

Long-Term Impact of Humanitarian Engineering Projects on Views of Diversity, Equity, and Inclusion: Preliminary Qualitative Results from Alumni

Abstract:

This paper details a poster presented in the National Science Foundation (NSF) Grantees Poster Session for the 2022 ASEE Annual Conference. The study, aptly titled, aims to examine the ‘Long-Term Effect of Involvement in Humanitarian Engineering Projects on Student Professional Formation and Views of Diversity, Equity, and Inclusion (DEI).’ As part of the larger study, this poster details the results from alumni (n=19) of the Lipscomb University engineering program collected through an open-ended questionnaire. The research team performed an inductive coding analysis of the qualitative data to understand the connections between humanitarian engineering projects, professional formation, and views of DEI. Quantitative results as well as data from other participant groups, including current students and non-alumni engineering professionals, will be presented elsewhere. Emergent codes showed that participants found both outward and inward value in serving others. Outward value reflected a better quality of life for the person benefiting from service while inward value provided personal satisfaction, learning, or growth for the participant. This inward value was also evident with respect to views of DEI where participants mentioned learning or growing from past events. Two participants directly mentioned a connection between their experiences with humanitarian engineering projects and their views of DEI. Additionally, the codes connected to existing literature in engineering education as well as theories like empathy, identity development, and emotional intelligence. These results are promising for this study and will be expanded upon through interviews where these connections will be examined at a deeper level.

Background:

The basis of this project is described in [1] and will be briefly described here. The broader impact of this NSF PFE:RIEF grant (#2024525) is to increase diversity in engineering by developing a model to create more inclusive engineers. A variety of projects and initiatives have been designed to increase diversity by providing guidance and support to underrepresented groups to better overcome challenges in their engineering career [2-6]. This project shifts the focus from removing the burden on underrepresented groups to eliminating the barriers from the workplace itself. As Rambo-Hernandez *et al.* put it: "Efforts aimed at broadening participation... must address culture and particularly attitudes toward diversity and inclusive behaviors in engineering." [7] In their paper describing the Valuing Diversity and Enactive Inclusion in Engineering scale, the authors examined educational intervention activities to promote DEI. Here, we hypothesize that student involvement in humanitarian engineering projects supports professional formation to better embrace DEI in the workplace. The program under investigation has an 18-year history of providing curricular and extracurricular opportunities for undergraduate student involvement in humanitarian engineering projects. This mixed-methods study aims to understand the impact of this program in order to develop a model for other engineering programs with the intention of creating more inclusive engineers.

This study builds on existing research which demonstrates the positive impacts of humanitarian engineering, community engagement, and service-learning projects on the students involved. Whereas other studies have focused on the direct impact to the student, this study

extends longitudinally, examining long-term effects, as well as outwardly, investigating secondary or indirect impacts. As humanitarian engineering grows as a discipline, there will be a corresponding need to understand the long-term impacts of such programs. Berg, Lee, and Buchanan discussed a methodology for studying humanitarian service-learning within Engineers Without Borders-USA and the need for more research on these long-term impacts [8]. With respect to the outward impact on student involvement, Reynante described an overlap between community engagement in engineering education and the recognition of inequity and empathy development [9]. Furthermore, Canney and Bielefeldt developed an instrument to measure student views of personal and professional social responsibility in engineers, but also made note that scaled items might not be the best strategy to measure such complex attitudes [10]. If valuing diversity is seen as passive, could social responsibility be seen as the active or outward method of exhibiting inclusivity? Might these learnings about inequity, responsibility, and empathy extend past their experiences as a student into their professional workplace culture? Walther, Miller, and Sochacka proposed a model of empathy in engineering as a practice orientation and a professional way of being that could relate to fostering inclusion in engineering [11]. Lastly, Huff detailed identity development for early career engineers and how professional identity development is not disconnected from personal social context [12]. From these works, we find the following key points:

- Engineering students are positively impacted by involvement in humanitarian engineering projects, but the length of impact is not well-studied, nor is the impact on views of DEI.
- Community engagement (a cousin to humanitarian engineering) provides opportunities for students to understand inequity and develop empathy.
- Social responsibility could be an indicator of active inclusivity but may require a more nuanced approach than scaled items in a questionnaire.
- Empathy in engineering is a teachable and learnable skill but requires students to question their contextual situation and engineering professional identity.
- Professional identity development for early career engineers is connected to their social context, i.e. their workplace.

