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“Difficult but worth it”: Exploring the Experiences of Women in Engineering during Co-op

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Although there is an extensive amount of research focusing on women in engineering, the engineering field continues to experience the most gender disparity of any workforce disparities within the United States (National Science Foundation, 2018). Engineering has been labeled “the least gender-equitable profession in the United States,” demonstrating that the experience of women in engineering and the factors that impact retention is a social justice issue (Pierrakos et al., 2009, p. 1). Despite substantial literature discussing the experiences of women in engineering, there has been little progress over the past several decades in the recruitment and retention of women engineers in higher education and in the workforce. In order to address this gap, the current study uses a Participatory Action Research framework to explore women’s experiences in engineering and capture their perspective on how to create change.

The objective of this study is to better understand the experiences of women engineering students while participating in cooperative education (co-op) through the social justice lens of Participatory Action Research (PAR). Using a PAR approach, which is rooted in social justice and inclusive practice, we employed a qualitative participatory method, Group Level Assessment (GLA), to explore women’s experiences on co-op. The GLA method allowed for participants to be involved in data generation, data analysis, and prioritization.

Co-op experiences or internships are common components of a students’ undergraduate experience, providing students the opportunity to work in the field of engineering while still an undergraduate student (American Society of Engineering Education, 2021). Co-op experiences can prove to be

a great learning experience for all students, but for women students it can serve to be an initial exposure to the masculine culture of engineering. Seron et al. (2018) explain that even during internship experiences, men and women students often have different experiences. Cech (2013) found that once they enter the field, men are concentrated in more “technical subfields,” while women are employed in subfields that prioritize more social skills (p.1148).

Oftentimes women experience their identity of being an engineer as overlooked, feeling “invisible as engineers” (Faulkner, 2009) while their gender identity is overly validated, contributing to their marginalization within the field (Hatmaker, 2013). The hegemonic culture of engineering identifies masculine specific traits and behaviors in the field as being associated with success and labels more feminine traits as being associated with failure (Seron et al., 2016).

Women in engineering acknowledge their marginalization, however, they typically respond to this status by “adopting the norms and expectations of the majority group” (Seron et al., 2016). In doing so, they reduce their visibility as women and contribute to the perpetuation of the profession’s norms. Additionally, women often express that surviving within engineering required that they disassociate with other women in an attempt to make themselves seem less feminine (Bastalich et al., 2007). These behaviors and responses lead to a cycle of marginalization and invisibility of women within the field of engineering.

Methods

In order to authentically listen for the voices of the participants—undergraduate women in engineering—an approach that addressed power/powerless-

ness, while also emphasizing collaboration, is necessary. Therefore, Group Level Assessment (GLA) was implemented for the current study. GLA is a qualitative participatory method that allows for a group of stakeholders to collaboratively generate and evaluate data, while also developing an action plan (Vaughn & Lohmueller, 2014). The GLA process acknowledges that the participants have the expertise and knowledge to inform the discussion and contribute to the creation of actionable results (Vaughn et al., 2011).

Participants

The current study focused on undergraduate women in engineering students at a large midwestern research institution. Engineering students at this institution are required to complete five full-time co-op experiences, with each experience lasting a semester. Participants were recruited via email, which was distributed to all undergraduate women enrolled in the college of engineering (approximately 575 students). Twenty-eight college-aged women engineering students participated, from a variety of engineering majors. Additionally, the twenty-eight participants varied in the number of co-op experiences they had completed, with some participants completing only one co-op and others completing as many as five. Participants engaged in one of two online GLA sessions.

Procedures

GLA leads participants through a seven-step structured process, to allow for “salient themes to be identified” and actionable deliverables to be generated (Vaughn & Dejonckheere, 2019). GLA is a collaborative participatory method that involves gathering stakeholders to discuss a common topic or theme. The GLA process invites participants to identify relevant needs, analyze data, prioritize, and develop an action plan (Vaughn & DeJonckheere, 2019). GLA is different from traditional focus groups and interviews, both of which are researcher-centric, focusing on the researcher’s agenda (Vaughn & Lohmueller, 2014). In contrast, GLA seeks to meet the needs of the community or participating stakeholders. The GLA process ensures that both the problem and potential solutions are defined by the participants from the group’s perspective (Vaughn et al., 2011).

