Addressing wicked problems through empathy-enhanced design-based team learning: illustrating implicit and explicit approach

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Abstract

This practice paper aims at contributing to the conversation about caring pedagogies and sustainable engineering education by focusing on empathy, 'the ability to understand people by perceiving or experiencing their life situations'. Based on our experiences as engineering educators in Europe and North America, we offer examples of how design-based learning can be enhanced through the purposeful integration of empathy nurturing activities at every stage of the team project work. More specifically, we describe an approach in which empathy is an explicit focus of learning activities and an approach in which empathy is a more implicit learning outcome that is embedded within broader transversal learning goals. The design projects we offer as illustrations center on 'wicked problems' that affect various stakeholders beyond technical experts. By encouraging a decentralized, multi-perspective approach, wicked problems can enhance a caring pedagogy in project-based learning. By integrating empathy with technical expertise, be it explicitly or in more implicit ways, we highlight the crucial role of emotional intelligence, ethical decision-making, and interpersonal skills in engineering practice—an approach that cultivates responsibility and equips individuals to tackle real-world challenges with compassion and ethical insight.

Keywords: empathy, design-based learning, engineering education, wicked problems, project-based learning

1 Background and rationale

In this introductory section we sketch the rationale for structurally integrating empathy-nurturing learning activities in design team projects in engineering education to support students in addressing so-called wicked problems in the real world.

1.1 Wicked problems in design-based engineering education

Wicked problems have been defined as real-life issues that have no definitive formulation nor completion since they are both symptoms and causes of other problems (Rittel & Webber, 1973). The concept of wicked problems has facilitated discussions about the limitations of more traditional problem-solving approaches in which delineated puzzles are put to students, who are then expected to apply taught protocols and algorithms in order to arrive at a correct or optimal solution (Lönngren & van Poeck, 2020). Wicked problems do not lend themselves to such an approach, however. The tensions inherent in wicked problems are more suited to being approached as dilemmas or even more so as paradoxes that accommodate all sides of a tension in some synthesis (de Wit & Meyer, 2005; Van Maele & Vassilicos, 2013). In addition, wicked problems can enhance a pedagogy that fosters a 'caring community' (Rogers & Freiberg, 1994) by encouraging a decentralized, multi-perspective approach that calls for deep listening.

Design education offers a powerful platform for engaging with these wicked problems (Buchanan, 1992). In those complex, multifaceted challenges that resist straightforward solutions, empathy is emphasized as a core component of the creative process (Brown, 2009; Dorst, 2011). This is precisely because in design courses the design thinking philosophy serves as a foundation of the curriculum. Unlike traditional problem-solving approaches, which often seek linear solutions, the application of the design thinking framework encourages students to deeply understand the human context behind an issue, considering the lived experiences, needs, and values of diverse stakeholders (Kouprie & Visser, 2009). This empathetic grounding not only fosters more inclusive and sustainable solutions but also cultivates in students a mindset attuned to ambiguity, collaboration, and social responsibility (Mattelmäki & Sleeswijk Visser, 2011). As such, design courses are uniquely positioned to prepare learners to tackle wicked, global and societal challenges with creativity, critical thinking, and empathy.

1.2 Empathy-enhancing learning activities in engineering education

Empathy is defined as 'the ability to understand people by perceiving or experiencing their life situations' (Segal, 2011, p. 267). It involves putting oneself in someone else's shoes, seeing the world from their perspective, and sometimes experiencing their emotions as if they were one's own (Davis, 1994). In recent years empathy has been conceptualized as a concept for empowering engineering students to design and create solutions that are not only technologically sound but also ethically grounded and socially impactful (Bairaktarova, 2022; Walther et al., 2017). This has enabled educators to design a more structured pedagogical approach to nurturing empathy in engineering students through developing a variety of innovative learning activities, as the following resources illustrate.

