A Quantitative, Pilot Investigation of a Service-Learning Trip as a Platform for Growth of Empathy

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***Abstract*— This work presents the quantitative findings from a multi-method study investigating service-learning as a platform to promote empathy growth within engineering undergraduates. Qualitative results from this study have previously demonstrated the potential of service-learning activities to support the development of empathy by leveraging group dynamics, interactions with the community, and self-reflection. A repeated measures design using the Davis' Interpersonal Relativity Index (IRI) was administered to the 14 undergraduate student participants before and after a service learning experience. Exploratory quantitative findings indicating the potential of service-learning and the use of reflection as a platform for the growth of empathy, particularly within the IRI constructs of empathic concern and perspective taking, are presented. These findings, along with associated limitations, demonstrate the importance of further investigation into the use of service-learning, and other community-engaged student learning (CESL) activities as platforms for empathy development among undergraduate engineering students.**

Keywords—Community Engagement; Empathy; Service-Learning

I. INTRODUCTION

As the world becomes more globalized and interdependent, engineers are increasingly confronted with socio-technical, and ill-structured problems [1]. This means that engineers must recognize certain context specific needs and constraints, in order to provide technological solutions that can be adopted by users in a practical and sustainable manner. In other words, the engineer of today must leverage multiple stakeholder perspectives, and work within diverse, multidisciplinary teams [2]. These factors are beginning to conflate to influence the expansion of undergraduate engineering curricula to facilitate the development of professionals who exhibit the requisite non-technical skills to be part of this emerging engineering landscape [3]. While the technical core of the engineering curriculum has been maintained as a primary element of these programs, more attention is being focused on the development of holistic approaches within engineering programs [4], [5]. Service-learning, an educational approach in which student learning outcomes are blended with community interactions, provides an experiential learning opportunity for undergraduate students to navigate the complexities of the engineering and address societal needs [6], while developing technical and professional skills.

Bringle and Hatcher's definition of service-learning is commonly accepted in the literature: "Course based, credit bearing educational experience in which students participate in an organized service activity that meets identified community needs, and reflect on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility" [7, p. 112]. In this sense, we consider service-learning a community-engaged student learning (CESL) activity. In 1995, the Engineering Projects in Community Service Program (EPICS) became the first service-learning program integrated into an engineering curriculum, providing an unique and innovative learning experience for engineering undergraduate students [8]. Since then, service-learning has become an important complement to classroom-based engineering pedagogy. When performed effectively, it has shown potential to assist in the development of professional skills, such as communication, social responsibility, problem solving, and critical thinking among engineering students [9]. This is important because some of these skills are not explicitly taught in traditional engineering curricula. Further, service-learning has shown positive effects on student social-emotional skills such as personal, moral, and interpersonal development [10]. An international service-learning experience serves as the context for the study discussed here, as we investigate service-learning's potential to foster undergraduates another important professional skill: empathy.

Empathy has been studied across multiple disciplines [11] including cognitive neuroscience [12], social psychology [13], and behavioral science [14]. The Oxford English Dictionary defines empathy as "the ability to understand and share the feelings of another [15]." In the field of social work, empathy is regarded as a critical skill and orientation among its practitioners [16]. This approach can inform engineering education which similarly focuses on developing engineers as functioning practitioners [17]. Empathy is believed to impact communication [18], design processes [19], professional success, ethics [20], and the culture of engineering [21]. This paper explores the measurable growth of empathy in undergraduate engineering students participating in an international service-learning experience.

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While literature on the theoretical model of empathy in engineering education exists [21], [22], empathy development within service-learning/community-engaged contexts has received limited attention [23]. This study analyzes students' experience within a service learning activity to explore the development of empathy during the course of an international service-learning activity. The purpose of this paper is to provide an initial understanding of service-learning as a platform for empathy development by analyzing the empathic growth of undergraduate engineering students, from a large land-grant institution in the US, as they participate in a service-learning trip to a foreign community. The research question guiding this paper is: *How can an international, undergraduate-engineering service-learning trip contextualize student development of empathy?*

II. Research Methodology

A multi-method design was implemented for this pilot study. According to Janice Morse [24, Ch. 7], the purpose of a multi-method design is to form comprehensive whole by involving both quantitative and qualitative studies that are "relatively complete on their own" and answer "particular sub-questions". Our research question to guide both portions of the study is: *How can an international, undergraduate-engineering service-learning trip contextualize student growth and development of empathy?* The qualitative portion of the study is designed to provide insight into the mechanisms that facilitate empathic development in a service-learning context, when empathy occurs during the interactions with the others [23]. The quantitative portion of the study aims to examine empathy inside oneself before and after a service-learning trip. Altogether, the empathy development can be examined as a complete concept. *Fig 1.* shows a graphic of the design of the complete project.

