Aligning Student Interest with Program Design in Engineering Education

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1. Introduction and Background

While women are making gains in some STEM fields, they continue to lag behind in engineering, where only 16% of engineers in the college-educated STEM workforce are women. In comparison, 61% of social scientists are women [1]. For women who chose to pursue an engineering degree, it can be a highly rewarding but also challenging path, making women more likely than men to switch out of STEM fields [2]. Barriers that contribute to low retention rates among women in engineering include low academic self-confidence, feelings of isolation, a lack of role models (established women engineers and faculty), an unwelcoming or "chilly" academic climate, demotivating instructional approaches, and male-centered academic situations [3][4][5][6][7][8]. Addressing these challenges requires institutions to create programming that fosters belonging, strengthens engineering identity, and equips women with the resources they need to achieve academic success.

Sense of belonging has a profound impact on academic achievement and retention, particularly for students from underrepresented groups [9][10]. Strong connections, fostered through academic, social, and extracurricular experiences, have been shown to improve both retention and graduation rates. These activities offer students opportunities to build networks of faculty, peers, and advisors, which are essential to students' persistence and academic success [11][12]. For women in STEM, proactive initiatives, programs, seminars, and workshops have been shown to integrate women into their academic departments more effectively [13] and help them navigate the challenges of higher education. By fostering a sense of belonging and a strong social network, these experiences not only provide academic benefits but also boost students' confidence and motivation [14][15]. In addition, high-impact practices, such as mentorship programs, undergraduate research, and academic support, have been proven to boost retention and success for marginalized groups in STEM [16][17].

While there are many types of programs and supports that foster the success and retention of women engineering students, there are often real-world constraints like budgets, staff capacity, and institutional factors that limit the type and amount of programming that can be offered [17]. In addition, students often have limited time and competing priorities [18]—making them highly selective in what programs and events they choose to engage.

This evaluation aims to better understand women engineering students' preferences and interests, so those can be factored into programming decisions, by answering the following key questions:

1. **Programming Preferences**: What types of programs (such as research, academic tutoring, mentorship, etc.) are women engineering students most interested in participating in?
2. **Topics of Interest**: During events and workshops, what topics (such as study skills, leadership, technical skill building) are women engineering students most interested in learning about?
3. **Engagement Preferences**: Who do women engineering students most want to engage with during programs and events (such as industry representatives, faculty, or students)?

Recognizing that women are not a monolithic group, and their needs are shaped by intersecting identities such as socioeconomic background, first-generation status, and racial/ethnic identity [8][19][17] this evaluation also explored preferences and interests across subgroups of women, and how they differ from male and non-binary/other-gendered students. For the purposes of this study, first-generation students are defined as those for whom neither parent has completed a four-year college degree or higher. Underrepresented minority (URM) students are defined as students from racial and ethnic groups historically underrepresented in engineering, including Black or African American, Hispanic or Latino(a), American Indian, and Native Hawaiian or other Pacific Islander students. Key questions included:

- How do women's preferences differ by subgroup, including graduate and undergraduate, first- and continuing-generation, Pell-eligible (low-income) and non-Pell-eligible, and URM students?
- How do women's preferences compare to those of male and non-binary students?

2. Methodology

This evaluation used survey data collected at a large R1 university during March and April of 2024. The survey was distributed by the IDEA Engineering Student Center via email to all undergraduate and graduate engineering students at the university as part of a broad "Listening Campaign." The campaign aimed to gather feedback on the current climate, general student experiences in engineering, and resources with which students were most interested in engaging. Additionally, demographic data was collected to enable disaggregation of responses across student populations. The survey was administered using Qualtrics, and as an incentive to participate, respondents were entered into a gift card raffle.

The survey was specifically designed to address current institutional needs and included a combination of demographic, quantitative, and qualitative questions. The portion of the survey used in this evaluation focused on three 5-point Likert scale questions, where responses ranged from 1 = Not at all interested to 5 = Extremely interested. Specific questions included:

1. **Program Participation**: "Which of the following types of programs or events are you most interested in participating in?"
2. **Topics of Interest**: "Which of the following topics are you most interested in learning more about at workshops, events, or ongoing programs?"
3. **Engagement Preferences**: "To what extent are you interested in hearing from or connecting with the following groups during workshops, events, or programs?"

After the survey closed, responses were cleaned to ensure data quality. Surveys completed in under 90 seconds ("speed clickers"), unsubmitted surveys, and those with largely missing responses were excluded. Survey data used in this analysis includes participants from a broad range of engineering major and departments (Structural, Electrical and Computer, Bioengineering, Chemical and Nanoengineering, Computer Science and Engineering, and Mechanical and Aerospace) who identify as follows:

	Women	Men	Non-binary	Other/Prefer to self-describe	Prefer not to say
Responses:	380	577	10	5	36

Figure 1. Gender identity of survey respondents.

