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Creating Inclusive Engineers through Humanitarian Engineering Projects: Investigating the Correlation Between Professional Responsibility and Inclusive Behaviors from a Survey

Dr. Kirsten Heikkinen Dodson, Lipscomb University

Kirsten Heikkinen Dodson (pronouns: she/her) is an Associate Professor and the Chair of Mechanical Engineering in the Raymond B. Jones College of Engineering at Lipscomb University. She earned her B.S. in Mechanical Engineering from Lipscomb University and her Ph.D. from Vanderbilt University before returning to her alma mater. Her research interests focus on the connections between humanitarian engineering, engineering education, and equity and inclusion topics. She primarily teaches thermal-fluid sciences as well as introductory and advanced design courses. In addition to her courses and research, she serves as the Associate Director for Research and Education for the Peugeot Center. With the center, she is also an active leader for humanitarian engineering student project teams, primarily working in Guatemala.

René Marie Rosalie Marius

René Marius is an undergraduate student at Lipscomb University. She is studying Software Engineering with a German minor. René has been working with Dr. Dodson to research the connections of humanitarian engineering projects affecting views of diversity, equity, and inclusion.

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Abstract:

This empirical research brief expands on an existing research study to uncover the connections between humanitarian engineering, professional formation, and views of equity and inclusion. The objective of the project is focused on creating a more inclusive workplace environment which will support increased diversity in the field of engineering. Humanitarian engineering or community-engaged engineering has been well-studied to have positive impacts on the technical and professional skills of students. This study expands to investigate the impacts on more social and behavioral qualities like challenging discrimination and enacting inclusion. Three groups of participants, students and alumni of a humanitarian engineering program as well as professionals not affiliated with the program, were invited to complete a survey focused on professional responsibility and inclusive behaviors. Four factors from the survey were used to determine correlation using a Pearson's r test and significance using a t test. The correlation was compared across and within the three participant groups and also as sub-groups separated by past participation in a humanitarian engineering project. The analysis found that there was weak to moderate correlation between feelings of professional responsibility and inclusive behaviors among the participant groups. Within the subgroups of participants who had experience in a humanitarian engineering project, there was some moderate correlation between professional responsibility and inclusive behaviors, specifically for professionals and alumni. This suggests that participants who had experience in a humanitarian engineering project who practice professional responsibility tend to also enact inclusive behaviors. Though this quantitative analysis provides some insight into correlation between professional responsibility and inclusive behaviors, qualitative research would provide a better understanding of the complex attitudes and behaviors, especially around the impacts from humanitarian engineering projects. Conclusions drawn from these analyses will guide the development of a model and framework that may be used by other engineering educators to create inclusive engineers through humanitarian engineering.

Keywords: humanitarian engineering, quantitative methods, professional responsibility, diversity equity and inclusion

Background:

This empirical research brief builds on research connecting three areas of engineering education: professional responsibility, humanitarian engineering projects (HEPs), and diversity, equity, and inclusion (DEI) studies. This specific paper presents an analysis of correlations between professional responsibility and views of DEI from a survey based on a participant's experiences in HEPs. Other papers published from this research study provide reasoning and background for this analysis. The research design is a mixed methods approach including quantitative methods via a survey which informed the qualitative method via interviews [1]. To study the interactions among professional responsibility, HEPs, and DEI, two existing instruments were combined into a survey provided to engineering students and professionals. The Engineering Professional Responsibility Assessment (EPRA) was used to understand the perspectives

of students toward professional and social responsibility with special emphasis on recording participation in engineering service or humanitarian engineering projects (HEPs) [2]. Another instrument, the Valuing Diversity and Enacting Inclusion in Engineering (VDEIE) scale, was included to measure the attitudes and beliefs around diversity and inclusion [3].

Four factors from the survey were chosen for analysis: feelings of *Connectedness* (moral obligation to help others) and *Professional Connectedness* (professional responsibility to help others) from the EPRA and *Challenge Discriminatory Behavior* and *Promote a Healthy Work Environmen*t from the VDEIE. The two EPRA dimensions were selected as one focuses on a general feeling of obligation to help whereas the other focuses on a professional obligation. From the VDEIE, these two factors were chosen to better understand how engineers actually behave in a workplace environment rather than simply their views on a topic. An initial quantitative analysis of these four factors is presented in [4]. Interestingly, the results seemed to show that experiences in HEP did not predict stronger feelings of professional responsibility or more positive views of DEI. Though these results were unexpected, it did remove concern of self-selection bias that those who chose to participate in HEPs already have higher levels of professional responsibility or desires to practice equity and inclusiveness. To further understand the quantitative results, it was suggested by a reviewer to perform comparative analysis across the factors and investigate potential correlations leading to this brief.

