Fostering Community at the Graduate Level: One University's Student-led Approach

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Abstract

The purpose of this paper is to identify the needs of engineering graduate women at Penn State and propose a student-led approach to increase their sense of community and belonging. As recent reports indicate, women's enrollment in engineering graduate programs increased by only 4 percent from 2014 to 2019. To increase retention, departments and universities often rely on a professional development driven approach to establish community. While useful, these efforts are misdirected because literature shows that women's isolation and lack of sense of community, rather than lack of career preparedness, contribute to attrition from graduate programs. To best eradicate this isolation and lack of belonging among graduate women in engineering, we took a user-centered approach. Community-led, stakeholder-centric, participatory research is a stakeholder-owned means by which to elicit community member needs. This process translates into strategies that are developed by community members themselves to address those needs. The authors of this paper developed a pilot survey distributed to all graduate students in the College of Engineering to gauge need for community and student interest in creating a Graduate Women in Engineering (GradWIE) group. Results from the survey indicated that students lacked community and had an overwhelming desire to be involved in a graduate women in engineering group. As such, we felt compelled to form an official student organization for the engineering community, GradWIE. GradWIE welcomes people of all gender identities to support the personal and professional well-being of graduate students through peer support, the creation of safe spaces, social events, and diverse resources. In its first year, the organization has sponsored several community-building events, reaching over 150 students across all departments in the college. Through this work, GradWIE seeks to continue supporting graduate students by involving them directly in group and event development, providing a potential example for other universities.

Introduction

We formed the student organization "Graduate Women in Engineering (GradWIE)" at Penn State in 2022 as graduate students in the College of Engineering. GradWIE welcomes people of all gender identities to support the personal and professional wellbeing of graduate students through peer support, the creation of safe spaces, social events, and diverse resources. We chose to focus on women because they are a minority within the College of Engineering at Penn State, as reflected in the enrollment numbers of women from 2017 to 2021 seen in **Table 1**.

Prior to the formation of GradWIE, we developed and distributed a pilot survey to all graduate students in the College of Engineering to gauge (1) the need for community and (2) student interest in creating a group for women who are graduate students in the engineering field. Our process of assessing community needs prior to organizing within the community could potentially benefit the thousands of university student organizations in the United States. Students' valuable time and energy during very challenging years at university [1] could be directed towards creating more effective, meaningful outcomes of their extracurricular activities. Such experience may enhance professional appeal. Student organizations, especially those intended to support underrepresented groups, might also find it beneficial to intermittently check whether they are meeting their community's needs. Lastly, assessing community needs may

determine whether students are experiencing a sense of isolation and lack of belonging. Student organizations are a primary means by which university students create social capital and find support [2]. By embracing the community survey – a user-centered approach – student organizations deliver greater value to not only student members but to their universities.

Table 1: Enrollment numbers for women in the College of Engineering at Penn State University Park

Year	Women	All	%
2017	292	1370	21.3
2018	289	1394	20.7
2019	336	1514	22.2
2020	337	1523	22.1
2021	410	1692	24.2

Literature Review

Addressing gender inequality is key to sustainable development, a priority for engineering disciplines. The amount of evidence that connects gender inequality with economic, social, and environmental sustainability of society is surmounting [3]. However, gender inequality is not simply an aspect of sustainable development to be studied in the engineering classroom; it is influencing who studies in these classrooms to begin with. The percentage of undergraduate engineering degrees awarded to women in the United States has consistently remained around 20% since 2000 [4]. Interestingly, graduate engineering students from minoritized groups leave doctoral programs without their intended degrees at higher rates than their peers [4]. As recent reports indicate, women's enrollment in engineering graduate programs increased by only 4 percent from 2014 to 2019 [5]. From observation at Penn State, department-level efforts to improve the well-being of graduate students and limit attrition often rely on professional development or lecture-based approaches to establish community. While these efforts can be useful, literature shows that feelings of isolation and a lack of sense of community, rather than a lack of career preparedness, contribute to attrition from graduate programs [6].