After cleaning the data, descriptive statistics, including means, were calculated to summarize overall trends in programming, topic, and engagement preferences. Likert-scale responses were analyzed, and t-tests were conducted to identify significant differences across subgroups (e.g., first-generation vs. continuing-generation) and between genders. Responses were disaggregated by key demographic factors, including educational level, socioeconomic status, and racial/ethnic representation, to better understand the diverse needs of women engineering students.

3. Results

This evaluation identified trends in the engagement preferences of women engineering students, focusing on preferred program types, topics of interest, and speaker preferences. Findings for each of these are presented in three main areas: (1) overall trends, (2) subgroup differences among women, and (3) gender comparisons between women and men. These results highlight actionable insights for institutions seeking to develop evidence-based programming that meets the varied needs of women in engineering.

3.1 Women's Programming Preferences

This section discusses women engineering students overall programming preferences focusing on the types of activities they value the most. In response to the question "*Which of the following types of programs or events are you most interested in participating in?"* women engineering students expressed a clear preference for participating in programs related to Technical Training (M=4.07) and Professional Development (M=3.96) and were the least interested in participating in Academic (M=3.16) and Social (M=3.22) programs.

				Women Engineering Students' Mean Responses by Sub-Group							
Which of the following types of programs or events are you most interested in participating in?	**All Women N=380**	**Men N=577**	**Non-Binary/Other N=15**	**Undergraduate n=235**	**Graduate n=108**	**Pell-Eligible n=90**	**Non-Pell-Eligible n=174**	**URM n=68**	**Non-URM n=312**	**First-Generation n=108**	**Continuing Generation n=253**
Technical Training that focuses on building specific programming or practical engineering skills	4.06	3.84	3.67	4.13	3.84	4.17	4.02	4.26	4.01	4.26	3.97
Professional Development events or that engage both students and industry	3.96	3.87	3.67	3.95	3.88	3.90	3.91	4.06	3.90	3.94	3.91
Research programs that facilitate learning about and engaging with research	3.84	3.67	3.73	3.82	3.83	3.74	3.88	3.87	3.83	3.90	3.80
Mentorship programs that foster connections and provide guidance	3.59	3.43	3.47	3.54	3.58	3.63	3.49	3.62	3.55	3.80	3.48
Workshops that provide information about relevant topics	3.58	3.44	3.27	3.48	3.74	3.46	3.57	3.63	3.55	3.56	3.56
Social programs that are fun and promote engaging with other students	3.22	3.23	3.00	3.16	3.34	3.22	3.22	3.41	3.19	3.13	3.26
Academic tutoring, formal study groups, or other academic supports for courses	3.16	2.95	2.93	3.27	2.78	3.51	2.96	3.75	2.99	3.58	2.95

Figure 2 Programing preferences by gender identity and subgroups of women.

Note: When disaggregating data, cases with missing responses or students who selected "unsure" or "prefer not to say" were excluded from subgroup analyses. For example, three women did not report their first-generation status, and an additional 16 women selected "unsure" or "prefer not to say." These cases were excluded from first-generation subgroup analyses, with all calculations based on the available data.

3.1.1 Women's Programming Preferences by Sub-Group

To better understand how different groups of women prioritize these program types, preferences were further examined across subgroups. The data from women respondents was disaggregated into the following categories:

- Educational Level (graduate and undergraduate)
- First-Generation Status (first- and continuing-generation)
- Racial/Ethnic Representation (URM and non-URM)
- Socioeconomic Status (Pell-eligible and non-Pell-eligible)

When comparing programming preferences differences emerged between graduate and undergraduate women students. Undergraduates (M=4.13) expressed significantly greater interest in Technical Training than graduate students (M=3.84), $t(370) = -2.35$, $p = 0.0190$, Cohen's $d = 0.296$. This suggests that undergraduate women, who may still be in the early stages of developing their technical skills, value skill-building opportunities while graduate students may already possess foundational technical skills. Academic programs were not highly rated for any group, however, undergraduates (M=3.27) indicated significantly more interest than graduate women (M=2.78). This result ($t(370) = -3.16$, $p = 0.00173$, Cohen's $d = 0.379$) is likely explained by engineering graduate students' focus on research instead of coursework. Graduate women (M=3.74) had a small but significantly greater interest in participating in Workshops than undergraduates (M=3.48), $t(370) = 2.11$, $p = 0.0355$, Cohen's $d = 0.237$.

