A practical guide*. Thousand Oaks, CA: SAGE Publications, 2022.

[42] D. Byrne, "A worked example of Braun and Clarke's approach to reflexive thematic analysis," *Qual Quant*, vol. 56, no. 3, pp. 1391–1412, Jun. 2022, doi: 10.1007/s11135-021-01182-y.

[43] V. Braun and V. Clarke, "To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales," *Qualitative Research in Sport, Exercise and Health*, vol. 13, no. 2, pp. 201–216, Mar. 2021, doi: 10.1080/2159676X.2019.1704846.

[44] C. Rasoal, H. Danielsson, and T. Jungert, "Empathy among students in engineering programmes," *European Journal of Engineering Education*, vol. 37, no. 5, pp. 427–435, Oct. 2012, doi: 10.1080/03043797.2012.708720.

[45] J. Howcroft and K. Mercer, "Where we are: Understanding instructor perceptions of empathy in engineering education," in *Proceedings of the Canadian Engineering Education Association (CEEA)*, York University, Toronto, Nov. 2022. doi: 10.24908/pceea.vi.15913.

[46] B. V. Sundaram, N. N. Kellam, and S. S. Jordan, "Understanding the perspectives of empathy among engineering faculty members," in *ASEE 2021 Annual Conference & Exposition*, Online: American Society for Engineering Education, Jul. 2021. [Online]. Available: https://peer.asee.org/37971

[47] D. Gerrard, K. Newfield, N. Balouchestani Asli, and C. Variawa, "Are Students Overworked? Understanding the Workload Expectations and Realities of First-Year Engineering," presented at the ASEE Annual Conference & Exposition, Columbus, Ohio, 2017. doi: 10.18260/1-2--27612.

[48] K. Jensen, "The Time is Now to Build a Culture of Wellness in Engineering," vol. 2, no. 2, Art. no. 2, Jun. 2021, doi: 10.21061/see.67.