A Model of Empathy in Engineering as a Core Skill, Practice Orientation, and Professional Way of Being

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Abstract

Background Engineers are increasingly being asked to empathically engage with a broad range of stakeholders. Current efforts to educate empathic engineers, however, are hindered by the lack of a conceptually cohesive understanding of, and language for, applying empathy to engineering. Prior studies have suggested that research informed by long-standing traditions in other fields may provide the rigor, conceptual clarity, and expertise necessary to theoretically ground the education and practice of empathy in technical disciplines.

Purpose This study examined three research questions: What are current understandings of empathy in engineering and engineering education? How do these understandings compare with conceptions of empathy in social work, a professional discipline that defines empathy as a core skill and orientation of its practitioners? What can engineering educators learn from social work to inform the education of empathic engineers?

Scope/Method This article presents the findings from a sustained, four-year, interdisciplinary dialogue between engineering education and social work education researchers. This effort included an examination of productive tensions and similarities between the two fields, a critical synthesis of the literature on empathy in each discipline, and the development of a context-appropriate model for empathy in engineering.

Conclusions We propose a model of empathy in engineering as a teachable and learnable skill, a practice orientation, and a professional way of being. Expanding conceptions of empathy in social work, this model additionally emphasizes mode switching and a commitment to values pluralism.

Keywords empathy; professional skills; social responsibility; transdisciplinary; social work

Introduction

From preventing nuclear terror to providing clean access to water, the grand challenges that engineers face in the twenty-first century (National Academy of Engineering, 2013) are inescapably social and technical. To address these challenges, engineers must possess not only deep technical expertise but also broader social competencies, such as empathy, communication skills, and the ability to collaborate on interdisciplinary teams. Demands for such “T-shaped” engineers (Grasso, Brown Burkins, Helble, & Martinelli, 2010; Ravesteijn, Graaff, & Kroesen, 2006) have led many engineering programs to increase their focus on communication, teamwork, and interdisciplinary collaborations. Explicit consideration of empathy,
however, is far less common (Strobel, Hess, Pan, & Wachter Morris, 2013). One barrier to incorporating empathy training into undergraduate engineering education is the lack of a “coherent framework” (Strobel et al., 2013, p. 18) that defines and contextualizes this core social competence for the specific context of engineering. To overcome this barrier, Strobel et al. (2013) suggested that studies “informed by long-standing traditions in other fields, might provide the rigor [and] conceptual clarity” (p. 3) to inform research on, and the education and practice of, empathy in technical disciplines.

Social work, a discipline that conceptualizes empathy as an essential skill and orientation of its practitioners, offers a range of theoretical frameworks and pedagogical approaches for fostering empathy in students in preparation for professional practice (Gerdes, Segal, & Lietz, 2010). In this article, we draw on the intellectual and pedagogical traditions of social work to critically synthesize the literature on empathy in engineering and develop a conceptually cohesive and context-appropriate model for empathy in engineering. Our model conceives empathy as, concurrently and inseparably, a teachable skill, practice orientation, and professional way of being. We propose that this perspective on empathy in engineering will enable engineering educators to more effectively design pedagogical interventions aimed at fostering empathy in engineering students, enable students and engineering practitioners to more holistically and thoughtfully engage with the complex, socio-technical challenges that characterize the current age, and theoretically ground further research on the role of empathy in engineering practice and education.

Social Work and Engineering

While engineering and social work may seem an unlikely combination of disciplines, we argue that the two fields share a range of productive tensions and remarkable similarities that provide fertile ground for an examination of the role of empathy in engineering.

An overarching framework or bridging paradigm between the two disciplines, which has also served to guide the long-standing collaboration of the authors, is the focus on socio-technical systems as the locus of professional practice. As we describe in more detail below, social work explicitly defines professional practice through engagement in micro (individuals), mezzo (families and groups), and macro (communities, organizations, policy) level systems with a particular emphasis on human relations and interactions. An emerging discourse in the field is challenging this anthropocentric perspective and advocating for a stronger consideration of the physical environment in the form of, for example, technical or ecological systems in which human interactions are contextualized and embedded (Berger & Kelly, 1993; Besthorn & Canda, 2002; Coates, 2003; Dominelli, 2012; Gray, Coates, & Hetherington, 2012; Mary, 2008; Miller & Hayward, 2013). In contrast to social work’s focus on human relationships, the self-definition of engineering has traditionally centered on engagement with technology, albeit with increasing attention directed towards ecological aspects in the context of sustainable design and development. The social embeddedness of engineering work has also been explored by some engineering education scholars (Fila et al., 2014; Robbins, 2007; Trevelyan, 2007). In the mainstream of the educational discourse, however, this aspect of engineering is often downplayed as pertaining to necessary, but peripheral, “soft” or professional skills (see Empathy in Engineering section). This tension between human interaction as at the core or at the periphery of these professions provided the departure point for our exploration of empathy as a central aspect of what it means to educate, and to practice as, an engineer.

Another point of connection between the two disciplines is the role of engineering and social work as professions that are sanctioned by, and ultimately intended to, serve society.
Social work centrally and explicitly defines this service through furthering the welfare of all citizens and promoting social justice (National Association of Social Workers, 1999). While engineers are required to “hold paramount the health, safety and welfare of the public” (National Society of Professional Engineers, 2015), engineering’s service to society is often characterized in more implicit ways, for example, through increasing societal prosperity and economic development (Lucena, 2005; National Academy of Sciences, 2007; Riley, 2007; Sochacka, Walther, Wilson, & Brewer, 2014). The nuanced differences, as well as the overlap between, these two overarching goals of professional practice provided the context for our discussion of empathy in engineering as an inherent and necessary aspect of a practice orientation.

On the level of the practitioner’s engagement in professional settings, both professions share philosophical commitments to pragmatism, problem solving, and change. In preparing its future practitioners, each discipline differently emphasizes the skills necessary to embody these commitments. Engineering education, for example, is underpinned by rigorous technical training in a tradition grounded in what Schön (1983) terms “technical rationality” (p. 21), an epistemology that often sits uncomfortably alongside efforts to promote professional skills in engineering programs (Kumar & Hsiao, 2007; Pulko & Parikh, 2003). In the context of such efforts, engineering educators often experience interpersonal skills, such as empathy, as vaguely defined and pedagogically elusive (Fila & Hess, 2014; Strobel et al., 2013). In contrast, social work views the use of Self as the practitioner’s central tool and, accordingly, emphasizes the explicit development of a wide range of interpersonal competencies in its undergraduate and graduate programs (Council on Social Work, 2015). From this contrast regarding the role of, and pedagogies around, interpersonal skills, we framed our exploration of empathy as a teachable and learnable skill for engineering students.

