Classroom Practices that Support Minoritized Engineering Students' Sense of Belonging (Research)

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Abstract

Establishing and sustaining a sense of belonging is a necessary human motivation with particular implications for student learning, including in engineering. Students who experience a sense of belonging are more likely to display intrinsic motivation and establish a stronger sense of identity and persistence. It is important, however, to distinguish different domains of belonging, such as belonging to one's university, belonging to a major, and belonging in the classroom setting. Our study examines if and how faculty support efforts contribute to diverse students' sense of belonging in the classroom setting. Specifically, we sought to answer the following research questions: Which faculty support efforts promote a sense of classroom belongingness? Do faculty support efforts differentially promote a sense of classroom belongingness for students based on their demographic characteristics?

Data for this study was collected in the Fall of 2018, across ten institutions, $n = 819$. We used the Faculty Support items from the STEM Student Perspectives of Support Instrument developed from Lee's model of co-curricular support to answer our research questions. Demographic categories were created to understand if and how faculty support efforts differentially promote a sense of belonging for minoritized students compared to their counterparts. Multiple regression analysis was conducted to examine the faculty support efforts that fostered a sense of belonging in the classroom. Interaction effects were included to understand how faculty support efforts affected classroom belongingness for the students in the demographic groups we identified.

Minoritized women were less likely to feel a sense of belonging in the classroom when compared to majoritized men. Neither groups of women believed that their instructors wanted them to succeed, thus negatively impacting their classroom belongingness. There were, however, faculty support efforts that positively contributed to a sense of belonging in the classroom for minoritized women, including instructors' availability, knowing that they could ask instructors for help in course-related material, and when instructors fostered an atmosphere of mutual respect. Additionally, minoritized women felt a sense of classroom belonging when they could capitalize on their previous experiences to scaffold their learning.

Our findings highlight classroom practices and strategies faculty can use in the classroom to support minoritized women's sense of belonging. These practices and strategies will be a crucial resource for engineering educators and administrators who seek to improve the field's retention of minoritized and women students. Whereas efforts have been made to recruit minoritized students into engineering, our study points to a clear and crucial role for faculty to play: they can support minoritized students by fostering a sense of belonging in engineering classrooms.

I. Introduction

Students' sense of belonging has been a recent focus of some engineering education research due to the significant role it plays for student experience and success [1,2,3]. A student's ability to develop a sense of belonging within the higher education institution has been demonstrated to be a critical factor determining student retention [1]. A sense of belonging can also affect a student's degree of academic adjustment and achievement [2]. The existing research tends to study belongingness in general terms, drawing from dominant definitions that reference belonging to an "engineering context" [4] or "campus" [5]. Yet it is crucial to distinguish different forms of belonging, as they do not necessarily correlate with or imply one another. For example, low-income and first-generation students can experience belonging to engineering in general but not to their major, a classroom environment, or a work environment [3].

Our study examines if and how faculty support efforts contribute to minoritized students' sense of belonging in the classroom setting. The term minoritized is used to acknowledge the ongoing social experiences of marginalization, even when groups subject to racial-ethnic discrimination achieve a numerical majority in the population. In 2018, women received 22% of Bachelor's degrees in engineering. Of the 30,114 Bachelor's degrees awarded to women, 15,214 (or 50%) were awarded to white women; 4,849 (or 16%) to Asian-American women; 3,175 (or 11%) to Latinas; 1,332 (or 4%) to Black/African-American women; and the remaining 5,544 (or 19%) were awarded to women who were identified as nonresidents, American Indians, Pacific Islanders, two or more categories, or unknown categories [6]. While universities and other institutions have become better at tracking participation by gender, race, and ethnicity, we acknowledge that these dimensions of students' identities intersect with others, such as generational status, socioeconomic background, disability, and sexuality [7]. In this paper, we focus in particular on gender, race and ethnicity, and college generational status. By identifying the faculty support efforts that supported minoritized students' sense of classroom belonging, our research points to concrete strategies faculty can use to help broaden participation in engineering.

II. Literature review

Two dominant definitions for belongingness have been used in research studies. One definition presents belongingness as "a student's sense of belonging within an engineering context...defined by an individual's self-measure of 'fit' within a higher education institution's social and academic systems" [4]. A strong sense of belonging would then mean that the individual feels they "match-up" to their environment and their peers in terms of being able to navigate and form relationships, whereas a weak or absent sense of belonging would imply a lack of fit. In Baumeister and Leary's definition, belongingness is seen as "a student's perceived social support on campus, a feeling or sensation of connectedness, the experiences of mattering or feeling cared about…" [5]. The second

definition emphasizes the emotional dimension of belongingness, such as students' feelings about how they are treated, if they feel like they are cared about, etc.

