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A Literature Review to Explore a Relationship: Empathy and Mindfulness in Design Education

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Empathy and mindfulness in design education: A literature review to explore a relationship

Abstract

Learning to design in undergraduate engineering is a higher-order mentality that entails creative, conceptual, and methodological capabilities. One of the core principles of design thinking is its focus on human values at every stage of the process, including empathy for the eventual recipients or users of the tangible outcomes of the designs. Learning to be empathetic has a wide range of benefits, such as supporting effective teamwork and communication; supporting ethical decision-making; and informing the design process. The existing literature provides not enough guidance on how to foster empathy in undergraduate engineering programs, despite the recognized benefits. However, a growing body of research on the benefits of mindfulness has begun to show its potential as an intervention strategy to improve empathy in design. In this theory/method paper, we present an extended review that explores the relationship between how empathy may be supported through mindfulness practice.

Based on the content of the studies, we organized publications in terms of the research focus. While some reported on the relationship between empathy and mindfulness practice, other publications focused on specific effects on individuals. These specific effects clustered around three major groups important to design education: (1) transition between analytical and affective mindsets (2) subjective understanding of the profession by focusing the mind on how we conceptualize engineering expectations, and (3) increased behaviors to support sustainability mindsets. Through our extended literature review on these topics, we suggest that promoting mindfulness practice in engineering design courses, workplaces and elsewhere encourages whole-bodied processes in professional decision-making and empathetic designs.

Keywords: empathy, mindfulness, engineering design

Introduction

For someone to be empathetic, it requires them to have “the ability to step outside their immediate experience” (Safran & Segal, 1990, p. 117). This detachment involves creating a distance from one’s opinions and stance and expanding one's attentional space (Martin, 1997). Although empathy may seem intrinsic to engineering work, as a construct, it is not common in the engineering vocabulary leading to various understandings of its utility in education and professional practice (Strobel et al., 2013).

Engineering design education has multifaceted aims in the engineering curriculum. Among many skills that we want to instill through engineering design, holistic decision-making is one of them. Students are making analytical and affective decisions in the decision-making process that

showcases the intricacies of the engineering profession and work. In the context of making ethical decisions, empathy plays a central role, however, it is not the only aspect of the process (Hess et al., 2017).

Empathy, as a construct, has been discussed in the literature through many perspectives about its purpose, ways of enactment, and impact in engineering education. The challenges and tensions articulated by authors often stems from the idea that empathy can be considered to have an emotional, cognitive, and/or actionable component (Goleman et al., 2017). As such, engineering educators find it challenging to bring in empathy training as part of their pedagogy as it relates to their own perceptions of empathy in engineering. Also, mindfulness affords a state of non-judgmental and alert awareness due to being present in the moment (Brown & Ryan, 2003). This non-judgmental awareness involved in mindfulness can also seem foreign to engineering educators since making informed judgements through analysis and interpretation is a typical component of engineering practice.

Empathy in engineering design entails a deep understanding of the engineering problem, including the values and perspectives of different stakeholders (e.g. the end-users, and design partners who may represent different sub-disciplines and geographic or cultural aspects of the project). Also, empathy is a nuanced concept that includes various elements such as a construct, ability, skill, disposition, and intellectual virtue. Empathy includes both cognitive and affective processes that strengthen each other without losing perspective on who owns the emotions (Decety & Jackson, 2004). Mindfulness helps us to recognize more subtle emotional states in ourselves and others, facilitating our understanding of human emotions and societal needs. This benefit suggests a possible role for mindfulness, defined as intentionally paying attention with openness, kindness, and curiosity (Luberto et al., 2018), in introducing empathy in engineering design.

Mindfulness is a mental training technique that promotes awareness and a more mindful way of living. Through our review, we found that mindfulness has been subject to an increasing number of scientific studies. We believe the reported effects on individuals and teams, such as increased well-being, value clarification, awareness, and compassion, could help support empathy in engineering design processes.

