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The Dynamics of Belonging: A Look Into Belonging and its Outcomes Across Organizational Levels for Women in Undergraduate Engineering Programs

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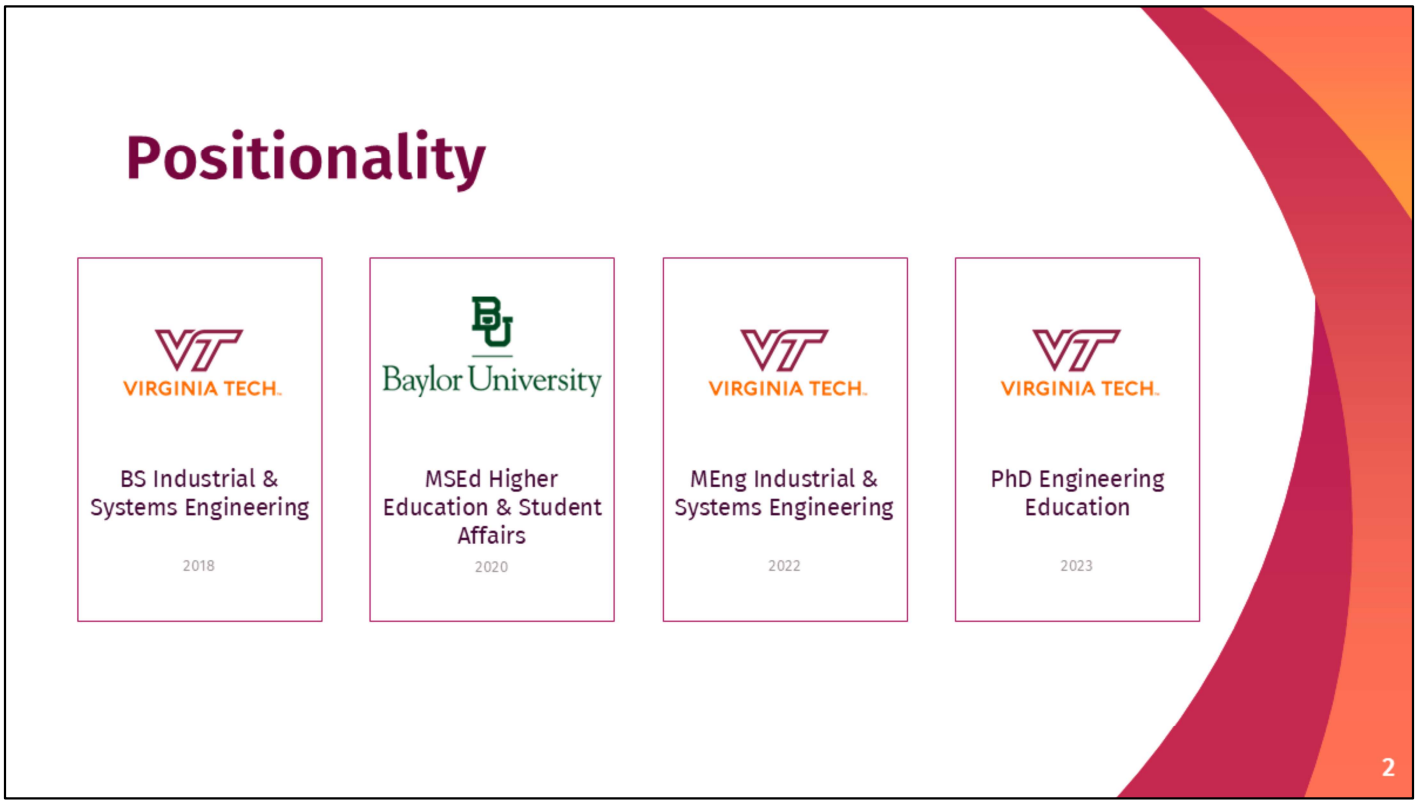
The Dynamics of Belonging Among Women in Engineering

