

Article

An In-Depth Exploration of the BELONG Conceptual Model of Engineering Persistence

Gail Baura ^{1,*}, Leanne Kallemeyn ², Erika Esmeralda de la Riva ², Andrea Hercules ² and Matthew J. Miller ²

¹ Department of Engineering, Loyola University Chicago, Chicago, IL 60660, USA

² School of Education, Loyola University Chicago, Chicago, IL 60611, USA; lkallemeyn@luc.edu (L.K.); edelariva@luc.edu (E.E.d.l.R.); ahercules@luc.edu (A.H.); mmill11@luc.edu (M.J.M.)

* Correspondence: gbaura@luc.edu

Abstract

At Loyola University Chicago, the B.S. Engineering program graduates about 53% women annually, which is much higher than the United States' average of 25%. In this paper, Loyola University Chicago's BELONG (Becoming Engineers Leading Our Next Generation) Conceptual Model of Engineering Persistence is described. Grounded in social cognitive career theory, the BELONG model inputs collaborative program structures and uses sense of belonging to explain engineering persistence. Program structures that minimize the chilly climate of engineering for women, particularly those administered during the first undergraduate semester, are described. To explore the model, qualitative semi-structured interviews with self-identified women of color were conducted to gain an in-depth understanding of their program experiences during their first semester. After applying emergent, focused, and thematic coding, results revealed student experiences and understandings of engineering self-efficacy, outcome expectations, interest, sense of belonging, and experiences of program structures. Results support the BELONG model, an approach that addresses the exclusion of women in engineering through program structures and rethinks and repositions engineering education as a more inclusive environment.

Keywords: women in engineering; engineering persistence; chilly climate; sense of belonging; active learning; social justice; engineering education; social cognitive career theory

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1. Introduction

In response to numerous American policymakers warning that the annual number of engineering graduates must increase for future U.S. economic growth (Jamieson & Lohmann, 2009; National Academies, 2010, 2011; National Research Council, 2012; National Science and Technology Council, 2013; National Science Board, 2010; PCAST, 2012), universities responded by expanding engineering schools and creating new engineering programs (Matthews et al., 2017). Some universities also worked to increase the participation of underrepresented populations, such as women, that enter the engineering student pathway (ASEE & NAE, 2024; Malcom, 2022; National Academies, 2011; National Science Board, 2010; Ong et al., 2020). However, looking at ten-year increments from 2003 to 2013 and then to 2023, the percentage of bachelor's degrees awarded to women decreased from 20.4% to 18.9%, and then increased to 24.8%, respectively (Figure 1) (Roy &

Erdiaw-Kwasie, 2023; Yoder, 2012). In contrast, Loyola University Chicago's Engineering program has graduated about 53% women annually since 2020, the year it achieved ABET accreditation (Figure 1).

In this article, the typical learning environment of women engineering students is reviewed, and Loyola Engineering collaborative program structures and a new model of engineering persistence based on the Loyola program are described. The results of qualitative analysis of six interviews with six women of color in the Loyola Engineering Class of 2028 are also reported. The intersectionality of women of color is used as an analytic tool to “help uncover, explain, and illuminate the complexity of discrimination faced by people within spaces that were built to perpetuate a dominant power narrative of White, male, heterosexual, Christian norms” (Alfred et al., 2019), and to potentially improve the engineering education environment for *all* women. This analysis study is a first step towards model validation (Baura et al., 2025) and the repositioning of engineering education within an inclusive environment (S. Sorby et al., 2021).

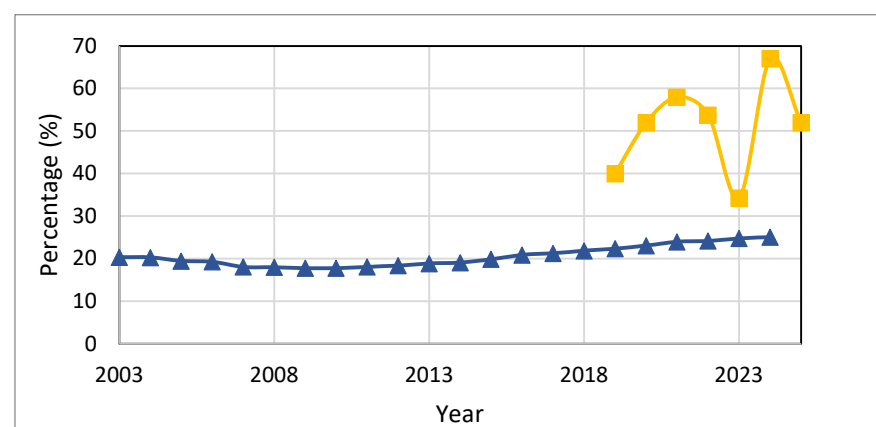


Figure 1. Percentage of engineering bachelor's degrees awarded to women in the U.S. (blue) (Roy & Erdiaw-Kwasie, 2023; Yoder, 2012) and at Loyola University Chicago (yellow) (Baura et al., 2025).

2. Background

Engineering education in the United States has historically favored white males. Before engineering education can be rethought and repositioned within an inclusive environment, the underlying causes of exclusion for various groups must be understood. Decreased engineering persistence of women can be traced to the chilly climate. Loyola Engineering] collaborative program structures may mitigate the chilly climate.

2.1. The Chilly Climate

The term “chilly climate” was coined by Hall and Sandler in 1982, and refers to the subtle or overt ways in which “a chilling classroom climate puts women students at a significant education disadvantage” (Hall & Sandler, 1982). A hostile and unwelcoming space for women is created by faculty classroom behaviors such as overtly discriminatory comments to women, nonverbal cues such as less eye contact and less attentiveness when women speak, and identification of intelligence and authority through assertive male speaking patterns (Hall & Sandler, 1982). For example, in 1982, the first author was trained in, but did not learn, the resistor color code mnemonic, *Bad Boys Rape Our Young Girls But Violet Gives Willingly*, in a required electronic circuits course. That same year, physics professor Sue Nichparenko publicly voiced her distress at this mnemonic, and suggested alternative mnemonics for the resistor color code (Nichparenko & Brown, 1982).

In the 1990s, Sadker and Sadker summarized their two decades of university classroom observations as “men are twice as likely to monopolize class discussions, and

women are twice as likely to be silent” (Sadker & Sadker, 1994). When Felder et al. conducted a longitudinal study of chemical engineering students (87 men, 34 women) who first enrolled in an introductory chemical engineering course, disparaging remarks about women students from engineering professors were reported by several women. These remarks may have contributed to the students’ lowering of self-confidence (Felder et al., 1995). Perceptions of an unwelcoming engineering department climate, bias, and lack of faculty support lessen engineering persistence (Davis et al., 2023).

Unfortunately, time has not mitigated the chilly climate. As reported in 2017, instructors of engineering students do not respond to students’ gender expression through gender interventions, meaning active intervention as part of teaching responsibilities. Rather, they are more likely to respond through gender blindness, not acknowledging gender inequity, or through gender acknowledgment, believing causes of gender inequity are outside instructor interactions with students (Blair et al., 2017). Male Ivy League college students may speak in the classroom 1.6 times more than female students, as determined from 95 h of observation of nine social science, humanities, and natural science courses over 80 course sessions (J. J. Lee & McCabe, 2021).