Methods

We wanted to explore and present a relationship between empathy and mindfulness; thus we have drawn literature from various disciplines. We build on existing work related to the role of empathy and mindfulness in education and the engineering design process. This body of literature is from different fields, including engineering education, social psychology, and learning sciences. The review draws upon work done at the nexus of design education, the role of empathy in design, and nurturing empathy through mindfulness. We chose the extended literature

review as a means of data synthesis since it offers the possibility to integrate a large body of research from different methodologies (quantitative, qualitative, and mixed methods).
We searched databases with keywords: “empathy”; “engineering education”; “mindfulness”; “mindful attitude”; “engineering design”; “empathic design” and “empathy in design”. In terms of constraints, we drew from literature in the past three decades and published in peer reviewed journals and conference proceedings.

The literature review drew from various disciplines to look at the relationship between empathy and mindfulness through a holistic lens. The search with the keywords mentioned generated articles from disciplines including engineering education, learning sciences, design science, and psychology. The reviewed papers have been categorized in the following table according to discipline. After review, the insights have been presented in conversation with each other.

Table 1. Literature reviewed in disciplinary categories.

Engineering Education
1. Bairaktarova, D., Bernstein, W. Z., Reid, T., & Ramani, K. (2016). Beyond surface knowledge: An exploration of how empathic design techniques enhances engineers understanding of users’ needs. 2. Bairaktarova, D. (2022). Caring for the future: Empathy in engineering education to empower learning. 3. Bernárdez, B., Durán, A., Parejo, J. A., Juristo, N., & Ruiz–Cortés, A. (2022). Effects of Mindfulness on Conceptual Modeling Performance: A Series of Experiments. 4. Carbonetto, T., & Grodziak, E. M. (2019, July 28). *Mindfulness in Engineering v2*. 5. Estrada, T., & Dalton, E. (2019). *Impact of Student Mindfulness Facets on Engineering Education Outcomes: An Initial Exploration*. 6. Hess, J. L., Beever, J., Strobel, J., & Brightman, A. O. (2017). Empathic Perspective-Taking and Ethical Decision-Making in Engineering Ethics Education. 7. Hess, J. L., & Fila, N. D. (2016, June 26). *The Development and Growth of Empathy Among Engineering Students*. 8. Huerta, M. V., Carberry, A. R., Pipe, T., & McKenna, A. F. (2021). Inner engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students. 9. Kjolsing, E., Van Den Einde, L., & Todd, M. (2016). Using a Design Project to Instill Empathy in Structural Engineering Teaching Assistants. 10. Rasoal, C., Danielsson, H., & Jungert, T. (2012). Empathy among students in engineering programmes. 11. Rieken, B., Schar, M., Shapiro, S., Gilmartin, S., & Sheppard, S. (2017). Exploring the Relationship between Mindfulness and Innovation in Engineering Students. 12. Riley, D. (2008). Toward a More Socially Just Engineering.

13. Strobel, J., Hess, J., Pan, R., & Wachter Morris, C. A. (2013). Empathy and care within engineering: Qualitative perspectives from engineering faculty and practicing engineers.
14. Walther, J., Brewer, M. A., Sochacka, N. W., & Miller, S. E. (2020). Empathy and engineering formation.
15. Yeaman, A., Bairaktarova, D., & Reid, K. (2020, June). A qualitative study of empathy in the experiences of students in a first-year engineering service learning course.
16. Khan, R., Romkey, L., & Slotta, J. (2022). Towards forming learning communities-Understanding the role of collaborative work in an undergraduate engineering program.

Learning Sciences

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2. Ickes, W. (1993). Empathic Accuracy.
3. Kvalsund, R., Baardsen, B., & Allgood, E. (2016). Mindfulness Subjectivity through Q Methodology: Training and Practising Mindfulness in an Educational Program as Influential and Transformative.
4. Lebuda, I., Zabelina, D. L., & Karwowski, M. (2016). Mind full of ideas: A meta-analysis of the mindfulness–creativity link.
5. Oxley, J. (2011). *The Moral Dimensions of Empathy Limits and Applications in Ethical Theory and Practice*
6. Wamsler, C., & Brink, E. (2018). Mindsets for sustainability: Exploring the link between mindfulness and sustainable climate adaptation.