Instructors have effectively increased student retention in engineering fields by encouraging self-efficacy and belonging as a part of their practice [7]. This is not surprising, since it is in these areas that literature shows engineering students experience a deficit. One study indicated that senior graduate students and postdoctoral researchers experience imposter phenomenon and struggle with maintaining positive self-perceptions of their productivity, capabilities, and success compared to faculty [8]. This same study also found that graduate students, particularly those who identify as underrepresented, are least likely to feel a sense of belonging [8].

Low sense of belonging has also been shown to predict disengagement, poor academic performance, and dropping out of school among first-year STEM students in undergraduate programs [9]. While sense of belonging is important for student retention at all stages of their academic journey, having an engineering identity or seeing oneself as an engineer also greatly influence student retention. In chemical engineering, women tend to show a high sense of

belonging in the discipline, however, the engineering identity of women compared to men is still low [10]. Community-oriented approaches have shown success in contributing to factors that aid in student retention. One study found that meetings with faculty, peer support groups, and leadership opportunities resulted in higher academic performance and enhanced retention of underrepresented students in electrical and computer engineering departments [11]. A university engineering program facilitated engagement activities, systematic meetings, and dedication of physical space (a "third space" [12]), which made women engineering students feel more connected to faculty and other female peers and enhanced their identity development [13]. The authors report that the activities, meetings, and spaces enable students to feel a sense of community both inside and outside of the classroom. They found that "students believed that the program has helped them to feel more like an engineer by enabling them to work on and build an interest in real-life engineering issues, be recognized by their faculty and female peers, and feel a sense of competence and belonging within their department and college [13]." Another study found that engineering identity has potential as an interpersonal factor which can help sustain students through unconscionable and demoralizing experiences [4]. A study of an entire graduate academic community at an R1 STEM department shows that communicating about science with peers, talking about teaching hurdles, and engaging in mentoring relationships contribute heavily to a sense of belonging [8]. Fostering community and creating channels for communication with graduate students and their peers and faculty members could provide these opportunities to circulate information about career opportunities, attract job recruiters, and lead to perceived academic success.

To assess community needs, this study uses community-led, stakeholder-centric, participatory research. Community-led, stakeholder-centric, participatory research is a stakeholder-owned means by which to elicit community member needs. Participatory research has been conducted and examined in contexts of COVID-19, climate adaptation, neurodivergence, and many other areas of research [14] - [16]. This approach translates into strategies that are developed by community members themselves to address those needs. Authors of the book *Participatory Research for Health and Social Well-Being* state that participatory means involving people whose lives are at the center of research in making key decisions of any research project, including decisions pertaining to the (1) focus of the research, (2) research questions, (3) method of answering questions, (4) information to collect, (5) method of making sense of the information, (6) how to share it, (7) and what actions to take [17]. Through this community-led, stakeholder-centric, participatory research conducted by and for graduate student members of GradWIE with College of Engineering support, we have gained clarity as to what measures might increase sense of belonging, self-efficacy, and connection in our specific community. We act upon this knowledge to design our community with our stakeholders in mind in an effort to aid in the retention of graduate women in engineering.

Research Questions

This work sought to answer three main research questions (RQs):

RQ1: Are students at Penn State lacking community? We hypothesized that students, particularly women students, would identify themselves as not having the level of community that would make them feel welcome in an engineering program. Women tend to feel isolated in

male-dominated academic fields [8], and we wanted to understand whether this is valid in our engineering community.

RQ2: Do students think that the College of Engineering needs a Graduate Women in Engineering organization? We hypothesized that students would show a desire for a graduate women in engineering group if they lacked a sense of belonging, engineering identity, or social connectedness, which are commonly observed in literature [8].

RQ3: What types of unmet needs in the form of events do students want to attend with a Graduate Women in Engineering organization? The goal of this survey was to determine if there existed a need for a graduate woman in engineering group, and also to gather information about what types of unmet needs students have by determining the types of events participants were looking to attend.

Purpose and Methods

The driving purpose for this work was to determine the unmet needs of graduate students, with a focus on women-identifying students, and use that information to shape a new student group aimed at better supporting these graduate students. Participants first received an email with a brief description of the purpose and procedure of the survey before accessing it. Upon opening the survey, participants were taken to a consent form and implied consent was received as per Institutional Review Board (IRB) protocol based on their decision to continue and finish the survey. Once the survey was completed, content analysis and descriptive statistics were used to help shape the structure of the GradWIE organization.

