Board 360: Reflections from Graduates on the Impact of Engineers Without Borders USA Experiences on Professional Preparation

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Abstract

As engineering education seeks to integrate more experiential learning into the undergraduate portfolio, experiences within and outside of the traditional curriculum are being explored. To this end, community engagement is a particularly promising pedagogy, given its alignment with diversity research and the leveraging of university resources to address needs within our society. One of the largest engineering engagement organizations is Engineers Without Borders USA (EWB-USA), which recently celebrated 20 years of student and community engagement. This poster presents results that are part of a larger sequential mixed-methods study consisting of surveys followed by interviews from program alumni of EWB-USA as well as individuals who have interacted professionally with the EWB-USA alumni. Surveys were designed for both populations and the results show positive impact on alumni transition into a wide range of industry settings. Interviews were conducted with alumni as well as the professional connections who were not part of EWB-USA. This poster will present two individuals as cases that span both categories of alumni who have risen professionally to become mentors of younger EWB alumni. Their perspectives shine light on the impact they have seen personally as well as the benefits they have seen through interacting with other professionals who participated in EWB-USA as students.

Introduction

In the search for more effective ways to equip engineering graduates to enter and succeed in today's world, many leaders are turning to active learning and in particular to more experiential learning [1]. Integrating experiences into the curriculum that have been traditionally outside presents many opportunities and challenges. Community engaged learning is a type of experiential learning that adds benefits of engaging students with underserved communities locally or globally. Within engineering, the engagement is typically through design projects [2].

Community-engaged design experiences place students and universities or colleges in partnerships with organizations that address needs of underserved people. These partners may be in the local community, within their region, or international. Together, they identify and address needs within the community, offering opportunities for students to learn through authentic experiences as well as impact the community and broader society. Research has shown many benefits of community-engaged learning that includes development of a broad range of professional skills, [3-8], core disciplinary material [10-13], as well as enhancing motivation and retention within engineering [13-15]. Research has also shown that the approach can enhance diversity within engineering [3,16-17].

This paper presents data that is part of a larger NSF-funded project being conducted in partnership with Engineers Without Borders USA (EWB-USA), one of the largest community-engaged engineering learning organizations in the U.S., with 5,600 current student participants, over 40% of whom identify as female. Most of the previous research on this organization has been done on student participants within the organization. These studies have documented

perceived impacts in areas that include teamwork, leadership, effective communication, decision-making, project management, appreciation for other cultures, and increased awareness of the role of ethics in engineering [3, 18-20].

This larger investigation builds on prior work and investigated five research questions through gathering data from two different populations: alums of EWB-USA undergraduate experiences and individuals who have interacted professionally with EWB-USA alums. Both cases use a sequential mixed-methods approach consisting of surveys followed by interviews. The five research questions are:

(1) What professional competencies do alumni identify as most developed through their EWB-USA experiences as undergraduates?
(2) What is the nature of how undergraduate participation in EWB-USA may bridge the experiences of formal post-secondary engineering education and professional practice?
(3) How do variations in the nature of involvement with and/or the structure of EWB-USA programs impact the above elements?
(4) How are Alumni of EWB-USA perceived by other members of industry, relative to their peers?
(5) How do the above elements vary between female versus male students, among students of different races and ethnicities, and for first-generation college students?

For the professional connections, participants were chosen that were not connected to EWB-USA themselves to provide a third-party observation. Two of the participants, however, were active in EWB-USA as students and have continued to be active themselves as well as supervise and interact with students in and recent graduates of EWB-USA. These two participants were not included in the professional connections data set and are presented here as cases of participants who can reflect on their own journey as well as observations of others.

Engineers Without Borders USA (EWB-USA)

Engineers Without Borders USA (EWB-USA) is one of the largest community-engaged engineering organizations in the U.S. with 165 university/college student chapters along with 74 professional active EWB-USA chapters. Their stated mission is to build a better world through engineering projects that empower communities to meet their basic human needs. Their volunteers work with communities to find appropriate solutions for their infrastructure needs. At its core, EWB-USA's model is rooted in practical and sustainable engineering solutions. To be successful, EWB-USA considers the socio-cultural dimensions of the community, local project ownership, and other requirements for long-term sustainability. EWB-USA programs are developed as full partnerships with a host community and one or more local non-governmental organizations (NGOs). EWB-USA members work alongside local community members to successfully build and deploy each project and work together to establish a plan to maintain and monitor them.

The integration of engineering and addressing community needs is a factor that has drawn a more diverse population to EWB-USA than in engineering more generally, with over 40% of the

5,600 student participants being female, which is consistent with literature [21-23]. Litchfield and Javernick examined how EWB-USA serves as an example for multi-faceted retention of engineers, particularly females [18]. Since 2002, EWB-USA has worked in 52 countries around the world as well as 27 U.S. states and territories and impacted more than 2.6 million lives through its projects. Example projects are shown in Table 1.