Design Sciences

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2. Hess, J. L., & Fila, N. D. (2016). The manifestation of empathy within design: findings from a service-learning course.
3. Kolko, J. (2014). *Well-designed: How to Use Empathy to Create Products People Love*.
4. Kouprie, M., & Visser, F. S. (2009). A framework for empathy in design: Stepping into and out of the user's life.
5. Li, J., & Hölttä-Otto, K. (2022). Inconstant Empathy—Interpersonal Factors That Influence the Incompleteness of User Understanding.
6. Nolte, H., Huff, J., & McComb, C. (2022). No time for that? An investigation of mindfulness and stress in first-year engineering design.
7. Tellez-Bohorquez, F., & Gonzalez-Tobon, J. (2019). Empathic Design as a Framework for Creating Meaningful Experiences.

Cognition, Psychology

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9. Martin, J. R. (1997). Mindfulness: A Proposed Common Factor.
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12. Smeenk, W., Sturm, J., & Eggen, B. (2019). *A Comparison of Existing Frameworks Leading to an Empathic Formation Compass for Co-design*
13. Stietz, J., Jauk, E., Krach, S., & Kanske, P. (2019). Dissociating Empathy From Perspective-Taking: Evidence From Intra- and Inter-Individual Differences Research.
14. Stocks, E. L., Lishner, D. A., Waits, B. L., & Downum, E. M. (2011). I'm embarrassed for you: The effect of valuing and perspective taking on empathic embarrassment and empathic concern.
15. Wen, X., Rafaï, I., Duchêne, S., & Willinger, M. (2022). Did Mindful People Do Better during the COVID-19 Pandemic? Mindfulness Is Associated with Well-Being and Compliance with Prophylactic Measures.
16. Wielgus, B., Urban, W., Patriak, A., & Cichocki, Ł. (2020). Examining the Associations between Psychological Flexibility, Mindfulness, Psychosomatic Functioning, and Anxiety during the COVID-19 Pandemic: A Path Analysis.

Existing conceptualizations of empathy and mindfulness

Empathy – a skill, trait, or way of being

Empathy is a skill that can be learned through training and practice (Walther et al., 2017). This notion is often not agreed upon by engineering instructors – many think empathy is a personal trait that students bring into the classroom (Strobel et al., 2013). In addition, perceptions of society and expectations from the discipline (Rasoal et al., 2012) influence the level of

importance we place on empathy in engineering education. Therefore, educators need professional development to teach empathy with epistemic aims in their engineering courses (Kjolsing et al., 2016).

Hess and Fila (2016) suggested that empathy can be taught through design thinking, service learning, communication, collaboration and ethics education. They also frame these contexts in terms of student action. These contexts can be further challenged by reconsidering the purpose of empathy in the design process to one from designing more desirable products to emphasizing design practices that value intersubjectivity and sociability (Devecchi & Guerrini, 2017). Also, for engineering students, empathy in the design process allows for comprehensive understanding of all actors in the design context (Kouprie & Visser, 2009). Such understanding requires more than understanding other's emotions, but also as a designer being aware of your own subjective emotional response and sensitivity of the situation (Ickes, 1993). These experiences embedded in the curriculum and engineering design courses allows engineering students to develop an empathic formation compass required to flourish in co-design processes (Smeenk et al., 2019).

In engineering education, especially in programs tending towards engineering science, teaching empathy needs careful pedagogical consideration. As such the need for empathy in engineering needs to be more visible to students to make meaningful and purposeful connections with prior assumptions and foster epistemic attitudes toward the construct (Walther et al., 2020). This embodiment of empathy in professional education allows students to recognize and reflect on the service nature of the engineering profession and its potential connections to social-justice concerns (Naphan-Kingery et al., 2019). However, it is important to recognize our students will demonstrate different levels and types of empathetic behaviors - this is a reflection of their lived experiences, conceptions, and cultural differences (Li & Hölttä-Otto, 2022). Therefore, empathetic attitudes need to be fostered and situated in authentic experiences such as design to have an understanding of empathy beyond the buzzword level (Tellez-Bohorquez & Gonzalez-Tobon, 2019).

