The role of a humanitarian focus in increasing gender diversity in engineering education

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SESSION S3: Integrating Humanitarianism in Engineering Education

CONTEXT Diversity within project teams is known to be advantageous when tackling complex problems, such as the barriers to achieving the Sustainable Development Goals (SDGs). To enhance the engineering profession's contribution to the SDGs, it is now more important than ever that a lack of gender diversity in the sector is resolved. Research from around the world is demonstrating that linking STEM subjects to positive social impact leads to a more gender diverse student cohort. As an organisation with both an explicit focus on social impact and relatively high participation of women in its education initiatives, Engineers Without Borders Australia (EWB) is well placed to further investigate the current and future role that humanitarianism plays in the creation of a gender diverse engineering sector.

PURPOSE This research investigates the links between gender diversity and humanitarian engineering education initiatives, and explores initial insights into how factors such as global relevance and social impact could be utilised by engineering educators to create a more diverse engineering profession.

APPROACH Students opting to participate in EWB humanitarian engineering education initiatives were asked via a survey tool to identify their gender and top five motivations for choosing to participate in that program. A predefined list of 24 motivations was generated from an analysis of previous motivation statements. The motivation statements were categorised into six themes: values, career, social-connectedness, social pressure / encouragement, understanding, and enhancement.

RESULTS Preliminary analysis of survey responses indicate that both men and women are primarily motivated to participate in EWB initiatives due to values-alignment, regardless of the program type (e.g. formal curriculum, volunteer opportunity, overseas professional development opportunity). When looking at the broader data set male respondents tend towards 'career' and 'enhancement' motivators with female respondents tending towards 'social connectedness' motivators.

CONCLUSIONS / LESSONS LEARNED This research demonstrates that both men and women are motivated to participate in humanitarian initiatives primarily due feeling aligned with the aim of that initiative. The two initiatives discussed, which are currently attracting a relatively high proportion of women, provide a rich context to begin to understand the implications of humanitarian engineering offerings on diversity as both humanitarian engineering and gender diversity become increasingly prioritised at Australian universities.

KEYWORDS

Gender diversity; Social value; Humanitarian engineering.

Introduction

Engineers have a reputation for solving complex problems; the 2030 global development agenda laid out by the United Nations (2015) in the Sustainable Development Goals (SDG's) certainly contains complex problems. Many, including Sinha (2015), believe that engineers will play a vital role in meeting these challenges with participation critical in the goals of 'clean water and sanitation', 'affordable and clean energy', 'sustainable cities and communities' and 'industry, innovation and infrastructure'. Achieving the SDG's will require engineers to be innovative; an important requisite for innovation is a team that brings different points of view, different backgrounds and different approaches to the same problem (Middleton, 2016). Indicators of a diverse team include varied cultures, languages, ages, geography or personal hardships and gender (Page 2007).

The engineering profession in Australia is still a male dominated field; in 2016, women made up only 12.4% of the Australian engineering labour force (Engineers Australia, 2017) and in 2015 women represented only 17.6% of those commencing engineering and related technologies courses at Australian Universities (Department of Education and Training, 2017). Low interest in engineering from young people, especially women, will negatively affect the capacity of the engineering sector to meet global sustainability challenges (UNESCO, 2010). Meanwhile, research from across the university engineering education space including Bielefeldt, Paterson, & Swan (2009), Dzombak, Mouakkad, & Mehta (2016), and Oakes, Hsu, & Zoltowski (2015), suggests that linking STEM subjects to positive social impact leads to increased gender diversity in these courses. As engineers are being called on to contribute to the sustainable development agenda and the lack of gender diversity in the profession is being challenged, the opportunity exists to explore the links between these two priorities.

As an organisation with high gender diversity in its education programs and an explicit focus on social impact, Engineers Without Borders Australia (EWB) is well placed to further investigate the linkages between gender diversity and humanitarian engineering education initiatives with social purpose. As part of a broader study funded by the Origin Foundation, EWB is identifying how factors such as global relevance and social impact can be utilised by engineering educators to create a more diverse engineering profession. The first component of this research, and the work presented in this paper, focusses on determining if there is a difference in the motivations between men and women for participating in EWB programs that have an embedded focus on social impact. The paper first provides a background to the two humanitarian engineering education initiatives at the centre of this study and outlines the survey technique utilised to determine the motivations of participants of different genders. Results demonstrating similarities and differences in motivations between men and women are noted, and the relevance of this work to the broader study discussed.

For context, EWB is a member-based not for profit organisation with the vision that everyone has access to the engineering knowledge and resources required to live a life of opportunity, free from poverty (Engineers Without Borders Australia, 2017). Whilst EWB coordinates several engineering education initiatives in which university students elect to participate through either formal or informal curriculum, this paper focuses on two: the Humanitarian Design Summit Program and the University Research Program. These initiatives were chosen for this study as they are both programs to which students apply to participate, rather than embedded in the mandatory university curriculum. Students are not necessarily associated with EWB before they elect to participate in either program.