The following review shows that some literature analyzes students' sense of belonging to the overall institution or engineering context, which mentions but not focuses on the classroom. Other research studies point to individual student experiences that reference classroom belonging, but that literature tends to emphasize the influence of peers rather than faculty. This paper helps to fill that gap by exploring the differential influence of faculty support practices on classroom belonging for majoritized and minoritized students.

A. Belongingness & gender

Some strands of research have suggested that engineering females perceive lesser feelings of belonging than males. Pearson et al. [8] performed a study that looked at belonging for different demographics among first-year engineering students and concluded that female students entered engineering feeling that they belong but at a level significantly lower than their male peers. Additionally, Godwin & Potvin [9] presented findings that indicated a lack of belonging among female engineering students. These studies, however, do not demonstrate where this lack of belonging originates.

In a study by Kirn et al. [10], two female students of different races both expressed frustration within the engineering culture present in their classrooms. While one talked about experiencing sexism and feeling the need to prove herself, another student mentioned being typecast as a notetaker among her group of male peers [10]. The lack of belonging these female students faced stemmed from the perceptions of women held by their male peers and a sense of exclusion from their male peers. Another study by Foor et al. [11] presented the story of Inez, a multi-ethnic female engineering student, who expressed how she just wished she "belonged more in this whole engineering group, with the students and the teachers" and how she "never got that feeling". Her experience suggests that faculty can contribute to peer ostracization. Inez expressed a feeling of "them" vs. "us" fostered by faculty, vividly describing how faculty had favorite students (the "them") who do not necessarily click with those outside of the circle. It is possible that socioeconomic disadvantage also played a role in her case, as faculty clicked with students who had internship experiences not available to all students. Inez expressed her perception that teachers saw a lack of internship experience as a sign of not knowing anything, without acknowledging the multiple factors that constrain marginalized students from doing internships [2].

B. Belongingness, race, and ethnicity

The relationship between race and feelings of belonging within engineering classrooms is more inconclusive than the research on belongingness and gender. Some quantitative, survey-based studies report findings that display no difference in sense of belonging among different racial

groups [8,12]. Even though Benson et al. [12] do not quantitatively identify a general lack of belonging in engineering among black students, with this study focusing on civil engineering, one interview with a black female student described how she experienced feeling as though she couldn't talk with anyone. One qualitative study with individual minoritized students suggests that they do experience a lack of belonging. In the study, the context for which belonging is experienced includes the classroom, the major, the profession, and the institution type and is explored as a variable influencing student experience. Berhan et al. [13] interviewed black students at a predominantly white institution (PWI) and presented results demonstrating that these students felt a lack of belonging in the classroom. The lack of belonging stemmed from their treatment by both faculty and students, where students described feeling like they had to constantly be on the defensive or as though people treated them like they didn't know what they were talking about. Berhan et al. [13] ask questions specifically tied to belonging in relation to cultural responsiveness and sensitivity, as well as perceptions of discrimination. These kinds of questions were not posed in the studies that reported no difference in belonging among the different racial groups, which could have played a role in their findings, suggesting that students perceived a lack of belonging when asked specifically about racially-based experiences.

When analyzing sense of belonging among Latinos/as in classroom settings, similar findings emerge as those from the experiences of black students. Rodriguez & Blaney [14] focused on belongingness for Latina students enrolled in STEM at a PWI and concluded that these students experienced a lack of belonging in the classroom, citing feelings of exclusion and self-doubt inflicted by their male peers. One Latina student also saw this marginalization by male peers as supported by instructors, and she also discussed her feelings of professors preferring male students in their classes. This finding demonstrates how the intersectionality of race and gender contribute to a specific lack of belonging, as is expressed in other interviews with minoritized women [11]. Lopez et al. [15] referenced STEM undergraduate formal professor-pupil interactions, of which include classroom spaces, as having a negative impact on a Latino/a students' sense of *familioso*, which is described as a cultural value that emphasizes loyalty, responsibility, solidarity, and reciprocity [16]. This *familioso* is opposed to classroom structures that reinforce competition, include reward systems, and foster individualism [15], or what Stephens et al. would contrast as interdependent versus independent models of social life [17]. The characteristics of *familioso* resonate with belongingness through embodying connectedness. Lopez et al. [15] argued that faculty should incorporate more *familioso* values into their mentorship of Latino/a students to encourage a sense of belonging.