Rambo-Hernandez pointed toward a potential link between engineering identity development and inclusivity in their study of first-year engineering students [7]. In this study, we will examine the potential relationships between empathy and identity development in engineers and how this could relate to a secondary or indirect benefit in their workplace through inclusivity.

Methods:

To better understand the long-term impacts of involvement in humanitarian engineering projects, alumni of the Lipscomb engineering program were selected as potential participants for this study. Current students and non-alumni engineering professionals also participated in the study but those groups will be discussed elsewhere. A questionnaire was designed and is detailed in [1] but will be summarized here. Items from the Engineering Professional Responsibility Assessment [10] as well as the Valuing Diversity and Enacting Inclusion in Engineering [7] instruments were used to build the scaled items. Open-ended questions were also included and iteratively designed by the research team through piloting, discussion, and revision. This study was determined exempt by the Lipscomb and Marshfield Clinic Institutional Review Boards.

Following data collection through the questionnaire, the research team performed inductive thematic analysis for the open-ended questions. Each team member performed open or initial coding on the responses by highlighting key words or phrases. Following this first iteration of coding, team members reviewed the highlighting, took notes on significant or interesting findings, and began second coding by assigning names to the codes. Note that the team allowed codes to emerge from the data rather than utilizing a predefined set of codes [13]. This method of data analysis will allow theory to emerge from the data since the model for creating inclusive engineers has not been defined and is the purpose of this study. To ensure inter-rater reliability, the research team then met together to discuss codes and find group consensus on appropriate names for the codes. There was some variation on the amount of codes with some members performing ‘lumper’ coding (lumping large pieces of text as a code) and others ‘splitter’ coding (splitting text into many codes) [14]. Overall, the discussion found team members were in agreement with most codes with only minor changes in names and some adjustments on coding amounts.

Results:

Demographics

Nineteen alumni responded to the questionnaire with nearly all providing some response to the four open-ended questions. Four of the respondents identified as female and three identified as Hispanic/Latinx (see Figure 1). Graduation year ranged from 2006 to 2021 which overlaps much of the history of humanitarian engineering project opportunities for students at Lipscomb as shown in the timeline in Figure 2.

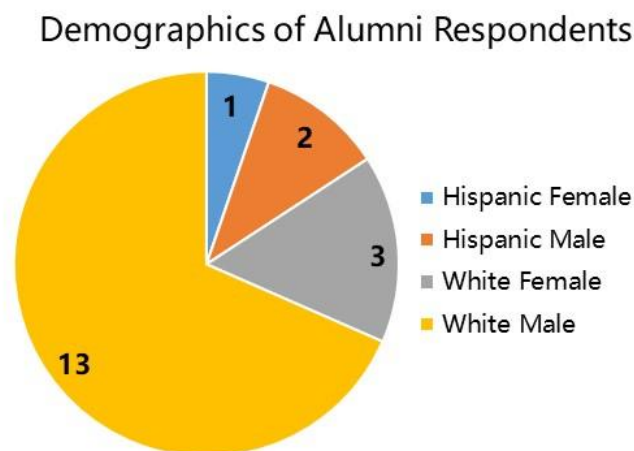


Figure 1: The demographic profile by gender and ethnicity for alumni respondents to the questionnaire.