EWB Humanitarian Design Summits - Initiative A

Since January 2015, over 800 students have participated in the EWB-led Humanitarian Design Summits, Initiative A. The aim of this program is to nurture future development leaders and embed human-centred values and approaches in engineering, design and

technology education. Six countries in the Asia-Pacific region provide the context for each immersive learning experience. Each Design Summit runs for two weeks and includes workshop sessions, cultural immersion activities and student-led investigations to help participants develop a deep understanding of the role Human-Centred Design (HCD) and technology play in creating positive change within communities. To deliver the program, EWB collaborates with numerous Australian Universities and partners closely with local grass-roots organisations that have a working relationship with communities. Since the recording of gender data began in mid-2016, 41% of program applicants and 45% of program participants have identified as female. The activities and structure of the program are described in more depth by (Brown, Price, Turner, & Colley, 2016) and by EWB (2017).

EWB University Research Program - Initiative B

Through final year research projects, the University Research Program, Initiative B, engages passionate academics and students to solve real-world problems in collaboration with development organisations who propose the research topic. In addition to developing new knowledge and technologies, students gain key engineering competencies as well as humanitarian skills. Research projects tend to be linked to partners working with marginalised or disadvantaged groups in the Asia-Pacific region under themes such as 'water and sanitation', 'clean energy', 'appropriate housing', 'assistive technology' and 'education and training'. Over the past 10 years, the University Research Program has seen a female participation rate of around 35-40%. The activities and structure of this program have been previously presented by Smith, Brown, & Cahill, (2009).

Approach

The first analytical component of the study, presented in this paper, assesses variations in motivations among participants in two humanitarian engineering initiatives: Initiative A and Initiative B. The objective was to explore similarities and differences in motivation between genders, and to determine if any variation is linked to the social impact of the initiative itself. It was determined that a relatively large sample size would be beneficial to enable the identification of potential variations, and as such a survey technique was employed for data collection.

To generate a discrete list of motivations for the survey, participants in Initiative A and Initiative B were asked to write open-ended statements describing their motivation for applying to that initiative. These motivation statements were coded, assessed and combined with input from individuals at the Centre for Ethical Leadership to inform the 24 distinct motivation statements (organised into six motivation categories) shown in Table 1. External input and additional deliberation meant that a slightly broader range of possible motivation statements were included in the final list. This was to mitigate any bias from the open-ended question respondents potentially skewing their answers in an effort to be perceived by EWB staff as holding more 'desirable' motivations for attending a program.

For this study, new participants in both initiatives who had not previously provided open-ended motivation responses were asked through a survey to identify their gender from four options: 'male', 'female', 'other', and 'prefer not to say'. Participants then selected the five motivation statements, from the list shown in Table 1, that had most resonated with them when applying to participate in the relevant initiative. For participants in Initiative A the motivation options, were presented in a consistent scrambled order whereas for Initiative B the motivation options were presented in the order shown in Table 1 with the motivation question inserted into an existing survey (with research consent obtained).

To mitigate bias the survey was distributed to participants after they had already been accepted onto the relevant program. Additionally, participants in Initiative A were invited to remain anonymous and participants in Initiative B were informed that their responses would not affect their place on the program, however it is noted that not being anonymous may

have introduced a slight bias to stated motivations. Integrating the motivation question into an existing survey for Initiative B reduced the administrative load on the participants which resulted in a response rate of 71%. Whilst this high response rate may indicate a self-selecting group, anecdotal feedback from academic supervisors suggests these students tend to be highly driven and engaged.

Table 1: List of possible motivations

Motivation Category	Motivation
Values	Wanting to give back to the community
	The possibility of making positive social changes
	Work directly with and help people who might be disadvantaged
	Inspired from personal experience to make a difference
Career	Gain relevant work experience
	Build up your CV
	Kickstart a career in humanitarian work
	It is a way to earn course credits towards your degree
	Expand engineering knowledge
	Make new connections that might help your career
Social-Connectedness	Know EWB and just want to continue to be involved with EWB
	Looking for an opportunity to connect with like-minded people
	Looking for a way to feel connected with different people
Social Pressure / Encouragement	My parents have encouraged me to participate in this kind of program
	My friends have encouraged me to participate in this kind of program
	Other with whom I am close place a high value in this kind of program
Understanding	It is an opportunity to learn about, from and experience different cultures
	Learning about and applying humanitarian engineering
	Experience developing-world issues first hand
	Understanding how engineering works in the real world
Enhancement	Looking for an opportunity to put what you know into practice
	Being able to develop personal skills
	Gain leadership skills
	Looking for a truly challenging task

The differences between the two initiatives chosen for this study provide an opportunity to check that any variations in motivation between participants of different genders was not purely based on the ‘type’ of initiative chosen. The major differences include participants’ year of study, program location/duration, the course credit obtained. Initiative A is open to students from any year group whereas Initiative B is only available to final year students who

mostly graduate upon completion. Students participate in Initiative A for two weeks overseas with the experience mainly counting towards required industry experience while Initiative B lasts between one and two semesters, is mainly based at the student's university (with potential for field work) and must be part of a for-credit course or unit.