These connections between the two fields also served as departure points for, and were mirrored by, our transdisciplinary dialogue that led to the development of the model presented in this article. The shared philosophical and pedagogical commitments, as well as the productive tensions in the epistemological and ontological bases of our respective fields, presented both challenges and opportunities to us as educators and educational researchers from different disciplines. Given the nature of these differences, we emphasized a purposeful, genuine dialogue in our transdisciplinary encounter that benefited from trust and personal engagement and took, above all else, time. Over a four-year period, we met on average twice per month for often exploratory, open discussions that were not necessarily oriented towards immediate deliverables. We complemented this shared exploration and mutual learning with pursuing small-scale projects in scholarship and teaching that capitalized on local funding opportunities to generate more tangible scholarly products or teaching innovations. Trusting in and committing to this sustained exploration was personally and professionally rewarding, required a degree of risk tolerance within traditional academic structures, and, ultimately, opened a space for emergent outcomes, such as the empathy model presented here. The model combines this spirit of shared, mutual learning with a systematic analysis and creative synthesis of prior scholarly work across a range of disciplines.

**Empathy in Social Work**

This section explores the intellectual, theoretical, and applied traditions around empathy in social work. An overview of the nature and scope of pedagogical practices designed to foster empathy in social work students and practitioners is also provided. This discussion lays the conceptual groundwork for our examination of empathy in engineering.
Empathy in Professional Practice

Like engineering, social work is a profession with broad practice applications. It has deep roots in pragmatism and humanism; emphasizes social justice as a core professional value (National Association of Social Workers, 2008); and highlights cultural compassion, a strengths perspective, and collaboration in working toward empowered change for humans in the context of their environment(s). Though social workers’ practice in a variety of settings and with a variety of client systems spanning the micro–mezzo–macro continuum, the field is unified by its explicitly derived set of core values, which directly informs its professional culture and a long tradition of conceptualizing empathy as a key professional attribute. Approaches to educating social workers for practice in the context of this overarching professional orientation include, among other aspects, a rich practice of fostering empathy in students (Gerdes et al., 2010). Given the possible breadth of application in practice, social workers are educated to develop a body of knowledge, skills, and values elemental to practice across client systems (micro to macro), across diverse populations, and across practice environments. Central to all of these perspectives is the idea that social workers “start where the client is” and approach from a place of empathy, warmth, and genuineness in all interchanges. These notions are nested strongly in the values of the profession, which include service, social justice, dignity and worth of the person, importance of human relationships, integrity, and competence (National Association of Social Workers, 2008). Both implicit and explicit in this values-driven professional culture is a strengths perspective that rests on the assumption that strengths and resources exist in every environment, and that change is best made through collaborations with clients and client systems that leverage these strengths (Saleebey, 2012). This strengths perspective links directly to the idea of empowered change, which recognizes circumstances whereby a client system engaging with a social worker is an active participant in intervention and action for change, rather than a passive recipient of services.

Theoretical Foundations

Empathy has always been manifest in some form or another among humans, but has evolved with shifts in socio-cultural context (Rifkin, 2009). Conceptualizations of empathy have shifted as well. In the mid-twentieth century, psychological thinkers primarily defined empathy as a capacity, with particular emphasis on the ability to “think and feel oneself into the inner life of another person” (Kohut, 1959, p. 82) or “to sense the client’s private world as if it were your own, but without ever losing the ‘as if’ quality” (Rogers, 1957). Eventually, others built on these ideas, clarifying empathy – rather than solely a capacity applied in interpersonal processes – as a specific skill oriented to facilitating effective communication (Gerdes et al., 2010). Levenson and Ruef (1992) parsed the conceptual complexity and identified three essential qualities of empathy that appear in the body of literature: the cognitive component (knowing what another person feels), the emotional component (feeling what another person feels), and the responding component (responding with compassion to another person’s experience). Building on this understanding, the field of empathy research continues to develop with current advances including the neurobiological discovery of “mirror neurons,” nerve cells that allow sentient animals to understand the experiences of others via the mechanism of a neurological response, or “echo,” when observing behavior (Iacoboni, 2008; Keysers, 2011).

Combining the expansive psychological literature with emerging neurobiological research, Decety and Moriguchi (2007) defined empathy as rooted in four observable neural networks
that map to the following four components of empathy: affective sharing, self-awareness, mental flexibility and perspective taking, and emotion regulation. Social work has employed these shifting, and increasingly parsimonious, definitions of empathy in informing approaches to social work education and also practice. Social work, with its emphasis on social justice and larger socio-structural issues, also extends applications of empathy beyond individuals and interpersonal relationships to larger socio-structural issues. Segal (2011) offered a theoretical framework for social empathy, which is grounded in the most current psychological and neurobiological conceptualizations of empathy but expands its reach to larger social structures. She defines social empathy as

The ability to understand people by perceiving or experiencing their life situations and as a result gain insight into structural inequalities and disparities. Increased understanding of social and economic inequalities can lead to actions that effect positive change, social and economic justice, and general well-being. (p. 267)

According to Decety and Moriguchi’s (2007) conceptualization, taking action on the basis of the affective response and cognitive processing is not a necessary component of empathy. From a social work perspective, however, having empathic feelings alone and extending those into the realm of perspective taking does not capture the full complex of empathy – empathy extends to the decision-making process, informed by a conscious choice toward action. The action is chosen on the basis of the affective response and the cognitive processing (Gerdes & Segal, 2009); it is via the action that empathy extends into the space of Segal’s (2011) conceptualization of social empathy. Decety and Moriguchi’s (2007) definition of empathy and Segal’s (2011) social empathy together provide an organizing framework that we will draw on to develop a model of empathy for engineering.