Survey Design

The aim of this survey was to assess the perceptions of engineering graduate students towards forming a Graduate Women in Engineering group. Specifically, the survey was meant to assess whether students perceived a need for a Graduate Women in Engineering (GradWIE) group and what functions that group should serve. The survey included demographic questions related to academic discipline, number of years in their degree program, degree type (PhD, master's, or graduate certificate), and involvement in other on-campus activities. It also included specific questions about a Graduate Women in Engineering group and thoughts on community within the engineering school. A 5-point Likert scale ranging from not very likely to very likely was used to determine student likelihood to attend various types of events. The categories used in this survey were social events, career development events, networking events, outreach events, general information events, and stress relief events. Social events were events intending to build community in a casual way such as hiking or paintball. Career development events were defined as events that contribute to career success such as resume or job fair preparation. Networking events were defined as events that allow students to get to know other graduate students, professors, or alumni. Outreach events were defined as activities that allow students to give back to the community, such as local volunteering or STEM initiatives for younger students. Stress relief events were defined as those intending to increase the mental well-being of students, such as yoga or painting. And finally, general information events were defined as anything outside of the defined categories such as financial planning or other specialty topics.

We also asked open-ended questions about what students would hope to gain from participating in a GradWIE group, what types of resources or graduate school information they wish they knew when they started their degree, and if there was anything else they wanted to share. The complete survey can be found in the Appendix.

Participants

This survey was sent to a pre-existing listserv of all graduate students within the College of Engineering and to College of Engineering student organizations whose members primarily consist of graduate students. The survey was available to all graduate students in the College of Engineering, regardless of the gender they identified with, and remained open for responses for one month. Participation in this survey required students to be at least 18 years of age, fluent in English, and actively enrolled in a graduate program at Penn State. Only the responses of participants who fully completed the survey were included in this study. 74 people opened the survey link and 49 completed it, resulting in N=49 participant responses. The average time enrolled in graduate school for participants was 1.78 years with experience levels ranging from 0.25 years to 4 years in graduate school. A summary of the respondent demographics can be seen in **Table 2**.

Table 2: Demographic Summary of Respondents

Total Responses	49
Master's Students	7
PhD Students	42

Results

We answer each research question separately in this section.

RQ1: Are graduate students at this university lacking community? We hypothesized that engineering students, particularly women students, would identify themselves as not having the level of community that would make them feel welcome in an engineering program because literature indicates that underrepresented minorities tend to lack a sense of belonging in engineering [8]. For this question, the response options were "yes", "no", and "it's complicated" with an additional open-ended answer box for people to explain why they selected this. 51% of respondents said yes, they felt like they were lacking community. 24.5% selected "it's complicated". Those who explained why they selected "it's complicated" explained the difficulty of meeting people outside of their lab environment and specific discipline, with 5 of 12 people citing these types of reasons. For example, one participant said, "I know that there are other women in engineering on campus, but they are hard to find in my classes/research group." Another respondent said, "I have a group of engineering women friends but would like more outside my discipline." Other answers focused on broader issues they were feeling such as "I'm both female and an ethnic minority in the field, so I feel out of place the majority of the time."

RQ2: Do students think that the College of Engineering needs a Graduate Women in Engineering organization? We hypothesized that students would show a desire for a graduate women in engineering group to address any unmet needs [8]. Of the 49 responses, 47 (96%)

indicated that they did believe the College of Engineering would benefit from a Graduate Women in Engineering group. Additionally, when asked how a Graduate Women in Engineering group would benefit them personally, 35 people responded and 54% had answers including the word or parts of the word "friend," "connection," "support" or "community." The two participants who did not indicate that this group would be beneficial explained that it was not that they did not see the need for the group, but more that they felt the addition of the group would not serve them personally. They responded with "As a guy, I don't think this is for me. I would be down to participate if welcomed but I think it's more to help the relatively few women in the grad program feel [they] have more community and support" and "I don't live on campus so a remote group that is active would be great."