In the qualitative portion of this study, a framework of empathy developed within the neurosciences by Decety & Moriguchi [20] was adopted. This framework consisted of 4 empathy constructs which are shown along with their definitions in *Table 1.*

Results of the qualitative portion of this study revealed that empathy development is facilitated by group dynamics among the participants, interactions between the participants and the local community, and the participants' interpretation of the experience through self-reflections [23]. The strength of these findings, is that they provide insight into several aspects of a service-learning context that contribute to empathy development. Further, the findings provide some information regarding the call from Hess & Fila's work [25] about

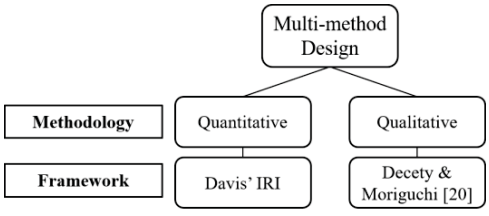

Figure 1. Multi-method design

Table 1. Decety & Moriguchi Empathy Framework [20].

Construct	Definition
Affective Sharing	The 'reflection' of another person's observable experience
Self-Awareness	A person's ability to differentiate between his/her experience person's.
Mental Flexibility/ Perspective Taking	The ability to learn about the situations affecting others, and to effectively imagine what it would be like to experience the world from the other's position.
Emotion Regulation	The ability to 'turn down the volume' of one's own feelings as they arise from mirroring another's experience.

examining the process of empathy development in participants' experience in five different contexts, including service-learning. While, the quantitative portion presented in this paper addresses whether or not empathy growth occurs within participants during the service-learning activity.

As this paper presents the quantitative results of this study, empathy was operationalized via the Davis Inter Personal Reactivity Index (IRI) [14]. The reason why this particular instrument was selected is because of the similarities of its constituent constructs to those of the Decety and Moriguchi framework; and the high reliability of its measures for these constructs [26].

Davis' empathy measurement is based on a multidimensional view of empathy. It assumes that empathy consists of several separate yet related constructs, shown in *Table 2.* According to Davis, the IRI is a measure of empathy that takes the view that "empathy consists of a set of separate but related constructs and seeks to provide measures of dispositional tendencies in several areas" [14, p. 55]. It is a self-report instrument that contains four-7 item subscales, each of which corresponds to Davis' four empathy constructs.

The context for this study was the service-learning component of a semester-long, credit-bearing engineering course at a large Mid-Western university. The course is based on a project-based learning pedagogy (PBL), which is a form of situated-learning designed to help students construct better understanding of engineering practice by working on projects in real-world environments [27]. Within this course, the real-world environment was a week-long service-learning trip to Montaña de Luz (MdL) at a center for children who have been affected by HIV/AIDS in the country of Honduras.

In preparation for the service-learning experience at MdL,

Table 2. Constructs of the Davis IRI empathy measure [14].

Construct	Definition
Perspective Taking	Spontaneously adopting the psychological point of view of others in everyday life.
Empathic Concern	Experiencing sympathy and compassion for unfortunate others.
Personal Distress	Experiencing distress and discomfort in response to extreme distress in others.
Fantasy	Imaginatively transposing oneself into fictional situations.

students were asked to take the IRI in order to take a baseline measurement of their scores on the four empathy constructs assessed in the IRI [14]. Though the instrument is designed to measure individual differences in empathy, the current study employed a one-group pretest-posttest design [28] in order to assess changes in empathy during the course of the service-learning experience. This design specifically takes out the impact of individual differences in order to assess within-participant differences, leading to a measurement of intrapersonal differences on the measure assessed by the instrument [28]. In order to facilitate empathy growth during this experience, students were asked to write reflections around prompts that were provided to them each day. The qualitative data suggested the service-learning experience, as well as contextualizing their experiences via the reflections, led to an increase in empathy growth among the participants [23]. Recall, from above that the goal for this study is to better understand how an international, undergraduate-engineering service-learning trip contextualizes empathy growth among undergraduate engineering students. Though this goal is qualitative in nature, the quantitative method described was implemented to assess whether or not there is evidence of empathy development that is consistent with the qualitative results reported previously [23]. Reflection prompts were developed to allow students to reflect on issues associated with their experience during the service-learning experience. The authors believe that having reflections embedded within a service-learning activity did contribute to empathy development in the participants.

The study was conducted in the spring 2017 semester, with 14 students enrolled in a semester-long course. During the course, the students were required to prepare for a group project during the semester and implement the project during the service-learning trip to MdL. Upon return, the students presented their final project implementation and deliverables, to the class. All 14 students were split into four project groups as shown in *Table 3*. One student did not travel to Honduras and thus did not participate in the research.

Each group was assigned a project that was developed in collaboration between the representatives of the local community/MdL and the instructors who had been familiar with the community in MdL. The goal of these projects was to support the development of solutions to local needs within the MdL community in Honduras.

Table 3. Projects assigned within the service-learning course.