Teaching for Empathy

Empathy – as a construct, required skill, process, and orientation – appears consistently across social work practice textbooks (e.g., Gambrill, 2012; Hepworth & Larsen, 2010; Johnson & Yanca, 2010; Miley & DuBois, 2011; Shulman, 2011; Zastrow, 2012). In these textbooks, discussions of empathy vary in detail, but all identify empathy as a key foundational element of social work practice. In one of the most widely used practice texts, Hepworth et al. (2010) devote 18 pages to defining empathy, presenting its relevance in communication, and its application. In their framework, empathy is operationalized across five levels of increasing responsive depth (low to high). Students are provided with detailed explication of each level. Then students read a series of case-based responses and determine at which level of empathic depth each fits. The purpose of these exercises is to enhance students’ ability to develop their own empathic responsiveness in communication. Beyond its specific location in social work practice classes, empathy and its relevance to social work also appear across the curriculum. Empathy is specified in the Council on Social Work Education’s Educational Policy and Accreditation Standards (2015) as an essential element of core practice competence; accredited social work programs in the United States must then teach toward this aspect of competence. In addition, then, to the explicit emphasis on teaching toward the development of empathy as a skill, because of the unique values structure of the profession, there is a concurrent emphasis on teaching toward empathy as an orientation (Gerdes, Segal, Jackson, & Mullins, 2011). Social work students, both undergraduate and graduate, are asked to engage directly with this set of professional values and to critically reflect on their own personal values in relationship to these. Because of the profession’s commitment to the inherent worth of
multiple and diverse perspectives, students are never asked to alter their personal values, but instead to engage critically with the professional values: students consider how they translate values into action, determine whether there are any value conflicts, and, if there are conflicts, learn how to negotiate those in professional practice. This critical reflection around values is an essential aspect of empathic engagement because it orients the developing social work practitioner toward deep recognition of multiple perspectives and also the ways in which those perspectives manifest in people’s actions. It is from this place that empathically informed decisions are made in the context of praxis. In teaching toward empathy, then, as a skill and an orientation, a variety of other methods can be applied, including those that emphasize mirror neuron activity and involve the use of videos, role plays, mindfulness practice, art, and finally cases designed to provide opportunities to consider social action (Gerdes, Segal, Jackson, & Mullins, 2011).

**Empathy in Engineering**

This section presents a critical synthesis of the literature on empathy in engineering, with a particular focus on empathy as a professional skill and empathic design. As we will demonstrate, this discourse is characterized by a range of diffuse and disparate understandings that currently hamper research and pedagogical development efforts.

**Empathy as a Skill**

**Calls for empathic engineers** Empathy is often highlighted as one of a broad range of professional skills for twenty-first-century engineers (Penzenstadler, Haller, Schlosser, & Frenzel, 2009). In these discussions, empathy is classified as a “soft” or “professional” skill, as opposed to a “hard” or “core” skill. Patil (2005), for instance, listed the need for an “awareness of engineering ethics and empathy skills” (p. 51) alongside five other “soft skills,” such as competence in managerial and organizational matters, and understanding safety and sustainability issues. Similarly, Hecker (1997) noted how soft skills such as “active listening skills, the ability to show concern and empathy, and a positive attitude” (p. 63) “may have as great an influence over an engineer’s overall career success as technical competence” (p. 62).

In parallel to these discussions, the increasingly globalized nature of society is also cited as an important reason for engineering students to develop professional and particularly empathic skills (Rasoal, Danielsson, & Tomas, 2012). Balaji and Somashekar (2009), for example, argued that “soft skills for engineers have become indispensable in this highly competitive global environment” (p. 50). More specifically, Sheppard, Dominick, and Aronson (2004) explained how having empathy for others can help engineering leaders to navigate challenges associated with differing cultures, languages, and virtual teams.

Despite a growing recognition of the importance of empathy for contemporary engineering practice, the professional skills literature does not provide guidance on how to foster empathy in undergraduate engineering programs.

**Emotional intelligence** Empathy is one of five components, alongside self-awareness, motivation, self-regulation, and adeptness in relationships, that together constitute the notion of emotional intelligence (EQ; Goleman, 1998). In engineering, Riemer (2003) argued that EQ “makes a considerable impact on communication skills” and can act “as an enhancer for work skills and employment opportunities” (p. 189), particularly in intercultural contexts (Riemer & Jansen, 2003). Similarly, Culver (1998) explained that in order to ensure the long-term success
of engineering students, educators must attend not only to students’ cognitive development but also to the affective dimensions of intelligence, that is, EQ. In contrast to the professional skills literature, this body of work points to a range of activities that can support the development of EQ in engineering students, including role play, peer reviews, increased opportunities for communication and reflection, learning another language (Riemer, 2003, 2004, 2007; Riemer & Jansen, 2003), and stress management and conflict resolution training (Culver, 1998).

While this research does not focus specifically on empathy, it is relevant to our goal of developing a coherent understanding of empathy in engineering because it suggests that EQ and thereby empathy, is a teachable and learnable skill. This assumption stands in contrast to other studies in engineering, which have described empathy as a fixed personality trait. As Vallero and Vesilind (2006) stated, “it is not possible to choose to have or not to have empathy. One either has empathy or one does not. One either cares for those in need, or one does not” (p. 273).

The literature on EQ in engineering offers disparate perspectives on the relationship between EQ and morally informed practice. Paraphrasing Goleman, Culver (1998) wrote that

> People who are empathic are attuned to the subtle social signals that indicate what others need or want. Empathy kindles altruism, which is the basis for social morality. (p. 2)

In contrast, Riemer (2003) explained how

> The emotional skills offered through EQ are morally neutral, similar to intellectual skills. EQ does not provide values that actually govern their use. For example, intellect can generate a cure for cancer or manufacture deadly biological weaponry. Likewise, EQ can inspire colleagues or exploit them. (p. 189)

This lack of conceptual clarity regarding the nature and purpose of empathy, in this case as part of EQ, presents a challenge to engineering educators who wish to integrate such skills training into undergraduate programs.

**Empathic and analytical thinking** In addition to arguing that EQ is crucial to professional success, proponents of EQ training in engineering also assert a positive relationship between EQ and effective learning (Culver, 1998; Riemer, 2003). Other studies have contradicted this claim. For example, based on survey data from 177 undergraduate engineering students, Lakshmi and Rama (2014) found no significant relationship between EQ and academic performance. Emerging neurological research may help to explain this finding. Specifically, a study conducted by Jack et al. (2013) identified a reciprocal inhibitory relationship between “tasks requiring social cognition, i.e., reasoning about the mental states of other persons, and tasks requiring physical cognition, i.e., reasoning about the causal/mechanical properties of inanimate objects” (p. 385). In other words, Jack et al. and others (e.g., Small, Loewenstein, & Slovic, 2007) have argued that analytical thinking suppresses the ability to respond empathically at the micro level of individual cognitive processes.

