121st ASEE Annual Conference & Exposition
Indianapolis, IN
June 15-18, 2014
Paper ID #8772

Collaborative Research: Gender Diversity, Identity and EWB-USA

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Introduction

In 2000, the United Nations[1] introduced eight Millennium Development Goals, which demonstrated a global effort to "meet the needs of the world's poorest." Similarly, in 2008 the National Academies[2] revealed fourteen Grand Challenges for Engineering, which if met, "could dramatically improve life for everyone." The objectives in this report challenge the engineering profession to meet pressing worldwide issues and have been mirrored in similar reports (e.g.[4–7]). With calls for more numerous, diverse, and globally-prepared engineers capable of meeting the world's greatest issues of basic human rights and quality of life, how can the profession recruit, create, and retain engineers of the future? This research aims to better understand one way in which the profession may be preparing such engineers—through the engineering service organization, Engineers without Borders—USA (EWB-USA), so that employers and educators may be better equipped to attract, train, and retain engineers of the future, capable of addressing such global challenges.

Within EWB-USA, student and professional members volunteer their time to design and implement engineering solutions for developing communities around the world. Since its foundation in 2002, membership has grown to over 13,800 members who have completed 389 projects in 47 countries[7]. In its twelve year history, EWB-USA has grown rapidly and has created a nearly gender-balanced setting at over 40% female involvement[8], which is a noticeable diversity achievement for an engineering setting, where females usually represent 11 to 20% of the population[9]. EWB-USA's members have also been given exposure to non-traditional engineering subjects and experiences aiding the breadth of their education[8,10,11], which map onto sought-after traits of future engineers[4]. For these reasons, EWB-USA members create a relevant and interesting group to study.

Objectives

In this paper, we outline the past and future work contributing to a three-year, NSF-Research in Engineering Education (REE) funded project focused on engineers involved with EWB-USA. Simplified, the study asks, *how are EWB-USA members similar to and different from engineers not involved with such an organization?* This research responds to calls by the NAE[12,13] and others[3,11,14,15] to better understand ways in which engineering education can prepare engineers capable of addressing the most globally pressing issues—engineers of the future.

Points of Departure

Project-based service learning (PBSL) is defined as, "a form of active learning where students work on projects that benefit a real community or client while also providing a rich learning experience"[16]. PBSL has been used within curricula, classes, and extracurricular activities, and it has become a popular and influential pedagogical strategy for retaining engineers, increasing female participation, achieving ABET learning outcomes, and preparing students for practice[16].

Among the many new PBSL approaches in engineering, EWB-USA continues to be mentioned as a valuable learning activity in engineering[8,11,16–20].

The prominence and potential of EWB-USA in engineering education fuels this research's focus on the organization's membership. Despite its rapid popularity and success, few have rigorously studied EWB-USA to provide evidence for claims of educational benefits. Some small-scale studies of individual chapters have been reported (e.g. [21,22]), but no large-scale study has been completed. To respond to this need, this research studies EWB-USA members' personal characteristics, educational experiences, and career expectations and analyzing how they compare to, and differ from, engineers not involved with the organization. By doing so, the research will provide actual evidence for the perceived benefits of organizational involvement.

As a relatively unexplored area of study, there is no comprehensive theory that examines engineers involved with PBSL or EWB-USA specifically. Therefore, we draw on the work done by Jacquelyn Eccles and colleagues on expectancy-value theory[23]. The theory claims that people make certain choices due to their traits, experiences, expectations, and subjective values (such as identity and goals), and it claims that actions influence future choices in a cyclical pattern. Eccles has used this framework to show why women make different career choices than men[24,25]. We draw on this theory to analyze the differences between engineers involved and not involved with EWB-USA, understanding that choices made to participate in an activity like EWB-USA influences other future choices and outcomes. By comparing traits, experiences, expectations and subjective values from these groups, we can assess differences between engineers involved and not involved with the organization to inform how the engineering community can adjust to attract, educate and retain more diversely prepared engineers.

Research Methods

This research employs a sequential mixed methods strategy[26], which begins with preliminary qualitative data flowed by a large quantitative survey to generalize findings to a larger population. The steps for the research method are depicted in Figure 1.