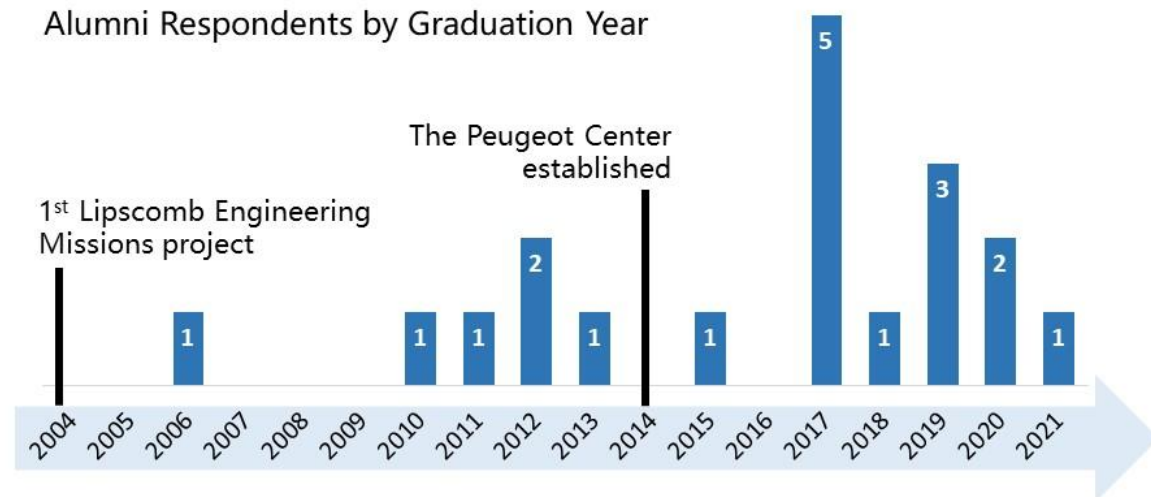


Figure 2: The number of alumni respondents to the questionnaire is shown in correlation with the timeline of humanitarian engineering project opportunities at Lipscomb.

Of the respondents, two identified as first-generation college students and seven identified as the first to study engineering in their family. Sixteen of the respondents are currently working in the engineering field. Of the three that did not specify a current occupation in the engineering field, one is attending graduate school and one mentioned a career change to law. At the end of the survey, the participant who transitioned to a law described the following: “I cannot overstate the impact that my time working with Lipscomb engineering missions has had on my life, as that has played a major role in my career path...” Though this is only a glimpse into the participant’s career path, it seems to confirm studies that have found students motivated by social responsibility may be more likely to leave the engineering field [15]. Eighteen mentioned past experience with humanitarian engineering projects at Lipscomb with six having continued active involvement after graduation and three through donations. This continued involvement post-graduation is representative of the sustainability of the Peugeot Center program at Lipscomb University, which is described in detail elsewhere [16]. The unique program and significant mentoring involved in Peugeot Center projects could be a factor that supports this study and will be investigated further.

The demographics of the alumni respondents matched the expectations of the research team based on the demographics of Lipscomb [17] and the engineering field [18]. Additionally, because white males represent the majority of engineering jobs, data from this group will be highly useful to understanding inclusion perspectives in the workplace. Of note, however, is the impact that underrepresented groups may have on inclusivity in engineering. McGee and Bentley describe how black and Latinx undergraduate STEM students develop an equity ethic or a concern for social justice based on past suffering from inequities [19]. It’s possible that underrepresented groups in engineering feel a desire for inclusivity because of an equity ethic, but this data is difficult to gather in the context of Lipscomb and the engineering field. Rather, this study will focus on inclusivity perspectives from the majority population of engineering (white males), which could provide for a more substantial positive impact to the field simply due to high numbers. Results and analysis for two of the open-ended questions follow.

Q1: Explain your primary reason for volunteering or serving.

In response to the above question, five codes emerged from the data. The most frequent code was faith and religion (11 of 19) whereas the second highest frequency (8 of 19) found participants were motivated to serve out of a feeling of moral imperative (duty/responsibility) with three overlapping responses across the two. Faith and religion was also the highest recorded solo code with seven respondents mentioning only this code in their response (Figure 3).