A longitudinal study conducted by Cech (2014) illustrated the inverse relationship between empathic and analytic thought processes on a broader curricular level. In her study, Cech (2014) surveyed 236 engineering students at four U.S. colleges and found that students’ “public welfare commitments and public welfare concerns decline[d] significantly over the course of their engineering education” (p. 42). Cech attributed this finding to a “culture of disengagement,” in which “social” competencies are devalued and “any ‘non-technical’ concerns such as public welfare [are framed] as irrelevant to ‘real’ engineering work” (p. 45). Jack et al.’s (2013) research points to the possibility that engineering students’ tendency to devalue the social might be due not only to cultural but also neurobiological factors. We suggest that
both Jack et al.’s and Cech’s studies underscore the importance of explicit instruction in empathic ways of engaging with others so as to counteract any disengagement that might occur as a result of the analytical focus of undergraduate engineering programs.

**An opportunity for change** This review of the literature presents empathy in engineering as, first and foremost, a means to an end, or “tool to take off the shelf,” when there is likely to be some personal or professional benefit from doing so. As Riemer (2004) wrote, “the skillful recognition of others’ emotional reactions and empathy [enables engineers] to come across as genuine and warm, which will achieve greater cooperation from others” (p. 232; italics added). This utilitarian approach to empathy stands in contrast to conceptualizations of empathy in social work, which are underpinned by a commitment to social justice and focus on using the Self as a means to engage with and achieve improved outcomes for, and in collaboration with, the Other (Saleebey, 2012).

In engineering, the tension between employing empathy for oneself or for others, including both individuals and society at large, has been previously characterized by Strobel et al. (2013) as the difference between asking “How might empathy . . . help me in terms of becoming successful, delivering reliable products, or designing solutions?” and “How might empathy . . . enable me to help the other?” (p. 19). While we acknowledge the potential for mutually beneficial outcomes regardless of which question drives our practice, the inherent contrasting nature of these two perspectives is problematic for engineering educators who desire, or are being called upon, to foster empathic skills in students. Moreover, Cech’s (2014) study underscores the immediate need for engineering programs to foster a focus on and the valuing of others, i.e., the public, if engineers are to fulfill their ethical obligation to “hold paramount the health, safety and welfare of the public” (National Society of Professional Engineers, 2015). We contend that conceptualizing empathy solely as a professional skill or morally-neutral component of EQ will not address this need. We explore the tension between employing empathy for products or for people more deeply in our examination of empathic design.

**Empathic Design**

**Definitions** While empathic design is not limited to the field of engineering, discussions of empathic design are increasingly intersecting with, and informing discussions of, engineering design and practice (Algra & Johnston, 2015; Kouprie & Visser, 2009; Vallero & Vesilind, 2006; Zoltowski, Oakes, & Cardella, 2012). Generally speaking, empathic design can be described as offering an alternative to what Koskinen and Battarbee (2003) referred to as “designer-centered design” (p. 45). As Steen, Kuijt–Evers, and Klok (2007) explained, “The basi[c] movement of empathic design is that of researchers and designers moving towards end-users, of trying to get closer to their live[s] and work, of trying to empathise [sic] with them, with their experience and emotions” (p. 10). Empathic design is defined and enacted in various ways with nuanced but important differences. One such subtle difference lies in descriptions of empathic design as a type of user- versus human-centered design practice. Postma, Zwartkruis-Pelgrim, Daeman, and Du (2012), for example, defined empathic design as an “approach that is directed towards building creative understanding of users and their everyday lives for new product development” (p. 59). Alternatively, Zoltowski, Oakes, and Cardella (2012) described empathic design as a “human-centered” approach, noting that “although user-centered and human-centered design approaches are similar, user-centered design focuses on the end-user of the product, whereas human-centered design considers the stakeholders more broadly than the stereotypical user” (p. 31; see also Krippendorff, 2006).
Motivations  Engineers and designers have many motivations for choosing to engage in empathic design. Steen (2007) described these motivations as ranging from “a business-like approach . . . to a more creativity-like approach” (p. 10), the latter of which is often associated with higher levels of designer immersion (versus observation; Koskinen & Battarbee, 2003) and the involvement of users and other stakeholders as partners in the problem definition and solving process (Battarbee, Fulton Suri, & Gibbs Howard, 2014; Fila et al., 2014; Postma et al., 2012). Representing the business-oriented perspective, early proponents of empathic design, Leonard and Rayport (1997), explained,

Almost every company competes to some degree on the basis of continual innovation. And to be commercially successful, new product and service ideas must, of course, meet a real – or perceived – customer need. Hence the current managerial mantras: “Get close to the customer” and “Listen to the voice of the customer.” (p. 103)

Specifically, Leonard and Rayport outlined how, in contrast to market research and other conventional needs analysis techniques, empathic design centers on the observation of users in their own environment with the view to uncovering what Slater and Narver (1998, p. 1001) and others (Lin & Seepersad, 2007) have referred to as “customers’ latent needs.” As Leonard and Rayport (1997) clarified, “Sometimes customers are so accustomed to current conditions that they don’t think to ask for a new solution” (p. 1). Offering a critique of business-oriented approaches to empathic design, Fila et al. (2014) highlighted potential tensions that can arise in “profit-driven design” environments:

Much of engineering occurs in industrial settings where profit and competitive advantages drive decision-making. Creating engineering artifacts that will be bought by the consumer supersedes creating products that, overall, optimally benefit users. (p. 729)

With this critique in mind, more immersive and participative approaches to empathic design typically place a greater emphasis on “actual user needs and desires” with the view to developing “outcomes that are functional and emotionally meaningful for the people affected” (Battarbee et al., 2014, p. 2). The design firm IDEO is a leading advocate of immersive and participative approaches to empathic design, a design methodology that they now refer to as “Design Empathy” (Battarbee et al., 2014). Although firmly rooted in the business world, IDEO is very clear that the purpose of design empathy is to “effect positive change” for “all of a project’s stakeholders” (p. 1). Stanford’s d.school, which also draws on empathic design techniques (Stanford University, 2016), similarly places human values, alongside technological and business considerations, at the heart of their collaborative design approach. Similar to the strengths perspective in social work, these contemporary approaches to empathic design problematize the expert-nonexpert dichotomy between designers and users and, instead, seek to engage a broad range of stakeholders as valued partners in the design process (Mattelmäki, Vaajakallio, & Koskinen, 2014; Zoltowski et al., 2012).