Engineering design instructors engage students in activities to elicit empathy in the design process. Such activities enable empathic perspective-taking (a cognitive component of empathy (Stietz et al., 2019) to understand people and communities for whom students would like to design. These activities aim to replicate real decision-making processes in the industry and academia when we make decisions by considering the perspectives of people who are not present at the table. When making these decisions, especially ethical ones, Hess and colleagues (2017), suggest that although empathy is important in the ethical decision-making process, it is not sufficient. This suggestion stems from the idea that being empathetic is an act or tool to understand others but does not necessarily lead to moral acts or decisions (Oxley, 2011). Hence, it is important to highlight to our students that the understandings of others are limited by the tools we use during empathic perspective-taking. However, Hess et al. (2017) supported

perspective-taking and its importance when making deductions about acceptable engineering design risks, making social justice requirements, and considering the indirect impact of designs on the natural environment.

Students in engineering design courses are often asked to engage in design activities that encourage empathic creativity. These tasks are often anchored in concept generation and the selection of ideas. Empathy plays an integral role during concept generation and selection because students have to be constantly negotiating not just technical requirements and constraints but also consider the affective responses individuals and communities may have towards their design. As such, students who tend to show empathic concern (emotional response through compassion and concern) can generate more ideas during concept generation (Alzayed et al., 2021; Stocks et al., 2011).

Mindfulness – Shifting perspectives, activating senses and promoting holistic education

From a psychology perspective, Shapiro and Carlson (2017), posit that mindfulness leads to a developmental process through which we can learn to shift our consciousness toward our ways of thinking. The authors emphasize that this shift in perspective is instrumental in developing and growing awareness of our own needs and how they differ from others' aspirations. The transformational shift in perspective through mindfulness is termed as reperceiving, which can be manifested through a non-linear and interdependent process of self-regulation, values clarification, cognitive, emotional and behavioral flexibility, and exposure. Therefore, through reperceiving, the authors highlight that the practice of mindfulness allows one to augment their ability to objectify their own internal understanding.

Mindfulness practices help us to activate many of our senses. Such engagement of senses allows students to be receptive to diverse and growth mindsets, which have a positive impact on the thinking required in problem-solving (Carbonetto & Grodziak, 2019). These shifts, maybe small, may not contribute to trait mindfulness directly but have the potential to increase awareness of one's actions and reactions necessary for introspection, functioning effectively on teams, and communicating with a wide range of audiences (Estrada & Dalton, 2019). In cognitively heavy tasks such as conceptual modeling in software engineering, mindfulness may help to chunk large tasks and switch contexts to remain productive. In their paper, Bernardez and colleagues (2022) found that short mindfulness sessions helped to make it an acceptable practice with engineering students and also to understand its effects in various educational situations. In addition, engineering students are faced with anxiety-inducing situations such as taking tests which may disrupt cognitive control.

Students benefit from mindfulness by improving their emotional response to anxiety-laden situations such as tests (Bellinger et al., 2015). Also, as educators, we want our students to experience a holistic education in which they are connected to themselves and allow the whole

self to make academic and professional decisions. Through understanding the purpose of mindfulness, students can recognize that it is an ongoing learning process to be able to integrate their whole selves in relation to others and school surroundings (Kvalsund et al., 2016).

Mindfulness training has been introduced in many engineering institutions to promote well-being and increase self-awareness in various interactions expected of students. Rieken et al. (2017) investigated the relationship between mindfulness and students' attitude toward design and innovation experiences. The authors surveyed 1,460 engineering students and recent graduates and found a correlation between mindful attitudes and higher self-efficacy for innovation. They defined a mindful attitude as the willingness to engage in situations that may seem uncertain and novel in one's daily life. Respondents to the survey with mindful attitudes were more likely to have been involved with leadership and entrepreneurial clubs, courses, and initiatives. The results suggest that students who exercise mindfulness in their routine are set up for successful entrepreneurial and design-related endeavors.