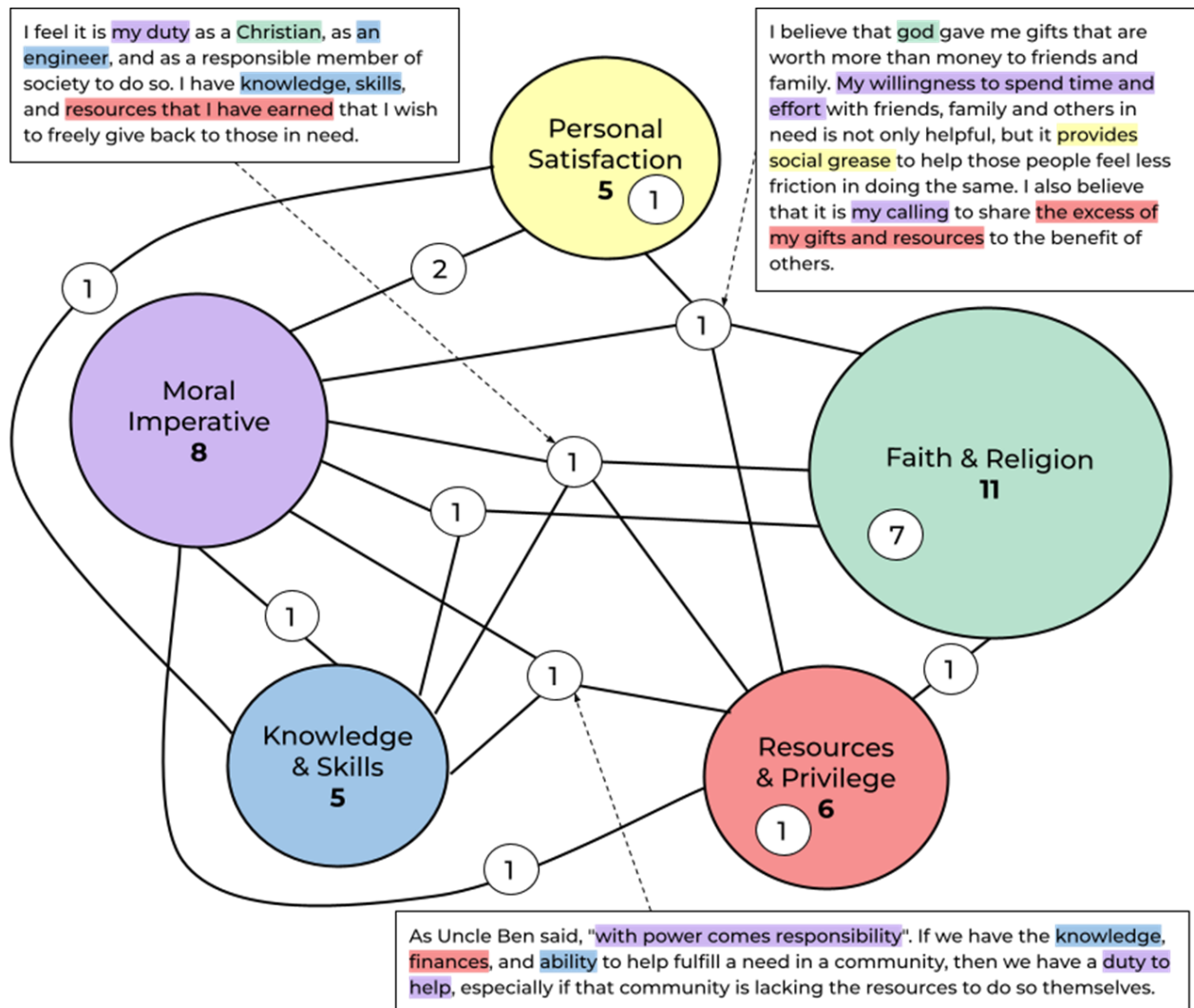


Figure 3: Coding visualization for Q1 with three representative responses included. Colored bubbles represent the codes whereas white bubbles show the number of responses that included connections between codes (or solo codes).

