



# Evidence-based Opportunities for the Development of Empathy in Engineering through Community-based Learning

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# Evidence-based Opportunities for Engineering Students’ Empathy Engagement in Community-based Learning

## 1. Introduction

Community-Based Learning (CBL) is an experiential pedagogy that involves a community partner in the learning process [1]. Through working with a real partner in engineering, CBL provides the learning platform to educate students to develop interpersonal skills and become socially-engaged engineers who prioritize understanding the needs of the community [2], [3]. In CBL, engineering students learn to develop authentic relationships with community partners when doing engineering projects. This deepened interpersonal relationship between the students and the community can positively influence student learning and the quality and sustainability of the engineering projects [4], [5]. Our prior work found that empathy is a critical skill to remind students to think of the community partners’ needs while implementing engineering projects. By using empathy, engineering students are prone to understanding what the community thinks, feels, and reacts to the engineering projects during their interactions with community partners [6]. Therefore, in this three-year-long NSF IUSE study, we used quantitative and qualitative methods to explore the student experiences when engaging with empathy in CBL and how to translate those experiences into evidence-based opportunities to teach empathy in CBL.

Empathy is a complex, multi-dimensional concept. Researchers have operationalized empathy into three aspects to describe how a person can internally experience empathy, including affective, cognitive, and behavioral [7]–[10]. Further, some researchers focus on two relational functions of how people use empathy in social contexts, including interpersonal empathy [11], [12] and social empathy [13]. In engineering education, Walther, Miller & Sochacka [14] developed a model for empathy in engineering which captures both the affective, cognitive, and behavioral as an internal experience of empathy; and the social and interpersonal empathy as relational functions of empathy. Their empathy in the engineering model serves as a conceptual framework in this study to guide our understanding of empathy in CBL and provide a theoretical connection between our findings in the literature.

Overall, the goals of this three-phase study are 1) to explore CBL as a platform that exposes students to empathy in the context of engineering CBL and 2) to understand the ways to support student empathy engagement in CBL through evidence-based opportunities, such as explicit teaching empathy in CBL. To accomplish these goals, we developed three research questions (RQs) in three phases to guide the study:

In *Phase 1*, we explored empathy engagement from student experiences in six different CBL contexts to answer RQ1: *To what extent and in what ways does participation in CBL impact undergraduate engineering students’ empathy?*

In *Phase 2*, we designed empathy instructions for four CBL contexts in *Phase 1* to answer RQ2: *Using contextual evidence of CBL participation, what empathy instructions can be designed to enhance learning outcomes around empathy in engineering?*

In *Phase 3*, we taught those explicit empathy instructions in four CBL contexts and explored empathy engagement from student experiences to answer RQ3: *To what extent and in what ways do CBL empathy instructions lead to improved gains in empathy in CBL contexts?*

## 2. Project Overview

In *Phase 1* and *Phase 3*, we used qualitative approaches to understand student experiences in CBL through conducting focus groups (N=10) and (N=13) interviews. Meanwhile, we used quantitative approaches by disseminating pre-and post-surveys to measure student empathy growth before and after the CBL participation with (or without) explicit empathy instructions. From *Phase 1* to *Phase 3*, the study collected 344 pre-post surveys that indicated the increase in student empathy before and after CBL participation; the interviews concluded 44 students' lived experiences to interpret empathy engagement from CBL participation (Table 1).

Table 1. Data Collection Overview of Phase 1 and Phase 3

	Quantitative pre-post surveys	Qualitative participants
Phase 1	109	18
Phase 3	235	26
Total	344	44

In *Phase 2*, the goal is not to collect data but to design empathy instructions through translating existing empathy modules [15] developed by the University of Georgia (UGA) to support missing opportunities in CBL contexts. We adapted the empathy instructions by involving more relevant teaching materials in the CBL contexts.

## 3. Research Findings

(1) Phase 1 & Phase 3 Quantitative findings show gains in empathy before and after student participation in CBL with (without) empathy instructions

The quantitative analysis of the pre-post surveys in *Phase 1* shows that students can implicitly engage with empathy, inherited in CBL, according to the significant change in Emotion Regulation (ER) and Personal Distress (PD). But when empathy is explicitly taught in *Phase 3*, students show growth in multiple empathy constructs through the same CBL case, according to the significant change in Perspective Taking (PT), Emotion Regulation (ER), Interpersonal Self Efficacy (ISE), Personal Distress (PD), and Fantasy (FS). When the empathy growth is compared between different ways of engagement, students' Perspective Taking (PT) shows significant gains in CBL with the addition of explicit empathy instructions than only through CBL on its own. **The findings from both phases indicate that CBL is appropriate for empathy engagement in engineering (Phase 1 and Phase 3). Moreover, CBL coupled with empathy modules has an EVEN MORE positive outcome on Perspective Taking (PT).**