Group Number	Project
1	Solar Panel Installation
2	Civil Engineering of Terraced Fields
3	K-12 STEM Educational Outreach
4	Wind Turbine with LED Installation

III. Results and Discussion

A. Discussion of Results

In order to examine whether or not students' empathy increased, as a result of service-learning participation and reflection, one-tailed paired-samples t-tests were conducted on the four measures of the IRI. It was found that on average students who took this course showed a very large increase in Perspective Taking (PT) score between their pre-course score (M = 4.02, SD = .819) and their post-course score (M = 4.276, SD = .589) $t(13) = 3.101$, $p = .004$, $d = .992$, r^2=.514. This result is consistent with results of the qualitative portion of the study [23]. Further, we found that our course participants showed moderate to large increase in Empathic Concern (EC) score between their pre-course score (M = 3.91, SD = .635) and their post-course score (M = 4.122, SD = .554) $t(13) = 2.427$, $p = .015$, $d = .605$, r^2=.283. This finding is also in agreement with the results of the qualitative data for this study [23]. These findings represent preliminary evidence that having students reflect on their experience during a service-learning activity facilitates development of their empathic concern and empathic perspective taking consistent with findings from other studies [22].

Fantasy (FS) and Personal Distress (PD) showed no significant changes as a result of the embedding reflections within the service-learning activity. Though this finding is not fully understood at this time, the authors offer three potential explanations for this. First the intervention does not explicitly address, personal distress and fantasy and as a result, there is reason to believe that they would not be developed to a significant extent as a result of the reflection embedded in a service-learning activity. The second potential explanation is that the FS and PD constructs in Davis empathy framework are not perfectly aligned with constructs of the Decety and Moriguchi empathy framework used to analyze the qualitative data. As a result, it could be that the way in which these constructs would be operationalized. The third explanation surrounds the issue of statistical power and will be discussed in detail in the next section.

B. Discussion of Limitations

The results above demonstrate the potential of service-learning as a platform for empathy development for undergraduate engineering students. We have shown that purposeful reflection is embedded within service-learning experiences can serve as an intervention that facilitates empathic growth. This finding demonstrates preliminary evidence that service-learning activities can promote a skill that is viewed by scholars as vital for practicing engineers [21]. While the findings of this study are very promising, they are not without limitations.

While the one-group pretest-posttest design is quite useful with respect to determining changes on a specific measure, it adds two major threats to validity to this study. One is that this design provides only weak information about what may have

happened to participants had they not been asked to write reflections during the service-learning experience [28], [29]. As a result, significant increases on any of the measures studied could be due to maturation, or history [28]. Due to the time constraints of this study, and the paucity of empathy instruments that have been validated for undergraduate students, the research team was not able to correct for this design flaw prior to the study. One way to better control for this threat in the future would be to add a second pretest during the classroom portion of the course, do another before the service-learning trip, then a third one after the trip. This extra test would allow the team to control for biases that may exist in assessment of treatment effects [28].

The second major validity threat is that of statistical conclusion validity [28], [30]. Statistical conclusion validity was threatened mainly by low sample size which resulted in low power. To demonstrate how this can impact the validity, a power analysis for the project, along with its implications for the EC construct are described below. Recall, that for EC, the effect size was reported as .605. Using G*Power software, a power analysis was performed to determine the sample size necessary to achieve a power of .8 for the given effect size. It was found that achieving power of .8 for this study would require 28 participants (twice the number of participants for this study). The estimated power for this, given our actual sample size study was .42. This power highlights two important points about the statistical conclusion validity of this study. First, due to the pilot nature of this study, and the self-select nature of the service-learning course, sample size (and therefore statistical power) were not completely in the control of the research team. The sample size was determined by the number of students who enrolled in the course. This is another reason that the multi-method design was important for this study, as it facilitates triangulation of the quantitative results, with the qualitative results. The second important note is that in this study power works against us in some one way, and in our favor in another. In one respect, having such low power could reasonably explain why PD and FS did not show statistically significant changes. There is a real chance that these findings are due to type II error. On the other hand, the fact that such an under-powered study yielded large effect sizes for EC and PT shows that there is evidence for the use of in-situ reflection as a tool for empathy growth in some service-learning contexts, though these findings should not be interpreted as definitive. They are only preliminary, and more work is needed to better understand the nature of the role of reflections embedded within a service-learning activity for empathy growth.

IV. Conclusion

We have demonstrated that a service-learning activity with in-situ written reflection can potentially serve as a platform for development of empathic concern and empathic perspective taking. Preliminary evidence suggests that having students reflect on their experience during a service-learning activity facilitates development of their empathic concern and empathic perspective taking. The results and limitations presented highlight both the promise of in-situ reflection in CESL experiences as a platform for empathy development, as well as the need for further investigation into the extent to which these findings hold.

There are unanswered questions around these findings. Do demographic factors moderate the relationship between the written reflections and empathic development? Since the participants all self-selected for the service-learning experience, this could speak to their being more prone to exhibit empathic characteristics, so more study is needed understand how empathy growth occurs. Also, there is a question of the extent to which the international context impacts the ways in which CESL activities affect empathy growth. Last, is the issue of whether or not written reflections have a confounding effect which impacts the ability of CESL activities to serve as interventions for empathy growth. Deeper understanding of these issues can lead to development of effective instructional tools for teaching empathic skills to undergraduate engineering students in CESL contexts.

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