Learning empathic design  Unlike the above-discussed literature that frames empathy as a pedagogically elusive personality trait, proponents of empathic design generally agree that empathic thinking requires deliberate practice. As Battarbee et al. (2014) explained,

We must intentionally seek opportunities to connect with people in meaningful ways and to set aside reactions and behaviors that will interfere with it. And, once empathy is achieved, it needs to be moderated: apply too much and our thinking loses focus; apply too little and the depth of our insight suffers. (p. 3)
There is a rich body of research that describes techniques and tools for engaging in empathic design (Jääskö & Mattelmäki, 2003; Koskinen & Battarbee, 2003; Kouprie & Visser, 2009; Visser, van der Lugt, & Stappers, 2007). It is important to point out, however, that similar to our discussion of the difference between user- and human-centered approaches to empathic design, most of these methods focus on micro level interactions between designers and users, rather than broader interactions at the mezzo and macro levels. One exception is pioneering work by Mattelmäki et al. (2014), who are experimenting with ways to expand empathic design thinking beyond products to systems, services, and communities. For example, related to Battarbee et al.'s (2014) description of the need to moderate, at different stages of the design process, how much empathy to apply, Kouprie and Visser (2009) proposed a framework for “stepping into and out of the user’s life” (p. 437). This framework presents empathy in design practice as a process of four phases: discovery, immersion, connection, and detachment. Drawing on both affective and cognitive dimensions of empathy, the purpose of this framework is to bring greater clarity to the different roles a designer can take in the empathic design process to enable the designer to make more informed decisions regarding which specific techniques and tools to use at different stages. Similarly, a study by Visser, van der Lugt, and Stappers (2007) offered a three-tiered model designed to facilitate the effective sharing of user experiences with design teams. The top tier comprises three qualities (empathy, inspiration, and engagement) that designers need in order to deeply understand user experiences during the creative process. The second tier includes various interaction factors that designers can use to engage with the user data, such as openness, personification, interactivity, interpretation, and ownership. As an example of the first factor, open-ended presentations of raw data (e.g., user quotes) might be used to invite designers to empathize with the authentic voices of the users and also to participate in structuring and making sense of the information. Finally, the bottom tier contains “aesthetic choices, structuring devices and graphic elements that can be manipulated to affect this interaction” (p. 37), such as photos, text, graphs and other materials.

These studies also highlight the importance of developing sufficient self-awareness to be able to effectively switch between cognitive and affective modes of thinking. Battarbee et al. (2014) described this skill as “A design environment that’s built around trust will promote empathy, but designers also need to build self-awareness about the mode they are operating in, and to develop a mental habit of switching modes” (p. 3). In other words, designers need to develop the skills to enable them to feel deeply with, and step into the world of, users and, then, analyze the insights gained in terms of how they might improve the solution that is being designed.

**Departure points** This review of the literature on empathic design highlights three tensions pertinent to our goal of developing a model of empathy for engineering. Building on our discussion of empathy as a professional skill, the first of these tensions relates to the underlying goals of empathic design. As we described, early accounts of empathic design were often characterized by a business-oriented approach. Users were important to understand because users were also potential consumers. More recently, however, there has been a shift toward empathic design as a way to genuinely engage with and involve users (and other stakeholders) in the development of solutions that best fit their needs and life circumstances, rather than simply the economic bottom line of designers. The degree to which this tension is problematic invariably depends on the design at hand, and it is precisely this need to reflect on each setting that provides the departure point for our discussion of empathy as an inseparable combination of skill and practice orientation.
The second tension concerns the challenge of recognizing when and how to appropriately switch between empathic and analytic mental modes. In light of emerging neurobiological research, which suggests that these two modes may actually mutually suppress one another, and the strong analytical and technical dimensions of engineering work, we argue that the ability to switch modes is central to developing a context-appropriate understanding of empathy in engineering.

Finally, a third tension concerns the locus of practice. Prior work on empathic design has typically focused on the user-designer interface, with the important exception of Zoltowski et al. (2012), who take a more holistic view of those affected by engineering design. Drawing on Segal’s (2011) model of social empathy, which links interpersonal interactions with efforts to address larger social challenges, this tension provides the impetus for our consideration of empathy as not only a skill and practice orientation but also a way of being, that is, a lived worldview and values system in action that embraces the inherent humanism and social-embeddedness of engineering practice.

A Model of Empathy for Engineering

In this section, we draw together the strands of the analysis of the literature to develop a model of empathy for engineering and engineering education. In this synthesis, we articulate where we draw on the theoretical grounding in neurobiology, psychology, and social work, and where we depart from these conceptualizations to define a model that is theoretically appropriate and pragmatically useful for engineering. Similarly, in developing the model we leverage prior efforts around empathy in engineering and denote which conceptual and practical issues our proposed model addresses and where we challenge, and expand on, prior conceptions.

The model in Figure 1 conceptualizes empathy as a skill, a practice orientation, and a professional way of being, and is purposefully composed to illustrate the mutually dependent and supportive nature of each dimension without ascribing a conceptual hierarchy or developmental trajectory. Briefly, the skill dimension comprises five distinct, socio-cognitive processes that interact with each other to form the foundation for empathic communication, relationship building, and decision making. The orientation dimension captures a range of mental dispositions that influence how engineers and engineering students engage in practice.

![Figure 1 A model of empathy for engineering.](image-url)
situations. These orientations around assumptions about the nature of knowledge and the role of values influence efforts to empathically engage with others. Finally, the being dimension highlights the need to situate empathic skills, practice orientations, and their development within a contextualizing framework of broader values.

Empathy as a Learnable Skill

The conceptual and pedagogical traditions around empathy in social work have been shaped, and continue to be shaped, by research from psychology and neurobiology (Decety & Ickes, 2009; Decety & Moriguchi, 2007). Drawing on these foundations, we conceptualize empathy in engineering as being underpinned by a dimension of learnable and teachable skills.

We specifically leverage Decety and Moriguchi’s (2007) neurobiologically anchored research to define the skill dimension of empathy as comprising four functional components: affective sharing, Self and Other awareness, perspective taking, and emotion regulation, to which we add a fifth component, mode switching, to acknowledge the need for engineers to switch between empathic and analytic modes.

**Affective sharing** Affective sharing describes a person’s capacity to share the emotional state of the Other (Decety & Moriguchi, 2007). This emotion sharing or “feeling with” is anchored in an “automatic mapping between self and other” (p. 5), a cognitive mechanism by which the “perception of emotion activates in the observer the neural mechanisms that are responsible for the generation of similar emotion” (p. 6).

**Self and Other awareness** The component of self and other awareness complements the capacity of affective sharing and consists of “an explicit representation of the subjectivity of the Other and a minimal self-other distinction” (Decety & Moriguchi, 2007, p. 13). Building on the experience affective sharing, this facet of empathy describes the ability to “model and understand the internal, subjective world of others” (p. 8). In other words, this facet speaks to the ability to feel with others and experience their internal world as if it were our own while being aware of and never “losing the ‘as if’ quality” (Rogers, 1957).