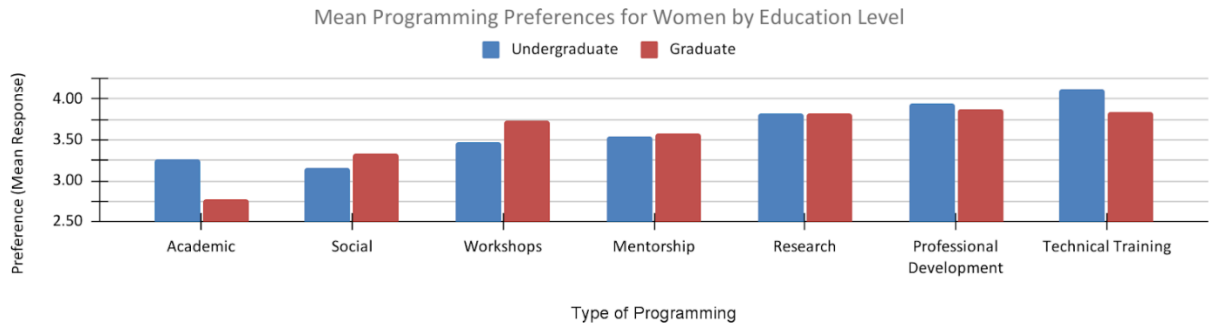

Figure 3. Program preferences among women by education level.

First-generation women engineering students showed significantly greater interest in Academic and Technical Training programs compared to their continuing-generation peers. Academic programs received the highest disparity, with first-generation students mean interest rated at 3.58 versus 2.95 for continuing-generation students ($t(352) = -4.41$, $p < 0.0001$, Cohen's $d = 0.490$). Similarly, Technical Training was highly rated, with first-generation students scoring it at 4.26 compared to 3.97 for their peers. These findings show the need for academic support and skill-building opportunities to help first-generation students navigate the challenges of engineering programs. Participating in Mentorship programs also received significantly higher interest

among first-generation students, possibly indicating a preference for structured guidance in unfamiliar academic and professional environments.

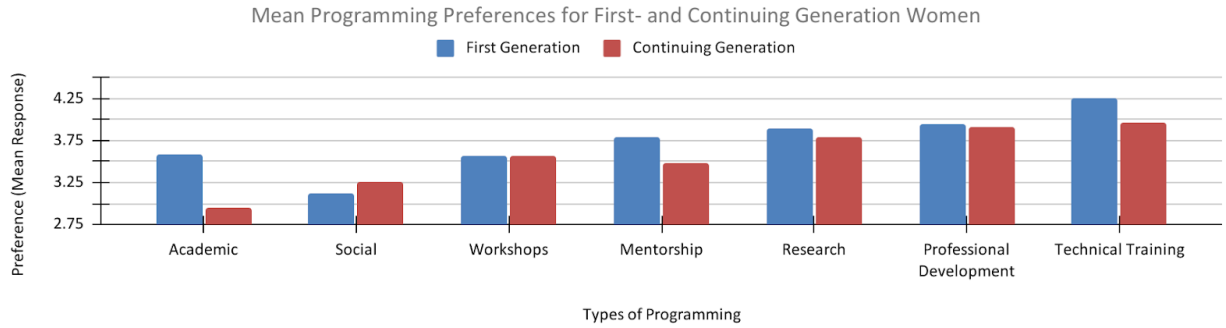

Figure 4. Program preferences among women by first-generation status.

Women from underrepresented racial/ethnic minority groups (URM) expressed the highest overall interest in all types of programming. Compared to their non-URM peers, women URM students had a particularly strong preferences for Academic programs (M=3.75 vs. 3.03) and Social programs (M=3.45 vs. 3.18). Pell-eligible (low-income) women also showed significantly greater interest in Academic programs (M=3.51) compared to non-Pell-eligible women (M=2.96), $t(257) = -3.27$, $p = 0.00117$, Cohen's $d = 0.419$. It is worth noting that first-generation, Pell-eligible, and URM women all expressed a stronger interest in participating in Academic programs than their peers, and important to consider this type of support when planning programming.

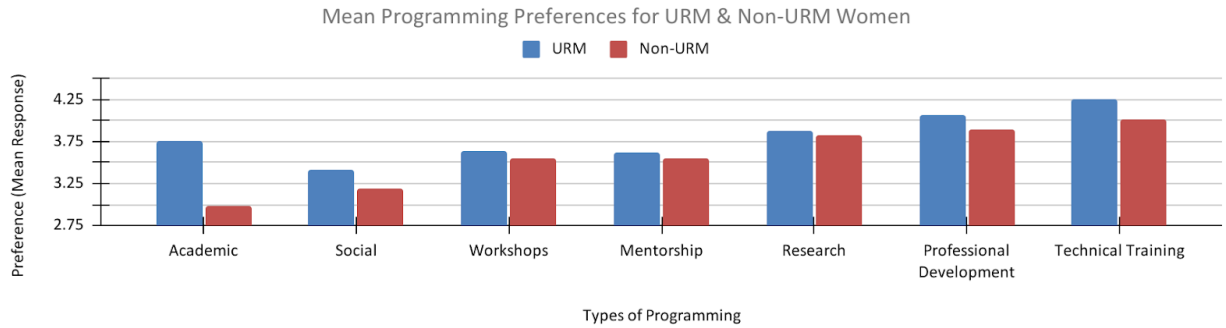

Figure 5. Program type preferences among women by racial/ethnic background.