As with gender, there appears to be a dearth of research that investigates how students who identify with particular racial and ethnic groups experience feelings of belonging as a result of faculty/student interactions in the classroom. Literature gives clues in specific cases of minoritized students experiencing a lack of classroom belonging due to the practices of their peers and faculty.

C. Belongingness, college generational status & socioeconomic status

A study that assesses feelings of belongingness for first-generation college students [18] reported higher belongingness to engineering majors and engineering classes than continuing-education students, but its results should be treated with caution as it almost exclusively evaluated belongingness for first-generation college students who were white males. These students referenced specific examples of belonging in the engineering classroom and faculty/student interactions, specifically describing how they were happy with their class sizes, how faculty encouraged them to think creatively, and how they did not believe faculty went through class material too fast [18]. Boone argues that first-generation students' belongingness in reference to these factors were higher than they were for continuing-education students. On the contrary, Benson et al.'s account of one white, male, first-generation student's perspective on classroom belonging described how he felt faculty only resonated with how some students solved problems and not all students, particularly those with access to skills and knowledge the student felt he lacked [12].

Socioeconomic background is often referenced alongside studies on first-generation college students due to the general correlation between low socioeconomic background and first-generation status [3,17]. Socioeconomic background was seen to play a role in belonging in the existing research, though it is sometimes difficult to disentangle from other demographic variables, given that identities are intersectional. Research suggests that students from disadvantaged economic backgrounds experience a *cultural mismatch* when in higher education. This mismatch stems from the perspective of interdependence that working-class families tend to adopt and the perspective of independence that upper- and middle-class families adopt, which is also typically the perspective of major universities [17]. In the interdependence perspective, "the normatively appropriate person should adjust to the conditions of the context, be connected to others, and respond to the needs, preferences, and interests of others" [17]. Therefore, working class students tend to see themselves as parts of a whole, focusing more on their role in relationship to others. In contrast, the independent perspective "assumes that the normatively appropriate person should influence the context, be separate or distinct from other people, and act freely based on personal motives, goals, and preferences" [17]. The mismatch that occurs when students who are accustomed to an interdependent perspective enroll in universities grounded in an independent perspective can erode feelings of belongingness. Beyond this study, very little research examines how students from low socioeconomic background experience belongingness in any part of the engineering context.

This study sought to understand how majoritized and minoritized students evaluate their faculty's efforts in terms of promoting a sense of belongingness, specifically in the classroom, and whether these efforts were perceived differently by students based on demographic characteristics.

III.   Research Questions

To understand the influence of faculty support practices on majoritized and minoritized students' sense of classroom belonging, we posed the following two research questions:

RQ1. Which faculty support efforts promote a sense of classroom belongingness?

RQ2. Do faculty support efforts differentially promote a sense of classroom belongingness for students based on their demographic characteristics?

IV. Methods

Data for this study came from students enrolled in ten, four-year ABET-accredited universities in the United States west, south, and mountain regions, $n = 819$. Data were cross-sectional, collected in the Fall of 2018. Demographic information on the participants can be found in Table 1. A four-level variable was created to categorize students who are the first in their families to attend college (i.e., first-generation college students) who receive a Federal Pell grant, first-generation college students who do not receive a Pell grant, students who have at least one parent with a Bachelor's degree (i.e., continuing-generation college students) who receive a Pell grant, and continuing-generation college students who do not receive a Pell grant. An institution type variable was created to categorize Hispanic Serving Institutions (HSI), emerging Hispanic Serving Institution (eHSI), and none HSI. Institutions were identified as HSIs, based on the "critical mass" eligibility criteria of 25% Latinx student enrollment, while institutions considered emerging HSIs have an enrollment size of 15% to 24% [19,20].

A. Participants' Demographic Characteristics

Demographic categories were created to understand if and how faculty support efforts differentially promote a sense of belonging for minoritized students compared to their counterparts. Students were divided into the following demographic groups: minoritized women (excluding White and Asian; 14%), minoritized men (excluding White and Asian; 23%), majoritized women and men (i.e., White and Asian 32% and 31%, respectively), and first-generation college students (46%). The term minoritized is used to acknowledge the ongoing social experiences of marginalization, even when groups subject to racial-ethnic discrimination achieve a numerical majority in the population. The majority of our participants indicated they were not transfer students (80%). Close to half of our participants were enrolled in Predominantly White Institutions (49%) while 29% and 22% of our sampled participants were enrolled in Hispanic Serving Institutions and emerging Hispanic Serving Institutions, respectively.