Women STEM students still experience gender disparities due to masculine cultures and choices by men. As defined by Cheryan et al., masculine defaults in masculine culture are a form of bias which reward behaviors typically associated with men, such as self-promotion and teaching with masculine topics. Differential treatment in masculine culture results in women treated worse than men. Because more men choose engineering as a major, they decrease the proportion of women in the classroom, increasing the likelihood of masculine cultures dominating (Cheryan et al., 2024; Cheryan & Markus, 2020). Normative male dominance and numerical male dominance, in turn, prevent women from developing a sense of belonging in the engineering environment (Wilson & VanAntwerp, 2021).

As subjects in the Talking About Leaving Revisited Study described during interviews, women students’ sense of belonging and commitment to persist were undermined by the competitive individualism by some male students to be recognized as the smartest in class, a form of self-promotion (Holland, 2019). Australian women students enrolled across five undergraduate engineering courses encountered gender stereotypes, whose origins stemmed from gendered perceptions around femininity and masculinity (Hardtke et al., 2023). Female engineering and computer science students engaged in team projects at two Swiss technical universities encountered male students who reinforced masculinity norms such as competitiveness and suppression of emotion, which led to decreased sense of belonging and decreased productivity (Krivoshchekov et al., 2025).

Women of color have intersecting marginalized social identities, encountering even more structural barriers and discrimination than white women (Alfred et al., 2019). Black women engineering students experience isolation; difficulty forming study groups, which can affect academic performance; and hypervisibility for “being the only one.” Their sense of belonging decreases after continued exposure to microaggressions (Blosser, 2020; Ong et al., 2020), when their skills and expertise are questioned and when they are subjected to racial or gendered stereotypes (Wilkins-Yel et al., 2019). Similarly, Latine women engineering students experience gendered, racist exclusion (Garriott et al., 2019; Garriott et al., 2023).

The overwhelming amount of time and energy required to navigate the chilly climate provides an understanding of why women have reported losing interest and motivation (Blosser, 2020; Hunter, 2019). Interventions, such as skills training (Godwin et al., 2024; Walton et al., 2015), counterspaces (Ong et al., 2018; Shortlidge et al., 2024), and increased faculty representation (Erichsen et al., 2024; Main et al., 2020), have been implemented, but have failed to truly mitigate the chilly climate. Most course interventions (Nguyen et

al., 2020; Stroud Rossmann & Armstrong, 2022) have also had limited impact. Only Sheryl Sorby's 3-D spatial visualization course (Home-Douglas, 2020) has enabled women, who were initially less skilled than men (Stafford, 1972), to take a graphics course during the first year of engineering and decrease the odds of them dropping engineering. Sorby et al. demonstrated that spatial visualization training improves both performance (S. A. Sorby, 2009; S. A. Sorby & Baartmans, 2000) and persistence (S. Sorby et al., 2018). Ultimately, eliminating engineering classrooms that favor men requires disruptions that stimulate structural change (Pawley, 2020) and address masculine defaults, differential treatment, proportion of women in the classroom, and sense of belonging.

2.2. Loyola University Chicago Collaborative Program Structures

The chilly climate may be mitigated by collaborative program structures. The Loyola BS Engineering program, which began enrolling students in Fall 2015, was created to provide social justice for the Engineering faculty and social justice for Engineering students. It is the first U.S. engineering program to fully integrate social justice into its curriculum (Baura & Kallemeyn 2019). In this section, Loyola University Chicago collaborative program structures for students that are outgrowths of social justice are described.

This general engineering program has three specializations—biomedical, computer, and environmental engineering. Each specialization emphasizes a social justice application, such as design and testing of robust electrical medical devices, regardless of a patient's ability to pay; controls for the smart electrical grid; and treatment of water and wastewater to minimize pollutants, such as per- and polyfluoroalkyl substances, respectively. All Engineering courses are taught using a mandatory active learning style, similar to but more collaborative than the minimal lecture style of the U.S. Air Force Academy (Novak, 1999; Shoop & Ressler, 2011), to a maximum course section size of 24 students. Active learning increases the performance (Freeman et al., 2014) and retention of women students (Holland, 2019; Ro & Knight, 2016), students of color (Lichtenstein et al., 2014), and first-generation students (D. Miller et al., 2021).

As a Jesuit Catholic university, Loyola University Chicago offers core liberal arts courses that are imbued with social justice—the moral imperative to take “personal and moral responsibility anchored in active involvement with diverse communities and real world challenges (through civic knowledge and engagement, intercultural knowledge and competence; ethical reasoning and action; and skills for lifelong learning)” (Brown & Jonte-Pace, 2010; Society of Jesus, 2005). This enables students to learn how to critically analyze social conditions. Engineering builds on this social justice foundation by assigning four social justice case study projects within four Engineering courses during freshman year, sophomore year, and senior year. Each case study project possesses a different format, with written, presentation and discussion components (Baura & Miller, 2024a). Through these case study projects, Engineering students analyze the effects of technology on others.

Numerous collaborative program structures address chilly climate issues (Table 1). For first-year students, most collaborative program structures are associated with the first Engineering course they take: ENGR 101: Introduction to Engineering Design. Since this is a four-credit hour design course, each of three course sections meets 100 min per course meeting, three times per week. For each course section, a main three-credit hour instructor teaches SolidWorks and other freshman topics. The first author, who is the chair, teaches thirteen out of 41 course meetings in each section as the fourth credit hour. Her course topics are engineering design and group design projects, systems, and a social justice introduction. Also, she arranges four guest lectures from engineers in industry, with a light dinner served to the speaker and students afterwards.

The course is centered around a freshman design project, as an open-ended first-year design project is the most effective way to retain engineering students (Fortenberry et al., 2007). The chair organizes students into groups of three to four students, assigning each group a problem to solve for a sponsor on campus. Sponsors are all Loyola employees, such as the Dean of Libraries, Nursing Professors from the Center for Simulation Education in the School of Nursing, an Emergency Medicine Professor in the School of Medicine, and/or a Sustainable Agricultural Manager in the School of Environmental Sustainability. To guarantee that the students solve their problems by the end of the course, each group is required to meet with the chair before each of three milestones is due. These milestones are the Project Requirement Specification, Progress Report, and Final Presentation/Report. The first-year design projects are described in greater detail in (Baura et al., 2024). Collaborative program structures within ENGR 101 address microaggressions, differential treatment, isolation, and gendered assignments (Table 1).

Table 1. Chilly Climate Issues (Cheryan et al., 2024; Cheryan & Markus, 2020; Wilson & VanAntwerp, 2021) addressed through Collaborative Program Structures (Baura et al., 2025).