3.2 Topics of Interest for Women

In addition to programming preferences, this evaluation examined women's interest in specific topics that might be covered at events and workshops asking survey respondents "*Which of the following topics are you most interested in learning about at workshops, events, or ongoing programs?*" Women engineering students expressed clear preferences and desire to learn about certain topics at workshops and events, with Connecting with Industry (M=4.07), Career Development (M=3.87), and Technical Skill Building (M=3.85) receiving the highest overall ratings. In contrast, lower-rated topics included Diversity and Inclusion (M=3.03) and Study Skills (M=2.98). While these means provide a broad overview, analyses revealed significant differences in interest levels based on subgroup.

				Women Engineering Students' Mean Responses by Sub-Group							
Which of the following topics are you most interested in learning more about at workshops, events, or ongoing programs?	**All Women N=380**	**Men N=577**	**Non-Binary/Other N=15**	**Undergraduate n=235**	**Graduate n=108**	**Pell-Eligible n=90**	**Non-Pell-Eligible n=174**	**URM n=68**	**Non-URM n=312**	**First-Generation n=108**	**Continuing Generation n=253**
Connecting with industry	4.07	3.97	3.80	4.16	4.01	4.22	4.10	4.03	4.13	4.21	4.07
Career development (Ex. resume writing, interviewing, networking, etc.)	3.87	3.71	3.13	3.89	3.83	3.86	3.84	3.96	3.85	3.99	3.80
Technical skill building (Ex. Intro to Python, AutoCAD, or SolidWorks)	3.85	3.67	3.20	3.90	3.72	4.01	3.82	4.16	3.80	4.13	3.75
Professional certifications (Ex. FE, PE, AWS, CISSP, PMP, CSM, etc.)	3.73	3.58	3.27	3.78	3.60	3.83	3.74	3.87	3.71	3.94	3.66
Research opportunities & general information about research	3.67	3.57	3.60	3.74	3.48	3.61	3.69	3.84	3.63	3.78	3.62
Innovation in engineering / engineering education (Ex. AI & machine learning)	3.53	3.55	3.20	3.49	3.63	3.51	3.49	3.75	3.49	3.63	3.50
Leadership and project management	3.37	3.33	2.93	3.31	3.52	3.28	3.32	3.69	3.30	3.40	3.35
Involvement opportunities (Ex. study abroad or student organizations)	3.33	3.14	3.07	3.32	3.29	3.27	3.33	3.47	3.29	3.38	3.30
Campus resource connections	3.32	3.24	3.20	3.41	3.09	3.42	3.31	3.69	3.24	3.59	3.19
Graduate school	3.27	3.13	3.27	3.43	2.85	3.34	3.25	3.26	3.27	3.28	3.24
Ethics and social responsibility	3.12	2.92	3.33	3.10	3.22	3.12	3.08	3.57	3.03	3.15	3.15
Personal wellness	3.09	3.05	2.93	2.98	3.41	3.24	2.88	3.59	2.98	3.29	3.00
Diversity and inclusion	3.03	2.77	3.20	2.93	3.30	3.07	2.96	3.51	2.94	3.13	3.02
Study skills	2.98	3.02	2.73	2.95	3.09	3.20	2.74	3.56	2.87	3.29	2.87

Figure 6. Topics of interest by gender identity and subgroups of women.

3.2.1 Topics of Interest for Women by Subgroup

Significant differences emerged between undergraduate and graduate women reflecting their differing stages in education and career preparation. Undergraduate women expressed stronger interest in learning about Graduate School, with a mean rating of 3.43 compared to 2.85 for graduate women ($t(364) = -3.40$, $p = 0.0008$, Cohen's $d = 0.415$). This moderate effect size highlights undergraduates' focus on future academic opportunities. Similarly, undergraduates rated Campus Resources slightly higher than graduate women ($M=3.41$ vs. $M=3.09$, $t(364) = -2.06$, $p = 0.0391$, Cohen's $d = 0.247$), suggesting they are more interested in learning about institutional supports to help navigate their undergraduate experience. In contrast, graduate women placed greater emphasis on topics related to Personal Wellness and Diversity and Inclusion.