CoNECD 2025

Hannah Glisson, PhD

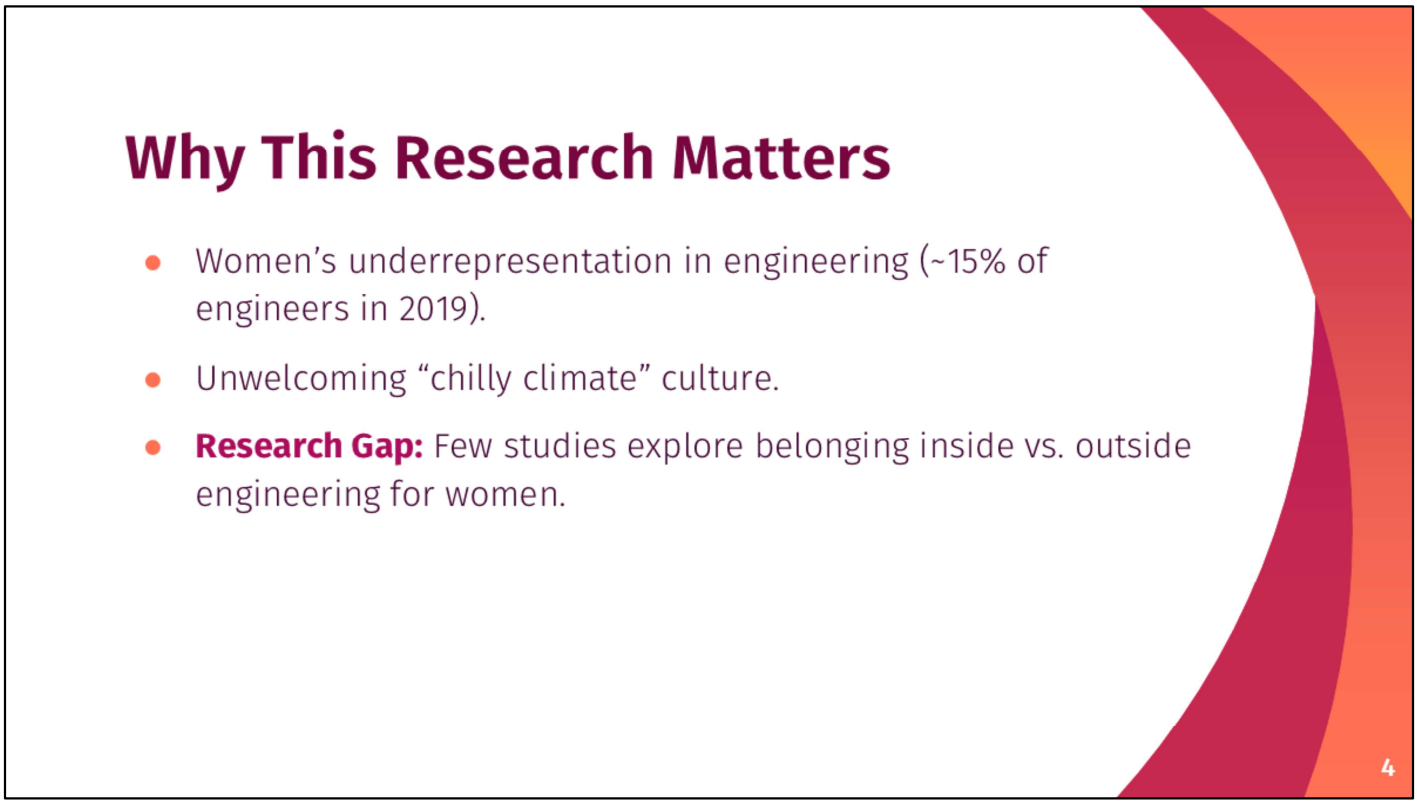


Hi, everyone! My name is Hannah Glisson, and I'm thrilled to present my research on belonging among women in engineering. I come from both engineering and higher education. My background includes a Ph.D. in Engineering Education, a Master's in Higher Education, and a Bachelor's and Master's in Industrial and Systems Engineering. Like many women, I struggled with feeling like I belonged in engineering, yet found stronger connections outside of it. Observing similar patterns in other women inspired me to explore these dynamics in-depth. Today, I'll share findings from this research, looking at belonging both within engineering and the broader institution.

Something different is happening in engineering.

Women who love their university feel like they do not belong in their engineering major.

Why?



Women are still significantly underrepresented in engineering—making up only about 15% of engineers in 2019. Many of us have encountered the 'chilly climate' of engineering, where the culture often feels unwelcoming or even hostile. Although we've seen initiatives to increase participation, research has yet to fully examine the difference in women's belonging within engineering compared to outside of it. My research aims to address this gap and understand the factors that shape women's belonging in these different contexts.

Theoretical Frameworks

Bronfenbrenner's Ecological Systems Theory

Examines multiple layers of influence

Allen's Belonging Framework

Identifies four constructs that make up belonging

Perceptions	Competencies
Motivations	Opportunities

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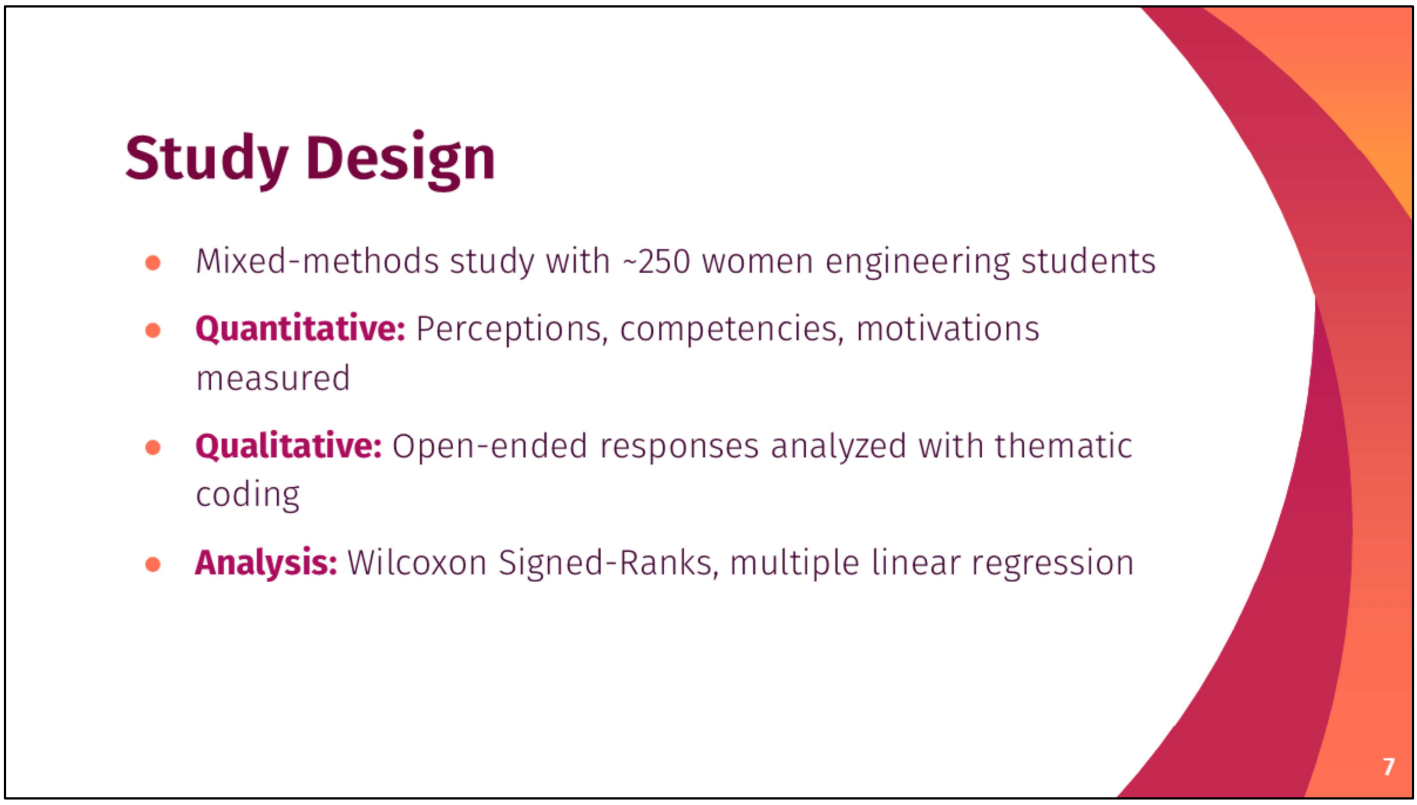
To analyze belonging, I relied on two frameworks. First, Bronfenbrenner's Ecological Systems Theory, which explores how we're influenced by different layers of our environment, from our immediate surroundings to broader societal structures. Second, Allen's Belonging Framework helped me break down belonging into specific components: perceptions, competencies, motivations, and opportunities. Together, these frameworks gave me a way to look at both individual and institutional influences on belonging.