Chilly Climate Issue	Collaborative Program Structure
Masculine Defaults	Microaggression Identification: During the second course meeting of the first ENGR course, within the social justice module, a table of common microaggressions (Goodman, 2015) is presented. The chair then asks that one student tell a second student if they are hurt by a microaggression and also states that she would be glad to tell the second student if the first student is uncomfortable having this conversation. The Department of Engineering should be a safe space.
	Freshman design projects for the Loyola Libraries, Nursing Simulation Lab, Medical School, and School of Environmental Sustainability are not gender-based.
	Industry-sponsored, two-semester capstone projects are not gender-based.
Differential Treatment	Each bimonthly faculty meeting begins with fifteen minutes of student review, to ensure faculty members are aware of and can support all student needs.
	All course projects have accompanying rubrics, so grading is transparent.
	During freshman orientation, the chair shares statistics indicating lack of diversity in undergraduate engineering and explains why more diverse engineers are needed to design products used by the world.
	Teamwork is emphasized through CATME peer evaluations, short CATME dimension training videos, and meeting support tools (Purdue University, 2024). The CATME adjustment factor without self is used to properly weigh each student's contribution to each project milestone grade.
Proportion of Women in Classroom	All Engineering courses are taught using a mandatory active learning style [problem-based learning (Baura et al., 2018, 2019, 2021, 2024) and collaborative learning], which increases the retention of women students, students of color, and first-generation students. Engineering course sections seat at most 24 students, to facilitate active learning. Collaboration, rather than competition, is emphasized.
	The Engineering faculty is diverse and models the gender and ethnic diversity Engineering wishes to see in its student population (Figure 2). The chair of Engineering is an Asian woman and full professor.
	Faculty diversity also includes industry and academic experience, with these industry experiences informing the first-year, collaborative, and problem-based learning activities given in courses.
Sense of Belonging	Each freshman or capstone design group is constructed so a woman or student of color is not isolated within a group of 3–4 students. A typical freshman group construction is 2 women students plus 2 students of color.

The combination classrooms/labs for Engineering courses are card-access only, for use by Engineering students, faculty, and staff. These dedicated spaces turn into study lounges at night, so it is easy to find other students working on the same homework.



Figure 2. The Loyola Engineering faculty.

The Loyola Engineering program graduated an average of 53% women annually, while graduating about 22 students total annually from 2020 to 2025 (Figure 1). After receiving ABET accreditation in 2020, Loyola began participating in the ASEE annual survey and was ranked #6 in 2020 (52%), ranked #6 in 2021 (58%), ranked #5 in 2022 (54%), unranked in 2023 (34%), and ranked #8 in 2024 (67%) for Percentage Bachelor's Degrees Awarded to Women, the only program years for which ASEE survey data are currently available. In 2025, Loyola graduated 52% women (Figure 1). Although women enroll in the program with lower levels of self-efficacy than men, women stay in Engineering at similar rates as men, as determined by first-year and sophomore student completion of the Longitudinal Assessment of Engineering Self-Efficacy (Kallemeyn et al. 2021).

2.3. Theoretical Framework

The engineering persistence of women in the [INSTITUTION] Engineering program may be described by the Becoming Engineers Leading Our Next Generation (BELONG) Conceptual Model of Engineering Persistence (Baura & Miller, 2024b), which is based on social cognitive career theory (SCCT) (Lent et al., 1994). SCCT is a framework that has been used to explain the underlying psychological and social learning processes and external influences that translate academic and/or vocational learning experiences (e.g., engineering case studies) into interest in and intent to persist a given academic and/or vocational field (e.g., engineering). Over the past several years, SCCT has become one of the leading theoretical frameworks used to study the development of engineering interest, commitment, and persistence in diverse student populations (Byars-Winston et al., 2010; H.-S. Lee et al., 2015; Lent et al., 2013, 2015, 2016). Since its initial articulation in 1994, SCCT hypotheses have been supported in several individual and meta-analytic studies (Sheu et al., 2018).

Within the context of engineering education, SCCT hypothesizes that students are likely to develop interest in engineering when they are confident in their ability to perform engineering related tasks (self-efficacy) and when they believe that engaging in engineering will lead to positive outcomes (outcome expectations); increased self-efficacy and outcome expectations beliefs lead to an increased interest in engineering. Together, self-efficacy, outcome expectations, and interests ultimately lead to an intent or commitment to engage and persist in engineering even when confronted with barriers. SCCT is especially relevant in helping to elucidate the underrepresentation of women in engineering because it accounts for the influence of external contextual supports (e.g., inclusive program structures) and barriers (e.g., hostile and unwelcoming environment) on engineering

persistence. Increased contextual support leads to stronger self-efficacy beliefs and outcome expectations and ultimately increases the likelihood of persisting in engineering in the future, whereas increased barriers may disrupt the translation of self-efficacy and outcome expectations into interest and persistence (Figure 3).

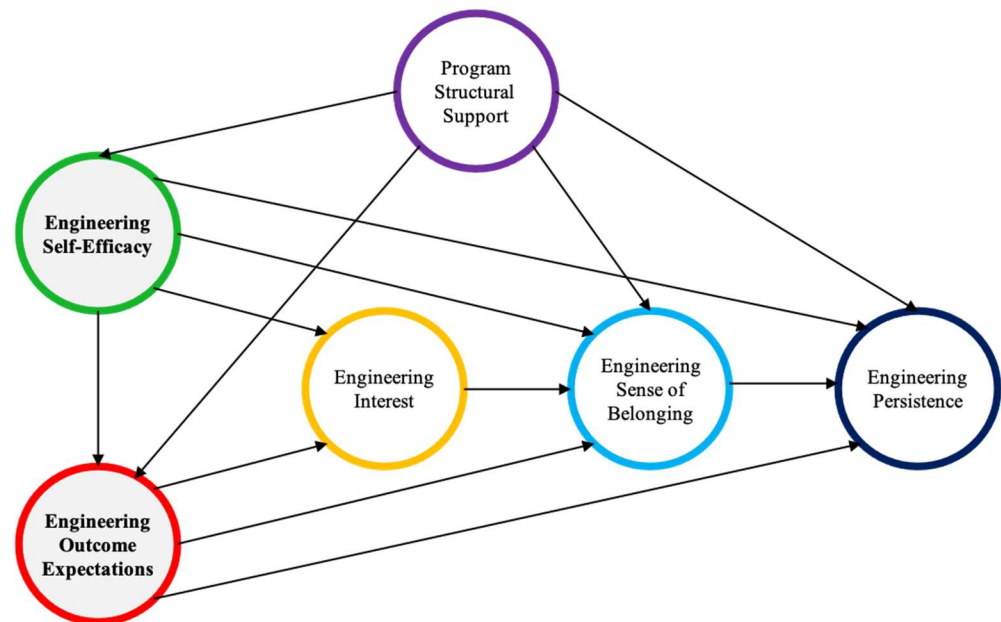


Figure 3. The BELONG Conceptual Model of Engineering Persistence (Baura et al., 2025).