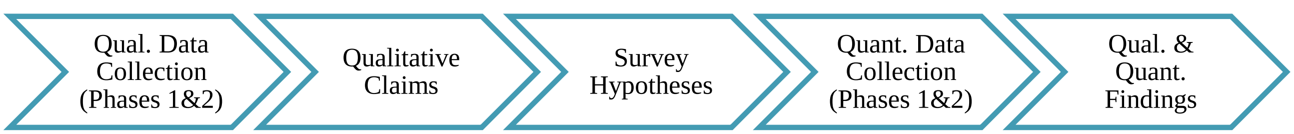

Figure 1: General research methods strategy

First, two phases of qualitative research methods were employed. The first phase, a collection of open-ended questionnaire responses, assessed (a) the educational gains of EWB-USA members and (b) descriptions of these members. The second qualitative phase used focus groups and interviews with 165 engineers involved and not involved with EWB-USA. This data provides rich detail into the differences between the two groups of interest.

Both phases of qualitative data help to inform themes for the quantitative surveys. The first survey will be a pilot version sent out to engineering students at the University of Colorado at Boulder, and the second phase of the survey will be sent to memberships of ASCE, ASME, SWE, and EWB-USA. Final results of this research will combine the qualitative and quantitative findings to answer the research questions.

Qualitative Data & Results

Phase 1: Open-ended Questionnaires

Phase 1 of the qualitative data collection consisted of open-ended questionnaires that were distributed at seven regional EWB-USA conferences in the fall of 2011. Participants were asked to answer the following questions in a corresponding colored box on a piece of paper shown in Figure 2:

- Q.1. How do you describe yourself?
- Q.2. How do you describe an engineer?
- Q.3. How do you describe an EWB-USA member?
- Q.4. What do you think an engineer needs to know?
- Q.5. What, if any, are the gaps in your engineering education?
- Q.6. What are your biggest gains from your experience with EWB-USA?

Of the 505 respondents who answered these questions and reported their gender, 43% were female (n=215), and 54% were male (n=275); and of those who reported their professional status, 76% were students (n=197), and 16% were professionals (n=82).

Figure 2: Blank open-ended response form used for questionnaires

Questions one through three were analyzed together to understand the different and similar ways in which EWB-USA members described themselves, engineers, and EWB-USA members. Results found that many EWB-USA members described themselves as a combination of an engineer and an EWB-USA member, indicating that they viewed themselves as broader than the typical engineer. Questions four through six were analyzed together, separately from the first three questions, to understand what EWB-USA members perceive as important for engineers to know, gaps in their education, and gains from EWB-USA. Results showed that EWB-USA members perceive their EWB-USA experience to fill many of the gaps in their education and to provide more personal and meaningful gains. The results from this phase have been disseminated in one published journal article[27] and one journal article currently under review.

Phase 2: Interviews & Focus Groups

The second qualitative phase of this project used interviews and focus groups with engineers both involved and not involved with EWB-USA. Convenience and snowball sampling techniques were used to ensure representation from both males and females as well as both student and professional engineers (see Table 1 for a breakdown of participants). Participants were also selected to ensure a range of geographical locations (24 states were represented) and engineering disciplines (13 different disciplines were represented).

Table 1: Breakdown of qualitative data (phase 2) participant population, n =165

EWB-USA Members				Non-EWB-USA Members[1]			
105				60			
Females		**Males**		**Females**		**Males**	
51		54		29		31	
Prof.	**Students**	**Prof.**	**Students**	**Prof.**	**Students**	**Prof.**	**Students**
14	37	30	24	13	16	18	13

Questions during the sessions included topics of engineering motivations, engineering identity, future goals and expectations, extracurricular activities, and educational experiences. Focus groups and interviews lasted an average of 40 minutes. Each session was recorded using an audio recorder which totaled over 37 hours of recording. Each session was later transcribed, and the text was imported into qualitative coding software QSR NVivo 10. Transcripts were first coded deductively on a macro level based on the question themes and were later coded for emergent sub-themes. For example, all responses to questions about engineering motivations were first coded into an "engineering motivations" theme and then coded again into emergent themes of motivations such as "aptitude for math and science," "family influence," etc. We developed and maintained a coding dictionary throughout this process, iteratively coding the prior results to ensure consistency and reliability of the findings. Over 250 unique codes have been included within this coding dictionary.

