"No, I'm not the secretary": Using participatory methods to explore women engineering students experiences on co-op

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Studies exploring engineering students' experiences with cooperative education (co-op) typically utilize traditional quantitative and qualitative methods to focus on overall outcomes as opposed to individual voices. As a result of this, women's experiences in a co-op environment are rarely captured. Historically, women are underrepresented in engineering undergraduate programs, and this can lead to feelings of isolation and low self-efficacy, which, in turn, can lead to attrition. Participatory action research (PAR) not only highlights marginalized voices, but also empowers participants. The current study implements group-level assessment (GLA), a large-group PAR method, to study the co-op experiences of women in engineering at a large US research institution. During the GLA, participants developed an action plan to improve co-op experiences for women in order to improve retention and help future women succeed.

Keywords: Co-op, engineering, women, action research, participatory methods

Despite a continuous effort to increase the number of women in undergraduate STEM (science, technology, engineering, and math) majors, women are still lagging in enrollment in engineering majors within the United States. Since 2000, women have earned roughly half of the bachelor degrees administered; however, women account for only 20% of engineering degrees administered in the United States in 2015 (National Science Board, 2018). According to the Bureau of Labor Statistics (2011), women represent only 10% of full-time employed engineers. As a result of this, undergraduate women in engineering tend to feel lonely, unsupported, and tokenized (Haas, Koeszegi, & Zedlacher, 2016).

This gender gap continues to cause concerns for universities of higher education and employers around the United States. With organizations such as the National Research Council (2007) releasing a call to action, stressing that the science and technology fields must be strengthened to maintain economic and social prosperity. Therefore, an increase in the number of engineers entering the workforce, by way of retaining and recruiting more female engineering students, could ensure prosperity continues within the engineering and technology field. However, researchers continue to struggle with understanding strategies for recruitment and retention of women engineering students.

College campuses continue to make strides to improve recruitment and retention of engineering students, with the development and implementation of mentor programs, research opportunities, and learning communities. However, women continue to be a minority in the engineering field, with engineering being the "last gender-equitable and race-equitable profession in the United States" (Pierrakos, Beam, Constantz, Johri, & Anderson, 2009, M4F-1). Engineering as a profession is considered "gender typed as masculine," often referred to as *manly* and *male-centered* (Hatmaker, 2013). The gendering of engineering causes the perception that men are more appropriately suited for careers in the field, with the assumption that men have more beneficial traits and are more competent (Hatmaker, 2013). This can cause women to experience resistance from co-workers and supervisors. It

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has been noted that women engineers live within a paradox where they are highly visible as being women, but at the same time invisible as an engineer (Faulkner, 2009).

Balakrishnan and Low (2016) mention the importance of the college experience on increasing the pipeline of women engineering professionals, saying:

> collegiate experiences... have an immense impact on their [women's] intentions to pursue careers in the engineering field. These intentions are shaped through positive learning experiences in terms of quality of teaching, respect and care from lecturers, and good communication and interaction with peers, especially male students .(p. 236)

Authors suggest that continued research must be done to understand the causes of attrition and uncover impactful interventions that can improve retention.

A recent study looked at the factors that impact a female student's decision to persist in computing majors, findings suggested that students who choose to persist had (1) adequate exposure to learn the necessary computing skills, (2) community support, which included parents, peers, and faculty, and (3) encouragement and respect from others in their computing community (DuBow, Kaminsky, & Weidler-Lewis, 2017). Students perceptions and attitudes regarding engineering impact their decision to remain in an engineering major (Pierrakos et al., 2009). Studies suggest that female students, as compared to their male peers, have lower confidence in their engineering background knowledge and in their ability to succeed in engineering (Besterfield-Sacre, Moreno, Shuman, & Atman, 2001).