Table 1. Demographic Information of Students	
Total number of students	819

First-Generation College Student w/ Pell Grant[+]	330 (40%)
First-Generation College Student w/out Pell Grant[+]	97 (11%)
Continuing-Generation College Student w/ Pell Grant	114 (14%)
Continuing-Generation College Student w/out Pell Grant	247 (30%)
Female	376 (46%)
Male	443 (54%)
Minoritized Group[++]	273 (33.3%)
Black or African American	33
Latinx	226
Native American or Alaska Native	7
Native Hawaiian or other Pacific Islander	12
Another race/ethnicity not listed	4
Majority Group[++]	546 (66.6%)
Asian	195
Middle Eastern	35
White	402
Transferred from community college	160 (20%)
Hispanic Serving Institution (HSI)	239 (29%)
Emerging Hispanic Serving Institution (E-HSI)	181(22%)
Predominantly White Institution (PWI)	399 (49%)
Note. [+]Students who reported both parent(s)/guardian(s) level of education "less than a high school diploma," "high school diploma/GED," or "some college or associate/trade degree," were coded as first-generation college students. [++]Students were given the opportunity to mark all that apply for their race/ethnicity classification.	

B. Survey Scales

The Faculty Support items used in this analysis came from the STEM Student Perspectives of Support Instrument (STEM-SPSI) instrument [21]. STEM-SPSI is intended to be a diagnostic tool for colleges of engineering and science. In our study, we focus on students enrolled in colleges of engineering across ten institutions. Nine items for the faculty support construct were used. Four

Connecting Experiences items from the Funds of Knowledge scale [22] were used to understand the practices students agentically applied in their engineering courses, for example "I draw on my previous experiences at home when little instruction is given on how to solve an engineering task." Students were asked to rate their level of agreement measured on a seven-point anchored numeric scale ranging from 0-"Strongly disagree" to 6-"Strongly agree" for statements pertaining to faculty support efforts and connecting experiences. The survey items for belonging in the classroom prompted students to consider their level of agreement to statements pertaining to classroom belongingness. A seven-point anchored numeric scale ranging from 0- "Not at all" to 6- "Very much so" was used to capture students' sense of belongingness in their engineering classroom. The survey scale for classroom belongingness has been used in prior published work focused on minoritized student populations [23].

C. Data Analysis

A multiple regression analysis was conducted to examine the faculty support factors that foster a sense of belonging in the classroom. Five control variables pertaining to students' demographic information and institution type were included in the model. The control variable pertaining to gender and minoritized status is a four-level variable, where level 0 (reference group) = majoritized men, level 1 = minoritized women, level 2 = minoritized men, and level 3 = majoritized women. First-generation college student status was coded as a two-level variable with the reference group consisting of continuing-generation college students. The variable for Pell grant recipients was coded as a two-level variable with the reference group consisting of non-Pell grant recipients. The variable indicating transfer student status was coded as a two-level variable with non-transfer students serving as the reference group. Lastly, the institutional variable was coded as a three-level variable, where level 0 (reference group) = Predominantly White Institutions (PWI), level 2 = Hispanic Serving Institutions (HSI), and level 3 = emerging Hispanic Serving Institutions (E-HSI). Interaction effects were included to understand how faculty support factors differentially affected students based on their demographic information and type of institution. A backward elimination method was used to reduce the model to the most parsimonious one [24]. All analyses were conducted using the R programming statistical language version 3.5.1 [25]. Data used in this study are cross-sectional (i.e., collected at one point in time).

Assumptions of multivariate outliers and univariate normality were examined. Univariate normality was within acceptable range determined by skewness and kurtosis [26,27]. The model was screened for multicollinearity and influential cases. The correlation matrix of all predictor variables did not exceed 0.80, all variance inflation factor values were less than 5, and tolerance was above the recommended 0.1 cutoff value [28,29]. Case wise diagnostics were evaluated by examining the standardized residuals and Cook's distance; there was no evidence of significant deviation of normality [30]. Lastly, the variable for belonging in the engineering classroom was created into a composite score. The internal consistency for the composite score was evaluated

using Cronbach alpha; our alpha value of 0.88 demonstrates acceptable reliability (see Table 2) [31].