While eleven respondents mentioned faith or religion as a primary reason for volunteering, eighteen of the nineteen identified with a religion. Of those, fourteen mentioned that religion was very important, two deemed religion somewhat important, and two said it was not too important. Because Lipscomb is a Christian university with service as a missional pillar [20], these responses were expected, as the combination of skills or knowledge, religion, and moral imperative tends to be the driving force of any service learning project. Another common

response (6 of 19) mentioned an abundance of resources or privilege as a reason for serving, which again may reflect the population who is able to attend a private Christian college. This recognition of privilege is significant for this study and will be further investigated as we examine views of inclusivity of a majority population.

Of the remaining two codes, five respondents mentioned a personal satisfaction that is gained from volunteering or serving and five mentioned having knowledge and skills that are useful for serving. Interestingly, most respondents (11 of 19) mentioned multiple reasons for serving, many of which were reflected in interconnected codes. For example, in this response “I feel it is my duty as a Christian, as an engineer (to serve),” faith and religion and knowledge and skills were sub-codes within the code for moral imperative. Additionally, two respondents mentioned three different reasons for serving while two others mentioned four reasons. Clearly, the motivation for serving or volunteering is not always so simple and can represent complicated thoughts, views, and beliefs. The complexities unveiled in these responses show promise for a deeper investigation and richer understanding following interviews in the next step of the study.

Overall, the majority of respondents showed clear outward motivation for serving. Some went so far as to mention things such as “a genuine desire to see others’ needs met” and “[being] a responsible member of society” as their reasons for serving. This set of responses differs from the set that mention volunteering as a means of “[leading] to a meaningful life” and “[giving] great satisfaction,” as those responses have a more inward or personal result from the action. One respondent specifically mentioned humility as an important factor in volunteering whereas another described learning empathy from their parents as a reason for their service. While humility and empathy are not necessarily equivalent to inclusion, these responses show a deep level of thought and maturity on a personal level that could be investigated more fully in upcoming interviews.

Q2: Briefly describe an event that has influenced your views of diversity, equity, and inclusion.

While it is widely known that the field of engineering suffers from a lack of diversity, our participants reinforced this reality through their responses. In the words of one participant, “the environment is unbalanced.” Many respondents mentioned working in a diverse environment, however there were a substantial amount of responses that described disparities within the field. Some respondents mentioned firsthand experiences or a close relationship with someone who experienced discrimination or bias whereas others simply described a team environment or working with a client as influential to their views of DEI. Overall, the majority (12 of 19) of the respondents described a clear reason or specific event that has influenced their views of DEI. Nine of the nineteen went further to explain how their perspective changed as well: “opened my eyes to some of the prejudices” and “I have learned... the value of listening”. Of the remaining seven (shown as a separate bubble in Figure 4), three participants did not provide a response to this question and four provided vague responses with a short phrase or non-specific general comment. It is unclear whether these responses without relevant codes had not experienced an event that influenced their views of DEI, if they did not want to answer the question, or if they were experiencing survey fatigue since this was near the end of the questionnaire.