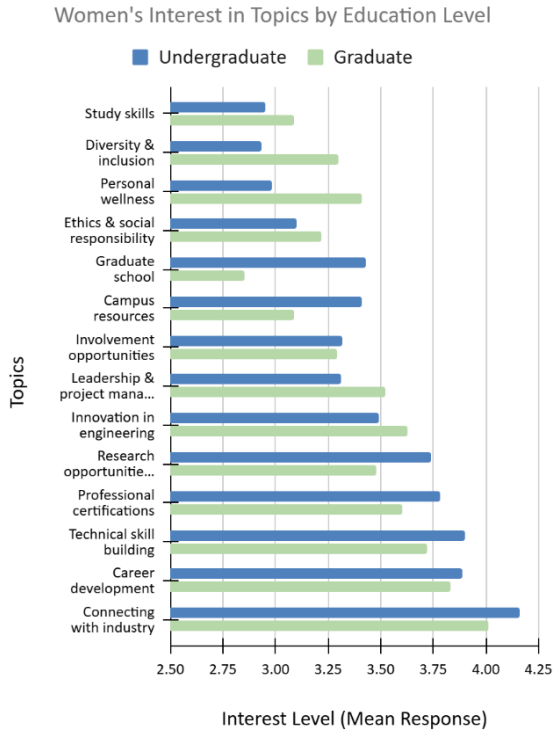

Figure 7. Topics of interest among women by education level.

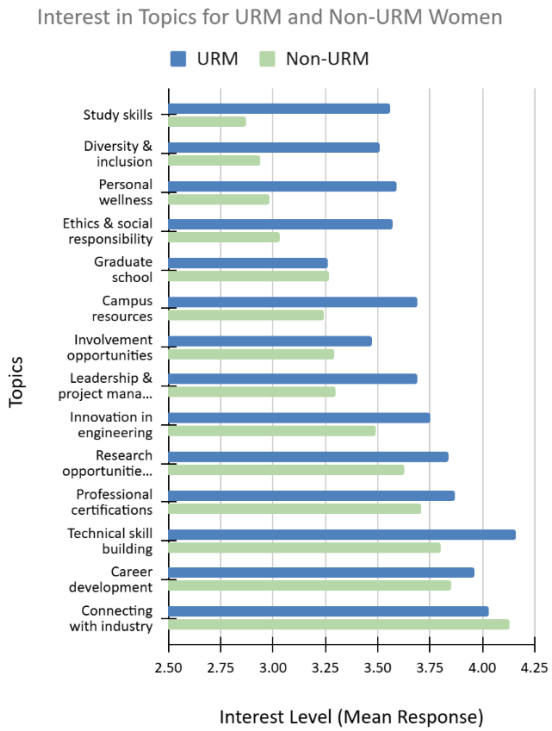

Figure 8. Topics of interest among women by racial/ethnic background.

Women from underrepresented racial/ethnic groups rated all topics higher overall than their non-URM peers. The consistently higher ratings across topics suggest a broader desire among URM women to engage with institutional resources. In particular, differences were observed for Diversity and Inclusion (M=3.52 vs. M=2.93), Personal Wellness (M=3.58 vs. M=2.99), and Research Opportunities (M=3.83 vs. M=3.63). These higher ratings suggest that URM women may seek programming that promotes equity, provides emotional and mental health support, and creates access to research opportunities that advance their academic and professional trajectories.

First-generation women engineering students expressed consistently greater interest in academic and professional skill-building topics compared to their continuing-generation peers. The largest difference was observed in Technical Skill Building, with first-generation students rating their interest significantly higher (M=4.13 vs. M=3.75, Cohen's d = 0.365). This finding indicates first-generation students place value on acquiring the technical competencies needed for success in engineering. Similarly, first-generation students reported significantly greater interest in learning about Study Skills, Campus Resources, and Professional Certifications, suggesting a clear preference for structured academic support and career-related opportunities.

Pell-eligible (low-income) women engineering students showed more interest than their more resourced peers in learning about topics that support their academic success and well-being. For example, they rated Study Skills significantly higher (M=3.20 vs. M=2.74, Cohen's d = 0.356) as well as Personal Wellness higher (M=3.24 vs. M=2.88, Cohen's d = 0.269).

3.3 Women's Speaker and Engagement Preferences

The type of speakers and engagement opportunities at events can shape how engineering students connect with and benefit from programming, and popular speakers often drive attendance at events. When asked *"To what extent are you interested in hearing from or connecting with the following groups during workshops, events, or programs?*", women engineering students placed a high value on real-world insights and networking opportunities, rating Industry Representatives as the most preferred speakers (M=4.15). This was followed by Engineering Faculty (M=3.84). In contrast, university staff, including both the Engineering Student Center Staff (M=3.14) and Staff from Campus Groups (M=2.87) were the least preferred options.