V.   Results

We examined how faculty supported students' sense of belonging in the engineering classroom and the differential effect based on student and university characteristics. A significant regression equation was found ($F(771, 82) = 23.24$, $p < .001$), with an adjusted R^2 of 0.55 indicating that the faculty support efforts explained 55% of the variance for belonging in the engineering classroom environment. First, we present the results of student and university characteristics that support classroom belongingness, that is, without considering support efforts. Next, we discuss how students' sense of belonging is promoted through faculty support efforts. Lastly, we discuss the results of the interaction effect which emphasize the differential consequence faculty support efforts have on classroom belongingness based on student and university characteristics.

Women from underrepresented racial/ethnic groups were less likely to feel as though they belonged in the classroom environment compared to the reference group (i.e., men from majority backgrounds; $\beta = -.49$ $p < .002$), perhaps due to the dominance of the field by men and the hypervisibility women experience in male dominated fields. Majoritized men's sense of classroom belongingness was reinforced by their perception that the majority of their instructors wanted them to succeed, in contrast with minoritized women ($\beta = -.43$, $p < .022$) and majoritized women ($\beta = -.57$, $p < .005$). Students enrolled in Hispanic Serving Institutions (HSI) were less likely to indicate they felt a sense of belonging in the classroom space compared to students enrolled in predominantly white institutions ($\beta = -.24$, $p < .025$). Institutions are classified as HSI when their Latinx student enrollment reaches 25% or more. Given the overall low participation of minoritized students in engineering [6] and low levels of minoritized engineering faculty [32,22], the classroom setting at HSIs may still be more oriented to serve students in the majority group.

Nine survey items pertaining to faculty support were modeled, and from the list of items modeled only one had a main effect that was not contingent on students' demographic background or institution type (i.e., interaction effect). For all students, their sense of belonging in their engineering classroom was bolstered when they perceived that their instructors *supported* their learning ($\beta = .09$, $p < .053$). All other significant main effects were contingent on students' demographics or institution type, as we discuss next.

Instructors' practice of **providing supplemental resources** to support students' learning was more influential for majoritized men's sense of belonging in the classroom compared to women in the majority group ($\beta = -.34$, $p < .035$). Similarly, continuing-generation college students' sense of belonging in the classroom was further supported when they received supplemental resources from their instructors ($\beta = -.49$, $p < .000$). Our study thus suggests that the use of supplemental resources is a support effort that continues to privilege already privileged groups of students rather than supporting minoritized students. Similar results were reported by Boone [18] and McLoughlin [34], who note that first-generation and female engineering students

may experience self-doubt when they believe they are given additional help and/or resources over males.

Instructors' practice of **connecting course topics to future career options** more supported majoritized men's belongingness in the classroom than minoritized women's belongingness ($\beta = -.43$, $p < .000$). This could be due to what type of future career options are being presented to students by instructors. Godwin & Potvin [9] discuss how many female students feel more belonging within engineering when they see how it has the potential to change lives and help others. This is in line with multiple studies demonstrating that a sense of social responsibility is important for women's interest and persistence in engineering [35, 36, 37, 38].

While both providing supplemental resources and connecting topics to future careers greater supported belongingness for majoritized rather than minoritized students, there were faculty support efforts that were more supportive of classroom belonging for minority students, such as first-generation college students and women. First, we found that first-generation college students were more likely to feel as though they belonged in the classroom when their instructors **provided useful feedback on their course assignments** ($\beta = .28$, $p < .005$). This could be because individual feedback is more personalized, signaling faculty investment in individual students, in contrast to supplemental resources, which are created without particular students in mind and distributed to multiple students at one time. Additionally, individual feedback is usually perceived as being offered to everyone, whereas students might perceive targeted supplemental resources offered to some students but not others as unwelcomed singling out [34], as discussed above.

Second, we found that two efforts were especially important for minoritized women's classroom belongingness compared to all other groups: **knowing that an instructor was available to meet** ($\beta = .38$, $p < .021$) and that an **instructor provided helpful support on course-related material** ($\beta = .44$, $p < .002$). This corroborates other studies that highlighted the importance of instructor availability for minoritized female engineering students [11,39], as explained in greater depth in the Discussions section, and the previous finding about the importance of providing tailored feedback to students without creating a feeling that they are being singled out in receiving it. We also found that women from the majority group and students enrolled in emerging Hispanic Serving Institutions demonstrated an increase in classroom belongingness when their instructors promoted an **atmosphere of mutual respect** ($\beta = .44$, $p < .005$) and ($\beta = .23$, $p < .034$), respectively. This could be related to the importance of what Calzada et al. call *familioso* for fostering belongingness [16], as we described above. Espinosa et al. [40] argues that institutions that have a large proportion of minority students (e.g., HSI) play a critical role in serving underrepresented students in STEM. Our study further unpacks how institution types (i.e., emerging HSIs) support students' sense of belonging which is through establishing the atmosphere that conveys to students that they are valued and respected members of the classroom culture.