Women in engineering frequently view the environment of engineering as cold and unreliable (Malicky, 2003), which is further supported by the frequently described "chilly" climate in engineering in a higher education setting (Cole & Espinoza, 2011). A study by Thoman, Arizaga, Smith, Story, and Soncuya (2014) highlights the isolation felt by women in engineering, indicating that these women are more likely than their male counterparts to switch out of engineering to another field. Bernold, Spurlin, & Anson (2007) state that "in spite of considerable research about the poor retention rate of undergraduate engineering students, we still have an inadequate understanding of the factors that affect students' decisions to remain in engineering programs" (p. 26), suggesting that continued research must be done to understand the causes of attrition and uncover impactful interventions that can improve retention. This could be studied and achieved using participatory methods.

Participating in a cooperative education (co-op), or work integrated learning, experience has many benefits for undergraduate students. Co-op provides students the opportunity to integrate classroom learning into the workplace. Eames (2000) notes that while on co-op, students developed a variety of skills including: (1) additional skills and knowledge, (2) interpersonal skills, and (3) time management. It has also been found that students who participate in a co-op program receive promotions and pay increases at a higher rate than their peers (Phillips, 1978). Participating in co-op also provides students the opportunity to broaden their knowledge about their particular field or major (Drysdale, Frost, & McBeath, 2015). Participating in co-op provides students with an opportunity to develop themselves not only as a professional, but also holistically.

Specifically at the institution studied, engineering students participate in a mandatory co-op program. Through this co-op program students are required to complete five semesters of full-time co-op, where they alternate between being in classes and being on co-op. These co-op experiences allow students to gain real world experience in their field of study. Completing five semesters of co-op allows for

students to continue to build upon their professional skills, while also putting into action the knowledge they have gained in the classroom.

Although cooperative education and women in engineering are both well researched topics in their respective fields, there is a dearth of literature highlighting the experiences of women engineering students on co-op. The current study implements group-level assessment, a large-group participatory action research (PAR) method, to study the co-op experiences of women in engineering at a large US research institution. During the group level assessment (GLA), participants developed an action plan to improve co-op experiences for women in order to improve retention and help future women succeed. Our hope is that by better understanding the experiences of women in engineering that we can begin to create interventions that will improve the retention of women in the field.

METHODS

In the current study, Group Level Assessment (GLA) was employed, a qualitative, large group, participatory method that allows participants the opportunity to voice their opinion on a specific topic, while also developing action strategies for measurable change meant to benefit the community or institution. GLA involves an interactive session that mirrors a focus group in which participants individually respond to prompts, discuss major themes, and create an action plan. GLA has been used as a tool within organizations to engage stakeholders and recognize the needs and issues within a particular group (Vaughn & Lohmueller, 1998). It has been successfully used in a support group setting (Vaughn & Lohmueller, 1998) as well as within higher education (Guy, 2017; Guy & Boards, 2019). The emphasis of a GLA is action, allowing participants to develop realistic solutions and create sustainable change in their organization or group (Vaughn & Lohmueller, 2014). Participatory methods help empower participants and are particularly successful when working with marginalized groups (Anderson, Herr, & Nihlen, 2007) and GLA, specifically, allows participants to have a voice in the research process (Vaughn & Lohmueller, 2014). This study was approved by the universitys Institutional Review Board, which reviews all research studies that take place on campus.

Study Context

A series of GLAs were facilitated with women engineering students at a large, midwestern university in order to examine the experiences of these women at this particular institution. Seventy-nine women students participated in three GLAs over the course of three semesters, with 31, 39, and nine women participating in the 2018 Spring, Summer, and Fall GLAs, respectively. Two of these GLAs were with women engineering students in all stages of their experience (Spring 2018 & Summer 2018), and one was conducted with seniors in which the prompts were specifically focused on the co-op experience (Fall 2018). Participants were recruited via email through the university's Society for Women Engineers (SWE) chapter as well as the researchers' own connections with women engineering students (advisees and current or former students). Each participant received a $10 gift card for their time.