				Women Engineering Students' Mean Responses by Sub-Group							
To what extent are you interested in hearing from or connecting with the following groups during workshops, events, or programs?	**All Women N=380**	**Men N=577**	**Non-Binary/Other N=15**	**Undergraduate n=235**	**Graduate n=108**	**Pell-Eligible n=90**	**Non-Pell-Eligible n=174**	**URM n=68**	**Non-URM n=312**	**First-Generation n=108**	**Continuing Generation n=253**
Industry representatives (Ex. working engineers or recruiters)	4.15	4.03	3.73	4.15	4.15	4.08	4.19	4.13	4.15	4.21	4.13
Engineering faculty	3.84	3.77	3.40	3.85	3.81	3.85	3.79	3.94	3.82	3.93	3.79
Outside speakers	3.49	3.37	3.13	3.45	3.58	3.50	3.49	3.59	3.49	3.59	3.45
Other engineering students	3.46	3.29	3.00	3.42	3.55	3.56	3.37	3.69	3.39	3.65	3.35
Graduate students	3.44	3.42	3.20	3.37	3.62	3.45	3.37	3.50	3.45	3.57	3.40
Engineering Student Center staff	3.14	3.08	2.73	3.09	3.28	3.19	3.01	3.29	3.13	3.37	3.07
Staff from other campus groups (Ex. Career Center or the library)	2.87	2.90	2.47	2.79	3.08	2.78	2.83	3.00	2.85	2.99	2.85

Figure 9. Speaker and engagement preferences by gender identity and subgroup of women.

3.3.1 Women's Speaker and Engagement Preferences by Subgroup

When comparing the speaker and engagement preferences by subgroup, graduate women showed slightly greater interest in engaging with certain groups compared to undergraduate women. For example, "Graduate Students" as a speaker and engagement option was rated higher by graduate women (M=3.62) than by undergraduates (M=3.37), $t(366) = 2.01$, $p = 0.0454$, Cohen's $d = 0.234$. Similarly, graduate women expressed more interest in engaging with Staff from Campus Groups, such as the career center or library (M=3.08 vs. M=2.78), $t(365) = 2.01$, $p = 0.0449$, Cohen's $d = 0.243$.

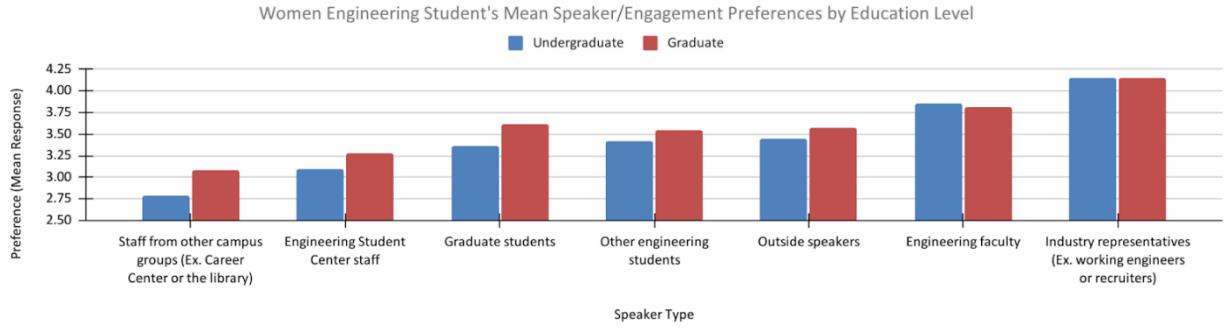

Figure 10. Speaker and engagement preferences among women by education level.

First-generation and URM women both placed significant value on engaging with peers, rating Other Engineering Students highly. First-generation students rated their interest in this group at 3.65 compared to 3.35 for continuing-generation peers, $t(350) = 2.16$, $p = 0.0156$, Cohen's $d = 0.285$. Similarly, URM women rated their interest in engaging with Other Engineering Students at 3.69 compared to 3.39 for non-URM women, $t(358) = 2.19$, $p = 0.0290$, Cohen's $d = 0.284$. This shared preference indicates the importance of peer connections for these groups in fostering a sense of belonging and support. In addition, first-generation women expressed significantly greater interest in engaging with Engineering Student Center Staff ($M=3.37$ vs. $M=3.07$, $t(348) = 2.14$, $p = 0.0327$).