Research Questions

- How do belonging components differ at institutional vs. engineering levels?
- What relationships exist between belonging components?
- How does engagement affect belonging?
- How do belonging components impact persistence in engineering?

These four questions guide my study. First, I wanted to know if there's a difference in how women experience belonging in engineering compared to the institution as a whole. Then, I looked at the relationships between belonging components—like perceptions and motivations—and examined if engagement in different activities impacts belonging. Finally, I asked whether these belonging components influence women's intentions to persist in engineering.



This study used a mixed-methods approach, combining both quantitative and qualitative data. I surveyed about 250 women engineering students, measuring perceptions, competencies, and motivations. Quantitatively, I used tests like Wilcoxon Signed-Ranks and multiple linear regression to analyze relationships between belonging components. I also asked open-ended questions, which I analyzed thematically to capture personal experiences.

RQ1
Belonging Levels - Institutional vs. Engineering

Belonging Levels - Institutional vs. Engineering

Institutional Belonging

Perceptions
- People at my university outside of engineering are friendly to me.
- I can really be myself *at my university.*

Competencies
- I have the personal skills I need to belong *at my university.*

Motivations
- I have (or plan to) put great effort into finding belonging *at my university.*

Engineering Belonging

Perceptions
- People *in my engineering program* are friendly to me.
- I can really be myself *in my engineering program.*

Competencies
- I have the personal skills I need to belong *in engineering.*

Motivations
- I have (or plan to) put great effort into finding belonging *in engineering.*

Test = Perceptions of Belonging (Institution) - Perceptions of Belonging (Engineering)

Student	Institutional Belonging Score	Engineering Belonging Score	Test	Rank
Student A	5	4	1	Positive
Student B	4	5	-1	Negative
Student C	4	4	0	Tie

Positive Ranks – higher institutional belonging
Negative Ranks – higher engineering belonging
Ties – equal engineering & institutional belonging

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The first result compared women's levels of belonging within engineering and at the broader institutional level. Using the Wilcoxon Signed-Ranks test, I found that women consistently reported higher levels of belonging outside of engineering. This suggests that while they feel integrated into their universities, their experience in engineering specifically feels more isolating or exclusive.

Belonging Levels - Institutional vs. Engineering

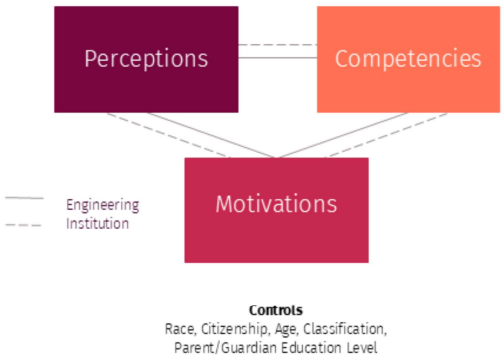
		N	Mean Rank	Sum of Ranks
Perceptions of Belonging (Institution) - Perceptions of Belonging (Engineering)	Negative Ranks	100	125.83	12582.5
	Positive Ranks	182	150.11	27320.5
	Ties	16		
	Total	298		
Competencies for Belonging (Institution) - Competencies for Belonging (Engineering)	Negative Ranks	40	95.83	3833
	Positive Ranks	186	117.3	21818
	Ties	72		
	Total	298		
Motivations to Belong (Institution) - Motivations to Belong (Engineering)	Negative Ranks	72	93.69	6746
	Positive Ranks	132	107.3	14164
	Ties	94		
	Total	298		

	Perceptions of Belonging (Institution) - Perceptions of Belonging (Engineering)	Competencies for Belonging (Institution) - Competencies for Belonging (Engineering)	Motivations to Belong (Institution) - Motivations to Belong (Engineering)
Z	-5.38	-9.247	-4.435
Asymp. Sig. (2-tailed)	0.000	0.000	0.000

This slide shows the results of the Wilcoxon signed ranks test described on the previous slide. The lower table shows statistical significance values ($p<.005$ for all)