The prompts created for the GLA were meant to provide a holistic look at women in engineering experiences at the university. Prompts were a mix of serious (advice I would give a freshman female engineering student at [institution name] would be...) and lighthearted (if the culture of engineering was a movie it would be titled...), as well as positive (things I enjoy about the engineering program at [institution name] is...) and critical (if I could change one thing about engineering at [institution name] it would be…). A blend of course-focused (my professors in engineering are...), co-op focused (being in a professional engineering environment [co-op] makes me feel...), and culture- focused (the culture

of engineering at [institution name] is…) prompts were included in order to explore the breadth of experience that women in engineering have at the university.

The GLA process was followed as defined in Vaughn and Lohmueller's article (2014), aside from a minor modification in Step 2. Below are the steps carried out during each GLA session (see Figure 1):

1. *Climate Setting*: During climate setting, the researchers introduced themselves and explained the GLA process. A brief icebreaker was facilitated so that participants could get to know each other and become comfortable with the researchers as the GLA facilitators.

2. *Generating*: The generating phase involved the qualitative data generation. In this step, participants responded to a series of open-ended prompts presented around the room on large poster paper. Instead of asking participants to write directly under each prompt, they were directed .to prepare their responses (words and brief phrases) on sticky notes, then place their answer under the appropriate prompt. This deviates slightly from the process outlined in Vaughn and Lohmueller (2014). The reasoning behind this modification is to add another layer of anonymity surrounding the GLA process; modifying this step prevents participants from being influenced by others' responses as they answer each prompt individually.

3. *Appreciating*: During the appreciation step, participants were instructed to walk around the room and read others' responses. Participants also identified answers they agreed with, and indicated this by writing check marks or stars by them.

4. *Reflecting:* The reflection phase involved participants individually reflecting upon prompt responses holistically.

5. *Understanding:* Participants were divided into small groups and randomly assigned a set of prompts to "analyze". The participants were asked to reflect on the answers to the prompts they were assigned, and collaboratively come up with 3-5 themes across the prompts that encapsulated overlapping ideas and the general spirit or tone of the prompt responses.

6. *Selection:* During the selection phase, small groups shared out their themes and the participants discussed them as a large group. The large group, as a whole, then condensed the small group themes and selected 3-5 main themes that identified common areas across all prompt responses.

7. *Action*: The end of the GLA process is when participants used the final themes to identify action steps to carry out that take into consideration the final themes. The facilitators guided the large group of participants to focus on action items that were both concrete and measurable as well as realistically achievable.

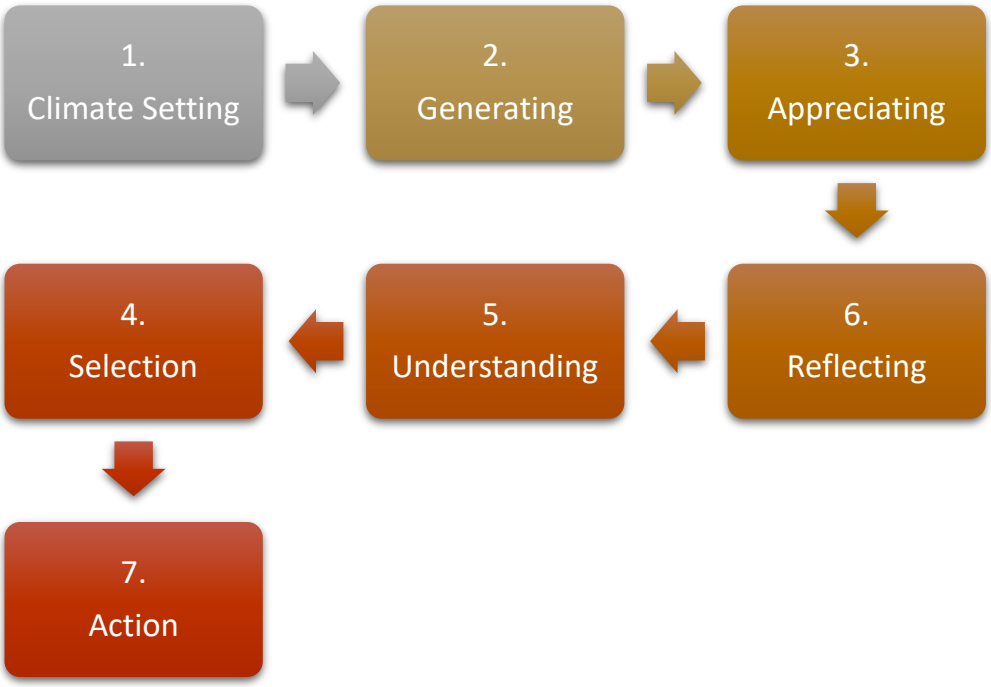

FIGURE 1: The seven steps of the group level assessment process.