Table 1: Example EWB-USA student chapter projects.

EWB-USA Gateway Professional Chapter partnered with EWB-USA Southern Illinois University Project Location: Pimienta, Honduras	Members of student and industry partnered to complete a construction project that diverts water under a roadway though a culvert system and built a bridge over a ravine for both vehicles and pedestrians.
EWB-USA University of Pittsburgh Student Chapter Project Location: Makili, Mali	Students made three trips to the community to assess community needs before building the farm in planning and constructing a fish farm 2010. The farm has been a success, adding an additional source of protein to local diets, and has proved to be self-sustainable.
University of Maryland College Park Student Chapter Project Location: Addis Alem, Ethiopia	Students and community members worked together to build a bridge that allows community inhabitants to safely access the local market. UMCP students were mentored by industry professionals.
Purdue University Student Chapter (Integrated with EPICS Program) Project Location: Kigalli Rwanda	Students, local NGO's and community members are working collaboratively to design and construct a water system to deliver safe and reliable water to the homes in the community

Methods

The overall project involved two investigations. The first one examined the experience of alumni of EWB-USA using a QUAN QUAL (Quantitative and Qualitative) explanatory sequential mixed-methods approach [24]. This phase involved surveys that showed overall positive impact across a wide range of outcomes [25]. Participants were identified through purposeful sampling for interviews and that data will be the subject for future publications. During the data collection, alumni were asked to identify professionals within their professional network who might be willing to participate in the second phase of the project. A snowball sampling approach was used for the EWB-USA alumni.

Emails were sent to the entire list of potential professional connections and 48 responded to a survey. 15 were selected for interviews. Interviews were conducted over Zoom with a target of one hour each. The interviews were recorded and transcribed using a professional service. The researchers then cleaned the transcripts and the recorded were deleted. The transcripts were entered into NVivo and coded using a thematic analysis that built on the results of the first phase. One of the screening conditions for the interview was whether the professional connection was an EWB-USA alumni themselves. If they were alumni, they were not asked for an interview so the focus would remain on the professional connections rather than alumni experiences. However, two participants who are EWB-USA alumni were still interviewed because of their

professional relationship to EWB-USA as an organization and its alumni. During the analysis of the study, these two interviews were removed from the data set as it was not possible to isolate their EWB-USA experiences as alumni from their professional experiences working EWB-USA and other alumni. However, their stories and reflections offer insights on their personal experiences as well as their observations of others. This paper shares the results from these two cases with combined personal and observed experiences. The information on each is shown below in Table 2.

Table 2: Participant Demographic Information and Connection with EWB-USA as an organization and its alumni.

Participant Pseudonym	Gender	Race	Years of Experience Post Graduation	Current Industry – Job Role	Experience with EWB-USA	EWB Alums in Professional Network
Ryan	Male	White	Six	Aerospace - Project Manager	Student and professional volunteer	More than10
Dominic	Male	White	Ten	Energy - Senior Electrical Engineer	Student and professional volunteer	More than 10

Themes and Quotes

One of the main themes that Ryan, a project manager in the aerospace field, talked about was the impact of EWB-USA on careers. For him personally, he found that he benefited from the experiences provided by EWB-USA and thought it accelerated his own career. He also found that he was able to appreciate the experiences more as time went on. While observing other alums, he saw skills that helped them especially in their early careers. He has noticed EWB-USA alums advancing faster within his organization due to the experiences and skills they bring.

> *I've seen some folks who are EWB alumni get promoted more quickly than their peers, which is kind of exciting to see. And I can speak from firsthand experience that my EWB skills that I gained, which I kind of just outlined, communications, time management, project management, all those things really helped me get a leg up and a kind of kickstarted my career.*

The EWB experience helped them develop skills that translated into the workplace.

> *I can definitely see the skills that EWB alumni possess when they come to the workplace, being leveraged much more quickly than their peers who don't have that engineering EWB experience.*

In addition to skills, their EWB-USA experience helped them clarify the type of career track they wished to pursue. In Ryan's organization, there are two main tracks of technical management and deep technical work. The EWB-USA graduates are able to figure out which path they want to take much more quickly and get started on that path.

> *But I've seen that doing EWB gives people the experience they need to find the right career path for them quicker and then advancing their career much more quickly because they have those fundamental skills that you know just can't teach in engineering school.*

Dominik, a senior electrical engineer in the energy field, also noticed how the clarity of career pathways helped them focus and advance more quickly.