Results and Discussion

This paper discusses the first set of motivation results from students participating in Initiative A and Initiative B.

Motivations for participation in Initiative A

Seven deliveries of Initiative A were completed over the period February to July 2017 during which 195 students completed the motivation survey. Of these, 103 identified as 'male' (representing 53% of responses) and 92 identified as 'female' (representing 47% of responses). No respondents selected a gender of 'other' or 'prefer not to say'. For this initiative, there were a relatively high number of responses, balanced across genders. As each respondent was asked to select exactly five motivations, 975 individual motivations were collected. Table 2 shows the distribution of these motivations across the six categories outlined in Table 1 as well as the percentage of participants selecting at least one motivation in each category.

Table 2 Distribution of motivations for participation in Initiative A

	% of total responses			% of participants selecting at least one motivation		
	Male	Female	**Female Swing**	Male	Female	**Female Swing**
Values	21	23	**+2**	72	76	**+4**
Career	25	18	**-7**	79	63	**-16**
Social-Connectedness	8	10	**+3**	32	46	**+14**
Social Pressure / Encouragement	2	1	**-1**	8	4	**-4**
Understanding	28	33	**+6**	88	94	**+6**
Enhancement	18	15	**-3**	64	59	**-5**

As can be seen from Table 2, the 'understanding' category contained the greatest proportion of selections for both female and male respondents, with 94% of female respondents selecting at least one of the motivations in this category.

The top three motivations, split by gender, are shown in Table 3.The top three motivations for both male and female respondents were extremely similar, suggesting that the major motivations for respondents to participate in the initiative did not depend on gender but rather the stated purpose of the initiative. Additionally, the data shows that a greater proportion of female respondents selected a 'social connectedness' motivation than male respondents with the reverse true for a 'career' motivation. Overall, both male and female participants in Initiative A are primarily motivated by statements in the 'understanding' category; across all motivation statement categories relatively large gender differences are seen in two, male respondents are more aligned to 'career' and female respondents to 'social connectedness'.

Table 3 Top three motivators by gender for Initiative A

Female		Male	
Motivation	% of total responses	Motivation	% of total responses
Learning about and applying humanitarian engineering (U)	12	Learning about and applying humanitarian engineering (U)	8
It is an opportunity to learn about, from and experience different cultures (U)	11	The possibility of making positive social changes (V)	8
The possibility of making positive social changes (V)	10	Experience developing-world issues first hand (U)	7

Motivations for participation in Initative B

Of the 52 participants entering Initiative B between December 2016 and August 2017 who responded to the motivation survey, 38 identified as ‘male’ (representing 70% of responses) and 14 identified as ‘female’ (representing 30% of responses). No respondents selected a gender of ‘other’ or ‘prefer not to say’. Whilst this dataset is not as balanced as that for Initiative A, it provides a useful initial insight into student motivations. Again, each respondent was asked to select exactly five motivations resulting in the collection of 260 individual motivations. Table 4 shows the distribution of these motivations across the six categories outlined in Table 1 as well as the percentage of participants selecting at least one motivation in each category.

Table 4 Distribution of motivations for participation in Initiative B

	% of total responses			% of participants selecting at least one motivation		
	Male	Female	**Female Swing**	Male	Female	**Female Swing**
Values	32	39	**+7**	92	93	**+1**
Career	25	20	**-5**	77	71	**-6**
Social-Connectedness	6	10	**+4**	32	50	**+18**
Social Pressure / Encouragement	0	0	**0**	0	0	**0**
Understanding	22	27	**+5**	74	71	**-3**
Enhancement	15	4	**-11**	61	21	**-40**

Both male and female respondents in Initiative B strongly identified with motivation statements in the ‘values’ category. For both genders, at least 92% of participants selected at least one ‘values’ motivation statement. No participant reported being motivated due to social pressure or encouragement. The top three motivational responses for Initiative B are shown in Table 5.