RQ3: What types of unmet needs in the form of events do students want to attend with a Graduate Women in Engineering Group? We hypothesized that students interested in a graduate women in engineering group would be the most interested in social events to combat the isolation and lack of community we expected to see based on the literature [8]. Based on the responses, outreach events, social events, and stress-relief events had the highest percentages of people responding either "likely" or "very likely" to attend, with all three answers having over 65% in those two response categories combined. **Figure 1** shows the full breakdown of responses for each type of event.

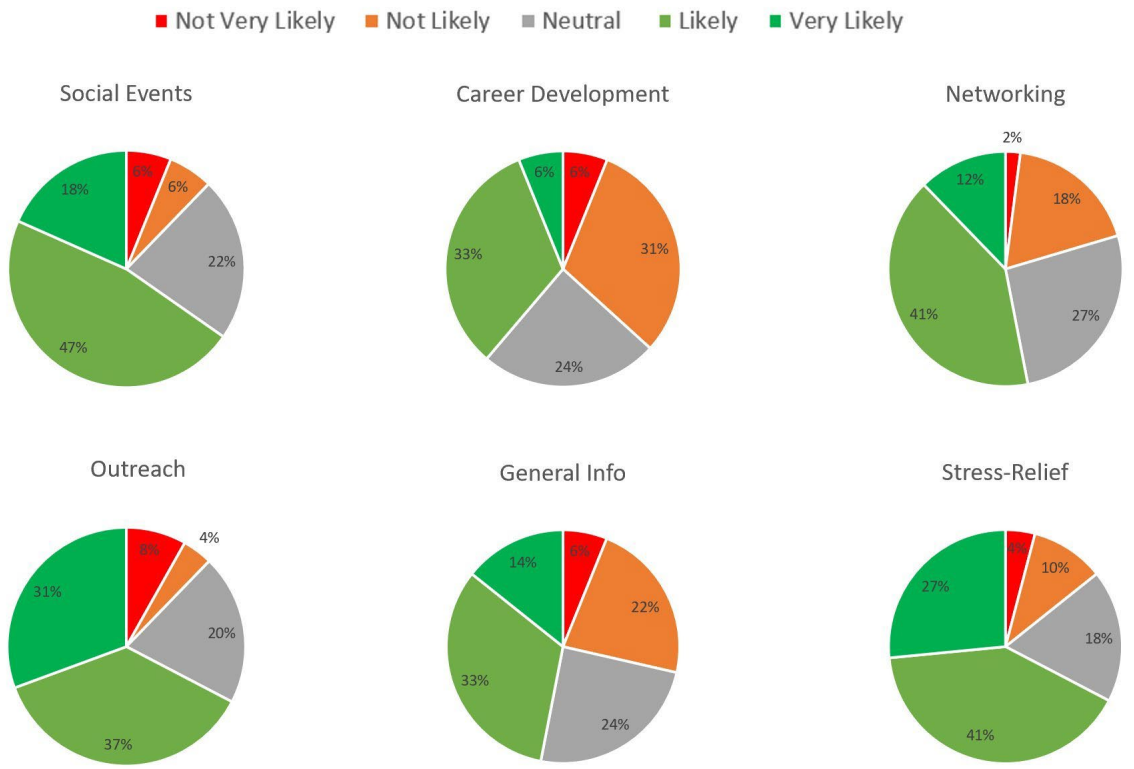

Figure 1. Breakdown of prospective attendance by event type.

Discussion

It was clear from the survey results that graduate students felt like they needed a stronger community in the engineering program, which was not surprising given that graduate students traditionally struggle with identity and belonging in graduate school [8]. The main driver behind the development of GradWIE from these results is to explore and highlight the engineering experience through a lens focused on gender to help combat increased feelings of isolation [8]. With this survey, we were encouraged to officially establish the Graduate Women in Engineering organization. As to not discriminate against anyone looking for community, we created GradWIE to be a space that welcomes people of all gender identities to support the personal and professional well-being of graduate students through peer support, the creation of safe spaces, social events, diverse resources, and professional development.

How survey results have shaped the group thus far

We decided the best method for creating this type of group was to go through the process of becoming an official organization at Penn State. The main benefit of this method is that the group would be eligible for seed funding from Student Affairs. Before becoming an official group, Penn State's Center for Engineering Outreach and Inclusion (CEOI) provided 100% of the funding for events. While some of the GradWIE events funding is still allocated from CEOI, it is useful for the group to be able to acquire its own funding through fundraising or company sponsorships. Additionally, official recognition from the school allows GradWIE to volunteer at school events such as basketball games to acquire further funding.