> *I would say that probably the progression is a bit faster, but I wouldn't say that it's any different than their peers in terms of the options they have in front of them. So, what I mean to say is, at my company, there's kind of two paths, there's technical management and deep technical work that doesn't have anything to do with management. I think EWB'ers are able to figure out which path they want to take much more quickly and get started on that path. So, by identifying that earlier on, they're able to progress down that path more quickly than their peers.*

While sometimes this moves graduates into more people-focused opportunities, Ryan observed that this can also move them into more technical focused careers after experiencing project management in EWB-USA.

> *I've also seen people who understand through the EWB experience that they might not want to be a project manager in their company. Maybe they've learned that they're much more apt or happy doing a deep technical role. And that's fine too.*

Dominik also made the observation that EWB-USA graduates may not be solely focused on their technical careers and may be looking for opportunities to make more of the type of impact they had during their EWB-USA experience.

> *If you're managing an EWB alum, they may be looking over their shoulder and looking for other opportunities even early in their career. Whereas perhaps other just engineers may be more grateful or more satisfied or more complacent. If a job's paying well and they're good at it and just keep them happy, they're never going to leave. But myself and other EWB alums have a hunger to make an impact like they did in college.*

There can be a restlessness as Dominik describes that may draw graduates out of engineering or into different areas of engineering.

> *That restlessness can be paralyzing in some ways. It can cause people to really question what they're doing for their job or withdraw from certain aspects of their work. I certainly know many engineering EWB alums who are no longer in engineering, but also, that dissonance or restlessness can help folks to push themselves and their peers much harder into positive impact and more radical engineering roles and more radical engineering projects.*

Dominik shared his own experience as an EWB graduate.

I, myself as an EWB alum, have left a bunch of different roles for greener pastures or to find something that was better aligned with my values or something that was going to allow me to do more international travel or have more leadership responsibility. So, I definitely find at least in myself and other EWB alums that there is a desire to have greater autonomy in our roles.

Another major theme from Ryan's interview is that the EWB-USA experience equipped graduates with skills that directly benefit them in their later careers. Being able work with a team that is diverse is one example.

I think having the knowledge of working with teams effectively helps to bring in additional perspectives that benefit the customer. Bringing in sort of diversity of thought. And EWB is always strong in teaming. So, a lot of the projects I work on in the aerospace industry are extremely complex and you need a team to support a project and EWB has a definitely strong teaming individuals and team builders as well.

Ryan described one alum with a keen awareness of diverse perspectives and how that helped him in his professional role.

I think also that individual has a very keen awareness and focus on including diverse perspectives on the projects he's working on at work because of his experiences with EWB. So, in this individual, learned the value of bringing in diverse perspectives, and consulting experts, and checking ideas off of people with more experience. And he was able to bring this all into the workplace and leverage it to strengthen his projects.

During the pandemic, Ryan observed one graduate, who had also continued to be involved in EWB-USA as a professional, adapt the skills and experiences developed through EWB to his professional work. He was leading a team during the pandemic and used his EWB experience to effectively pivot to remote work.

One individual at my company still volunteered with EWB and he was leading a, I'll call it a geographically distributed team working on a project. And he really mastered how to do that before the pandemic started. And then, when the pandemic hit, he was able to directly translate his EWB experience into the professional world and successfully steer and drive the team fully virtually throughout the years of the pandemic.

Ryan also reflected on his personal journey and how his EWB experience helped equip him to work with clients more effectively.

I learned very early on, halfway through college, that if we don't truly understand the needs of our customer, in my case, it was a village in [Country], we're not going to deliver value to this customer and they won't care about the project. We're only valuable when we're delivering needed technology or needed solutions to problems…
You need to integrate many different stakeholders from people who deal with manufacturing, and cost, and structural engineering, and thermal engineering, and design engineering, and program office, and customer and manufacture. And bringing

that all together is not easy for everyone. And this individual was able to run with it and be very successful. I think because of his EWB experience, right?...
Translating that into the workplace, I came in with an understanding that I should be checking with my customers and talking with them often. Understanding their needs, understanding how their needs may change, understanding more about how I can be meeting their needs with my technical solutions that I might be working on.

Dominik observed that the EWB experience nurtured an entrepreneurial mindset.

I think also there is an entrepreneurial thread with EWB alum, where a lot of us find over the course of our first 5 years or 10 years in the engineering industry, that there aren't very many firms in the engineering industry right now that prioritize developing communities or that prioritize marginalized populations with access to engineering services.

Ryan attributed EWB experience to helping develop a tenacity to work through challenging problems while working on a defense project.

The person had a unique opportunity early on to manage an entire part for an important engine for the military. And things go wrong all the time in terms of manufacturing and analysis and design. And this individual was able to navigate that pretty successfully and remain agile and nimble enough to continue to press projects and reach some resolution on challenging problems. Not everyone has the tenacity to work through difficult problems like EWB'ers do. I've seen this individual is pretty remarkable in the way that they work, exhausting every opportunity and remaining agile and resilient when things go wrong.