Data Analysis

Qualitative data from both the GLA as well as the questionnaire were analyzed. During each GLA, preliminary analysis of the prompt responses was conducted during the understandingphase of the GLA. The researchers combined the data and final themes from the three GLAs and thematically analyzed them using with undergraduate research assistants using Jackson's (2008) group analysis method as a guideline. This provided an initial coding of the themes; researchers then facilitated a second-cycle of coding amongst co-researchers. The questionnaire responses were analyzed using Braun and Clarke's (2006) thematic analysis to identify common themes.

FINDINGS

Based on the GLA responses, women students in engineering find co-op to be a valuable experience; an overwhelming number of participants indicated that the opportunity to co-op is one of their favorite aspects of being a part of the engineering program at the university. In response to the prompt, "Things I enjoy about the engineering program at [this university] are" 17 out of the 28 responses during the spring 2018 GLA involved "co-op," and in summer 2018, "co-op" made up 28 of the 39 responses to this prompt. Extracting from this data, it is clear that women engineering students enjoyed and appreciated their co-op experiences overall.

In each GLA, one prompt presented was "being in a professional engineering environment (co-op), makes me feel. . . ". The predominant answer was "nervous" or "anxious" during the spring 2018 GLA, which was comprised primarily of underclassmen (college freshmen and sophomores), particularly first-year women engineering students. However, during the fall 2018 GLA with the senior women engineering students, responses involved more variety of experiences. For example, one participant indicated that "being in a professional engineering environment" made her feel both "out of my league" and "excited to explore my options". Another participant responded that she felt "either comfortable

or at the bottom of the totem pole". From these responses, it is clear that through the variety of co-op experiences engineering students were provided with, experiences which can vary from one extreme to the other.

During the GLA with senior students, in particular, more targeted questions were asked specifically about the co-op experience. From the responses to these prompts, we gathered that while there are several positive aspects about being on co-op for women engineering students, there are still several issues within co-op environments that companies and universities should make an effort to address. Positives aspects of co-op involve the sense of responsibility it imparts on being a woman in engineering, leading them to feel confident and empowered. On the other hand, co-ops also made participants feel overwhelmed, inadequate, and insecure. Additionally, supervisors run the gamut between being supportive mentors or being unhelpful and poor leaders. Table 1 outlines primary themes and subthemes found in regards to the co-op experience.

DISCUSSION

Theme 1: Growth on Co-op

Women engineering students overwhelmingly stressed the various ways that they grew professionally and personally through their co-op experiences. Namely, they expressed that participating in the co-op program led them to (1) feel empowered, (2) learn responsibility, and (3) develop collaborators. The level of independence that was experienced on co-op can lead to empowerment. One participant in particular expressed that her co-op experience involved "exploration & experimentation", which made her feel empowered and confident. According to particpants, co-op experiences contribute to their learning in that the work itself instills a level of responsibility through real-world experience and knowledge. During the GLA discussion, it was also explained that their co-op experiences led them to develop relationships with their peers and supervisors, to learn collaboration skills, and feel supported in their careers.

Theme 2: "Chilly" Co-op environment

While there are several positive aspects of co-op, the women particpants also indicated that some environments were less-than-supportive, and are, in fact, "chilly" for women in the field, such as an (1) unwelcoming environment due to (2) varying relationships, which leads to (3) feeling underestimated. Many of the women described the co-op environment as making them feel inadequate. For example, while some women felt supported while on co-op, others felt secluded from their co-workers. Although women engineering students indicated that they developed collaborations on co-op, they also experienced some strained relationships in their co-op environment, causing impacts to self-esteem and confidence.