At this point, all 59 transcriptions (27 interviews plus 32 focus groups) have been coded at the macro level codes and for emergent sub-codes. We initially analyzed the data using relative frequencies among respondent populations. The main findings concerning motivations suggested that EWB-USA engineers are often motivated to study engineering for unique reasons that do not necessarily align with the intrinsic motivations found in literature, and that these unique engineering motivations are even more prevalent among women involved with EWB-USA than men. In addition, EWB-USA members were strongly influenced by their EWB-USA

[1] The term non-EWB member is used for simplicity throughout this paper. This term is not meant to be derogatory—it is used instead as a distinction between the two groups of comparison. In this paper, non-EWB members will refer to engineers—either students or professionals—that are not members of EWB-USA.

involvement, which suggests the organization's influence on recruiting engineers. Similarly, the findings concerning engineering outcome expectations highlighted differences in career expectations between EWB-USA members and non-EWB members, where EWB-USA members showed more hesitancy about their fit with the engineering field[28]. This hesitancy was often influenced by their organizational involvement, and may be related to members' diverse interests apart from traditional engineering. Further analysis of this data is ongoing. The current approach is analyzing the 27 interviews using a case-oriented strategy[29] to compare engineering motivations, extra-curricular involvement, and career expectations with more depth.

Quantitative Survey

Using results from the qualitative phases, nine themes of interest were selected for further study in the quantitative phase of the research. These themes were selected based on their continued emergence from the qualitative data and their relevance to current literature on PBSL or engineers of the future. Table 2 below lists the nine survey sub-themes that have been grouped into three major themes—one to represent pre-educational traits and motivations, one to represent the engineering education experience, and one that focuses on career expectations. Generalized hypotheses for each of these themes, generated from either literature or the qualitative results, are listed next to each sub-theme.

Table2: Themes of interest for pilot survey

Major Theme	Sub-Theme	Generalized Hypotheses (to be tested)
Engineering Motivations & Characteristics	Motivations	EWB-USA members have different engineering motivations than non-EWB engineers.
	Personality	EWB-USA members have different personalities than non-EWB engineers.
	Community Service Attitudes	EWB-USA members have stronger attitudes towards community service than non-EWB engineers.
Engineering Educational Experience: Gained Skills	ABET Outcomes	EWB-USA members perceive themselves to have more professional outcomes than non-EWB engineers.
	Professional vs. Technical Skills	EWB-USA members gain more professional skills from their EWB experience than from their courses.
	Global Competency	EWB-USA members have more global competence than non-EWB engineers.
Career Expectations	Identity	EWB-USA members identify as engineers differently than non-EWB members.
	Expected Outcomes	EWB-USA members have different expectations of an engineering career than non-EWB engineers.
	Career Goals	EWB-USA members have different intentions for careers than non-EWB engineers.

Survey items for each of these sub-themes were largely taken from literature with the exception of the global competency theme, for which items were created by the research team. This construct is still being piloted as a separate part of this study. The survey consisted of 35 questions, many with multiple items, and took an average of 16 minutes to complete. The pilot version of the survey was sent out to 5,275 engineering undergraduate and graduate students at one large research university in the US and resulted in 566 useful responses (an 11% response rate). Results from the pilot survey are undergoing analysis and will inform any changes for the final version of the survey. The final survey will be deployed in January 2014 to the memberships of EWB-USA, ASCE, ASME, and SWE as the final phase of the project.

Conclusion

After two years of this three-year NSF-REE project, two qualitative phases have led to pilot a quantitative survey, and a final large-scale survey phase remains to be completed. Results from the qualitative phases have pointed to key differences between EWB-USA engineers and non-EWB engineers highlighting the wider breath of traits, motivations, educational outcomes, and career expectations that EWB-USA members hold. These findings support claims that EWB-USA is attracting a unique population of engineers, is helping to better prepare engineers of the future, and is sending engineers into more widespread roles. The final phase of the research will help to test these claims further.

The outcomes of this research will provide theoretical contributions from the hypotheses generated about the differences between these two populations of engineers and from the application of expectancy-value theory in a new context. The practical implications will include general support for PBSL pedagogy and LTS programs and more specific support for EWB-USA organizational support and funding. Universities will be encouraged to promote these activities and programs for the recruitment of a more gender-balanced engineering population, for the recruitment of more engineers with atypical interest in engineering, and for the creation of more well-rounded, globally prepared engineers of the future that are capable of addressing the world's increasingly complex challenges. In the workplace, these results may aid employers in their recruitment of engineers that exhibit the traits they claim to be seeking. Overall, these results may assist the engineering profession in its transition into the future by highlighting ways in which universities and companies, classrooms and office spaces, and students and professionals can adjust to meet the growing global challenges and create more prepared engineers of the future. Our poster presentation will summarize the project objectives, methods, and findings to date, including the pilot survey data, and it will share our plans for dissemination of the findings and future research.

Acknowledgements

This material is based in part upon work supported by the National Science Foundation Research in Engineering Education program under Grant No. 1129178. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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