Table 5 Top three motivators by gender for Initiative B

Female		Male	
Motivation	% of total responses	Motivation	% of total responses
Wanting to give back to the community (V)	13	The possibility of making positive social changes (V)	16
The possibility of making positive social changes (V)	11	Learning about and applying humanitarian engineering (U)	8
Learning about and applying humanitarian engineering (U)	10	Expand engineering knowledge (C)	7

For male respondents 'the possibility of making positive social changes' in the values category was the most popular response (31 selections comprising 16% of responses), almost double that of the next most popular motivation which was 'learning about and applying humanitarian engineering' (16 selections comprising 8% of responses) in the understanding category. Two motivation statements appear in the top three selections for both female and male respondents, again suggesting that there is no significant gender difference in the primary motivation for participation in this initiative.

When looking at the differences between the genders, male respondents select a greater portion of motivations in 'career' and 'enhancement' categories while female respondents skew towards 'values', 'understanding' and 'social-connectedness'. By looking at respondents who select at least one motivation in that category a larger disparity is observed; female motivation skewing towards 'social connectedness' and away from 'enhancement'; even though enhancement was not a popular male response it was still higher than that of female selection. The results show that all participants in this initiative are motivated by an alignment of 'values'. When looking in more detail at participants selecting at least one motivation in each category female respondents have a skew towards 'social-connectedness' and away from 'enhancement'.

Insights from a comparison of responses

The most popular motivation category for both male and female respondents participating in Initiative A is 'understanding' whereas for Initiative B for both male and female respondents it is 'values'. The motivations in these categories are consistent with the aims of the respective program; Initiative A is tailored more towards experiencing humanitarian engineering in an immersive hands-on experience while Initiative B is more aligned to taking acquired knowledge and applying it in a humanitarian project. The second most popular motivational category for each initiative was the same as the most popular category for the other initiative showing that motivations across initiatives is relatively similar.

Of all the individual motivation statements, 'learning about and applying humanitarian engineering', and 'the possibility of making positive social changes' appear in the most popular three motivations for both genders across both initiatives, suggesting students have similar motivations for engaging with EWB irrespective of the particular engineering education initiative.

For both initiatives, female respondents tended to select 'social connectedness' motivations more frequently than their male counterparts. In contrast, male respondents in both initiatives were more likely to select motivations in the 'career' (Initiative A) or 'enhancement' (Initiative B) categories. Looking at differences in gender for these initiatives, female respondents do tend to have a stronger alignment to motivations around social connectedness including

‘looking for a way to feel connected with different people’ as well as ‘looking for an opportunity to connect with like-minded people’.

Of the motivation statements used in this study it is those in the ‘values’ category that are most aligned with the notion of having ‘social impact’. For both initiatives in this study female respondents included a greater number of selections in this category which suggests that female respondents may be slightly more motivated to participate in engineering education initiatives for reasons of social impact.

Opportunities and imperative for furthering the research

The initial findings presented in this paper provide a basis for further investigation into the relationship between engineering education initiatives with a humanitarian focus and a diverse university engineering student cohort. The two initiatives discussed are currently attracting a significantly higher proportion of women compared to the engineering discipline more broadly. These initiatives provide a rich context to begin to understand the implications of humanitarian engineering offerings on diversity in the classroom as both humanitarian engineering and gender diversity become increasingly prioritised at Australian universities. As an example, in both Initiative A and Initiative B female respondents related more than their male counterparts to motivations in the ‘social connectedness’ category. The motivation statements in this category, such as ‘looking for a way to feel connected with different people’ (see Table 1), do not specify only feeling connected to other participants of the same gender. It is possible that participants are looking to connect with a community defined by something common to humanitarian engineering education initiatives; this is to be investigated in future research.

Further research to support confidence in these initial findings, using additional methods and techniques, is currently planned or already underway. This includes interviews with a selection of respondents to understand how participants have understood and perceived each of the motivational categories and to generate further insights. Data has also been collected in which selected motivation statements are ranked, analysis of which could provide insights into the primary motivator of each participant compared to what may be secondary motivations. Comparisons of these findings can be made against the analysis presented in this paper.

Additionally, while the research described in this paper focuses on diversity using a gender lens, the opportunity exists to use similar mechanisms and datasets to further investigate the relationship between humanitarian engineering education initiatives and other forms of diversity which will create more creative, innovative engineering teams in the future.

Conclusions

This paper takes the initial step of identifying student motivations for opting-in to engineering education initiatives with a humanitarian focus, and exploring any differences in responses between genders.

The data collected indicates that the most common motivator for participating in two of EWB’s initiatives does not vary with gender, instead, and unsurprisingly, it is strongly aligned to the aims of that initiative. However, when looking across the whole dataset the popularity of motivations does vary by gender. In general, male respondents tended towards motivators in the ‘career’ and ‘enhancement’ category more than females, while female respondents tended towards motivators in the ‘social connectedness’ category more than males. This research is an initial indication of trends and further work is required for confirmation.

To establish a deeper understanding of this issue, further work is planned to create a methodology that can be used to study diversity in other forms.

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