Theme 3: Internal Struggle

One theme that came up consistently throughout the GLAs was that of an internal struggle, where women engineering students simultaneously felt (1) confidence and a lack of confidence, and felt both (2) capable and incapable. For example, feeling doubted from peers or on co-op can make women engineering students question their confidence, while supportive supervisors have the opposite effect. One woman explained that even though she "seems smart to others, [she] feels dumb or out of place". Another woman expressed advice for future women engineering students, stating, "You're probably underestimating yourself. Go for it".

TABLE 1: Examples of participant responses for each theme.

Theme	Subtheme	Representative Quotes
Growth on Co-op	Feel empowered	"At first overwhelming but then exciting and empowering-- I'm really doing this."
		"Excited to see how I can change the environment someday."
	Learn responsibility	"Truly learned responsibility, how to professionally carry myself, & how to work in my field."
		"Having responsibilities and taking charge of my own projects."
	Develop collaborations	"Everyone was willing to help whenever I had questions."
		"Growth and learning collaborative!"
"Chilly" environment	Unwelcoming environment	"Know-it-alls."
		"At the bottom of the totem pole."
	Varying relationships	"Either amazing or not helpful at all."
		"Sometimes not around a lot and not helpful, other times super patient and great teachers and mentors."
	Feel underestimated	"people are surprised by me but in a condescending way."
		"Inadequate and unsure"
Internal struggle	Confidence vs. lack of	"More confident in my skills, but out of place at times."
		"You're probably underestimating yourself. Go for it."
	Capable vs. incapable	"Out of my league. Inspired to finish my degree. Excited to explore my options."
		"Seems smart to others, but feels dumb or out of place."

Action Items

Based on the themes and GLA discussion, the women during each GLA process came up with concrete, actionable items to move forward with (see Table 2). The action items created that directly involve the co-op experience included the following:

1. *Integrate inclusion into coursework*: Include lessons on diversity and inclusion in the Introduction to Co-op course, including information on sexual harassment and appropriate reporting procedures, abnormal behavior in the workplace, and handling microaggressions.

2. *Training male peers to be advocates*: Provide men in engineering with language to be supportive of a more diverse and inclusive environment and bystander intervention techniques.

3. *Additional prep work* for co-op supervisors**:** Require co-op supervisors to engage in training on emotional intelligence, microaggressions, sexual harassment, and encourage -co-op supervisors to engage in self-reflection.

CONCLUSION

Overall, women in engineering assert that the co-op program is a great opportunity and allows for professional growth; however, there are several issues within engineering co-ops that need to be addressed at this intitution in order to provide a better experience for women in engineering. Therefore, it is essential to not only tackle issues with co-op, but also capitalize on what is working or going well. One of the senior women responded that if her co-op experience was a movie, it would be called: "No, I am not the secretary". This quote highlights the inequitable environment between men and women that frequently occurs in professional engineering environments (Faulkner, 2009), which is an issue that could be rectified through items such as incorporating inclusive practices as well as supervisor training in fostering diverse work environments. In fact, through these GLAs, participants developed action items that have either already been acted upon, or are currently actively engaging relevant stakeholders to help bring the plans to fruition. These action steps include working towards building a stronger community of undergraduate women in engineering, plans for addressing inappropriate behavior on co-op, and improving staff/faculty training.

The women stressed that co-op provided them a unique experience that allowed them to grow both personally and professionally in a professional engineering work environment. Many of the women acknowledged that their co-op experience allowed them to feel more confident and empowered in their abilities. As this experience provided them the opportunity to practice and further develop their technical skills in the field.