The BELONG model builds upon the SCCT framework by integrating sense of belonging, a well-established construct that helps explain how individual differences and external factors influence an individual's sense of acceptance and connection in an academic field such as engineering (Godwin et al., 2024; Ong et al., 2020; Patrick et al., 2023; Wilson & VanAntwerp, 2021). Sense of belonging was included because it was determined to be an especially relevant construct when attempting to understand the impact of structural factors (e.g., hostile climate) that tend to exclude populations (e.g., women in engineering) and inhibit academic progress. Sense of belonging was also included in the model given the program's focus on social justice literature (M. J. Miller & Sendrowitz, 2011; M. J. Miller et al., 2009; Vera & Speight, 2003) and the importance of focusing on structural and systemic change in efforts to promote equity and inclusion. Research also suggests that experiences of injustice (e.g., sexism) can result in an increased commitment to social justice (Beer et al., 2012). Therefore, because women may experience injustice in the form of a hostile chilly climate and because engineering students, in general, have the opportunity to learn about unjust applications of engineering that benefit some populations while disadvantaging others, they may be more compelled to pursue and persist in engineering if their program learning experiences are understood as a form of social justice advocacy.

The following research question was asked to investigate the influences that lead to Loyola's engineering persistence of women: In what ways does the BELONG model represent the experiences of first-year women engineering students of color who persist in engineering?

3. Materials and Methods

This study is a phenomenological qualitative research design that used individual interviews (Kvale & Brinkmann, 2009). Phenomenological interviewing is a social practice rooted in professional conversations about everyday life. An individual interview is

“literally an *inter view*, an inter-change of views between two persons conversing about a theme of mutual interest” (p. 2). In this study, qualitative interviews provide rich, thick descriptions of about the lived experiences and their meanings of self-identified women of color in an undergraduate Engineering program. Qualitative studies are not intended to generalize from a sample to a population (Flyvbjerg, 2006). Such in-depth descriptions provide practical knowledge that is beneficial for professionals, such as engineering educators, working to address practical problems, such as the underrepresentation of women and women of color in engineering programs. Qualitative studies are also beneficial for understanding processes and addressing *how* questions, which this study aims to do through understanding how students persist in engineering. Such knowledge provides opportunities for analytic generalizations to theory (i.e., BELONG model), which supports theory development and validation.

3.1. Sampling

Qualitative studies are beneficial for studying unique or extreme cases (Flyvbjerg, 2006) which support theory development and validation. Through understanding the atypical, researchers can also gain new insights about the typical. For example, if an Engineering program has program structures to retain women of color, then they are also likely to have processes that retain all women.

This study used purposive sampling (Patton, 2014) to recruit participants, as follows: (1) enrolled during Fall 2024 in the Loyola Engineering program, which has program structures that support women of color; (2) self-identified as women of color on admissions forms; (3) during the first semester received grades of C- or higher in required classes for Engineering, including their ENGR 101: Introduction to Engineering Design course; and (4) enrolled in courses for Spring 2025, demonstrating retention.

During Fall 2024, 58 first-year students enrolled in the Engineering program, across three sections of ENGR 101. Based on demographic characteristics self-reported in their university-level academic records, this cohort included 26 men (45%), including 15 out of 58 (26%) self-identified as men of color; and 32 women (55%), including 18 out of 58 (31%) self-identified as women of color.

In the Loyola Engineering program over nine years, most students who did not persist to the third semester failed Calculus I, College Physics I, Calculus II, and/or College Physics II. For this reason, one woman of color was dismissed from the program and encouraged to explore other majors due to two grades of less than C- in required math and science courses. A record 90% of this cohort persisted to the second semester. Three women of color received one grade lower than a C- in a required math or science course. During the first month of the semester, one woman of color switched programs. Thus, 13 of 18 (72% women of color) women were eligible for interviews, representing 22% of the first-year students. Out of these 13 women, six participants (42% of eligible women of color) completed interviews for this study. To protect anonymity in this small sample, there is no table of demographic information. Pseudonyms, rather than their names, are used throughout the findings, although even pseudonyms are intentionally not used when sharing findings that include other identifying information.

3.2. Data Collection Procedures

Aligning with an Institutional Review Board approved protocol, the program faculty and chair were not involved in recruitment and data collection to ensure participation was voluntary and students could share confidentially. After the final grades were posted, the Engineering administrative assistant recruited women students of color in ENGR 101. School of Education graduate student researchers, who also identified as women of color, then consented and interviewed the women. The graduate student researchers conducted

six semi-structured individual interviews over Zoom to understand the women's experiences during their first semester. Examples of interview questions include "What has been beneficial in helping you succeed in the Engineering program?" and "In the last semester, tell us about any challenges that you encountered, and how you overcame them." The interviews lasted between 30–60 min. Interviewers recorded, with transcriptions, the Zoom interviews and also took notes. Notes and audio recordings were used to ensure transcript accuracy.

3.3. Data Analysis

Analysis of the interviews focused on interpreting the meaning of the women's experiences through developing categories or themes and using a hermeneutic approach to interpret these categories in relation to the whole context of the interview, other interviews, and the Engineering program at Loyola (Kvale & Brinkmann, 2009; Saldaña, 2013). First, interviewers completed initial open-coding, consisting of reading line-by-line attributing emergent codes to the data. Through this process, they identified and refined emergent categories. Next, interviewers compared these emergent categories to the BELONG model and then across interviews, identifying commonalities and differences. Individual interviews were analyzed again for categories that may not have been apparent in initial analyses. Throughout this process, the research team met (excluding the first author) to discuss preliminary interpretations. They also documented meanings of categories through memos. Participants reviewed draft findings via a member check to help validate findings and interpretations. Finally, the research team used these preliminary categories to develop a detailed codebook for a final round of coding using the BELONG model as focused codes, in addition to emergent subcodes (e.g., elements of program structures). The two interviewers coded each interview in this round and discussed discrepancies to ensure consistency and credibility. They identified minimal discrepancies.

4. Results

The first section addresses how the women of color perceived their identities based on what they shared in the interviews. Next, the results provide women's experiences related to each BELONG model element based on stories they shared in interviews after their first semester. The women focused on several collaborative program structures. In the last section, the women's experiences demonstrate how these structures facilitated their sense of belonging and self-efficacy.

4.1. Identities as Women of Color

Students participating in interviews identified as women and noted that the Loyola Engineering program had a large percentage of women. Only five of six participating students identified as women of color. When asked, Nadia (all names are pseudonyms) explained "it's not too important for me to address ... as long as there is respect within my peers and professors." The five students that identified as women of color all recognized the racial and ethnic diversity within their cohort. They also described different experiences between their gender and racial identities. For example, a student that identified as bi-racial reported experiencing no microaggressions but related a story of another Engineering student who had experienced a racial microaggression from an Engineering classmate. She described her identity in relation to her classmates.

At first I was a little bit afraid to go into engineering, because I thought it would be more male dominated. But I mean at Loyola, it's pretty 50/50, I would say. My biggest thing ... I didn't expect ... all the racism ... I'm just gonna continue

because I mean, it's like real life, too. There's gonna be people like that. I just have to learn how to navigate it.

Even though she experienced affirmation for her identity as a woman, she did not experience affirmation for her racial identity.