**Perspective taking** Adding a dimension of purposeful action to these affective and cognitive capacities, perspective taking is the ability to “adopt more or less consciously the subjective point of view of the other” (Decety & Moriguchi, 2007, p. 10). This facet of empathy allows individuals to move beyond the general human tendency to extrapolate one’s own experiences and perspective when trying to understand others (Epley, Keysar, Van Bovan, & Gilovich, 2004). Through considering the features and dynamics of our interactions with others, we can intentionally learn what they might think and feel.

**Emotion regulation** The facet of emotion regulation describes an individual’s ability to influence the ways in which they experience and express the emotions resulting from empathic interactions with others. Decety and Moriguchi (2007) suggested that a productive empathic response requires some regulation of “the emotional state and affective consequences generated in the self from the perception or imagination of the other’s affective state” (p. 12). This ability to be aware of, and manage, one’s emotional response is intended to prevent undue “empathic distress” or “emotional over-arousal” (Hoffman, 2001, p. 197) that could hamper one’s ability to focus on the Other. In this way, critical self-awareness combined with active emotion regulation can promote a level of acceptance of the Other as the basis for a genuine, empathic interaction.

These first four facets of the skill dimension of empathy are neuro-cognitively distinct, but in operation are contingent upon each other and interact in complex ways to produce empathic responses.
Mode switching Complementing these skills, we introduce the facet of mode switching as the ability to recognize, consciously apply, or switch between empathic and analytic cognitive mechanisms. This facet of engineering empathy acknowledges the cognitive difficulties associated with operating simultaneously in analytic and empathic modes of thinking (Jack et al., 2013) as well as the necessity for engineers to work across these domains. It is therefore important for engineers to recognize these two facets of engaging in socio-technical contexts to be able to purposefully modulate them. This level of awareness and directedness could take explicit metacognitive or tacit, habitual forms. This awareness would enable engineers to assemble the insights and information gained in both empathic and analytic modes into a holistic understanding of technical aspects, social context, and stakeholders’ perspectives (Battarbee et al., 2014).

Explicitly identifying these five distinct facets of the skill dimension provides specific avenues for pedagogically addressing their development in engineering classrooms (see our ongoing work on empathy modules in Miller, Walther, & Kellam, 2012; Walther, Miller, & Kellam, 2012; Walther, Miller, & Sochacka, 2016), thus overcoming the problematic perception of empathy as an intractable and unteachable trait. The notion of mode switching also offers a conceptual and practical basis to address the challenges around educating for empathy alongside a technical training that are perceived in the engineering literature (Fila & Hess, 2014; Strobel et al., 2013).

Our discussion of empathy in social work education and the persistent challenges around teaching empathy as an isolated, utilitarian skill in engineering suggest that the skill components are, and pedagogically need to be, contextualized in a broader dimension of a practice orientation.

A Practice Orientation
As Gerdes and Segal (2009) noted, action as a component of empathy is not necessarily a given outcome; however, a focus on action is essential for professionals when embodying empathy in their practice. Extending empathy to action occurs through a specifically conscious process of decision making that is informed by affective responding and cognitive processing (Gerdes & Segal, 2009). The dimension of a critically reflected-upon practice orientation speaks to aspects of worldviews, epistemologies, and habits of mind that inform how engineers act in and respond to situations in practice – in other words, how engineers choose to utilize their various skill sets, and what course of thought or action they are predisposed to take. These orientations serve to contextualize and orient the empathic skills in professional engineering settings, and simultaneously support and undergird the development of those skills. Drawing on the synthesis of literature from social work and engineering, we propose the practice orientation dimension to comprise four facets.

Epistemological openness Epistemological openness is an orientation that predisposes engineers to recognize and value the subjective experiences and perspectives of others as valid and important sources of knowledge for engineering work in practice. Developing such an orientation in engineering students responds to calls for a greater focus on workplace problems (Jonassen, Strobel, & Lee, 2006) and context-appropriate (Robbins, 2007) or human-centered approaches to engineering work (Zolitowski et al., 2012), which draw attention to the complex, socio-technical, and ill-structured nature of engineering problems.

Developing and utilizing empathic skills in these settings necessitates a reconsideration of, and shift away from, technical rationality (Schön, 1983) as the foundation of engineering practice. More specifically, genuineness, characterized by respect, mutual trust, and care, provides the necessary foundation for effectively embodying empathic skills when interacting with others. This orientation will make room for engineers to connect with and value
stakeholders as partners and resources, thus evoking the strengths perspective as conceptualized in social work. Attempts to embody or teach empathy as an isolated, utilitarian skill (Riemer, 2003) are consequently problematic and of limited effectiveness.

**Micro to macro focus** Expanding on the notion of epistemological openness, we draw on conceptions of professional practice in social work to propose an orientation toward a micro to macro focus of engineering work. More specifically, at the same time as encountering individuals and groups with genuineness in a local context, we contend that engineers should also be oriented toward recognizing and attending to the larger systems-level implications of their work (see also ABET, 2013, graduate outcome 3h: “the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context”). Such a focus entails an awareness and consideration of structures of power and social organization as both contexts and consequences of engineering work (Lucena, 2005; Winner, 1980). This expanded view of empathy in engineering mirrors Segal’s (2011) framework for social empathy in social work, which links micro level interactions to the recognition of mezzo- and macro-level structural inequalities and disparities. In a similar way, we propose that engineers practicing in larger scale technological systems should consider the implications of their work for individuals and groups at the micro level (Amir & Juraku, 2014; Armstrong & Baillie, 2012; Barrington, Dobbs, & Loden, 2012). Such an orientation would be similarly suited to guiding the infusion of ecological or sustainability considerations into engineering practice (Bonnett, 2002; Schultz, 2000).

**Reflective values awareness** When working in engineering practice settings that span the micro to macro continuum, and that contain more or less overt ethical issues, engineering students and practitioners require the ability to recognize the value dimensions inherent to all engineering work (Baillie & Levine, 2013; Cech, 2012; Zwart, Jacobs, & van de Poel, 2013). More specifically, this facet calls on practitioners not only to be attuned to the inherent values dimension of engineering, but also to be oriented towards fully engaging with ethical issues through critical consideration of their impact on both a professional and personal level (see also Engineers as Whole Professionals section). The ability and intention to purposefully and critically develop one’s own values orientation offers a contextualizing orientation for the empathic skills presented above and challenges prevalent perceptions and self-perceptions of engineers as objective and impartial (National Society of Professional Engineers, 2015). Students’ and practitioners’ continuous and active development of this orientation complements existing notions of lifelong learning and professional development.