In addition to the EPRA and VDEIE items, the survey also included two open-ended questions: “Explain your primary reason for volunteering or serving.” and “Briefly describe an event that has influenced your views of diversity, equity, and inclusion.” Inductive thematic analysis was performed from these results allowing codes to emerge from the data. Results from this analysis is presented in [5] and was the basis of the codebook that was used for thematic analysis of the interviews. Two preliminary interviews of students who participated in HEPs are discussed in [6] though 23 other interviews have been conducted with results intended for publication elsewhere. As described in [6], though a changed perspective toward inclusiveness is desired to create a more equitable and diverse workplace, positive views and attitudes about DEI might not create a meaningful impact unless they are followed by a change in behavior and action. From these learnings, the authors found further importance in investigating correlations between a feeling of professional responsibility to behave inclusively in their workplace.

Objective:

The objective of this research study is to understand how involvement in HEPs can influence views and behaviors of DEI and specifically the results on workplace culture. The research team proposes that HEPs can create more inclusive engineers who will positively influence their workplace environment toward more equity and diversity. The primary research questions are:

- RQ1: What perceived impact does student involvement in HEPs have on professional formation and perspectives of DEI?
- RQ2: How has involvement in HEPs influenced the professional workplace culture and perspectives of DEI of alumni?

From the related studies reviewed above, a new research question emerged that is addressed in this brief:

- RQ3: Do correlations exist between feelings of professional responsibility and inclusive behaviors? Is there a difference in these correlations among those who have participated in HEPs compared to those who have not?

RQ1 and RQ2 are best served through qualitative methods, but RQ3 may be studied via quantitative methods using the survey which served as the foundation of the full research study. Though RQ3 has stemmed from the original research questions, the results and conclusions still provide a meaningful comparison of the attitudes and behaviors of DEI across those who have and have not been involved in HEPs. From this project, the team is working to build a model and framework that other organizations and companies may utilize to support a more inclusive workplace through humanitarian engineering.

Methods:

The study is designed as mixed methods including a survey with both Likert-scaled items and open-ended questions as well as semi-structured interviews though this brief will focus on just four factors from the survey. Three sets of participants were invited to participate in the study:

- Current ***students*** of Lipscomb University's engineering program
- ***Alumni*** of Lipscomb's engineering program
- Engineering ***professionals*** who are not alumni of Lipscomb

Each participant group provides a unique perspective to the research study through immediate impacts of HEPs (students), long-term impacts (alumni), and a comparison to HEPs through other programs (professionals). The design of the program at Lipscomb University, called the Peugeot Center, that hosts curricular and extracurricular HEPs for students with support from alumni and professionals is detailed in [7]. The study was deemed exempt from full review by the Lipscomb Institutional Review Board.

To perform the analysis, each participant group was analyzed as an individual dataset as well as together for a fourth dataset. These datasets were further separated by those who had participated in a HEP prior to the survey and those who had not to provide a comparison across the sub-groups. This provided a total of 16 datasets. Each of the four variables within each dataset was then checked for normal distribution. A correlation coefficient matrix was created for each dataset using Pearson's r if normal and a Spearman's rho correlation if not. Following the creation of the matrices, the t value for each r or rho value was compared to the two-tailed critical t value to determine significance of the correlation.

Results:

Table 3 presents correlation coefficient matrices for the 16 datasets. Most pairs showed a positive weak to moderate correlation with a few showing strong correlation (>0.5). Interestingly, a few showed negative correlations contrary to expectations, but none of these were significant. One pair of dimensions showed strong correlation with significance for all groups: *Connectedness* and *Professional Connectedness*. This result is expected as both refer to a feeling of obligation to help and is confirmed through this analysis.

For students, the correlations were mostly weak and even those with strong correlation were not significant. For alumni, the analysis was limited as nearly all of the alumni (18 of 19) who participated in

the survey had participated in a HEP, thus there are no correlation coefficients for the alumni without HEP experience. For professionals, more significance was found among the correlation coefficients, especially those with experience in HEPs. From the analysis, there was a strong correlation between feelings of responsibility (both personal and professional) and a desire to challenge discriminatory behavior for professionals with HEP experience. This is notable as the comparison to professionals with no HEP experience did not show a similar correlation though this group has small numbers (n=7) which weakens the conclusion. For the combined group (students, alumni, and professionals), most factors showed weak correlation, but there was some significance in the subgroup who had participated in HEPs compared to those who had not. This combined group and the associated subgroup may provide the most notable information for the analysis due to the larger numbers compared to the other datasets.