4.2. BELONG Model

The experiences these women shared aligned with elements of the BELONG model, as shown in Table 2. This table demonstrates the students' emphasis on collaborative program structures, which were further divided into six subthemes and represented by the first six columns of findings in the table. Although university-level (e.g., tutoring) and familial supports were an important part of these women's experiences, the results presented focus on the collaborative program structures because they were most salient in these women's experiences. These structures are also what engineering and other STEM faculties have the most agency to create and change. In the next subsections, these collaborative structures are described based on these women's experiences. Although they are described distinctly, the structures are interrelated. For example, the faculty can implement active, collaborative learning pedagogies more effectively with small class sizes, compared to larger, lecture sections.

For the remaining four elements of the BELONG model, represented by the last four columns in Table 2, the dark shading on the table demonstrates that sense of belonging and self-efficacy were most salient during their first semester. Also, most students mentioned outcome expectations and engineering interests, which are indicated by the light shading. The remainder of the results section is organized by the BELONG model, starting with findings for each of the six collaborative program structures. Next, the results focus on sense of belonging and self-efficacy in relation to program structures that the women identified. Finally, a brief description of engineering interests and outcomes expectations is included.

Table 2. Summary of Interview Participant Responses in Relation to BELONG Model.[illegible]

Shading Key: 15% shading = Mentioned by not emphasized; 50% shading = Emphasized.

4.2.1. Collaborative Program Structure: Student and Faculty Diversity

Students identified the gender and racial diversity of their cohort and faculty as a key structural support. Seeing more women in Engineering reassured them that their voices would be heard and that they had a place in the field. Nadia commented that at a recruitment visit she “saw a lot of females there, and it wasn’t like other schools, whereas [were] male dominated,” which cemented her decision to enroll in the program. Elise shared “I think from the very beginning I could kind of feel like this program is really good, especially with like diversity and inclusion. I don’t think I’ve ever felt like I didn’t belong.” Others described how the presence of diverse peers created a welcoming environment and helped them focus on their work. Students also reflected on how diversity helped counter feelings of exclusion and provided a sense of community, even as some continued to navigate racial microaggressions or being one of few students of their racial identity in class.

The women had mixed experiences regarding their racial identities at this predominately White institution (PWI).

There are instances where I can see differences between me and my classmates, whether it’s like I’m like one of two Black women in my classes ... it’s just little stuff like that that you kinda are aware of. But it doesn’t really—I don’t allow it to deter me if that makes sense.

Other women shared similar experiences. Another student referenced her cultural connection with a particular faculty member and being able to develop a strong relationship because of this shared racial background. In contrast, a student that identified as Mexican explained that she had previous negative experiences associated with being the only Hispanic in a predominantly white high school, coming into the program with impostor syndrome. “When I went to the first dinner [within the Engineering program], I realized there wasn’t many Hispanics. I just kind of got that feeling again.” One of the few challenges she faced her first semester was overcoming imposter syndrome. “As soon as I got to my classes, I realized I was able to make other friends.” She described flipping her negative thinking into finding a positive with being one of the few Hispanic women within her Engineering class.

4.2.2. Collaborative Program Structure: Active, Collaborative Learning Pedagogies

Students identified the program’s use of active, collaborative learning as a key structural support that shaped their experience in the first year. They noted that this approach was different from the traditional instruction they were used to and pushed them to engage in a novel way. Team-based projects, especially the ENGR 101 design project, were consistently described as a highlight of the program’s first year. These projects illustrate how the program intentionally integrates collaboration into coursework, giving students opportunities to practice teamwork and build peer connections.

Students mentioned that group projects provided a way for them to collaborate, build relationships, work through challenges, and demonstrate mastery of what they learned throughout the semester. Elise explained:

I think Loyola’s Engineering program is really good with that active learning. It’s kind of like in the beginning. It can be a little frustrating because like, you don’t know what you’re doing. But then it really does stick with me and like I feel like I’m a lot. I’m able to learn a lot better, and maybe not quicker, but deep deeper, I guess. And then it also helps with like, I feel like collaboration. I feel

like we do lots of group work in the engineering courses, even outside the engineering courses. It's a lot of group work which I think will help in the future.

Elise's explanation demonstrates how active learning facilitates her self-efficacy related to her experiences as a learner and her future career.

Nadia, Maria, and Aaliya reported learning to work through communication issues and to get along with fellow students. In addition, Elise, Kaelyn, and Bette recognized that group projects provided them with essential skills for their future careers. Elise specified that working in groups was a valuable skill, specifically working through the stress when "some parts of the project ... had to be changed" would be "helpful in the future." Bette mentioned group projects served as "a nice introduction into like what it means to be an engineer."

When prompted, students described case studies covering multiple real-life scenarios that invited them to explore the role engineering plays in solving world problems. Nadia, Aaliya, Elise and Bette mentioned that these cases helped them understand that engineering is "more than just like problem solving." Elisa commented that she now realizes that engineers need to have a more comprehensive understanding of communities and "take into account the ... factors like the environment, community, history, culture."

While collaboration was widely viewed as a central support in the Engineering program, some students reported mixed experiences with how it was structured. Maria reflected that small groups were helpful but sometimes limited opportunities for deeper discussion. Similarly, although not discussed by other students, Kaelyn described competition and tension within groups.

There's a lot of competition where I feel like there shouldn't be. It's very much like you're working together ... but there's a lot of just tension between a lot of people, I would say. So it makes it a bit awkward, but I wouldn't compare it to pre-med section. When I was in there that was so much more cutthroat.

Despite these views, students notably enjoyed and valued both the active learning activities they partook in within their respective groups and their group members.

4.2.3. Collaborative Program Structure: Supportive Climate Among Peers

All the women repeatedly described a supportive climate among peers through the stories they shared about their first semester. For example, Bette described her experiences. "I would say, it's a very welcoming environment. I've never felt like I didn't belong. If that makes sense. I feel like everyone just kind of builds each other up in this department." Students mentioned that they enjoy studying and working together with other students, both in their first engineering class and in other required program courses, such as physics. One student described working with other students to help her make it through physics which was the "hardest class in her life." She mentioned that the students organized study groups to help them prepare "before exams or before quizzes, just like going over the material, doing practice problems, making sure that we knew the ins and outs of everything we needed to know in order to do well on the test ..." The students consistently supported each other throughout their academic studies. Beyond academic collaboration, students emphasized that they regularly received positive reinforcement from peers that fostered endurance and connection during challenging projects. Maria reflected, "We're like our own cheerleader(s) ... group projects aren't always the most fun ... but like we all compliment each other ... we make sure to show our appreciation for other people." She added that when she reached out to others for help, they would reassure her by saying, "It was also hard for me too in the beginning, but ... I'm gonna help you along the way."

4.2.4. Collaborative Program Structure: Supportive Climate from Faculty and Sponsors

Several students commented that faculty were “helpful” and that office hours were a resource if they had questions about the class material. Elisa described “I feel like I haven’t met a teacher yet that’s like super, I guess, strict, maybe about like how you’re supposed to learn.” She elaborated that “They’re very open to like new questions ..., which is really nice.” She also viewed faculty as “approachable” and did “not feel intimidated by them.” Kaelyn described “feeling very comfortable to talking to [woman chair of Engineering]”, whereas Aaliya described that “it might be scary at first” but it was worth the “effort” to “(get) out of (her) comfort zone” to talk with faculty. One student mentioned a talk with a faculty member easing her worries when she was thinking of quitting Engineering, “But then I think I talked to [woman chair of Engineering] about this and like, and then I felt a lot better about that.” Maria noted that all of her professors “just cheer me on” with comments such as “you’re doing great. Keep going. Like, I believe in you. I’m really proud of you.”