Another benefit of creating a student organization is the associated leadership and service positions available to its members. The leadership structure of GradWIE includes a president who presides over all meetings and is the spokesperson for the organization. The vice president serves as president when the president is unable to do so and attends diversity discussions for the College of Engineering and the Center for Engineering Outreach and Inclusion. The treasurer handles all finances for the organization. The secretary records meeting minutes, manages the listserv, and manages communications with the members. The web team coordinator maintains the organization's online presence including the website, Instagram, and Microsoft Teams page. The public relations coordinator creates event advertising posters and communicates GradWIE events and activities to the public. The events coordinator plans and executes social, wellness, and other events. The outreach coordinator plans and executes outreach events. Finally, the fundraising coordinator plans and executes fundraising events. We also have an academic advisor who helps organize meetings, reserve spaces for events, and secure resources and funding when needed.

For GradWIE membership, any student officially enrolled at Penn State may become an official voting member by attending any 3 hosted events. To run for an officer position, a student must be a member of the organization. To promote connectedness within the university, any person associated with the university who is interested in furthering the purpose of GradWIE, including but not limited to faculty, staff, and community members, shall be considered associate members.

Since its inception, GradWIE has held a variety of events, see **Figure 2**, including financial literacy workshops, hiking trips, workshops at the university makerspace, mug painting,

coloring, vision board making, volunteering at STEM outreach events, indoor rock climbing, and career talks by engineering PhD-holders outside of academia. The most popular events to date have been makerspace workshops, events where students get to spend a few hours in the makerspace to learn new skills and build something they can take home with them, and the student-faculty mixer, an informal coffee event where graduates students and faculty could casually mingle and network.

Figure 2: (left) GradWIE members participating in a makerspace workshop; (right) GradWIE members participating in vision boarding.

Measuring Success and Future Plans

Thus far, the main metrics for measuring success are event attendance. What we have seen to date is that the average event attendance for GradWIE events held before the organization was officially established was 10 people. Since the organization became official, average attendance increased to 16 people, over a 50% increase. As the world continues to move fully out of COVID restrictions, we expect this number to continue to increase. Additionally, as of January 2023, we have over 170 people voluntarily subscribed to our listserv meaning that they have opted into receiving updates and news about our events and opportunities. We plan to continue to measure event attendance and observe ways that we can increase it.

In the future, we would like to do a follow-up survey asking how people learned about GradWIE and if they find it helpful. We also want to ask again if people are lacking community in the College of Engineering at the graduate level, as we hope the answer will show a reduction in overall student isolation. Future work might entail research into measures that have been known to drive women's interest in engineering and retention of women in engineering fields. Such measures may include creating environments which encourage women to exercise their interests in engineering tasks that address societal challenges. Studies have shown that women earn larger portions of undergraduate degrees in programs which prepare them for careers that will benefit society [18]. GradWIE may seek to facilitate such environments and measure correlation with retention.

While the initial successes of GradWIE have been promising, time is needed to establish the longevity of the group. The user-centered approach of checking in with the community and continuing to shape the group around their identified needs has proven successful with our group, and we believe that the creation of a GradWIE at other universities could help combat the

loneliness and isolation associated with graduate school. We plan to make this paper with our methodology of group creation available to other universities through our website https://sites.psu.edu/gradwie/.

Limitations

There are a few limitations for this study that need to be acknowledged. First, there is potential for self-selection bias within the respondents to the survey. Since it was sent out to multiple listservs and people chose to respond, there is a likelihood that the people who chose to fill out the survey are those more likely to attend events and want a GradWIE group, resulting in skewed results. Additionally, after filtering out incomplete answers, we were left with 49 responses, which was much lower than the number of graduate students, women or otherwise, enrolled in the College. In future work, sending the survey out to more lists and targeting a larger sample size would help overcome these limitations.