The GLA process, traditionally following a seven-step sequence, was modified to accommodate facilitation in an online environment. Typically, all aspects of the GLA are completed in-person, and as follows:

1. Climate Setting: an ice breaker to allow participants to get to know one another and the

facilitators, establishing trust

2. Generating: participants respond to a series of prompts on poster paper, across the walls of a large room
3. Appreciating: participants walk around and read others’ responses to the prompts, and write a star or checkmark by the responses they agree with
4. Reflecting: participants individually reflect on the prompt responses
5. Understanding: participants divide into small groups and identify 3-5 themes across a deck of prompts
6. Selecting: the small groups get back together to form a larger group, share out their themes, and the large group identifies 3-5 overarching themes
7. Action: facilitators guide the group to develop an action plan in response to the identified themes

The modified GLA steps and process can be seen in Figure 1.

Data Analysis

Through the GLA, “the group publicly and synergistically shares information and comes to own the data they generated and evaluated” (Vaughn & Lohmueller, 2014, p. 346). This collaborative process allows for all stakeholders to work together to discuss a complicated issue, create data, and analyze findings (Vaughn & Lohmueller, 2014). The traditional GLA process includes a facilitator guiding the stakeholders through the following seven steps: climate setting, generating, appreciating, reflecting, understanding, selecting, and action (Vaughn & Lohmueller, 2014).

While the initial analysis was conducted during the synchronous GLA process, specifically during the understanding and selecting step, the research team conducted a second cycle of analysis. The purpose of this second round of analysis was to combine the discussion and findings from the two separate GLAs, to create overarching themes. Inductive analysis was used to combine the findings (GLA prompt responses and GLA discussion data) into salient themes.

Modified Online Group Level Assessment (GLA)



Figure 1. Modified Online GLA Process

Note: The steps in blue were completed individually, while the steps in purple were done collectively.

Positionality

Herr & Anderson (2015) discuss the importance of researcher positionality, challenging us to ask ourselves the question “who am I in relation to my participants and my setting?” (p. 37). As Participatory Action Researchers, it is critical that we not only reflect on the research question, but also on our positionality and how this impacts the way in which we see and experience reality (Anderson et al., 2007). Exploring our positionality ensures that our work is ethical and authentic to our participants, but it also ensures the study’s trustworthiness (Herr & Anderson, 2015). By taking the time to reflect on our assumptions about the world, we tease out the implications of our assumptions on our research.

Our research team developed our own positionality at the beginning of the analysis phase, to ensure we recognized our own perspective and experiences as a collaborative team. We wrote this statement together in a collaborative manner:

Together we are a group of women, both students and an educator, who are striving for positive change within engineering. We come to this Participatory Action Research (PAR) space, as both expert and novice, in hopes that collaboration will strengthen our work. We recognize our privilege as educated white women, which makes us both insider and outsider in the research space. Acknowledging this work is deeply personal for each of us, as we ourselves have been victims of harassment, masculine cultures, and hegemonic

meritocracy. As a collective, we strive to ensure that we amplify the voices of women, we don’t give them voice, while welcoming the diversity of experiences of women in engineering. We celebrate the messiness of collaborating with people and refuse to generalize the experiences of women as monolithic. We are passionate about contributing to the creation of a brighter and more just future!

Findings & Discussion

Themes were developed by participants through discussion during each of the two virtual GLAs. After the GLA sessions the themes from the individual GLAs were reviewed by the research team and overall themes for the research study were agreed upon. Themes include: (1) impact of relationships, (2) struggle for equality, and (3) growth through the co-op experience. After agreeing on the themes, sub themes were developed for each overall theme, which can be seen in Table 1. Additionally, Table 1 includes representative quotes of each of the sub-themes.

Impact of Relationships

Women in our study who felt they had strong relationships during their experience perceived their co-op as more positive. During the theme development that took place during the GLA sessions (Steps 4 and 5), the women discussed relationships in three ways, (1) relationship with colleagues, (2) relationship with the company, and (3) relationship with self. One student highlighted that the best part of her co-op experience was “building relationships.”

Relationship with Colleagues

The women stated that interactions and relationships with colleagues significantly impacted their overall co-op experience. Relationships with colleagues were so critical that they influenced many of the other themes, showing the centrality of relationships in the co-op experience. One participant stated that the biggest challenge she faced on co-op was “learning how to form relationships in a professional setting.”

Investing the time to build interpersonal relationships with colleagues, allowed the women to feel part of the group/team. Having relationships with colleagues outside of the work environment also had a positive impact on the co-op experience. Additionally, women wished relationships with colleagues could be more casual, open, and accepting. Participants articulated that they felt more connected with colleagues when “we talk about non-work stuff” and when “we ask each other questions about our lives.”