**Values pluralism** We argue that individual engineering students’ and practitioners’ development of a reflective values orientation cannot be guided by a specific, unified definition of the purposes guiding the engineering profession. This departure from conceptions in social work, where promoting social justice through all professional actions defines the profession’s mission, is owed to the diversity of engineering practice contexts, in some of which, actively and directly promoting social justice may not be a realistic or productive orientation and expectation. At the same time, we advocate that the tacit adoption of economic growth as the guiding purpose of the profession is equally not suited to promoting an overall empathic orientation of its practitioners. Instead, we propose that the profession should commit to engaging in an active, purposeful, transparent, and equitable discourse around the heterogeneous values-informed purposes driving different forms of engineering work (Sochacka et al., 2014). Such a discourse would facilitate a critical examination of the values underpinning engineering work in traditional industrial or military settings (Lucena, 2005).
values pluralism would also make room for embracing engineering work for peace and social justice (Baillie & Catalano, 2009; Baillie & Levine, 2013; Catalano, 2006; Riley, 2008; Vesilind, 2010). Such endeavors could become part of the mainstream of the profession without necessarily mandating a corresponding values system for all types of engineering work.

For the individual practitioner, this orientation entails actively contributing to this ongoing, collective discourse, not to codify specific engineering values or associated purposes, but to articulate and foster the diversity that is already present in the range of career paths engineering students can pursue (Anderson, Courter, McGlamery, Nathans-Kelly, & Nicometo, 2010; Brewer, Sochacka, & Walther, 2015; Duderstadt, 2010; Sochacka et al., 2014).

A Professional Way of Being

Empathy as a core aspect of engineers’ professional way of being acknowledges that empathic skills and associated practice orientations cannot be developed by students or lived by engineers without the anchor of a contextualizing framework of broader value commitments. This argument draws on our synthesis of the literature that revealed facets of empathy and associated value commitments as being differently present in the discourse around preparing engineering students for professional practice and along the spectrum of business-oriented to stakeholders-oriented design. Moreover, Strobel et al.’s (2013) study indicated that even though empathy may not be part of the regular vocabulary of engineering faculty and practicing engineers, it is regarded as implicitly definitional to being an engineer because of the profession’s orientation towards improving society.

We have discussed how the profession of social work stresses a continued engagement of the learner or practitioner with the explicitly derived values framework as a core professional attribute. While we acknowledge the pluralism of value-informed purposes of engineering, we contend that in order to effectively practice empathy, students and practitioners need to personally and continually engage with the value commitments that ultimately undergird their actions in practice (Claris & Riley, 2012). In other words, we argue that, as educators, we cannot expect our students to develop and ultimately embody the skill and orientation dimensions of empathy without fundamentally grappling with the contextual and deeply personal questions of what it means to be an engineer in the world.

The conceptualization of empathy as a way of being also draws on a large body of work from engineering ethics (Fleddermann, 2008; Harris, Pritchard, Rabins, James, & Englehardt, 2013; Hashemian & Loui, 2010; Jonassen et al., 2009; van de Poel & Royakkers, 2011; Whitbeck, 2011), a full account of which is not feasible within the scope of this article. Rather, we offer the following three facets of an empathic way of being an engineer as a necessary part of the model, without which a theoretically coherent and practically applicable conception of engineering empathy would be incomplete. The following descriptions are connected to specific anchor points in the intellectual traditions of social work, link to broader discussions around engineering ethics, and are offered as starting points for further discussions in the engineering education community.

Service to society In order to provide the necessary foundation for engineering students and practitioners to develop and practice empathy, we propose a re-examination, and potential broadening, of the discourse and conceptions around engineers’ service to society. The orientations of reflective value awareness and the micro to macro focus lead us, as a profession, to question implicit assumptions that a focus on, and contributions to, economic growth inherently further our goal to contribute to the well-being of society. In this regard, we do
not suggest a complete re-orientation of the purposes of the profession to mirror the tenets and expressed goals of social work (for alternative suggestions, see Riley & Lambrinidou, 2015). We instead advocate for a broadening of the discourse to include a deep consideration of, and genuine service to, all human and nonhuman stakeholders impacted by engineering. Such a discourse would specifically attend to questions of power, inequality, and the often inequitable distribution of the risks and benefits of engineering work along the micro to macro spectrum. Framed in this way, holistic service to society also connects to the notion of social responsibility as conceptualized in engineering and business settings (Bucciarelli, 2008; Conlon, 2008; Heikkerö, 2008).

**Dignity and worth of all stakeholders** We propose that individuals’ efforts to embody the commitment to a broader notion of service in their practice need to be anchored in a core belief in the dignity and worth of people and the natural environment. While social work explicitly enshrines the dignity and worth of people as a central focus of education and practice (National Association of Social Workers, 2008; Saleebey, 2012), an empathic concern for the natural world is less developed (Berger & Kelly, 1993; Besthorn & Canda, 2002; Coates, 2003; Mary, 2008; Miller, Hayward, & Shaw, 2012; Zapf, 2010). The broader focus in human and nonhuman stakeholders proposed here is grounded in broader discussions around biophilia (Wilson, 1984) or biophilic design, and is anchored in a rich discourse around sustainability and sustainable design in engineering.

A genuine belief in the dignity and worth of all people inherently implies an epistemological openness that is reflected in adopting a strengths perspective when interacting with others. These beliefs consequently call into question the implicit assumption of objectivity as a key definitional feature of engineering professional identity. The apparent and expected objectivity of engineers is reflected explicitly in engineering codes of ethics (“Engineers shall be objective and truthful in professional reports, statements, or testimony”) and implicitly in public paramountcy clauses in those same codes (e.g., “Engineers shall hold paramount the safety, health, and welfare of the public”; National Society of Professional Engineers, 2015). In these conventional conceptions of the engineering professional way of being, the public is framed as a passive entity in need of safeguarding by the engineer (see also Vallero & Vesilind, 2006). This way of defining the professional-client relationship is fundamentally at odds with the empathic skills and orientations in our model and, most prominently, leaves no room for such relationships to be informed by a strengths perspective.