Students also described weekly meetings with faculty sponsors who supported their design projects, providing feedback. Nadia mentioned that “we would often meet and check in with them. They would critique us sometimes, but they would also compliment us for our work, but it was more like a team compliment.”

4.2.5. Collaborative Program Structure: Dedicated, Accessible Physical Space for Engineering Students

Three of the six students referenced the “flex lab,” a dedicated space for Engineering students, as central to fostering a collaborative spirit and helping students develop a sense of belonging. The flex lab, which is accessible only to Engineering students daily until 10:00pm, provided a dedicated space for jointly working on projects, studying, and building relationships. Nadia explained “it definitely helped me stay on track and focus.” Students emphasized that having a space specifically for engineers encouraged collaboration and community-building. Maria echoed the value of having Engineering-only spaces like the freshman design classroom in Cuneo Hall where “we actually really get to kind of discuss with each other, work with each other, [and] help each other out.” Bette explained, “Being in the flex lab ... it’s very collaborative. It’s a whole ... very tight community. We don’t judge each other. We honestly like all of us in there just have the same goal of wanting to complete our projects.” This space helped establish a sense of camaraderie that made them feel comfortable and not intimidated.

4.2.6. Collaborative Program Structure: Small Class Sizes

In terms of the structure of engineering programs, most of the students commented that the smaller size incentivized them to enroll in Loyola’s Engineering program compared to other larger programs. Elisa explained “It feels a little bit less overwhelming to attend a smaller school.” Also, Aaliya described:

I love that they do the classes that are like smaller. And they actually put a lot more attention towards you. And it makes you like feeling such like a tight knit community, unlike other like schools that are bigger, and they just have like 50 to 100 students of engineering, like in one classroom. I love how they just have at most 25. And they put all their attention on you, and they make sure like that you are going to succeed.

4.2.7. Sense of Belonging and Self-Efficacy

Building on the emphasis the women had of sense of belonging and self-efficacy (see Table 2), examples of how students’ experiences with the collaborative program structures

fostered sense of belonging and self-efficacy are given in Table 3. Although these experiences were evident in all the interviews, as indicated from the examples in Table 3, the results in this section focus on one student's experiences. Telling these stories from the perspective of one student also illustrates the interconnectedness between the collaborative structures, sense of belonging and self-efficacy through her detailed stories. The model elements—engineering interest and outcome expectations—are not included in this analysis due to the limited mention of these elements in the interviews and will be addressed in subsequent sections.

Bette had a strong sense of her identity as a woman of color and prior experience navigating racism in a PWI. She described her sense of belonging as a Black woman in Engineering.

I would say, like honestly, within the Loyola Engineering department, going into like a STEM field, as any like woman is like terrifying. And then, as a woman of color that just adds a whole other layer. I will say I feel like at Loyola Engineering there are a good amount of like women of color. So in that aspect, it's just like not feeling completely alone. Like, I definitely think, that there is space to exist as a Black woman in the Loyola Engineering department. So I like, really, really appreciate that it's definitely made me more comfortable. And like even with like speaking up in my classes, or just being willing to like share my ideas like seeing other people that like look like me. It definitely helps.

As Bette stated, being able to identify with peers in her program fosters a sense of belonging, which provides the comfort and self-efficacy to participate actively in her classes. Such participation is essential to her engagement in learning. Bette understood herself as a learner.

The big thing that Loyola Engineering pushes is like the whole, like active learning. So like, I definitely knew that I wanted a program where I wasn't just going to be lectured at, because I can't learn that way like I need to like experience like what I'm supposed to be learning to like, actually like, comprehend, and then be able to like, go out and do it by myself.

The active learning pedagogies were a critical factor in choosing the program.

Bette also told stories that demonstrated how self-efficacy fostered her sense of belonging as an engineer. She described struggles with her physics course, which she viewed as a possible threat to belonging in the Engineering program and then the sense of belonging that she experienced when she passed physics. She also described approaching an assignment. "I first get an assignment, I'm like, I absolutely have no idea what I'm doing here. But I think what's so great is that everybody else is feeling the exact same way." Her sense of belonging as an engineer supported her self-efficacy to work on challenging assignments.

Table 3. Overview of the Collaborative Program Structures First Year Undergraduate, Women of Color Described and Influences on Sense of Belonging and Self-Efficacy.

Collaborative Program Structures	Example of Influence on Sense of Belonging	Example of Influence on Self-Efficacy
Student & faculty diversity in program ($n = 6$). Despite being a PWI, the visible presence of women and racially diverse students and faculty affirmed their identities and helped them feel they belonged in a traditionally male-dominated field.	"Whenever I'm with, like, honestly, just the women of engineering, then you really really feel included, everybody's very open, very diverse. It makes you forget about the problem, a little bit." — Kaelyn	"I feel like the students that I was in, at least in my engineering class. It was like a pretty diverse group. It wasn't just like specifically one race. I feel like that helped [combat feelings of imposter syndrome]" — Aaliya

Active/collaborative learning pedagogies ($n = 6$). Instructional approaches that require students to work in groups on hands-on projects and problem-solving activities, including first-year projects.	“So it [collaborative project] did make us become closer and closer together, and especially cause it was such like a team, heavy project, that you cannot do like a lot of the stuff alone like that’s what they bring us closer.” — Aaliya	“My current project is building an anatomical model of [collaborative project] ... It was a lot of work ... It was really difficult. (And) glad we got all the designs, everything, all the reports are completed and approved of.” — Kaelyn
Supportive climate among peers ($n = 6$). Classmates who problem-solve together, offer positive affirmations, and actively uplift one another during challenges.	“I feel like just the community. I guess in Loyola is really open, which I like. I feel like I can just like I don’t need to be nervous, I guess, to be myself here” — Elise	[when discussing getting a new assignment] “ ... with new experiences come hardships. But they also offer the opportunity to really grow and challenge yourself. And not only are you able to grow individually, but you can grow with other people by forming such like a collaborative environment and kind of like helping each other out” — Bette
Supportive faculty & sponsors ($n = 6$). Faculty and project sponsors who provide positive affirmations, meet with students during office hours for academic support and advice, and serve as role models whose identities and experiences inspire students.	“Being able to like envision myself in [chair of engineering’s] shoes, and like knowing that she has gone through like many challenges, as a woman of color like that just gives me more motivation.” — Bette	“Also the teachers, if you do use their hours, they do help a lot with you and overall just like asking And it might be like, really hard at first, I know, I wasn’t good asking a few teachers, I’m like, Oh, I don’t know, but it does help like asking questions, and just getting out of your comfort zone, for sure.” — Aaliya
Dedicated, accessible physical space for engineering students ($n = 3$). A designated study and collaboration space (e.g., flex lab) reserved for engineering students, acting as a central hub for community.	“... we actually get together, sit in the flex lab and just work on our projects together. Like, it’s a very close community. And I do really like that.” — Maria	“... being able to have a special, I guess, place for to study as an engineering student in flex labs that, like no other majors could go to, definitely helped me stay on track and focus” — Nadia
Small class sizes ($n = 5$). Smaller cohorts of students allow students to build relationships and frequently work together.	“I do enjoy having a smaller class size, where we get to interact with like the same few people really build, like close relationships” — Maria	“I think that’s when it helps that our program is so small, since everyone kind of knows everyone in the program, it’s easy to ask for help and work with other students to figure out, or we’ll do whatever problems we have together.” — Elise

In addition to peer diversity, Bette also described the impact of faculty diversity when asked “what do you think has been beneficial in helping you succeed at Loyola?”