Hermsen et al. (2023) apply 'perspective dialogue' techniques to support engineering students in dealing with wicked problems. In small groups students share how they would respond to authentic day-to-day situations that are provided by the instructors. Then they select 'guests' from a collection of well-known actual or fictional characters, represented by props - e.g., a Lisa Simpson doll, a poster of Nelson Mandela - and invite these 'guests' to participate in the dialogue and shed their light on the situation at hand. Adopting the perspective of these outsider guests provides an antidote to following familiar protocols and procedures, the authors explain. The activity aims to lead students to recognize their habits, perspectives and other underlying patterns as a first step towards valuing alternate ways of viewing and acting in day-to-day situations. In a similar vein, Walther and Sochacka (forthcoming) present various 'empathic imagination' exercises that can be used in the design phase of a study. These exercises allow students to become more keenly aware of one's own perspectives, assumptions and blind spots before gathering data through real-life interaction with the study participants. Examples include writing short vignettes about experiences that others who are very different from yourself may have; creating imaginary pieces of data (e.g., interview transcripts before the interview itself has been conducted); or role playing mock participant interactions. Each of these learning activities should be followed by guided reflection and is firmly geared at extending this empathic orientation into the actual data-gathering interactions. Sochacka et al. (2020), finally, provide probably the most comprehensive learning package for developing empathy in engineering education to date. The handbook includes 'empathic communication' learning modules on self and other awareness, emotion regulation and affective sharing, affective responding, and switching between analytic and empathic communication modes. In the module on affective responding, for instance, the authors highlight techniques as attending, paraphrasing, and reflective feeling, adding that teachers can heighten the learning effect by modeling affective responding themselves when facilitating plenary debriefs of learning activities.

Adding to these existing resources, we now turn to a description of how we have integrated various empathy-enhancing learning activities in design-based team projects in our own teaching practice. We will illustrate the points at which and the ways in which empathy nurturing can be mobilized to support student teams as they handle the different stages of the design process.

2 Empathy-enhanced design-based team learning in practice

In this section we describe how empathy can be cultivated in design-based team projects at the undergraduate and graduate level in the context of two engineering programs at a North-American and a European institution (see Bairaktarova et al., 2024, for further specifics about these courses and their respective educational contexts). Both projects provide practical guidance on how to cultivate empathy through various learning activities as described below. The courses share a common orientation towards supporting students in applying empathy effectively in their personal and professional lives. They do so by integrating empathy-enhanced learning activities in a structured and purposeful way throughout the design cycle, driven by iterative movements of divergence and convergence in both the problem and the solution space (Elmansy, 2021). However, they differ in the pedagogical approach they take to reach this end. In the

former course empathy is an explicit focus of learning activities while in the latter it is a more implicit learning outcome that is embedded within broader transversal learning goals.

2.1 Design-based project in a multidisciplinary course at bachelor level

The course, titled "Create! Ideation and Innovation" offers a semester-long, project-based exploration of empathy within the design thinking framework at a technological university in North-America. It begins with an explicit introduction of empathy as a critical component of design and problem-solving, and then moves into hands-on activities that allow students to experience empathy in action. These are several activities mobilized to this end roughly in the order in which students conduct them:

- One of the early in-class exercises is called "The Human Face" activity. Adapted from UNESCO (https://worldslargestlesson.globalgoals.org/resource/the-human-face-of-food-investigations-in-social-science/), this is one of the core in-class activities, where students use various materials brought to class to construct a 'face' that represents the human element central to their project. This creative process challenges students to visually express the diverse attributes and emotions of the end user, fostering a deeper connection to the people they design for.
- Another exercise students engage with through the semester is to develop storyboards (Buxton, 2007) that map out user experiences, encouraging them to visualize and plan the narrative of how their designs can impact real lives. The workbook of Greenberg et al. (2011) offers hands-on exercises and templates, including storyboard activities that could be directly adapted for design studio classes. If instructors are looking for more classroom activities or guidance for students, the Hasso Plattner Institute of Design (https://dschool.stanford.edu/innovate/tools)) could be a fruitful site for classroom activities, including storyboard design activities as they often integrate storyboarding into empathy and prototyping phases. Those resources are good for engineering and interdisciplinary design courses.
- To further immerse themselves in the user experience, another key exercise involves role-playing, where students perform the same tasks as their intended users, thereby stepping directly into their shoes. For example, in a design course focused on improving patient experiences in a clinic, students might first visit a local clinic or simulate a visit—from entering the building to checking in, waiting, and finally receiving care.

After this hands-on role-playing experience, they are asked to create a storyboard that illustrates each stage of the user's journey. The storyboard might include sketches and captions showing:

1. A patient arriving and struggling to find parking.
2. Confusion about where to check in.
3. A long wait time in a crowded, noisy waiting room.
4. A brief, impersonal interaction with a nurse.
5. Relief after receiving help but lingering frustration with the overall experience.