Lastly, we found that both first-generation college students and minoritized women felt a sense of belonging in the classroom when they could **leverage their previous experiences from home to help them solve an engineering task** ($\beta = .15$, $p < .044$) and ($\beta = .13$, $p < .019$). While this support mechanism is derived from students' agency and less from instructors' intervention,

our finding offers educators a useful strategy to further foster classroom belongingness for students who are the first in their families to attend college and women from underrepresented racial/ethnic groups. While applying prior home experiences to scaffold learning supported first-generation college students' classroom belonging, it would be reasonable to also conclude that their classroom belongingness was further reinforced through identifying connections between their home experiences and the learning taking place in the classroom. However, we also found that continuing-generation college students were more likely than their first-generation peers to see connections between their experiences and the content being taught in class, thus further reinforcing their classroom belongingness (β = -.21, p < .001). We discuss reasons for this potential disconnect in the following Discussion section.

Table 2
Summary of Multiple Regression Predicting Sense of Belonging in the Classroom

	β	*SE*	t	*p*
Intercept	0.00	0.31	3.03	.003
Control Variables				
First-Generation College Student (FGCS) (Ref. group = Continuing-Gen. College Student)	0.16	0.28	1.44	.151
Pell Grant Recipient (Ref. group = Non-Pell Grant Recipient)	-0.03	0.07	-1.25	.212
Minoritized Women (Ref. group = Majoritized Men)	**-0.49**	**0.44**	**-3.92**	**.000**
Minoritized Men (Ref. group = Majority Men)	-0.14	0.45	-0.87	.385
Majority Women (Ref. group = Majority Men)	-0.15	0.37	-1.08	.279
Transfer Student (Ref. group = non-transfer students)	0.07	0.30	0.61	.544
HSI (Ref. group PWI)	**-0.24**	**0.31**	**-2.25**	**.025**
Emerging HSI (Ref. group PWI)	0.16	0.28	1.44	.151
Main Effects				
Q15a. My instructors were available to meet with me if needed.	-0.09	0.07	-1.35	.177
Q15b. I believe that a majority of my instructors want me to succeed.	**0.32**	**0.08**	**4.05**	**.000**
Q15c. I receive responses from instructors in a timely manner.	-0.03	0.03	-0.85	.395
Q15d. My instructors fostered an atmosphere of mutual respect.	-0.01	0.07	-0.13	.897
Q15e. My instructors provide supplemental resources to support my learning.	**0.19**	**0.06**	**2.91**	**.004**
Q15g. My instructors support my learning in the classroom.	**0.09**	**0.05**	**1.94**	**.053**

Q15h. I received useful feedback on course assignments.	-0.01	0.04	-0.15	.883
Q15i. My instructors connect class topics to my future career.	**0.24**	**0.05**	**4.15**	**.000**
Q15j. I could ask my instructors for help if I did not understand course-related material.	0.00	0.06	0.03	.978
Q3a. I see connections between my hobbies and what I am learning in my engineering coursework (e.g., design projects, homework, exams, presentations).	**0.10**	**0.03**	**2.75**	**.006**
Q3d. I draw on my previous experiences at home when little instruction is given on how to solve an engineering task.	0.09	0.04	1.80	.072
Interaction Effects				
FGCS *Q15e. My instructors provide supplemental resources to support my learning.	**-0.49**	**0.06**	**-4.03**	**.000**
FGCS *Q15h. I received useful feedback on course assignments.	**0.28**	**0.05**	**2.82**	**.005**
Minoritized Women*Q15a. My instructors were available to meet with me if needed.	**0.38**	**0.12**	**2.32**	**.021**
Minoritized Men*Q15a. My instructors were available to meet with me if needed.	0.14	0.09	0.89	.376
Majority Women*Q15a. My instructors were available to meet with me if needed.	0.30	0.09	1.85	.065
Minoritized Women*Q15b. I believe that a majority of my instructors want me to succeed.	**-0.43**	**0.14**	**-2.29**	**.022**
Minoritized Men*Q15b. I believe that a majority of my instructors want me to succeed.	-0.07	0.11	-0.38	.705
Majority Women*Q15b. I believe that a majority of my instructors want me to succeed.	**-0.57**	**0.11**	**-2.80**	**.005**
Minoritized Women*Q15d. My instructors fostered an atmosphere of mutual respect.	**0.44**	**0.12**	**2.84**	**.005**
Minoritized Men*Q15d. My instructors fostered an atmosphere of mutual respect.	0.21	0.11	1.10	.273
Majority Women*Q15d. My instructors fostered an atmosphere of mutual respect.	**0.45**	**0.09**	**2.60**	**.009**
Minoritized Women*Q15e. My instructors provide supplemental resources to support my learning.	-0.18	0.11	-1.41	.160
Minoritized Men*Q15e. My instructors provide supplemental resources to support my learning.	0.02	0.09	0.10	.917