RQ2
Relationships Between Belonging Components

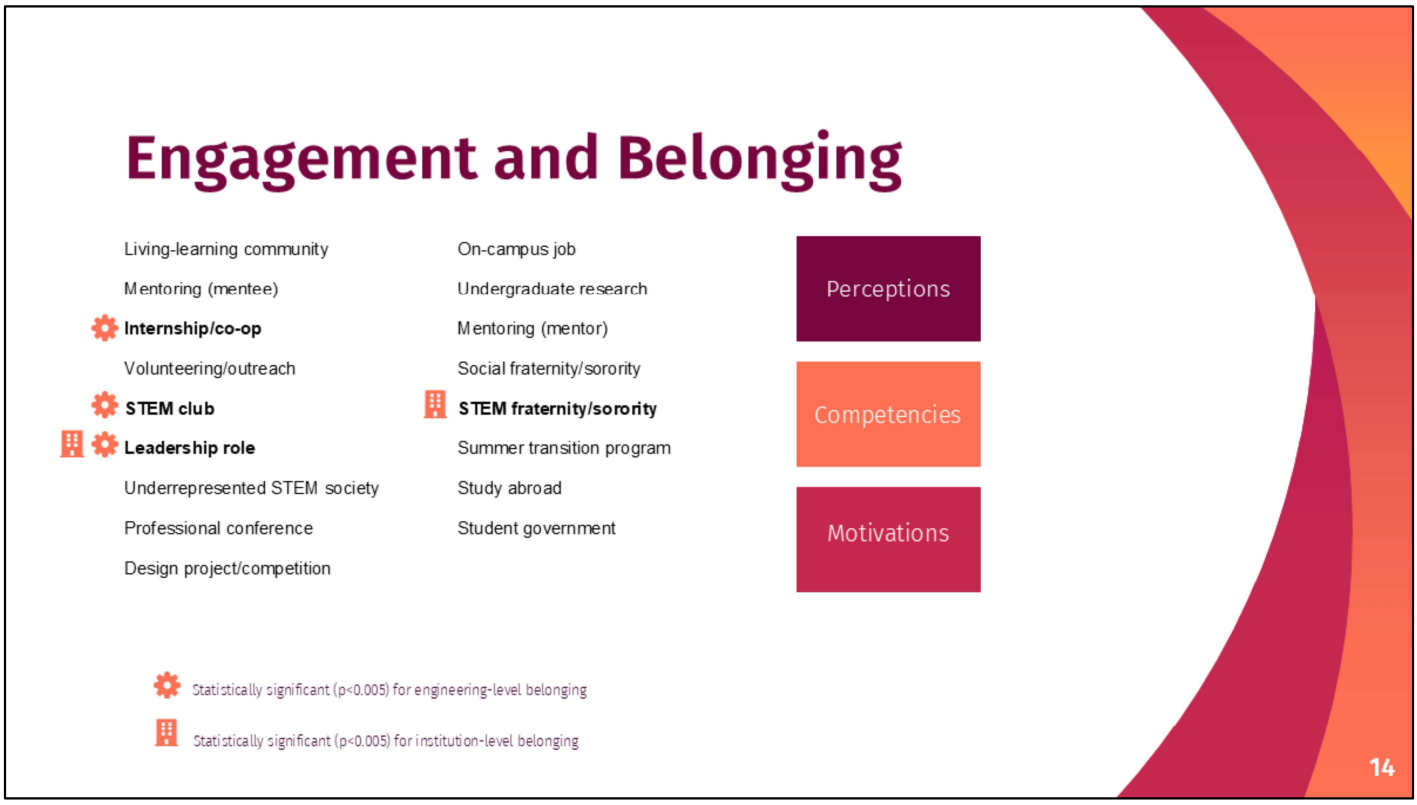
Relationships Between Belonging Components



Test	Model Significance	Factor Significance
Engineering		
Competencies -- Perceptions	p<0.001	β=0.512
Motivations -- Perceptions	p<0.001	β=0.309
Motivations -- Competencies	p<0.001	β=0.315
Institution		
Competencies -- Perceptions	p<0.001	β=0.618
Motivations -- Perceptions	p=0.002	β=0.344
Motivations -- Competencies	p<0.001	β=0.420

The next analysis looked at relationships among the components of belonging—perceptions, competencies, and motivations—at both the institutional and engineering levels. I found that these components are significantly interconnected. Women with high perceptions of belonging, for example, also had competencies that reinforced this sense of belonging, such as confidence and social skills. This consistency across contexts points to the importance of nurturing all these components to foster a stronger sense of belonging.

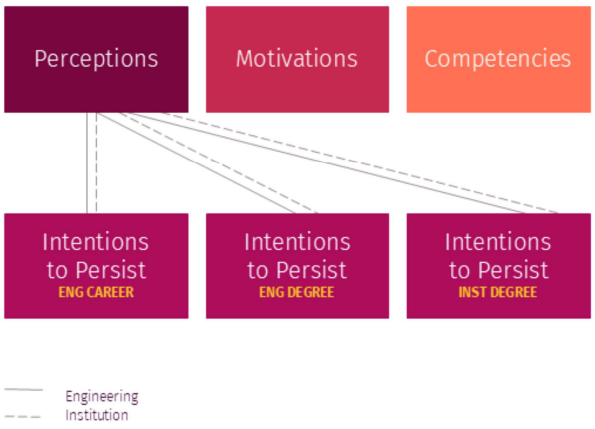
RQ3
Engagement and Belonging



For this research question I conducted multiple linear regression analysis with the belonging components as dependent variables and individual involvements as independent variables. The data showed that specific types of engagement were strongly correlated with ONLY COMPETENCIES for belonging. Women who participated in STEM-related activities, like engineering clubs and internships, reported stronger competencies for belonging within engineering. Meanwhile, those involved in non-STEM organizations or on-campus jobs felt more competencies for belonging at the institution level. These findings highlight the importance of encouraging women to pursue both STEM and non-STEM engagements to promote COMPETENCIES for belonging.