Table 3: Correlation coefficients within and across participant groups for four dimensions (abbreviated), also including comparisons separated by experience with HEPs (significance in yellow)

Combined

n=98	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.68	1		
Challenge	0.27	0.25	1	
Promote	0.13	0.19	0.26	1

Combined - HEP experience

n=60	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.56	1		
Challenge	0.22	0.30	1	
Promote	0.05	0.31	0.18	1

Combined - no HEP experience

n=38	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.73	1		
Challenge	0.29	0.30	1	
Promote	0.28	0.15	0.29	1

Students

n=39	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.68	1		
Challenge	0.25	0.30	1	
Promote	0.29	0.27	0.28	1

Students - HEP experience

n=9	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.63	1		
Challenge	-0.22	-0.47	1	
Promote	0.04	0.50	-0.16	1

Students - no HEP experience

n=30	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.70	1		
Challenge	0.29	0.30	1	
Promote	0.12	0.05	0.29	1

Alumni

n=19	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.58	1		
Challenge	0.34	0.30	1	
Promote	-0.11	0.10	0.03	1

Alumni - HEP experience

n=18	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.61	1		
Challenge	0.37	0.47	1	
Promote	-0.13	-0.03	0.23	1

Alumni - no HEP experience

n=1	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn		1		
Challenge			1	
Promote				1

Professionals

n=40	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.64	1		
Challenge	0.34	0.26	1	
Promote	0.13	0.34	0.36	1

Professionals - HEP experience

n=33	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.52	1		
Challenge	0.41	0.41	1	
Promote	0.21	0.55	0.34	1

Professionals - no HEP experience

n=7	Conn	Prof Conn	Challenge	Promote
Conn	1			
Prof Conn	0.94	1		
Challenge	-0.01	-0.20	1	
Promote	-0.25	-0.30	0.51	1

Conclusions:

The analysis of the correlation within the participant groups is somewhat limited by the small numbers, thus focusing on the combined group and subgroups may provide the most notable conclusions that may inform other research. Interestingly, the moderate strength of correlation between professional responsibility and inclusive behaviors (*Prof Conn-Challenge & Prof Conn-Promote*) is similar among the two subgroups though there is more significance for those with HEP experience. In contrast, though neither subgroup had significant results for *Conn-Challenge* and *Challenge-Promote*, the combined group was significant though a weak correlation for both. As expected, the association of *Conn-Prof Conn* was strong for all groups meaning that a general feeling of responsibility to help others correlates with the same feeling in a professional setting.

Reviewing correlations within groups, a few conclusions may be drawn. All three student groups showed little significance among the correlation even though there were somewhat strong correlations (-0.47 for *Prof Conn-Challenge* and 0.50 for *Prof Conn-Promote*) within the HEP experience subgroup. These two correlation results are seemingly contradictory to one another, but could be influenced by the low numbers of the subgroup (n=9). A negative correlation is especially surprising as this would mean those who have strong feelings of professional responsibility also avoid challenging discrimination. From the lack of association shown in the data for these groups, it's possible that students either lack the maturity or do not feel empowered to practice responsibility and inclusive behaviors. Within the alumni groups, there is also little correlation except for *Conn-Prof Conn* and *Prof Conn-Challenge*, both of which are significant for those with HEP experience. It seems that alumni with HEP experience who practice professional responsibility tend to also challenge discrimination. Again, the comparison without HEP experience is limited due to only one participant in this subgroup. Similar conclusions can be drawn for the professionals groups with more significance and generally stronger correlation between professional responsibility and inclusive behaviors among those with HEP experience. There also seems to be stronger differences in the professional subgroups which seems to indicate that HEP programs outside of Lipscomb University may be more impactful.

From these data, and as discussed in [4], though there are some moderate correlations between professional responsibility and inclusive behaviors, the cause and impact cannot be studied with quantitative results only. It’s possible that participants feel an obligation to help others, but may not believe it is their place or in their power to create an inclusive environment. There could be hesitancy surrounding challenging discrimination as it requires a level of boldness that is not easily measured in Likert-scaled items. Also, differences in HEP experiences are not included in this quantitative analysis. Lastly, the quantitative analysis, though separated by participation in HEPs for comparison, does not provide insight on how the HEPs might have impacted these attitudes and behaviors toward professional responsibility or inclusive behaviors.

Note that alongside this analysis, the research team has performed interviews to complement and better explain the quantitative results. The qualitative results from the interviews are planned for publication elsewhere with thorough analysis and reference to conclusions from the survey. Many dimensions in the survey were excluded from this paper for brevity but could be further analyzed to answer different research questions. From the results, the quantitative and qualitative analysis will be utilized to design a model and framework to guide engineering educators or companies in how to support and incentivize HEPs to create more inclusive engineers at their organization. The model will provide a foundation and reasoning for using HEPs to create inclusive engineers whereas the framework will present specific guidance on how to intentionally design HEPs toward the same objective.

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