Majority Women*Q15e. My instructors provide supplemental resources to support my learning.	**-0.34**	**0.09**	**-2.11**	**.035**
Minoritized Women*Q15i. My instructors connect class topics to my future career.	**-0.43**	**0.08**	**-4.14**	**.000**
Minoritized Men*Q15i. My instructors connect class topics to my future career.	-0.20	0.08	-1.49	.137
Majority Women*Q15i. My instructors connect class topics to my future career.	-0.02	0.07	-0.21	.834
Minoritized Women*Q15j. I could ask my instructors for help if I did not understand course-related material.	**0.44**	**0.11**	**3.11**	**.002**
Minoritized Men*Q15j. I could ask my instructors for help if I did not understand course-related material.	-0.05	0.10	-0.28	.779
Majority Women*Q15j. I could ask my instructors for help if I did not understand course-related material.	0.26	0.09	1.51	.130
HSI*Q15d. My instructors fostered an atmosphere of mutual respect.	0.01	0.06	0.04	.964
E-HSI*Q15d. My instructors fostered an atmosphere of mutual respect.	**0.23**	**0.07**	**2.13**	**.034**
FGCS*Q3a. I see connections between my hobbies and what I am learning in my engineering coursework (e.g. design projects, homework, exams, presentations).	**-0.21**	**0.04**	**-3.28**	**.001**
FGCS*Q3d. I draw on my previous experiences at home when little instruction is given on how to solve an engineering task.	**0.15**	**0.04**	**2.02**	**.044**
Minoritized Women*Q3d. I draw on my previous experiences at home when little instruction is given on how to solve an engineering task.	**0.13**	**0.06**	**2.35**	**.019**
Minoritized Men*Q3d. I draw on my previous experiences at home when little instruction is given on how to solve an engineering task.	0.08	0.05	1.20	.231
Majority Women*Q3d. I draw on my previous experiences at home when little instruction is given on how to solve an engineering task.	0.07	0.04	1.06	.289

VI.   Discussion

Our study demonstrates that faculty support efforts differentially enhance classroom belongingness for majoritized and minoritized engineering students. While faculty may believe that practices such as providing supplemental resources and connecting classroom topics to future careers may benefit all engineering students, our analysis shows that they supported belongingness for white males and continuing-generation college students. We suggest a few potential reasons for why this may happen. First, supplemental resources do not carry the same sense of personal investment as does individualized feedback, and students who receive supplemental resources may feel singled out as needing help in comparison with their peers. In a longitudinal study of 63 women engineering students, McLoughlin [34] found that even though they were appreciative of additional services offered in engineering, they resented feeling "spotlighted" or singled out as other than the norm. Second, faculty may be presenting narrow future engineering careers that do not appeal to minoritized students, many of whom are motivated by broader aspirations of using engineering to promote social responsibility and social justice [36,37]. It would be valuable to investigate if there is a link between which kinds of "future careers" and engineering applications faculty present to students and minoritized students' belongingness. Perhaps linking course content to future careers could foster belongingness among minoritized students if it included more diverse and socially engaged images of engineering careers.

Minoritized students' sense of belonging was positively reinforced when faculty provided useful feedback to students, offered helpful support, were available to meet, and cultivated an atmosphere of mutual respect. The significance of faculty being available to meet may reflect the significant demands that especially minoritized women face in managing multiple priorities on their time. One ethnographic study recounts how Inez, a minoritized multiethnic female student, felt hindered academically by her professors' lack of availability outside of office hours [11]. Another minoritized female student, Kitatoi, expressed her frustration with attempting to receive help from her instructors outside of office hours [39]. As a single mother, Kitatoi had competing priorities and a more flexible instructor could have better assisted her learning alongside her continued focus on other important obligations. Cole [41] also found that minoritized students believe college instructors to be less accessible and supportive of them, even if they are high-achieving students. These students also see in-class interactions with faculty as a potentially positive or negative indicator of how that faculty will respond to them outside of class. Cole's study was not focused on engineering students, so it suggests that faculty accessibility could be a broad concern for minoritized students irrespective of major [41]. Future research could explore if and how particular features of undergraduate engineering (such as a "weeding out" culture of competition) influenced students using classroom experiences to predict how a faculty would treat them outside of class.