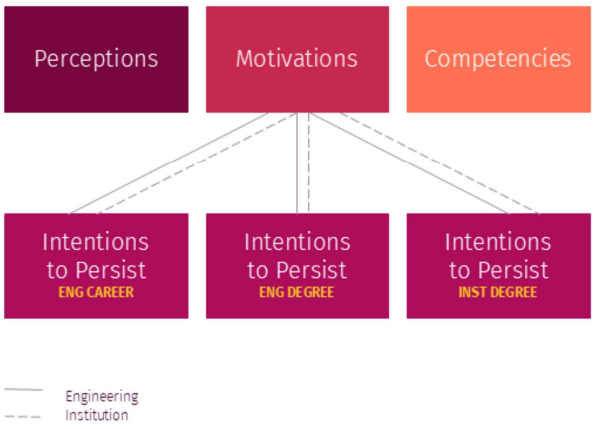
RQ4
Belonging Components and Persistence

Belonging Components and Persistence



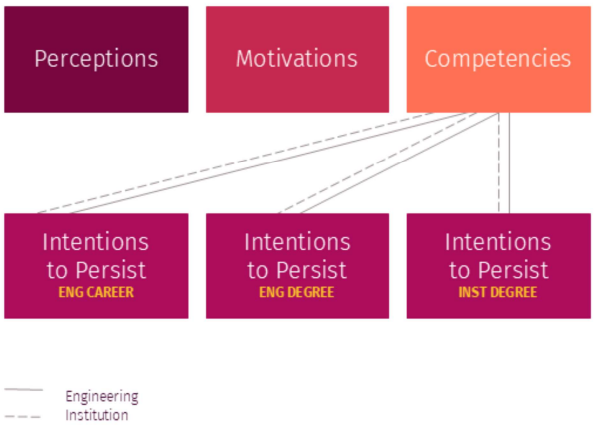
Finally, I looked at whether belonging within engineering influences women's intentions to persist in their engineering degrees and careers. This slide shows some of the relationships I looked at

Belonging Components and Persistence



This slide is a continuation of the previous one just to help clearly show which relationships were tested

Belonging Components and Persistence



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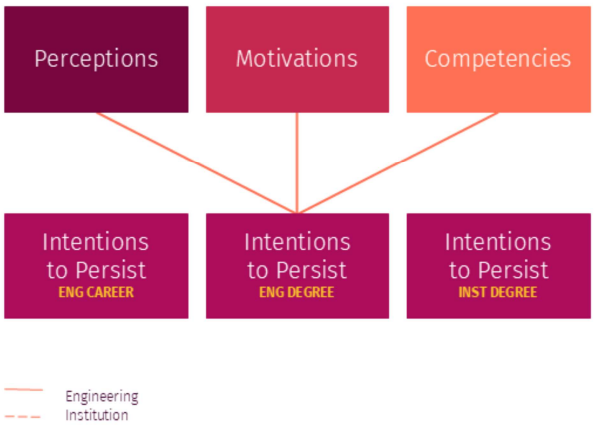
Belonging Components and Persistence



The results were clear: women who felt a stronger sense of belonging in all components (perceptions, motivations, competencies) within engineering were more likely to say they intended to complete their degrees. This finding emphasizes the importance of fostering belonging within engineering specifically—it's not just about making students feel comfortable but is essential for retaining them through graduation.

Open-Ended Questions

Through open-ended questions, I explored what contributed to women's sense of belonging both within and outside of engineering. For engineering belonging, women frequently mentioned the importance of supportive peers and faculty, particularly female mentors, as well as STEM-focused clubs and organizations. Outside of engineering, women felt that non-STEM organizations, living-learning communities, and campus-wide events helped them feel more connected to the broader campus community.

Belonging Detractors

Engineering

Men

In certain situations, I have felt underestimated or talked over by men - specifically in lab settings.

Many male students not taking me very seriously

Lack of Women

The lack of girls in my engineering/STEM classes has detracted from my sense of belongings at times. For example, I was a little late to my calculus II class on the first day and the class had naturally created a girls side of the room but there were no seats open so I sat in the other corner and the boys near me did not talk at all. During the rest of the semester the girls group blossomed and worked together and I was left out.

Disrespect

I've definitely heard discrimination/racism/sexism spoken from other students.

People Underestimating Abilities

During my final project in my freshman engineering class I was in a group with another girl and two guys. The two guys didn't even let us girls contribute to the project because they claimed it would be "best if they did it themselves." They didn't trust in our competency or intelligence enough to want to share a grade on a project that we contributed on. It was embarrassing and belittling to be called out like that just because of my gender. That was my first experience in engineering when I realized that the men did not respect us.

Faculty

Honestly, the teachers... Most of the time, it feels like they don't care whether or not I succeed.

Some old professors who don't understand/expect much from women

Women were also asked what detracted from their sense of belonging. Within engineering, they described a male-dominated culture where they often felt underestimated or treated with disrespect.

Belonging Detractors (cont.)

Institution

COVID-19

COVID really split everything up. While I was in my freshman and sophomore year, I had no ability to interact with anyone outside of my major and my zoom classes.