Through this visual storytelling, students capture not only the sequence of events but also the emotions and pain points that users may experience. This exercise encourages empathy and helps students identify specific opportunities for design improvements. Storyboarding, paired with role-play, thus becomes a powerful tool for understanding context and shaping user-centered solutions.

Weekly reflections and targeted questions on empathy complement these hands-on activities and help students connect theory to practice, encouraging introspection about how their design choices can impact diverse stakeholders. Throughout the semester, students work on the real-world project, engaging directly

with community members and industry partners to gather insights and understand the needs and perspectives of those affected by design outcomes. This immersive approach not only teaches empathy as a professional skill but also fosters personal growth, equipping students with strategies to integrate empathetic thinking into their daily lives and future careers.

2.2 Design-based project in a biomedical engineering course at master level

This second example pertains to a semester-long course for master students in biochemical engineering with a biomedical focus at a comprehensive university in Europe. The project revolves around a real-world problem introduced by a civil society stakeholder, who acts as the commissioner of the project. For instance, the manager of a horse owners' association raises grave concerns about an equine chronic liver disease that is assumedly caused by ragwort poisoning and asks the students to come up with solutions. Or a firefighter instructor wonders about the potential health risk of gases released by protective clothing after exposure to fire ('off-gassing') at the firefighter academy. In each case students are asked to come up with low-fidelity prototypes that address an aspect of the problem. Typically, all students work on the same problem in teams of three or four during seven full-day sessions spread out over a semester. The approach to developing empathy is implicit in that the instructors do not mention this concept when they introduce the tasks that require empathizing on the part of the students to bring the task to a fruitful end. Instead, the various learning activities are presented as ways for students to better understand and interact with key stakeholders of the issue at hand so as to arrive at more effective designs. These are several activities mobilized to this end roughly in the order in which students conduct them:

- Identifying, analyzing, prioritizing and mapping the parties and people who have a stake in the issue. Estimated expertise, influence, and willingness the relative position of each stakeholder group (Taylor and Bancilhon, 2019).
- Developing *personas*, i.e. fictional yet plausible representatives, for the key stakeholder groups and giving them a voice by narrating in the I-form a day in the life of each persona. These activities can enable students to gain a more concrete, 'emic' understanding of the different stakeholder groups (https://www.mindtools.com/a9rsycl/developing-personas).
- Brainstorming solutions to the issue from the perspective of the stakeholder personas ('figuring storming', Hansen, 2022) and engaging in other lateral thinking activities (such as the 'six thinking hats' of de Bono, 1986) for generating and exploring ideas from a variety of perspectives.
- Defining suitable stakeholder engagement approaches (Taylor and Bancilhon, 2019) and engaging with real-life stakeholders for checking one's assumptions, validating the personas, and collecting feedback about proposed solutions.

In contrast to the earlier described design-based team project, the concept of empathy is not explicitly introduced in this course nor is it mentioned as a desirable learning outcome. This choice was made to avoid potential adverse reactions and rejection by some students, who until that moment studied in an educational program and culture that hardly draws upon empathy as a valued asset. Instead, the instructors situate the described activities as contributions towards developing transversal professional skills, mostly under the name of stakeholder interaction.

3 Conclusion

In this short practice paper we introduced several tested learning activities for nurturing empathy in engineering education, supplementing the activities that can be found in related resources (Hermsen et al., 2023; Sochacka et al., 2020; Walther & Sochacka, forthcoming). These learning activities are conducted in the context of design projects and are aimed at equipping students with core competences for tackling wicked problems that reflect the world outside the classroom. Taken together, the presented activities

illustrate how design-based learning can be enhanced through the purposeful integration of empathy nurturing activities at every stage of team project work. By integrating empathy with technical expertise, be it explicitly or in more implicit ways, we intend to draw students' attention to emotional intelligence, ethical decision-making, and interpersonal skills as vital elements of effective engineering practice in real settings. As student reflections attest (Van Maele et al., 2025), this has been no vain hope.

By way of envoi, we would like to share this work with the reader within a 'propagation' paradigm (Sochacka et al., 2020). This means that much more than as a showcase, we offer this paper as an invitation to fellow educators, especially on the African continent where this conference is organized, to engage in dialogue with us so that we can exchange ideas and experiences on how empathy-nurturing approaches can be adapted to fit an ever-widening circle of settings in design-based team learning.

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