**Engineers as whole professionals** As discussed previously, engineering and engineering education have traditionally been underpinned by a culture of objectivity and professional detachment that explicitly informs professional codes of ethics (National Society of Professional Engineers, 2015) and implicitly shapes educational programs (Pawley, 2009; Sochacka et al., 2014). We contend that the resultant separation between the individual’s emotions, aspirations, and values from professional engineering work is problematic in the context of developing empathy as part of one’s professional way of being (Baxter Magolda, 2014; Nash & Jang, 2014).

Discussions in the area of humanitarian engineering (Lucena, 2013), and commentary on the relative lack of engineering pro bono work compared to other professions (Moulton, 2010), speak to a disciplinary culture that tacitly excludes the whole person from processes of professional formation (Hanson, 2014) and attest to the need for overcoming these barriers to a broad education (ABET, 2013) of engineers. Social work, on the other hand, includes a strong and explicit focus on individual activism as part of the professional code of ethics, and
educational approaches are consequently oriented towards integrating professional and personal ways of being (Gerdes et al., 2011; Miller, 2010, 2013) in order to effectively develop and practice empathy.

The notion of a whole professional (Huff, 2014; Tracy & Trehewey, 2005) as a facet of engineering empathy thus highlights the need to develop empathic skills and orientations alongside intentional connections to students’ maturing personally and morally (Baxter Magolda, 2014; Rest & Narvaez, 1994). Such a link between empathy and moral development has been well established in the literature (Hoffman, 2001). Developing a whole professional persona anchored in, and simultaneously supporting, the development of other facets of empathy would also afford students with tangible opportunities to integrate personal values and beliefs with professional goals and actions (Nash & Jang, 2014).

Discussion and Conclusion

Our model provides a theoretically grounded, conceptually coherent, and context-appropriate understanding of empathy in engineering. The model comprises teachable skills, practice orientations, and ways of being. These dimensions do not suggest a conceptual hierarchy or developmental trajectory but rather capture reciprocally supportive and conjointly developing facets of empathy.

The skill dimension is anchored in neurobiologically established functions present in all humans that are complemented by the engineering-specific facet of mode switching to acknowledge that analytic and empathic content can be simultaneously present in engineering communication. The main implication of this part of the model is that empathic skills are concretely teachable and that educators can specifically draw on and leverage students’ existing, albeit variably developed, empathic capacities.

The facets along the practice orientation dimension describe a range of habits of mind and predispositions that orient practitioners to think, make decisions, and act in particular ways in professional settings. While the facets of the skill dimension describe what an individual can do, the practice orientation dimension captures why, how, and whether an engineer might embody these skills in practice – what they will do in a given situation. The key implication of the discussion of practice orientations as part of engineering empathy is that empathic skills can neither be developed nor embodied in practice without attending to aspects of epistemology and values engagement that are inseparably part of engineering work. For educators, this recognition implies a need to purposefully and critically explore the often implicit orientations that underpin engineering, and to situate efforts to develop empathic skills explicitly in the context of such explorations. The need to attend to students’ developing practice orientations also offers an opportunity to pedagogically link empathic skill development with broader discussions of ethical frameworks that form the being dimension of the model.

Finally, the being dimension acknowledges the need for an overarching values framework to guide the development of the facets of empathy along the skill and orientation dimensions. If the skill dimension describes empathy as what we can do, and the orientation dimension as what we will do in a given situation, the being dimension captures how we fundamentally think and feel about the situation, our actions in it, and our role as engineers in the world. In conceptualizing this dimension, we drew on the relatively well-developed discourse of ethics in the engineering education community and related literature in other fields without presuming to comprehensively capture the respective discussions. The inclusion of a broader ethical
perspective as part of the model is necessary to provide the intended conceptual coherence, in other words, to see the full picture of what it means to develop and embody empathy in engineering. Our discussion of the being dimension thus indicates that in order to conceptually define and pedagogically support empathy in engineering, we need to engage with larger ethical commitments and moral principles. Such explorations, that need to become a more active part of the engineering discourse, inherently challenge some of the underlying assumptions and guiding values of engineering at the level of the profession and the individual.

Our model of empathy in engineering provides the conceptual clarity to inform future research efforts as well as pedagogical developments. Future research could include applying the model to longitudinal studies that investigate the development of empathy over the course of students’ engineering education or to empirical investigations of how learning arrangements and disciplinary cultures impact engineering students’ empathy development. The model could also provide a lens to further develop emerging research that considers conceptions of empathy held by engineering educators and practitioners and its relevance in a variety of settings (e.g., Hess, Strobel, & Pan, 2016; Strobel et al., 2013).

Pedagogically, we see potential for the model to link abstract explorations of engineering ethics and moral development more concretely to student learning. More specifically, we envisage pedagogical interventions that experientially connect students’ development of empathic capacities and communication skills to active and reflective processes of moral and identity development. For example, in our own, on-going work (Miller, Walther, & Kellam, 2012; Walther et al., 2012; Walther et al., 2016), we are using the model to develop an integrated series of empathy modules in a compulsory engineering and society course in a mechanical engineering program. The sequence of four modules is intertwined with critical readings that explore the socio-technical complexities of engineering work and semester-long team projects that focus on socio-technical systems understandings and analysis in the local setting. The modules progress from developing specific interpersonal skills (e.g., body language and proximity exercises) to broader, situated interactions in groups (e.g., role plays of stakeholder meetings). Each module combines skill-development exercises with application in authentic scenarios (e.g., managing a local food security project) and guided, self-reflective exercises. The combination of these elements provides students with opportunities to engage facets of their empathy development that span the skill, orientation, and being dimensions. For example, we have observed students struggle to take the perspectives of stakeholders who are different from themselves, and then make sense of those struggles in relation to their implicit views of engineers as experts and members of the public as nonexperts (Robbins, 2007).

While our model is anchored in the engineering education discourse and a critical juxtaposition with the intellectual traditions of social work, it is important to point out that its synthesis originates from a particular values perspective. The being dimension, especially, is grounded in values around the social good and the worth of the individual, which we propose ideally contextualizes and lends meaning and purpose to the professional orientation and skill dimensions. We developed this particular stance in a sustained dialogue with social work to learn and transfer insights to engineering without uncritically adopting preformed positions. However, we do not presume that the particular values we ground our position in constitute the only ones that can be assumed for the values dimension of empathy. In line with the proposed reflective values awareness and active commitment to values pluralism, we contend that, as a profession and as a community of educators, we need to continue to discuss the guiding values and moral commitments that affect students’ development of empathy as a
core skill and orientation for twenty-first-century engineering practitioners. We hope the model presented here can ground and structure this discussion.

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