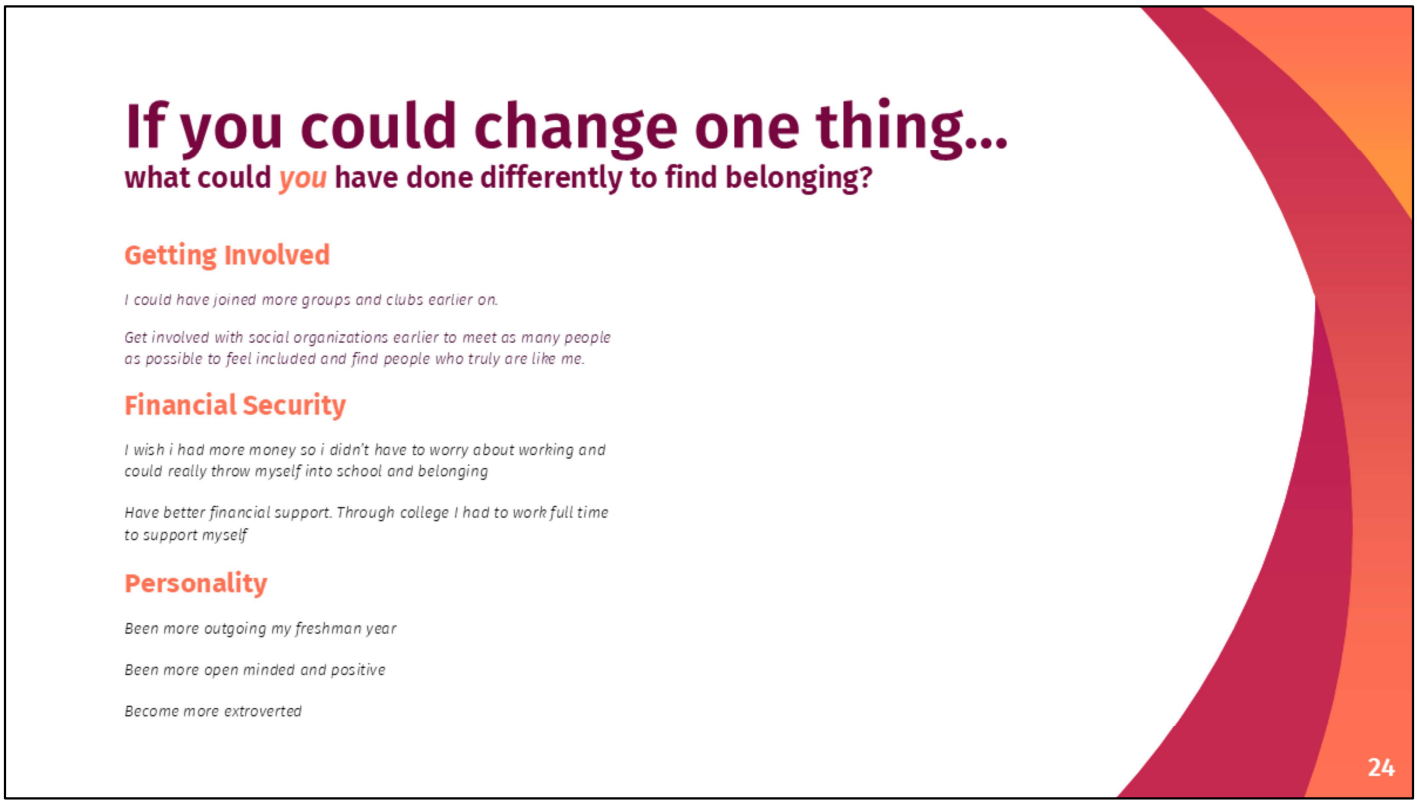
Time

Lack of time to do activities
Can't do fun activities that I love to do because of heavy coursework