But then also, like, when you look at [chair of Engineering] like she’s such an accomplished woman, and she’s the head of the Engineering department like, I feel like, that’s a really really powerful thing to see like, especially as a woman of color, like seeing another woman of color in such a high position. Really matters, because, like representation, like matters a lot, especially to like younger people. So like being able to like envision myself in (her) shoes, and like knowing that she has gone through like many challenges, as a woman of color like that just gives me more motivation.

Bette acknowledged that engineering is “really, really hard” and mentioned that a friend’s brother, who is a successful engineer, commented that “if you don’t make friends in your classes, you’re going to be struggling like it’s going to be hard to even like get through step one of a project you have to complete.” She told a story about working on an assignment in the flex lab.

I look at this other girl, and she’s also struggling. So I just go up to her. And I’m like, Hey, like, my name’s [redacted], like. Obviously, I’m an engineer. We’re working on the same assignment, like, if you want to like collaborate, or just like, you know, help each other out like I’m here. And we ended up like being able to like complete the project using each other’s help. And so it’s just moments like that where I’m like, okay ... This is what engineering is about. And this is why I’m in this program.

Having the dedicated, physical space in the flex lab facilitated collaboration with peers, and ultimately her sense of belonging.

Bette further described that at the flex lab students “gather together and bounce ideas off of each other” and that while she is there she explained “I don’t feel like. Oh, I’m gonna like, say, something stupid. And then everyone’s gonna judge me like” since “it’s very collaborative. It’s a whole. It’s like a very like tight knit community.” She described how everyone is working toward the same goals such as completing their projects, so “it’s really easy to like get some good progress on the projects.” This illustrates how the flex lab also provided opportunities for her to build self-efficacy in completing Engineering projects.

4.2.8. Outcome Expectations

Four women mentioned their outcome expectations for their Engineering degree. Elisa described hopes for a summer internship to explore her specialization. Nadia clarified her interests to use her Engineering specialization to pursue her career goal to go to medical school and be a doctor. Kaelyn and Bette described goals of getting jobs in their Engineering specialization.

4.2.9. Engineering Interests

All six women mentioned interests in engineering. Nadia, Elise, and Bette told stories about their interests in engineering starting prior to their undergraduate program through high school projects, robotics team, and a family member who was an engineer. Two of these women also referenced interest in their Engineering major in general or their specialization. Maria, Aaliya, and Kaelyn referenced interests in their undergraduate major, including one woman who transferred into Engineering from another major early in the semester. They referenced interests related to “problem solving,” knowing “how to fix things,” “building,” “working with (their) hands,” and “see(ing) the fruit of (their) labor.” In addition to the Engineering specializations, one woman mentioned how the small class sizes supported these opportunities and interests.

5. Discussion

The development and implementation of the BELONG (Becoming Engineers Leading Our Next Generation) Conceptual Model of Engineering Persistence at Loyola has resulted in the program’s ability to graduate about 50% women annually. The model is based on social cognitive career theory, one of the most popular vocational theories that explains how learning experiences are translated into academic and/or vocational interest, commitment, and persistence. The model incorporates collaborative program structural support and sense of belonging as precursors to engineering persistence. The BELONG

model represents a structural solution that addresses the exclusion of women while also attracting and potentially retaining women and women of color in engineering. As an initial empirical step towards model validation, we conducted six semi-structured interviews with self-identified women of color in the Class of 2028 with the goal of obtaining an in-depth understanding of their program experiences during their first semester. Data from this study support the meaningfulness and utility of the BELONG model and point to potential adaptations to the model.

Our findings revealed the compelling reasons why these women choose to persist in engineering. In general, these women sought a program in which they identified other women and students of color as engineers. They desired and appreciated opportunities for collaborative, active learning. Through their first semester, particularly through experiences with their freshman year design projects, they developed a sense of belonging and built self-efficacy. A supportive climate from faculty and peers also contributed to their sense of belonging and self-efficacy. The experiences of these women of color demonstrated that they were keenly aware of their identities in relation to the field of engineering and other students in their program. They shared variability in their experiences in relation to their identities and prior experiences in PWI, which shaped their experiences during their first semester. Although the women did not share examples of gender microaggressions, some women shared experiences of racial microaggressions at this PWI.

Many of the BELONG program structures, as designed, were critical for supporting their success, including diverse representation of students and faculty, active learning pedagogies, supportive climate among students, supportive climate from faculty and sponsors, and small class sizes. These structures overlap with several structures Ong et al. (2020) identified, including proportion of women in the classroom, and sense of belonging. From the SCCT perspective, these program structures likely operated as a support system that facilitated (directly and/or indirectly) self-efficacy, interest, and persistence; they also likely served as a support that deepened students' sense of belonging. For example, active learning pedagogies likely operate in a way to provide students with a performance accomplishment (cf. Lent et al., 1994), that serves to bolster one's sense of self-efficacy and ultimately lead to greater interest in and commitment to persist in engineering. Although the women did not explicitly note program structures that addressed masculine defaults and differential treatment, they also did not identify these as challenges to overcome. Their responses emphasized a climate of collaboration that likely facilitated their sense of belonging in engineering (Wilson & VanAntwerp, 2021; Holland, 2019; Ong et al., 2020).

5.1. Implications for BELONG Model Development

These findings validate the BELONG model and suggest potential adaptations. They demonstrate that in their first semester having a sense of belonging and building self-efficacy were the most salient for first year women of color. Although engineering interest and outcome expectations were still evident, these elements may become more salient for the women in subsequent years of their undergraduate program.

The model notes self-efficacy facilitating sense of belonging. However, based on the experiences of these women of color, this relationship appears bi-directional, and in their first semester sense of belonging seems to foster self-efficacy more than the reverse direction. When the women experience a sense of belonging, they were then able to engage in activities to build their self-efficacy. Participant responses also highlighted the ways in which individual and collective self-efficacy were facilitated through group-based learning experiences. Collective efficacy (Butel & Braun, 2019), or the confidence of a group to achieve a common goal, may be especially relevant for women (and other historically excluded communities subjected to hostile climates) in engineering.