Finally, belongingness was also reinforced when minoritized students were able to leverage their previous experiences from home to help them solve an engineering task. However, there seems to be a disconnect between this finding and our finding that seeing connections between home

experiences and class content supported belongingness for continuing-generation students more than their peers. In other words, first-generation college students are not seeing connections between their personal hobbies and their engineering coursework as much as their continuing-generation peers, even though their belongingness is supported through drawing on their personal experiences from home for guidance on engineering tasks. The disconnect could stem from how faculty present what counts as relevant knowledge for engineering. While majoritized students might see their personal hobbies reflected in instructional practices (problem examples, project ideas, etc.), first-generation students do not see their own hobbies represented and have to rely on making those connections themselves. This message about what "counts" as engineering can reinforce minoritized students seeing their home and university knowledge as existing in separate realms and differentially valued. This finding builds on our prior research, which also demonstrated that first-generation college students did not explicitly see the connections between most of their background funds of knowledge, such as mediational skills, and their engineering education [42]. The "connecting" practice positively supported classroom belonging only when students also believed that they could perform well in engineering. Collectively, this research points to the ways minoritized students have to negotiate the value of their bodies of knowledge instead of seeing them represented and supported by their instructors.

VII.   Implications

Our study suggests at least four concrete strategies that engineering faculty can use to promote greater sense of belonging among minoritized students. First, faculty should do their best to be available to students. Minoritized students often have multiple, competing time demands from work and family responsibilities so it can be difficult for them to make narrowly scheduled office hours, especially when those are scheduled during small blocks of a typical working day. Second, faculty should invest time in providing individualized feedback and helpful support to all students, rather than providing generic supplemental resources to particular students. When women and first-generation students receive supplemental resources, it can lead to them feeling singled out, whereas men and continuing-generation students do not experience that stigma. It could also be that women and first-generation college students feel greater belonging when faculty provide feedback because it signals faculty care and investment in them.

The importance of the care and investment associated with individual feedback is tied to our finding that feelings of mutual respect supported feelings of belonging for minoritized students, as suggested by other literature [15]. Improving the quality of the faculty/student relationships to include mutual respect is therefore our third recommendation, and providing individualized feedback and being available outside of narrowly defined office hours can be part of faculty strategies. It could also be beneficial to infuse more empathy into classroom teaching and advising. Burns and Lesseig [43] focused on a diverse group of sixth-graders as they attempted to create engineering designs and concluded that highlighting empathy as a component of engineering curriculum fostered a stronger sense of belonging among the female students in particular.

Finally, it is imperative for faculty to present a broad view of engineering both when linking students' past experiences to their future learning and when linking class content to future careers. First-generation and other minoritized students do have home and work experiences that are valuable to engineering learning, but the stereotypical activities that faculty and students alike reference as key for cultivating engineering interest and ability -- such as attending STEM camps and playing with Legos -- are not equally available to them [42]. Even faculty references to taken-for-granted experiences such as internships can contribute to minoritized students' ostracization from other students [11], and faculty would do well to remember that internships are not a meritocratic achievement but often garnered through social capital not available to minoritized students [44]. There is a particular opportunity to emphasize the inherent social responsibility and social justice dimensions of engineering and future engineering careers, as this supports interest and persistence in engineering among minoritized students.

VIII.   Conclusion

Our study raises both concern and hope for educators seeking to broaden participation in engineering. Women from underrepresented racial/ethnic groups were less likely to feel as though they belonged in the classroom environment compared to White men, and neither minoritized nor majoritized women believed that their instructors wanted them to succeed, which negatively impacted their sense of classroom belonging. Some faculty support efforts, such as providing supplemental resources and connecting course content to future careers, supported White, continuing-generation college student males predominantly.

At the same time, however, our study identified faculty support efforts that positively supported minoritized women's classroom belongingness: instructors' availability, knowing that they could ask instructors for help in course-related material, and feeling that instructors fostered an atmosphere of mutual respect. Minoritized women felt a sense of classroom belonging when they could capitalize on their previous experiences to scaffold their learning; there are also opportunities for faculty to leverage these opportunities in their classes. These opportunities will be most effective when the background experiences that are presented as relevant to engineering are inclusive of students who experience gender, racial, ethnic, and socioeconomic discrimination, but have much to contribute to engineering.

IX.   References

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