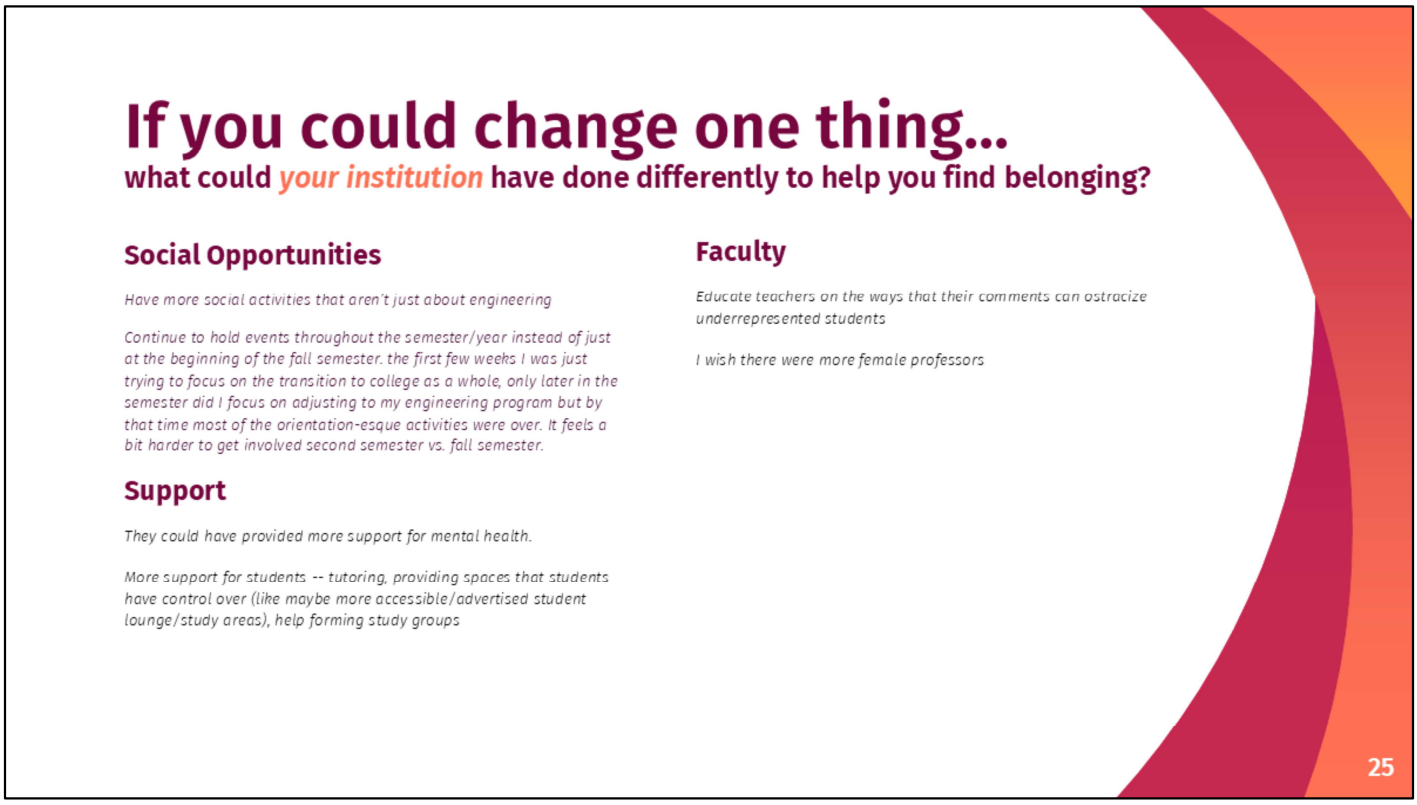
Mental Health

Mental health

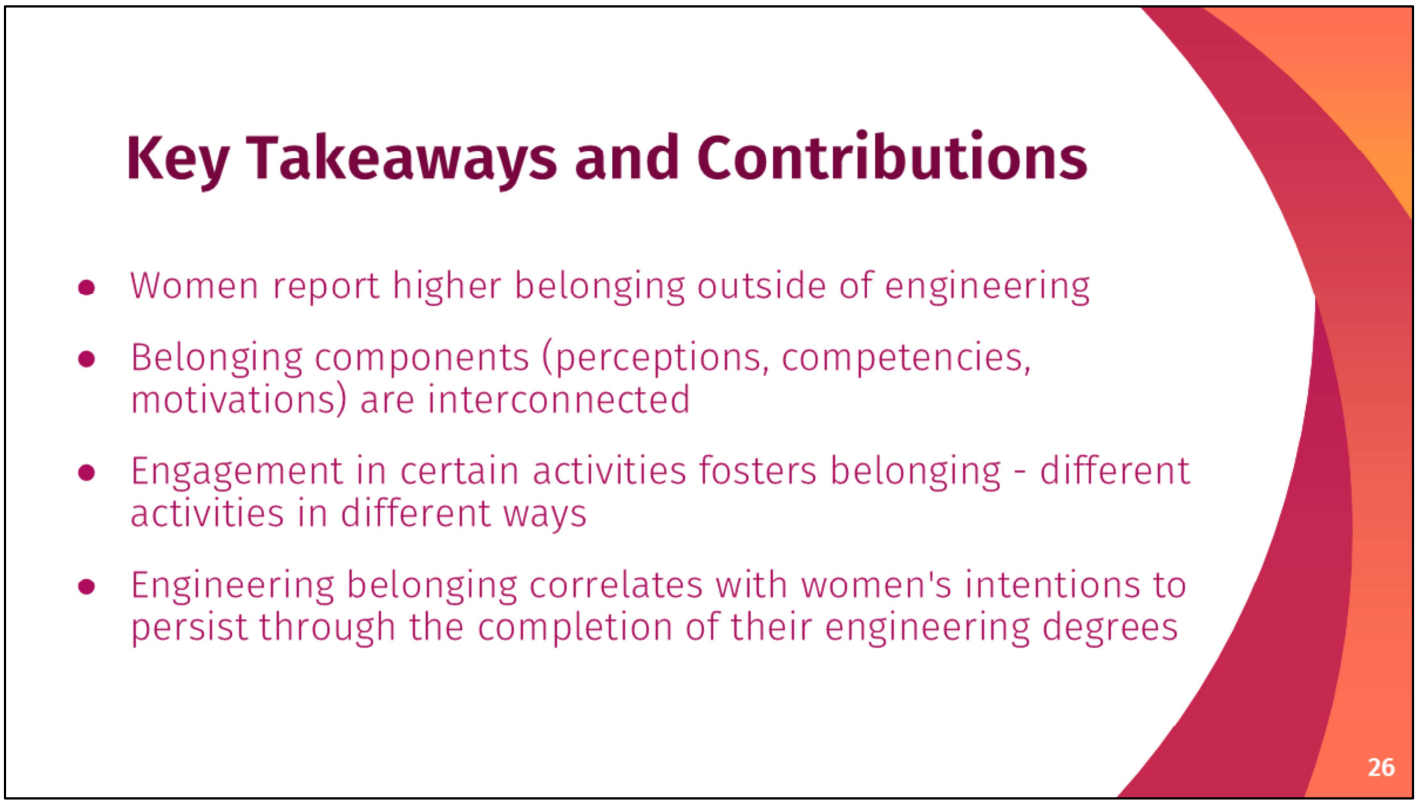
Outside of engineering, factors like exclusion from professional networks and limited access to institutional resources were common themes. Some women noted that a lack of diverse representation also contributed to feelings of isolation."