5.2. Implications for Practice to Rethink Engineering Education

The BELONG model and initial validation findings provide a roadmap for rethinking and repositioning engineering education as an inclusive environment. In the United States, not only is it imperative to increase the annual number of engineering graduates for future economic growth, but any increases are now threatened by the impending demographic cliff of 2026. Beginning in 2026, the annual number of U.S. high school graduates will sharply decline, due to declining birth rates (Grawe, 2018). The number of college-aged students from 2025 to 2030 is forecasted to drop by more than ten percent (Grawe, 2021). As U.S. engineering institutions grapple with concurrently attempting to attract college-age students who are much smaller in total number, it will be important to target untapped student groups, as well as to increase retention of existing students. Women, who make up half the population and include women of color, should be the first target group.

But how should engineering faculties target women college-age students and how can the engineering persistence of women be increased? This study points to several program structures that could support women of color at other institutions. These program structures welcome women in general, and specifically women of color, into an engineering student community, and enable cultivation of sense of belonging.

First, although campus space is always in short supply, designating a physical space exclusively for engineering students provides a collaborative meeting place for working on team projects, studying together, and building relationships. The dedicated physical space at Loyola was not an intentional program design nor previously identified in prior studies. The main Loyola Engineering space is a 10,000 ft² building containing three classroom/labs, a small makerspace, and two study lounges. Because expensive equipment is always out on workstations and counters in this building for learning activities, the building is ID card-access only for Engineering faculty, students, and staff. Women shared the value of such welcoming spaces for fostering sense of belonging and collaboration among the entire Engineering student community. In contrast, previously recommended counterspaces provide “safe spaces” *outside* of mainstream educational spaces to counter marginalization (Ong et al., 2018). Compared to other program structures, a dedicated physical space for engineering students may be feasible for other programs to create. This physical space should not just encompass an impractically large study lounge but could incorporate existing engineering classrooms and labs. The designated space should not appear to be a counterspace for underrepresented populations.

Second, faculty diversity should model the student diversity an engineering program is seeking. To encourage women high school seniors to apply, a program should not only have women faculty members of color (Main et al., 2020), but need women faculty members of color who are *tenured*, rather than contingent (i.e., non-tenure track) or pre-tenured. Once tenured, women faculty members can more easily challenge stereotypes and serve as faculty leaders in their departments (Erichsen et al., 2024). Some of the interviewed students mentioned their woman chair of Engineering as a role model and motivator for graduating in Engineering.

Although initial implementation requires extensive resources, active learning pedagogies should be adopted by engineering programs wishing to retain more women. Active learning implementation results in student performance and retention rewards that are well-established (Freeman et al., 2014; Holland, 2019). While it can be argued that implementing active learning requires substantial resources for converting course formats, training faculty, and purchasing equipment, engineering instructors must also respond to the increasing sophistication of artificial intelligence (AI). With AI chatbots now capable of calculating circuit parameters from a text description and a hand-drawn circuit and generating functional code in the programming languages engineering faculty members

assign to students, providing collaborative and problem-based learning assessments in class minimize the opportunities for cheating and also create the sense of belonging and collaboration students crave. Women high school seniors visiting engineering programs notice when courses are taught in a more collaborative, rather than competitive, style, and apply to these collaborative programs. While they add to the cost of implementation, small course sizes enable active learning pedagogies to be more effective in increasing student performance and persistence. Offering a freshman design project the first semester is the most effective way to initially implement active learning because students immediately begin to work in groups and collaborate together on an engineering project and other course assessments. This collaboration and increasing sense of belonging may be the underlying reasons that first-year projects increase engineering persistence (Fortenberry et al., 2007).

Of these three recommendations, adopting active learning pedagogies is the most difficult to implement. It can be argued that this adoption is much easier for the Loyola Engineering program with 160 students or the U.S. Air Force Academy Engineering Division with a few hundred more students, than for a public engineering school. Both smaller institutions have committed to training their faculty to teach with these pedagogies and monitor subsequent teaching effectiveness. It should be possible to adopt active learning pedagogies in engineering schools, if engineering students and their faculty were subdivided into smaller adoption pods of a few hundred students. The major barriers to adopting active learning in engineering education are instructional support, instructor comfort and confidence, and institutional rewards (Carroll et al., 2023). At Loyola, implementation of the program's mandated active learning teaching style is required for promotion and tenure. If an engineering institution truly desires to increase its number of women students and increase the engineering persistence of all its students, as means to increasing its total student population, it must commit to these two retention initiatives (Grawe, 2021) and associated active learning incentives, such as substantial faculty training, appropriate active learning classrooms, and tenure and promotion for implementing active learning (Carroll et al., 2023).

5.3. Limitations

Present findings should be considered in light of several study limitations. First, although the BELONG model makes causal claims about the role of self-efficacy, outcome expectations, interests, collaborative structures, and sense of belonging on student engineering persistence, the use of qualitative methods in the present study is perhaps not the optimal approach for testing such claims. In addition, whereas the BELONG model addresses engineering persistence over time, the present results reflect one cross-section of time and do not address how these experiences and processes may unfold over time. Studies interested in testing causal or temporal hypotheses could use experimental and longitudinal methods in the future. Further, women who left the Loyola Engineering program were not interviewed to investigate how elements of the BELONG model affected their decision to change programs.

5.4. Future Work

The goal of this study is to understand how women of color in three classes persist in the Loyola Engineering program. Class of 2028 study participants will continue to be interviewed annually to obtain longitudinal data as they progress through the Engineering program. Members of the Classes of 2029 and 2030 will also be interviewed annually. In addition to qualitative analysis, quantitative methods will be used to test temporal and/or causal relationships (e.g., examining the utility of self-efficacy, outcome

expectations, interest, and sense of belonging in explaining engineering persistence) within the BELONG model.

6. Conclusions

In summary, engineering education in the United States is at a crossroads, needing to increase the annual number of engineering graduates for future economic growth, while threatened by the impending demographic cliff of 2026. One way to address this problem and rethink engineering education is to target the untapped student group of women, who make up half the population and include women of color, and implement aspects of the BELONG (Becoming Engineers Leading Our Next Generation) Conceptual Model of Engineering Persistence. The development and implementation of the BELONG model at Loyola University Chicago has resulted in the program's ability to graduate about 50% women annually. The model is based on social cognitive career theory and incorporates collaborative program structural supports and sense of belonging as precursors to engineering persistence. To explore the model, qualitative semi-structured interviews with six self-identified women of color were conducted to gain an in-depth understanding of their program experiences during their first semester. After applying emergent, focused, and thematic coding, results revealed student experiences and understandings of engineering self-efficacy, outcome expectations, interest, sense of belonging, and experiences of program structures. Data from this study support the meaningfulness and utility of the BELONG model and point to potential adaptations in the model. To rethink and reposition engineering education as an inclusive environment for women, the following collaborative program structures are recommended: (1) designate a physical space exclusively for engineering students, (2) model the student diversity an engineering program is seeking by hiring or promoting tenured women faculty members of color, and (3) adopt active learning pedagogies.

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Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial Intelligence
BELONG	Becoming Engineers Leading Our Next Generation
PWI	Primary White Institution

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