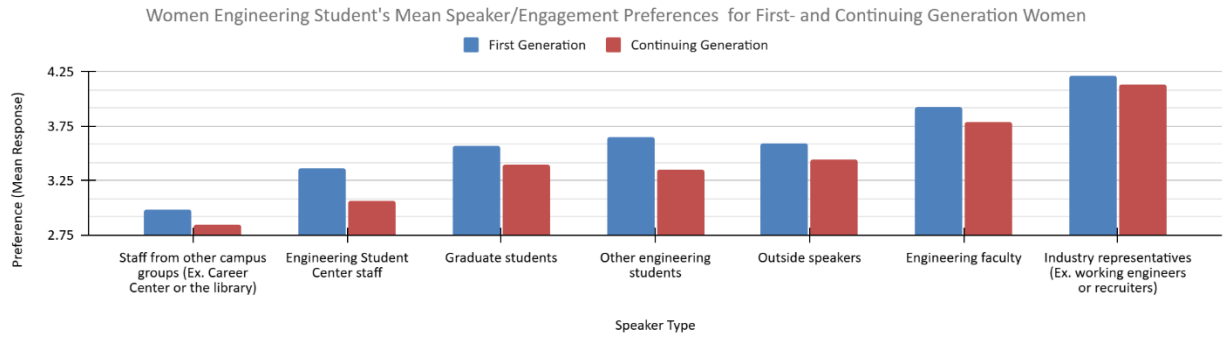

Figure 11. Speaker and engagement preferences among women by first-generation status.

No significant differences were observed in speaker or engagement preferences between Pell-eligible and non-Pell-eligible women.

3.4 Comparing Genders

This evaluation also explored differences in programming, topic, and speaker preferences between women and men engineering students to identify how gender may influence engagement priorities. While women and men shared many overlapping interests, women consistently demonstrated slightly higher interest in areas that align with academic support, professional growth, and values-based programming, such as diversity and ethics. These differences, though statistically significant, were small and less pronounced than the differences observed within subgroups of women.

3.4.1 Programming Preferences

Women expressed slightly greater interest in Technical Training ($M=4.05$ for women, $M=3.84$ for men, $p = 0.0022$, Cohen's $d = 0.200$) and Academic Programs ($M=3.13$ vs. 2.95, $p = 0.0417$, Cohen's $d = 0.137$) than men. These differences, though statistically significant, represent small effect sizes, suggesting that men and women share relatively similar programming priorities overall.

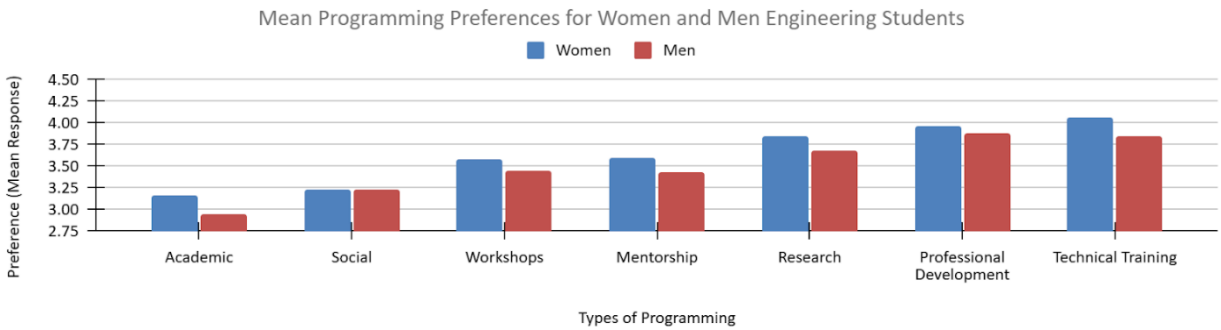

Figure 12. Programming preferences for women and men.

3.4.2 Topics of Interest

Women showed consistently higher interest in topics tied to diversity, ethics, and professional growth compared to men. The largest difference was for Diversity and Inclusion, with women rating their interest at 3.04 compared to 2.77 for men ($p = 0.0022$, Cohen's $d = 0.203$). Women also expressed greater interest in Ethics and Social Responsibility, Technical Skill Building, Career Development, and Connecting with Industry, although the effect sizes for these differences ranged from 0.138 to 0.167. These findings highlight women's slightly stronger emphasis on topics that integrate professional growth with values such as diversity and ethics.

3.4.3 Speaker and Engagement Preferences

Women and men's preferences for speakers and who they would like to engage with during programs and events were largely similar, with both groups prioritizing Industry Representatives and Engineering Faculty. However, one small but statistically significant difference emerged, women showed greater interest in connecting with Other Engineering Students ($M=3.46$ for women, $M=3.29$ for men), $t(938) = 2.27$, $p = 0.0238$, Cohen's $d = 0.151$. This small effect size suggests that women may place slightly more value on peer engagement as part of their learning and professional development experiences.