Developing relationships with their peers and supervisors proved to be a worthwhile component of co-op. However, some women also acknowledged that they were underestimated during their co-op through a lack of support from their supervisor or seclusion from co-workers. This lack of support impacted the womens' confidence and self-esteem moving forward in the co-op. Through these findings we see that relationships in the workplace were important to women, while also being acknowledged by colleagues and supervisors. Women develop an engineering identity through the intersectionality of performance (behaving like an engineer) and competence (understanding specific content that relates to the field). This engineering identity development also needs the recognition of others, having someone see you as an engineer (Carlone & Johnson, 2007). This helps

to understand that the recognition of peers is essential to the experiences of women students, therefore when this recognition of 'being an engineer' does not happen it can impact the confidence and self-esteem of women- potentially impacting their desire to stay within the field.

TABLE 2: Example of the action themes and specific action items developed by participants.

Action Theme	Action Item
Develop a stronger community of women	Create networking opportunities (e.g. chat rooms, informal social events or meetings)
	Host a banquet at the beginning of the year to meet classmates
	Encourage women to join student clubs and organizations (e.g. Society for Women in Engineering)
	Assign freshmen to senior mentors for informal meetings
Build confidence in women	Trainings to prep women for co-op experiences
	Consistency with advisor guidance/information
	Staff training in: emotional intelligence, motivating students, resolving issues
Create a more inclusive environment	Integrate diversity and inclusion trainings into coursework (e.g. Introduction to Co-op
	Train male peers to be advocates
	Encourage co-op supervisors to complete self-reflections
	Develop a women in engineering speaker series

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The participants also expressed an internal struggle that impacted them on co-op. This struggle was due to conflicting internal dialogue that the women experienced: "you are smart, but don't belong here" or "I'm intimidated, but ready to kick butt". Although the women didn't go into great detail explaining this internal struggle, through the literature around current research it can be speculated why this may be the case. Women engineers struggle to be taken seriously, while attempting to negotiate their professional roles in the field (Faulkner, 2009). It can be hypothesized that this is due to women having to negotiate their personal feminine identities with the masculine professional identity of engineering. Women mention that they feel invisible as an engineer, while highly visible as a female (Akpanudo, Huff, Williams, & Goodwin, 2017).

LIMITATIONS AND FUTURE RESEARCH

The current literature helps to understand that the engineering environment can more often be more difficult for women, often being described as "chilly". The women who participated in our study echoed the findings of other studies that describe the difficulty women face when attempting to build relationships with co-workers, being taken seriously in the workplace, and finding confidence in abilities. From the study researchers should be warned to not assume that the experiences of women in engineering are all the same, as can be seen through this study the experiences of women varied greatly by year of study, major, co-op employer, and the geographic location and industry of the co-op experience. The experiences of women are complex and different, it is important to not oversimplify the complexity of their experiences.

The researchers also encourage other researchers who are studying the experiences of women in engineering to do so with a feminist approach, to ensure that intentionally listen for the voice of women, rather than speak for women- as to not continue to marginalize this population. From this point, the researchers plan to continue to use participatory action research (PAR) methods to understand the experiences of women engineering students, as PAR methods allow research to be conducted in collaboration *with* women as opposed to *on* women. By collaborating with women and providing them an outlet and opportunity to discuss their experiences, the research is working to empower them to become more reflexive in regard to their own experiences. Including women in the entire research process also ensures that the action items and interventions developed through the study are culturally appropriate, as they are developed by the women. This collaboration allows the women to take ownership of the action items, in hopes they will go forth into their community and assist with making a positive change.

There are, however, a few limitations of PAR that should be addressed. Due to the in-depth nature of qualitative PAR methods, the number of participants to generate knowledge is typically low. That said, because the qualitative data is so rich, a higher number of participants would likely saturate the data, regardless. Additionally, the lack of quantitative data makes the findings difficult to generalize. This could be combated in the future by developing a mixed-methods study.

In regard to next steps, results will continue to be shared with others in the community including faculty, community partners, and employers in hopes that conversations can begin around creating sustainable change. The researchers plan to continue to use PAR methods to explore the experiences of women engineering students while on co-op, and these experiences effects on women. Due to the women participants requesting it, a similar GLA will be facilitated but specifically with male students to allow for the comparison of results. The researchers are passionate about improving the experiences of women in engineering and look forward to continuing to do this work *with* women students.

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