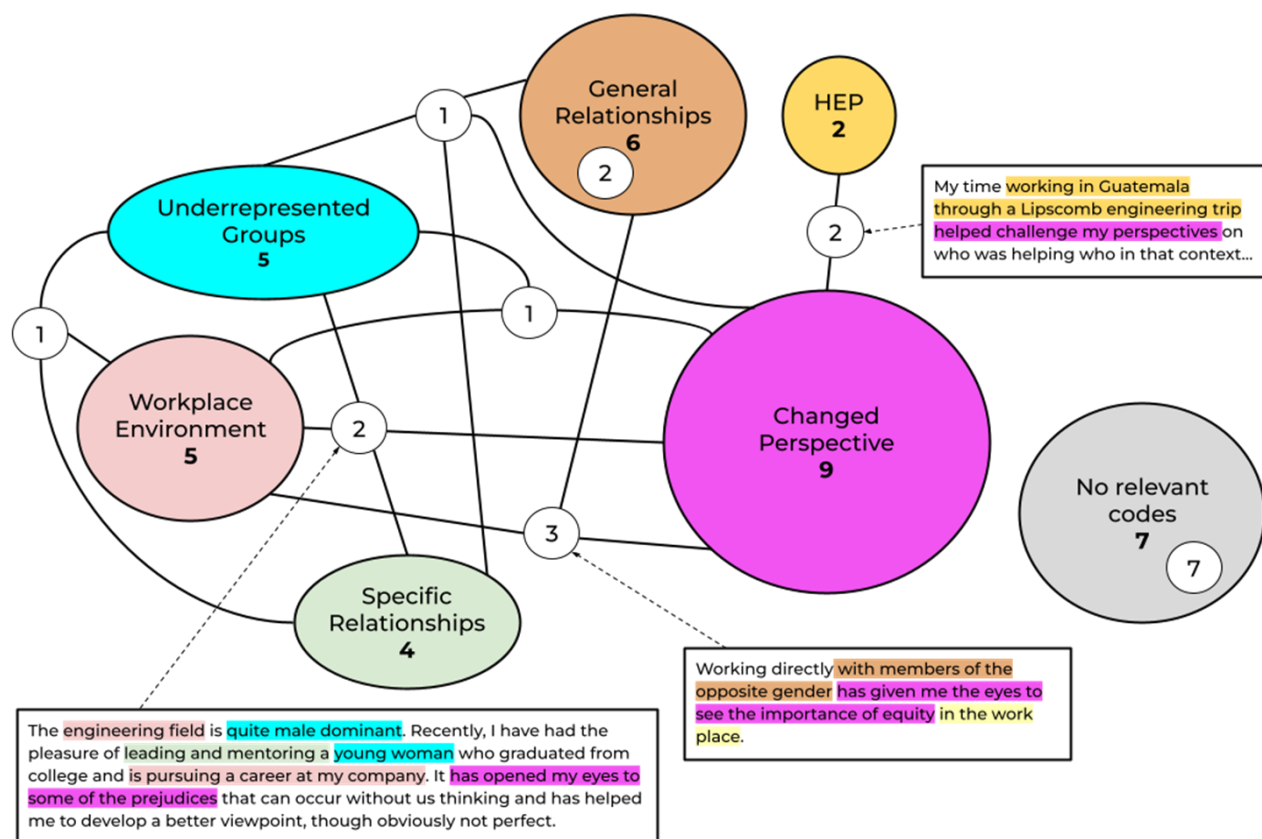


Figure 4: Coding visualization for Q2 with three representative responses included. Colored bubbles represent the codes whereas white bubbles show the number of responses that included connections between codes (or solo codes). HEP refers to a connection with humanitarian engineering projects.

According to respondents, engineering is recognized as a white male-dominated field. Five respondents mentioned an underrepresented group in engineering, either women or racial minorities, with an associated event or experience. Examples include women's voices being discredited, the feeling of being fragile or alone within their group, or having to rely on superiors to defend them in situations. Four respondents mentioned a specific relationship, like mentoring a young woman, whereas six mentioned more general relationships, like clients or colleagues, as influential on their views of DEI. Five also mentioned their workplace environment in some way though the question did not specifically probe for this. Similarly to Q1, the responses showed many interconnections among codes with five mentioning three codes and three mentioning four codes. Again, there is a level of complexity that is available for investigation during the coming interviews.

Two respondents mentioned how their experiences as women in a male-dominated field have provided new perspectives about diversity and inclusive actions: "This makes me quite sensitive to the people at the table" and "each individual had a unique perspective... that bettered our class as a whole." It's possible that these responses reflect the development of equity ethic for these women [19]. One alumni also described how their partner's experience (though in a different field) being treated differently due to their gender and race was influential to their views

of DEI. From the alumni responses, it seems that relationships and observations in the workplace can have a strong impact on the frame of mind of the employees.