Table 1. Representative Quotes based on Sub-Themes

THEME	SUB-THEME	REPRESENTATIVE QUOTE
Impact of Relationships	Relationships with Colleagues	I felt connected with my colleagues on co-op when we engaged in personal/ conversation, we perform tasks together, and everyone is open with each other.
	Relationship with Co-op Company	The worst part of my co-op experience was when I had to do work on my co-ops that felt like busywork and I didn't feel like I was relevant to the company.
	Relationship with Self	The most prominent feeling I experienced on co-op was excitement and loneliness. I knew that I was at a great company and truly gaining good experience towards my future, however, being so far from campus where my friends and family were proved extremely difficult.
Struggle for Equality	Age Gap	Some people will treat you like an adult and some people will treat you like a child.
	Gender Gap	While on co-op I experienced and saw quite a bit of lack of respect towards to women in STEM. I had some good experiences in terms of learning, but some not so great experiences as a woman in the industry.
Impact of the Co-op Experience	Experiences Vary	Being a woman in engineering is . . . different depending on the company you work at.
	Professional Growth	My co-op experience can be described as an extremely valuable time It also gave me a chance to network in my field, and gave time for me to explore what I want to do.
	Mental Health	The most prominent feeling I experienced on co-op was unhappiness I also didn't feel respected and saw the few other women that were there were treated the same.

Having good mentors/supervisors and being able to ask questions had a large impact on students' perceptions of their co-op experience by contributing to their sense of value. More specifically, supervisors who intentionally created an environment where students felt safe to ask questions contributed to the women's ability to develop relationships and build confidence. Other women explained that they experienced a sense of worth on co-op when they had a mentor that was "willing to take the time to teach/guide" them.

In the GLA prompt responses, we saw numerous responses that helped paint a clear picture of the importance of recognition for the women. Some women stated that having a mentor that "gives me affirmation that I have been doing well" or being "recognized in a meeting for my contributions" contributed to their sense of worth on co-op. Other students articulated that a sense of worth on co-op came from feeling appreciated, accomplishing something that matters, having a mentor take time to teach them, or being given a project that challenged them.

Through the prompt responses and discussion with the women, it is evident that relationships with colleagues was the single most important factor that affected their co-op experience.

Relationship with Co-op Company

Companies that intentionally created an environment where co-ops felt part of the team, contributed to the women's sense of belonging. Practices such as including co-ops in team meetings, including co-ops in discussions, and asking students for their input can sig-

nificantly shape the relationship that a student builds with a company. The participants tended to feel more connected with a company culture that was engaging and encouraged employees to get involved, which in turn created an environment where women felt they could more easily develop relationships with colleagues.

The women's ability to build connection with the company impacted their overall co-op experience. Connecting to the company was often facilitated by an inclusive company culture and the ability to have positive role models. A woman's access to support and connection from colleagues directly influences the way women experienced a company culture, showing the interplay between relationships with colleagues and relationship with co-op company.

Role models and representation were contributing factors to women feeling connected to the company culture. One participant stated, "I looked up a lot to the female engineers and supervisors I saw at co-op, so it can be very inspiring to see women in engineering who have been successful," suggesting that the power of representation and women being given the opportunity to see other women succeed and serve in leadership roles should not be underestimated.

Relationship with Self

Participants indicated that they sought out validation from colleagues, and when validation did not occur, it had a negative impact on their sense of self-worth. The women set high expectations of themselves; for example, one woman indicated that "taking initiative in order to exceed expectations when working on

projects” was the best part of her co-op experience. Some women experienced a disconnection within themselves when they felt as if they could not authentically share their feelings and experiences with others. Instead, they hid their true feelings in hopes they would be seen as “strong and doing well.” The desire to conceal feelings and emotions had an impact on the women’s mental health and contributed to women continuing to distance themselves from colleagues and their own emotions. One woman explained that being a woman in engineering is “a lifelong battle with oneself.” The battle between wanting to be accepted by co-workers and peers, while also wanting to stay true to oneself, was seen throughout the prompt responses and the GLA discussion. More on this in the mental health section.

Struggle for Equality

During both GLA discussions there was frequent dialogue surrounding equality—more specifically, women sharing their experiences with inequality as it relates to age and gender. Being both a college student (young) and a woman affected the quality of participants’ professional experience on co-op. Therefore, equality includes two sub themes: (1) age gap and (2) gender gap.

Age Gap

One participant averred, while on co-op she experienced “what real world engineering is like.” However, the women acknowledged that the age gap between themselves and their engineering colleagues made it difficult for them to relate to coworkers, which in turn made it difficult to build relationships.

Overall, the age gap between co-workers and women co-op students caused two distinct issues: identity discrepancy and relationship incompatibility. Participants felt that being young and inexperienced was judged more harshly than being a woman in the workplace, creating a situation where young women engineers had to “speak louder to be heard.”