We did not request information regarding race/ethnicity as a part of this study, therefore, we did not gain insights specific to the experiences of racially minoritized women in engineering. However, we acknowledge that intersectional considerations must be made when addressing retention in engineering academics. One study suggests that engineering identity development alone does not contribute to the retention of Black women in the workplace but that the confluence of race, gender, and role identity aids in the development of a resilient engineering identity [15]. Studies have also found many differences in social capital among ethno-racial groups and relatively few differences in social capital between men and women [19]. Thus, factors affecting women belonging to certain ethno-racial groups are essential to women engineering students' persistence and retention. Engineering departments, and institutions at large, should take responsibility for generating a sense of belonging for women of color by providing social and structural supports that increase self-efficacy, address social pain, and improve retention [20]. This can partially be achieved by supporting student-led communities, such as GradWIE, which form to support underrepresented students in engineering and will seek to do so in future work. In the future, we want to account more for intersectionality when looking for student viewpoints and see how we can better serve the community in making GradWIE diverse and useful for all students.

Conclusion

This paper identifies the needs of graduate women in engineering at Penn State, and discusses the formation of a student organization, GradWIE, to address those needs. To these ends, a pilot survey was designed by a group of engineering graduate students to primarily gauge the need for community and student interest in creating a group for women who are graduate students in the engineering field. Results from the survey showed that graduate students felt like they needed a stronger community in the College of Engineering and that they desired a graduate women in engineering group. Our methods of (a) leveraging a user-centric, stakeholder-led approach and (b) assessing community needs prior to community organization could benefit student organizations and universities alike. GradWIE has held various social, skill-building, professional development, outreach, and well-being related events since its formation. Such efforts have coincided with a calculated increase in attendance and subscription to GradWIE communications. Moving forward, a follow-up survey may be used to assess the progress of GradWIE's efforts, specifically investigating whether a sense of community is still lacking in the

College of Engineering. Additional research may determine applicable methods GradWIE might use to aid in community creation and the College of Engineering's retention of graduate women. This work serves as an addition to the body of literature which informs engineering education systems' fostering of inclusive and equitable programming.

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Appendix

Survey

Q1 How many years have you been in your graduate program?

Q2 What year do you intend to graduate?

Q3 What department are you in?

Q4 What is your intended degree?

- ○ MS (1)
- ○ MEng (2)
- ○ PhD (3)
- ○ Graduate Certificate (4)

Q5 Do you have a research advisor yet?

- ○ Yes (1)
- ○ No (2)

Q6 Are you involved in any other organizations on campus? If so, which ones?

Q7 Do you think the College of Engineering needs a Graduate Women in Engineering group?

- ○ Yes (1)
- ○ No (2)

Q8 Do you feel like you are lacking a community in the College of Engineering?

- ○ Yes (1)
- ○ No (2)
- ○ It's complicated (please elaborate) (3)

Q9 How likely are you to attend the following event types?

	Not very likely (1)	Not likely (2)	Neutral (3)	Likely (4)	Very likely (5)
Social Events (hiking, paintball) (1)	○	○	○	○	○
Career Development (resume, job fair prep) (2)	○	○	○	○	○
Networking (other grad students, alumni, professors) (3)	○	○	○	○	○
Outreach (local volunteering, STEM for younger students) (4)	○	○	○	○	○
Stress-Relief (yoga, painting) (5)	○	○	○	○	○
Information Sessions (financial planning, specialty topics, (6)	○	○	○	○	○

Q10 What would you hope to gain from participating in Graduate Women in Engineering events? (e.g., community, friends, new knowledge, relaxation)

Q11 I wish I knew more about:

- [ ] Having a mentor (1)
- [ ] Being a mentor (2)
- [ ] Extracurriculars in grad school (3)
- [ ] Financial planning/budgeting (4)
- [ ] Establishing work-life balance (5)
- [ ] How to find/establish a community (6)
- [ ] Career planning and career paths (7)
- [ ] Grant writing and publishing processes (8)
- [ ] Where to find mental health support (9)
- [ ] Where to find academic support (10)
- [ ] Volunteer and outreach opportunities (11)
- [ ] Goal setting (12)
- [ ] How to advocate for myself (13)
- [ ] Other: (14) _____

Q12 What would excite you (if anything) about joining a Graduate Women in Engineering group?

Q13 How do you think a Graduate Women in Engineering group would benefit you personally?

Q14 Is there anything else you wish to share with us?