Through a meta-analysis of literature in psychology, Lebuda et al. (2016) demonstrated that there is a statistically significant link between mindfulness and creativity. They found certain abilities that promote creativity to be fostered through mindfulness training or trait mindfulness. They found mindfulness to be linked with increased ability to switch perspectives, improve working memory, and respond to situations in a non-habitual manner. The authors also pointed out that creativity can be supported through removing external barriers such as reducing fear of judgment by practicing mindfulness. The authors stated that studies have shown mindfulness has a positive effect on creativity even through brief meditation exercises, hence the length of mindfulness practice should not be a deciding factor for inclusion in problem solving activities.

While creativity, a cognitive skill, has been shown to be supported through mindfulness as discussed above, Huerta et al. (2021) have investigated how being mindful also cultivates intrapersonal and interpersonal competencies. First year engineering students, in particular, face many challenges transitioning into university life and managing new expectations. Many students who may come in with aspirational and optimistic views about the engineering profession are often led to anxiety due to unexpected realities of academic studies. A positive step would be to bring students' minds to ease as a way to promote retention and reduce apprehension using contemplative pedagogies such as mindfulness practices (Carbonetto et al., 2019). Studies show that there are compelling relationships between mindfulness training and engineering students performing well on ABET related outcomes, such as intellectual curiosity, mindful nonreactivity and academic performance (Estrada & Dalton, 2019). The authors show connections to mindful reactivity, increased ability to reappraise their current situations, stretch their intellectual understandings, and take academic risks – all which would promote success for engineering students especially during their first year. Among many unique experiences that first-year students face are also new disciplinary courses and ways of learning. One such area is

engineering design which can be cognitively stressful. Mindfulness mechanisms such as breathing, taking a break, and recognizing distractions can help first-year students to cope with stressful design activities such as concept generation, concept selection, and physical modeling (Nolte et al., 2022).

During the COVID-19 pandemic, there was a proliferation of studies that incorporated mindfulness training in educational settings. Mindful moments were incorporated in virtual settings to deal with anxiety, stress, increased loneliness in restrictive conditions such as the lockdowns which negatively impacted resilience of children and adults (Godara et al., 2021). As educators, we expected our students to quickly adapt to learning online which required psychological flexibility which can be supported through mindfulness and mediate the development of mental health issues (Wielgus et al., 2020). A large-scale survey showed that mindful people coped better than others during the pandemic which further advocates for formal and informal mindfulness to increase students' self-awareness and overall well-being (Wen et al., 2022).

Discussion and Educational Implications

The empathetic approaches discussed in the previous sections are action oriented and mindfulness may play a complementary role alongside these approaches by setting the stage for these actions. In this section, we synthesize the findings from literature to show a supporting relationship between empathetic behaviors and mindful activities.

Mindfulness as a precursor to empathetic engagement

As shown in the literature review section, engineering design work requires engineers to move between analytical and affective mindsets. From a psychological viewpoint, such shifts happen but at the cost of high cognitive processing. As such, when we ask engineering design students to shift their thinking from making technical decisions to moving into perspective-taking roles, we need to acknowledge that this changing of attitudes creates high cognitive loads in addition to other stressors existing in students' lives. Such conditions result in superficial understandings of the individuals and communities for whom students are designing in the course. Therefore, to elicit genuine empathy through activities, students need to transition to a state that supports creativity and affective behaviors. This transition can be supported through mindfulness where students explicitly engage in shifting perspectives. Such transitions may help graduates in their future workplace to genuinely move across different paradigms as per the nature of work in engineering professional settings. In terms of implications, educators need to be mindful of how engineering design courses are planned and would benefit from incorporating mindfulness episodes within the lesson when students transition to tasks that require empathy. These mindfulness sessions may vary in length and research has shown that short sessions of mindfulness lead to positive impact and improved self-awareness (Nolte et al., 2022).