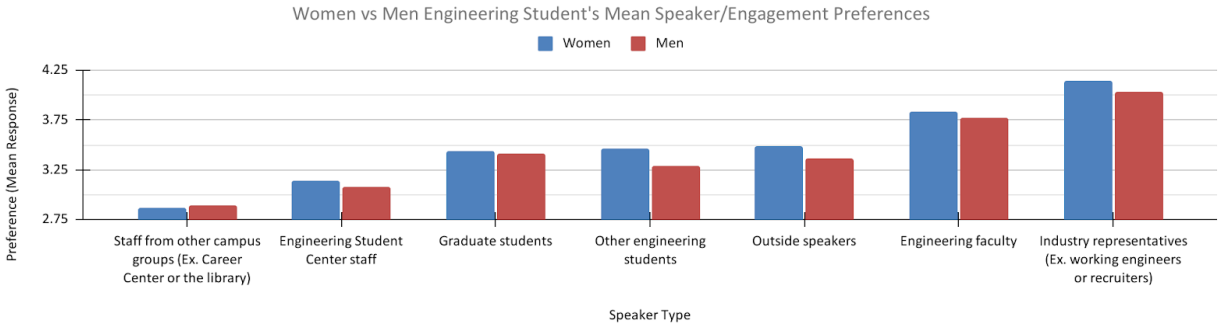

Figure 13. Speaker and engagement preferences for women and men.

3.4.4 Other Gender Groups

Due to the small sample size of non-binary and other-gendered respondents ($n = 15$), statistical analyses were not conducted for these groups. However, their mean preferences are included in summary tables to provide context.

4. Discussion and Conclusion

This evaluation explored the engagement preferences of women engineering students with the goal of providing real-world, actionable information for designing student programs that align with students' needs and preferences. By identifying types of programming women are most interested in—and would be most likely to attend—institutions can make best use of limited resources to offer the most needed and wanted programming. Findings revealed that women had the most interest in programming focused on technical training and professional development while expressing less interest in purely academic or social events. These preferences show the importance of offering programs that allows women to build skills and connections needed for academic success, professional development and engineering workforce readiness. Additionally, women's interest in learning about topics like career development, connecting with industry representatives, and technical skill-building reflects a desire for resources that prepare them for long-term success in their future careers as engineers.

The subgroup analyses explored variations in preferences based on intersecting identities. First-generation, Pell-eligible, and URM women showed consistently stronger interest in academic programs and mentorship opportunities than their peers. For example, first-generation women rated Academic Programs significantly higher than continuing-generation women, with a moderate effect size (Cohen's $d = 0.490$). In contrast, gender-based differences between women and men were smaller. For instance, the largest gender difference—greater interest in Technical Training among women compared to men—had a small effect size (Cohen's $d = 0.200$). This indicates that, at least in this evaluation, subgroup differences among women are often more pronounced than gender differences, highlighting the need for educators, resource centers, and student affairs practitioners to create nuanced, intersectional approaches to program design.

Undergraduate and graduate women, being at different stages of their educational journey, expressed distinct preferences that align with their academic and career goals. Many undergraduates are preparing to enter the engineering workforce directly after graduation, leading to a strong emphasis on skill-building programs such as technical training. In contrast, graduate students, who are often further along in their academic and professional development, expressed greater interest in workshops and topics related to personal wellness and diversity/inclusion.

While these insights provide a strong foundation for evidence-based programming, the study has limitations. The data was collected at a single R1 university, which may limit generalizability to other institutional contexts. Additionally, the study relied on self-reported preferences rather than actual participation data, which could provide a more accurate measure of student engagement behaviors. Furthermore, the small sample size for non-binary and other-gendered respondents precluded meaningful statistical analysis of their preferences, emphasizing the need for more inclusive data collection in future studies. Future research could address these gaps by incorporating qualitative methods, such as focus groups or interviews, to better understand the motivations behind students' preferences and engagement decisions. Combining survey data with qualitative insights would provide a more holistic understanding of how to design effective, impactful programs.

This evaluation highlights what women engineering students value most in programming, topics, and engagement opportunities, offering practical guidance for institutions seeking to better support their success. By taking into account what women want, such as technical training, professional development, and research programs, institutions can design offerings that align with students' priorities while fostering academic success and professional growth. The findings also emphasize that a one-size-fits-all approach is not sufficient. The varied needs of subgroups, such as first-generation and low-income women, must be considered. While focused on women, these insights are also relevant to enhancing the overall engineering student experience, ensuring programming reflects the interests and goals of the students it serves.

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