The age discrepancy created a unique dichotomy, as the women identified as college students but were also trying to be accepted in a professional environment, causing them to feel they did not belong in either category. The dissonance between their student and professional selves caused the women to feel further disconnected in developing meaningful relationships with coworkers and superiors. One participant responded to a GLA prompt by stating, “some people will treat you like an adult and some people will treat you like a child.” Unfortunately, the women felt that their age limited their growth in the professional environment.

Gender Gap

In addition to age equality, the fair treatment of women was important to a positive co-op experience. The women stated that in the workplace, “when treated as an equal, you feel more comfortable to share thoughts and opinions.” Participants recognized that women in engineering “have to work harder to prove themselves.” The women acknowledged that when they were treated as an equal, they felt more comfortable to share their thoughts and opinions in the workplace.

Many participants observed full-time women engineers “not taken seriously.” One participant stated that while on co-op she “saw quite a bit of lack of respect towards women in STEM,” going further to reflect, “I had some good experiences in terms of learning, but some not so great experiences as a woman in the industry.” Furthermore, women reported that many individuals on their team, such as “older white men,” were inexperienced in providing support to younger women in technical roles. The lack of support yielded a less friendly environment. Women thrived within co-ops when they were supported by co-workers and treated equally compared to male peers.

Impact of the Co-op Experience

The women agreed that co-op was an opportunity to learn, grow professionally, and gain exposure in their field of study. When asked to describe their co-op experience, one participant explained, “[co-op was an] extremely valuable time that has set me up to have more than I ever hoped for. It also gave me a chance to network in my field, and gave time for me to explore what I want to do.”

Experiences Vary

The women stressed the importance of not generalizing the experiences of women on co-op, as they were vastly different depending on team, company, industry, and individual colleagues. The women were mindful of not wanting to portray the experiences of women as monolithic. However, most of the women agreed that their experiences were shaped by the relationships developed at the company.

Professional Growth

Participants expressed that they noticed growth within themselves throughout the co-op experience, stating there was a “lack of confidence in the beginning” but “there is growth over the duration of the co-op.” Women noticed that after contributing to more projects and gaining responsibility, they felt that their “confidence in self grew.” More specifically, as women started to develop technical skills, they “start[ed] to feel worthy” of their title and thus felt more comfortable and confident in contributing in the workplace.

Mental Health

Relationships, equality and culture directly influenced the women's overall mental health. During their co-op experience, women felt significant pressure to successfully perform their responsibilities as a co-op. In addition to attempting to perform their co-op duties, the women remained mindful of being a woman in engineering, which is a male dominated field. Young women felt more pressure to be seen and valued, due to not always being taken seriously. One woman highlighted that she experienced a great deal of "stress" due to "having high expectations of myself to perform well."

The confidence gained (or not gained) during the co-op experience influenced the women's self-worth and overall well-being. Participants explained that staying positive was a regular struggle, such as when receiving unwanted comments from supervisors and colleagues. The women felt unable to openly and honestly share their negative experiences with others, because they wanted to be seen as "strong and doing well." The intentional hiding of their honest and authentic feelings contributed to feelings of isolation and disconnection from co-workers; this affect was felt across a variety of companies and fields. The lack of relationships and the compounding feeling of needing to be seen as "strong" created a significant burden for many of the women. When asked about the most prominent feeling experienced on co-op, the women said "stress," "anxiety," and "loneliness." The women illustrated that over time these feelings took a significant toll on their mental health. In some situations, women even described that the loneliness, stress, and anxiety created resentment toward their co-op and toward the engineering field. These findings emphasize the impact relationships have on mental health, but also how relationships impact the women's overall relationship with themselves.

Conclusion and Implications

Historically, the core values of American engineering have been meritocracy and individualism. By continuing to adopt these core values of the engineering profession, women, perhaps unknowingly, continue to perpetuate practices and structures that discriminate against them (Seron et al., 2016). The engineering culture deems topics such as gender equality off limits, as this falls within the realm of social and subjective, which go against engineering's commitment to individualism and empirical science (Seron et al., 2016). Throughout our research we found the sentiments above to be true, as few women spoke negatively about the engineering field, but rather spoke very spe-

cifically about "their own" experiences. The women continued to reiterate during the GLA discussion that the experiences of women vary and should not be portrayed as monolithic. More often, we saw the women placing the expectation for a positive co-op experience back on themselves. Although we do not seek to paint a homogenous picture of all women's experiences on engineering co-ops, as researchers, we were able to identify much overlap in their journeys.