He later refers to the tenacity as relentless work.

I guess in the professional space, it really means relentless work until an acceptable solution is achieved. I think it translates into passion for meeting the customer's needs and letting that passion fuel projects.

Ryan attributes part of this development to the long-term, multi-year timeline of the EWB-USA projects.

I mean, these projects are five years typically. So that time horizon is unique for college individuals. You don't always get that. But I think it is unique.

Dominik had a similar observation about the long-term timeline for these projects and partnerships, contrasting that timeline with more traditional design projects within the university.

For example, most engineers go through a capstone program that's either six months or 12 months. That's a lot shorter than four years. And your horizon for things to go wrong and your horizon to get very deep technical in that timeframe is much less than a four-year project. So, I think it affords the opportunity to go deeper, broader, and gain skill in

bringing new people into the fold, solving more technically complex problems. And it really gives the time horizon to work through problems, as opposed to sweeping them under the rug and finishing a project in six months. The longevity of the projects definitely allows for more thoughtful engineering work to be done.

A major theme in Dominik's interview was the broadening of the context of engineering and a wider view of the opportunities for impact as an engineer. He reflected on how this impacted him personally as well as describing what he has seen in other graduates of EWB-USA.

I hired an EWB alum to work with me on a project designing a microgrid in [country]. This person, I asked him to help me to come up with a model for how much power somebody would consume in rural [country]. They certainly looked at the data from past electricity consumption, but they also tried to evaluate various different consumer categories, various social and economic factors that would affect electricity consumption, as well as economic ability to pay, sources of income, things like that, and just looked past the original data set, which probably would've been adequate to answer the question and looked into a variety of social and economic factors that could influence the model and simulation of this engineering problem over time.

He described how EWB alums engage with more than the technical aspects of engineering and view the broader contexts and considerations that include ethics.

People demonstrate a large capacity and willingness to engage in discussions outside of the engineering technical discipline, that range into much different dimensions of engineering work and ethics that at least in my undergraduate education were not really centered or prioritized as dimensions of engineering education. It's not to say that EWB alums don't have technical rigor. In fact, they do, but this willingness to engage and question outside of the technical norms, standards, regulations, I find to be pretty unique to the EWB alum coworkers and network.

The broader social context is more visible and a larger priority for the EWB alums.

I would say the ones that I've worked with at EWB alums, who I've worked with directly in a professional capacity have a lot more emphasis in understanding initial conditions and root causes than other engineers I've worked with. They tend to spend a lot of time understanding social context. If somebody doesn't have access to infrastructure, why not? Have people been excluded? Are the solutions that I'm developing going to be accessible, available, and conducive to all users in a particular area, region, or user group?

Finally, Dominik reflected that EWB graduates appear to view the world and its challenges differently than most engineers.

I think EWB alums by and large probably have certain traits and also closely held beliefs and opinions that differ from engineering profession as a whole. I would hazard to guess that among EWB alums, climate change is a more existential threat or perceived as a more serious challenge to our generation than the general engineering population.

He specially used the example of climate change and how the graduates viewed engineering as a force for good.

> *I need to account for not only my written expectations within a certain role, but also, making the world a better place, social and environmental pressures of the world that we live in and the imperative of changing the engineering profession from within to be a greater force for good within the world and also a force not only for good, but a force of opposing detrimental consequences of engineering work.*

Conclusions

The interviews of Ryan and Dominik share stories of the impact of the EWB-USA experience on themselves as well as younger graduates who they observed in their professional roles. The interviews were complimentary as Ryan talked more about the skills needed to succeed within his professional context and Dominik focusing more on the broader societal context. Both of the interviews showed a foundational experience as students that translated into preparation for their professional work. The experiences as students impacted their careers in several ways. They also observed graduates who had been impacted by their own EWB experiences and were rising faster within organizations due in large part to the skills they developed and a more advanced understanding of their desired career path. They commented on the long-term, authentic experience in EWB-USA building characteristics that translated into valuable skills as a professional addressing significant challenges.

The interview participants observed that EWB alums advanced faster than their peers either because of their skills or perceived skills or their focus on their own career path. EWB-USA alums also seemed to have a more mature understanding of their own career paths. From their experience, they were more focused on career trajectories that were more people and management focused or technical and were able to advance within their respective tracks faster. It was also observed that some EWB-USA graduates migrated away from engineering seeking ways to more directly impact people. Whether staying or leaving engineering, the graduates have a more profound understanding of the larger social and ethical contexts of the technical work.

These reflections are limited to two white, male participants and generalizable findings have to be triangulated with other data. These interviews are part of a larger NSF funded project that includes data from EWB-USA alums and professional connections who have no prior EWB-USA experience themselves.

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