Making empathy visible in engineering

Also in the review, scholars have highlighted that discrepancies in the ways we conceptualize empathy impacts educators' sense of its utility in their courses. These discrepancies may stem from how we understand the purpose of engineering work and the philosophy of engineering design. Kolko (2014), in her book, shows that successful designs require the amalgamation of human factors as well as empathy with individuals and communities that may directly or indirectly use the designed artifact. However, a diagram in the book depicts a left circle is engineering and a right circle is design. This diagram shows that engineering may be a reductive activity and design, however, is frequently a generative activity – which seems to imply that engineering does not always overlap with design. Such notions ask us to reflect, rethink, and reimagine what engineering work is currently and how 21st-century issues challenge our current notions. As such, we need our students to also step out and expand their conceptions of engineering work and understand the role of empathy as engineering designers. Through the formal curriculum, mindfulness may allow educators and students to step out and observe the professional decisions we make. It may also help us open our minds to "take a critical look at what engineers do" and ask questions relevant to the practice of empathy, "for whom is engineering done, who wins and who loses by the actions of engineers, what work is considered engineering, and what values underlie the drawing of these professional boundaries" (Riley, 2008, p. 110).

Mindfulness and empathy supporting care for the environment

When scrutinizing the need for empathy in the engineering design process, this review shows that its need is broader than genuine understanding of individuals and communities' needs and their emotional responses towards our design. Hess et al. (2017) posits that as designers are more deeply involved with their users, communities, and society at large, their intentions with their design evolve and design values may change over time. In this regard, mindfulness plays a crucial role in being aware of shifts in beliefs and values and more importantly making objective observations on the reasons that shift mindsets over time.

In terms of broader impact of designs such as on non-human actors, empathy can help engineering designers to be aware of implications on the environment. Through mindfulness training, we can support our student's awareness of sustainability through visualizing ideal environments. These ideal conditions may influence students to unpack the broader environmental impact of engineering design and support pro environmental attitudes (Berenguer, 2007). As such, promoting mindfulness practice allows for clarification of design values and improved subjective well-being leading to more sustainable ways of life (Ericson et al., 2014). Lastly, mindfulness supports action-taking in terms of pro environmental behaviour that are 'other focused' which requires heightened levels of empathy (Wamsler & Brink, 2018).

Shifting design pedagogical aims

Our intentions to support more empathetic behaviours in our design classrooms needs revaluation on how and why we teach design to engineering students. For supporting the well-being of students, increase prosocial behaviours, and instill caring attitudes for the environment, we need to show our students that we have embodied these values and interwoven them in our design pedagogy. We need to offer students multiple techniques and pathways that support manifestation of empathy in the design process (Hess & Fila, 2016). These techniques need to be supported by caring methodologies to show our commitments to our students as they prepare for uncertain times ahead (Bairaktarova, 2022). In addition, we need to shift the narrative of engineering design towards post humanistic aims in which students collaborate, work as a learning community and strive to solve pressing issues together (Khan et. al, 2022). Design experiences have to move beyond achieving epistemic aims to include aims centered around building communities such as through service learning (Yeaman et al., 2020), and situated in global contexts (Bairaktarova et al., 2016) to make empathetic behaviours and mindful attitudes feel authentic and needed.

Conclusion

Given the benefits of empathy in the engineering design process and the limited work on incorporating empathy in undergraduate engineering design contexts, we explored a variety of literature to address this challenge through an extended literature review. We combined studies related to design education, the role of empathy in design, and nurturing empathy through mindfulness from the fields of engineering education, social psychology and learning sciences to explore the relationship between empathy and mindfulness practice. In our analysis, we clustered around three major groups important to design education: (1) scaffolding transitions between analytical and affective mindsets (2) supporting subjective understanding of the profession, and (3) increased behaviors to support sustainable mindsets. This work will support the design of a research study to understand student, faculty, and broader community perceptions of the usefulness of mindfulness training in the engineering design process.

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