Researchers in this space should be mindful that women in engineering often disassociate with the idea of feminism (Bastalich et al., 2007), as it is seen as not abiding by the norms and values of engineering. Women who have embraced the engineering culture may not feel comfortable participating or authentically sharing, feeling as if their participation goes against the norms of the profession. However, our research aligns with Harding (1987) who stated that women should be part of the process to understand and create new knowledge around the topic of women's experiences. One of the participants articulated the importance of involving women by stating:

[We should not] assume [women] want to be 'empowered' or whatever with inspiring images and quotes. Real empowerment comes from a sense of mastery, expertise, strong relationships, and confidence, as well as acute knowledge of the truth and how to navigate workplace politics gracefully. The important thing is to support women and help them find their own path.

The themes we discovered had significant overlap and crossover, reiterating the complexity of women's experiences. The women in our study did not just experience one of the themes—relationships, growth, and equity—but rather they experienced a blend of all of them. The women agreed that co-op was an opportunity to learn, grow professionally, and gain exposure in their field of study. And yet, many women found it difficult to navigate the overall co-op experience. Women expressed difficulty feeling heard or seen during their co-op experience, explaining they were seen as women but not as engineers, aligning with Akpanudo et al., (2017), who found that full-time women in engineering felt invisible as engineers, but highly visible as women. Relationships with colleagues made a significant impact on the women's perception of their co-op experience, as the women in the study highlighted that relationships helped them find their place and gave them a sense of belonging. The gender and age gap increased the difficulty of building relationships, as they were seeking opportunities to connect and identify with their colleagues who were often males 20+ years older. When women

were unable to develop strong relationships on co-op, their confidence and mental health suffered.

Furthermore, the women often withheld parts of themselves by not sharing their thoughts and feelings honestly. Miller and Stiver (1997) refer to this as the central relational paradox, when we continue to seek connection with others, however we are inauthentic about our own experiences and feelings, therefore making it impossible for us to be in mutual connection with others. The women in our study explained that they wanted to be seen as “strong” and “doing well” by others, therefore they withheld their authentic feelings about their experiences. Raider-Roth (2005) states that if relationships are compromised, even a relationship with self, it inhibits our capacity to learn and grow. Therefore, if women are experiencing the central relational paradox on co-op, by disconnecting from themselves and other relationships, it has the capacity to inhibit their ability to learn and grow. If women co-op students are juggling these relationships and are not able to be authentic, then they are unable to grow and develop to their full potential. This is highly problematic, since co-op is specifically designed to be a significant learning experience.

Regarding pedagogical implications, professors teaching introduction to co-op courses and other professional development courses must not only be aware of the co-op environment for women, but should also incorporate diversity, equity, and inclusion (DE&I) training into their courses. For example, modules regarding men as allies, working with diverse groups, and identifying and removing microaggressions must be present in these types of courses. Furthermore, professors teaching engineering courses and more technical courses would also serve to incorporate inclusive teaching practices, including explicitly developing DE&I modules that are relevant to their courses.

In sum, our study reveals that relationships are essential to the learning, growth, and success of women on co-op. Women’s growth and learning on co-op were hindered due to the contextual factors associated with building relationships. Due to this stunted growth and learning on co-op, women’s ability to contribute in the future could also be impeded, causing them to be lagging behind their male peers. Therefore, we can now articulate how serious the relationships developed on co-op are to contributing to the long-term success of women engineers. We argue that until women have equal access to developing relationships with peers, colleagues, and supervisors, they will continue to be at a disadvantage in the engineering space. The impetus for creating equitable engineering spaces for women

is the responsibility of all of us—the engineering industry, the institutions administering co-op programs, professors and peers, coworkers and advisors.

Future Directions

A key future direction for this study would be replicating the GLA specifically with women of color in engineering. As we consider intersectionality and racial justice in the context of pedagogy, experiential education, and engineering co-ops, specifically, we must take into account the unique experiences of women of color as racism and sexism compounds within engineering spaces. Replicating the current study with women of color in engineering could bring to light social justice issues not only in regard to gender, but racial justice implications, as well. These perspectives are essential in order to work towards creating gender-inclusive and anti-racist engineering spaces in multiple professional settings such as the classroom, on co-op, and in the workplace. Furthermore, we acknowledge that the issues brought to light with women in engineering may be true for women in other fields, and this study could be replicated with women in a variety of disciplines. In terms of future directions in the classroom, working with women and women of color in engineering to develop inclusive module topics is an important next step. Given the participatory spirit of GLA, implementing these action items with the women who developed them will ensure for equitable and inclusive implementation processes that are also salient and timely. ■

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