In addition to these factors, humanitarian engineering projects through Lipscomb had a major impact on two of the alumni. These alumni reported working on a project for and with a Guatemalan community with the intent to make changes in other people's lives. However, both alums reported significant personal learnings or growth from the projects. One alumni stated, "I realized how much I expected them to be helpless and the team to be 'saviors.' I was humbled" The second recognized that though they had the skills and knowledge to assist the community, it was the local people who had "more to offer in terms of practical implementation" These alumni indicated their experiences helped them understand how important it is to listen, practice humility, and challenge perspectives. Interestingly, the only two humanitarian engineering projects mentioned were based in Guatemala though Lipscomb's program has offered projects in at least five other countries. It's possible that there is something unique about Guatemala, the projects completed there, or the teams and leaders involved with those projects. Although survey responses elicited great insight of the engineering field, there is a substantial amount of research that remains unanswered. Our team intends to conduct interviews to further investigate these questions and uncover new insights.

Conclusions and Next Steps:

From this data, we found initial connections to existing literature around engineering and DEI, specifically empathy in engineering [9 & 11], social responsibility [10], identity development [12], and equity ethic [19]. Additionally, the emergent codes seemed representative of more well-known theories in psychology like emotional intelligence [21], empathy [22], and social cognitive theory [23]. These concepts are also connected to one another in many ways. Empathy is one of the five competencies of emotional intelligence as detailed by Goleman with the other four being self-awareness, self-regulation, motivation, and social skills [21]. Hoffman makes connections between empathy and social cognitive development and also mentions concepts like moral judgment, benevolence, justice, and caring which reflect some of the emergent codes [22]. Bandura on the other hand describes social cognitive theory as a model of an interacting triad of behavior, personal factors, and environmental events [23]. Whereas emotional intelligence and empathy reflect personal beliefs and views, social cognitive theory ties in the environment (involvement in HEPs) and behaviors (inclusivity in the workplace). Huff makes this connection between the environment and personal factors in his description of how the engineering workplace influences the development of a professional identity [12]. Another interesting study by Hyun connects diversity climate, emotional intelligence, and organizational citizenship through social cognitive theory thus providing more supporting evidence of the interconnectedness of these concepts [24].

Ongoing research will utilize these theories and investigate connections to understand the impacts of humanitarian engineering projects on views of DEI as well as how these alumni practice inclusivity in their workplace. There remains an obstacle in this work to differentiate views and beliefs from behaviors and actions. It is easy to support the ideas of diversity and equity in the workplace but practicing inclusivity by actively removing barriers for underrepresented groups is much more challenging. As described by Etzioni 1995, creating an 'authentic community' requires responsiveness of those within the community which seems to

reflect this need for action in addition to more passive beliefs [25]. From this work, we hope to gain an understanding of how to create more inclusive engineers that will move past positive views of DEI to actually enacting inclusive and equitable practices in the workplace.

In addition to analyzing data from alumni, the research team will also complete a similar process for the other two participant groups: current students of Lipscomb engineering and non-alumni engineering professionals. Current students will provide an immediate glimpse into the impact of humanitarian engineering projects on student development and formation. Engineering professionals will provide contrast to the experiences of students and alumni from Lipscomb to understand what makes the program unique or similar to others. Likewise, quantitative data from the scaled items in the questionnaire will be analyzed and compared to existing data from other studies. Specifically, the research team will compare results from this study to secular and other religious universities. Since faith and religion were found to be significant factors in the respondents' reasons for serving, it could provide useful information as to why students get involved in humanitarian engineering projects.

The data, results, and theories presented here provide the basis to design interview protocols for the next step of the study. Thirteen of the respondents stated interest in continuing participation in the research through an interview. These interviews will delve deeper into the connections between humanitarian engineering projects, professional formation, and views of diversity, equity, and inclusion. Because most of the alumni respondents participated in humanitarian engineering projects while in school, their experiences in the workplace will be vital for building a model for inclusive engineers.

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