(2) Phase 1 Qualitative findings show three evidence-based opportunities emerged through student participation in CBL without empathy instructions

Three opportunities for engineering undergraduates to develop empathy in CBL are categorized from five themes that emerged from student experiences in *Phase 1*: CBL structures, encountering unfamiliarity, interpersonal connections, the role of self, and the role of others. Those three categories of opportunities are: (1) CBL structures represent the *structural opportunity* for students to engage with empathy through the pedagogical design of CBL; (2) Encountering unfamiliarity and interpersonal connections points to the *social opportunity* to allow the students to engage with empathy while interacting with others during CBL; and (3) The role of self and the role of others represent the *interpretative opportunity* to allow the students to further their empathy engagement by reflecting on their CBL experiences. Here is an example of encountering unfamiliarity under *social opportunity*. One student from the workshop shared this feeling of unfamiliarity at the start of the relationship when meeting with a family who had a kid with special needs:

*“I think there can be a little bit of awkwardness cause you don’t know necessarily, like, what questions are appropriate. You don’t necessarily know how much the family is going to be willing to talk about it. So, I think that there can be a little apprehension on our end as volunteers to ask questions about the kids.”*

In this example quote, the student is confronted with how to address the “awkwardness” and ask questions about the kids that would not offend the families. Therefore, the student engaged with empathy by demonstrating an awareness of the unfamiliarity of what the families have experienced. This type of opportunity implies that CBL instructors can involve additional social practices for students before meeting with the community, such as role-play.

(3) Phase 3 Qualitative findings show three approaches to enhance the integration of empathy instruction in CBL and reinforce the above three evidence-based opportunities that emerged through student participation in CBL with empathy instructions

There are three approaches summarized students enhance their empathy engagement from the explicit empathy modules: 1) Students learn and practice skills as outsiders to build an authentic relationship with others who are insiders; 2) Students embrace the feelings of discomfort, vulnerability, and awkwardness; and 3) Students are directed to center the others in CBL work. All three approaches were relevant learning outcomes as part of the students’ CBL experiences when empathy modules were intentionally designed and taught in the specific CBL experiences. Those three learning outcomes perceived by the students match the goal of the empathy instructions, which shows a promising validation for teaching empathy in CBL.

The qualitative findings in Phase 3 also synthesize students’ CBL experiences across contexts and interpret moments and experiences related to empathy engagement according to students’ descriptions of their CBL experiences. These five themes, though they appear the same as Phase 1 findings, have more nuanced meanings: 1) *CBL structures* involve curricular decisions which can promote opportunities for students to engage with empathy; 2) *Encountering unfamiliarity* is the process of students experiencing new and often uncomfortable scenarios in CBL; 3) *Interpersonal connections* are processes of and opportunities for building authentic relationships with others; 4) *The role of self* includes opportunities for students to reflect on, interpret, and make sense of their role and contributions within CBL; and 5) *The role of others* includes opportunities for

students to explore and understand others' needs and perspectives within CBL. Through these five themes, Phase 3 reinforces the three opportunities for empathy engagement and affirms that students' CBL experiences intersect with empathy engagement.

#### **4. Conclusion & Implications**

Overall, this study accomplishes two goals: 1) exploring CBL as a platform that exposes students to empathy in engineering CBL, and 2) understanding the ways to support student empathy engagement in CBL through evidence-based opportunities, such as explicit teaching empathy in CBL. Specifically, this study provides evidence from multiple data sources to conclude that CBL is a promising platform to teach and practice empathy in engineering. Students' growth of empathy is supported by the quantitative findings of pre-post comparison before and after CBL participation. From the qualitative data, this study also obtains an empirical understanding of how CBL can engage students with empathy through three categories of opportunities: structural, social, and interpretative. Further, although empathy development can happen naturally within CBL, students' empathy engagement can be enhanced by three approaches to integrating empathy instructions in CBL: teaching empathy skills, embracing self's feelings, and centering others in CBL work.

For CBL instructors in engineering and from other disciplines who consider teaching empathy to enhance student learning, this study provides an example of exploring and integrating empathy within student experiences. For CBL programs and organizations, this work models a way of evaluation to understand the empathy engagement of their participants.

Ultimately, by teaching empathy as an explicit learning outcome in CBL, we believe that equity, social justice, and reciprocity will move more central and visible to CBL in engineering. After all, the "community" in CBL are real people. For future work, we will advocate for a more genuine, thoughtful pedagogical design behind CBL while limiting the negative implications for the community during the students' learning process.

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