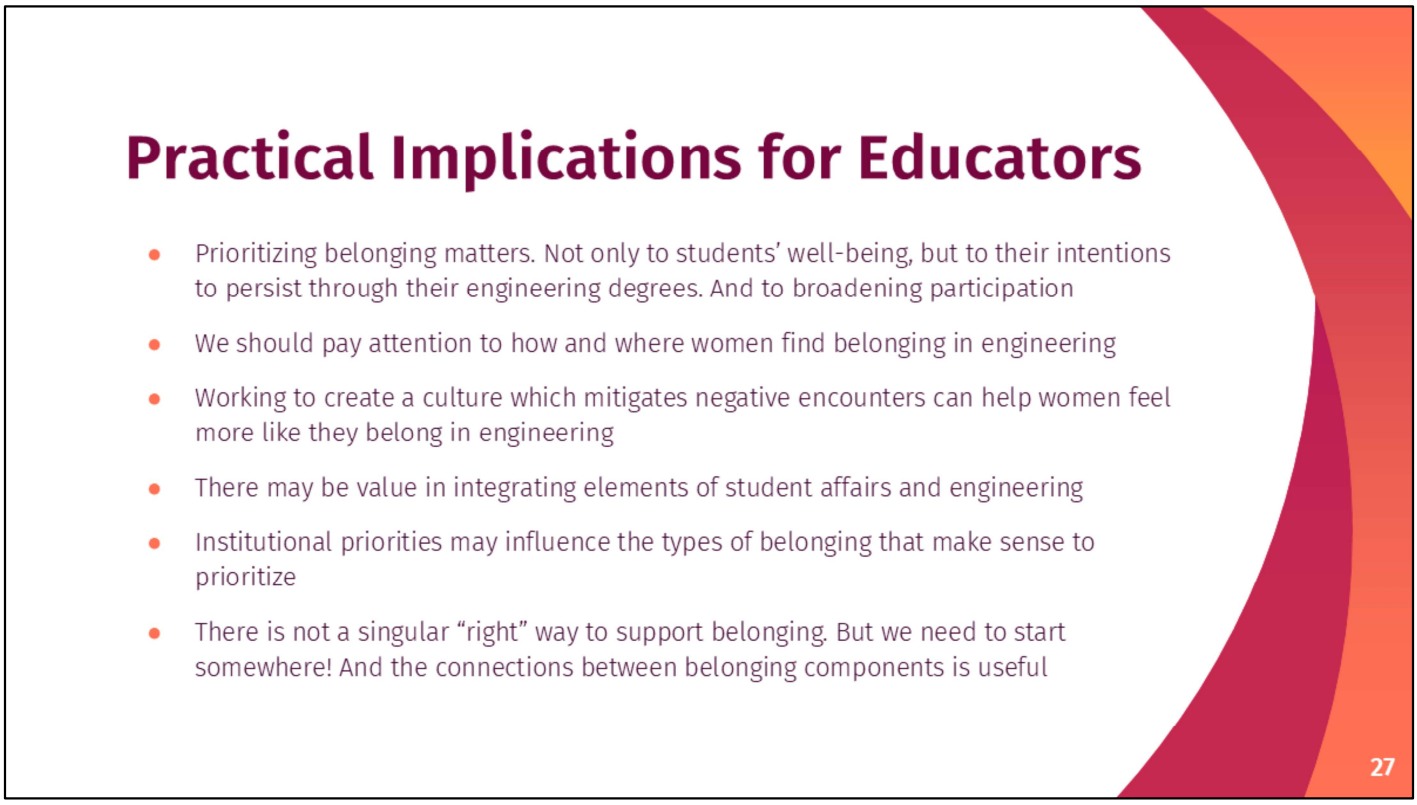
When asked what they could have done differently, many women reflected on missed opportunities for engagement and connection. Some wished they had gotten involved earlier, while others emphasized the importance of building strong faculty relationships. Many mentioned that joining women-focused organizations provided a sense of community that helped them feel more connected and supported.



Women also had suggestions for institutions to improve belonging. Common themes included increasing diversity within the engineering faculty and student body, creating more inclusive classroom and lab spaces, and offering mentorship and advising programs specifically tailored to the needs and challenges of women in engineering. These suggestions align with the broader goals of making engineering more inclusive and supportive for underrepresented groups.



In summary, this research revealed several key insights: Women generally feel a stronger sense of belonging outside of engineering. The components of belonging are deeply interconnected, suggesting multiple opportunities for fostering belonging. Engagement, both in STEM and non-STEM activities, plays a major role in shaping where women feel they belong. And critically, feeling a sense of belonging in engineering is directly linked to persistence, underscoring the importance of these findings for retention efforts.



Based on my findings, here are a few actionable steps for educators and institutions. First, fostering an inclusive environment within engineering programs is essential. This can be achieved through faculty support, diversity efforts, and inclusive classroom practices. Second, encouraging women to engage in both STEM and non-STEM activities can help create a well-rounded sense of belonging. Finally, institutions should prioritize interventions that directly support belonging within engineering spaces—because as we've seen, this is crucial for retaining women in the field.

To conclude, my research provides valuable insights into the dynamics of belonging for women in engineering. But there is still much to explore. Future studies should look at these findings across different types of institutions, such as community colleges or historically Black colleges and universities. Longitudinal studies could track how belonging changes over time and its direct impact on persistence. And finally, there is potential in exploring collaborations between student affairs and engineering programs to create better support systems for women in STEM.

I am so happy someone is researching this! Before college, I really thought that women were accepted in engineering, and as I've gotten deeper in my classes and had real-world experience, I've realized that acceptance and belonging is highly dependent on those in your immediate surroundings. In some groups and in some internships, my abilities are trusted, and I am welcomed with open arms. In others, I receive a lot of backlash, rude comments, and doubt. I passionately believe that there needs to be more support for women in engineering, and again, I'm happy someone is working on it!

Thank you!