

## **Work In Progress: Designing for First-Year Student Success: Understanding the Effects of Co-Curricular Programming on Feelings of Belonging**

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## **Designing for First-Year Student Success: Understanding the Effects of Co-Curricular Programming on Feelings of Belonging**

Retention is an issue across disciplines, but it is particularly salient in engineering majors as it affects the strength of the future engineering workforce (Chen, Carroll, & NCES, 2005). Significant attrition from engineering majors shows that there is a need to understand better how to support students who express interest in engineering majors to guide them in their journey to graduation (National Science Board, 2016). Prior research has suggested that one reason students might depart from their initially-selected STEM major could be the lack of a sense of belonging with their selected major and college (Good, Rattan, & Dweck, 2012). Indeed, feelings of belonging are related to overall well-being (Ryan & Deci, 2000) as well as higher levels of academic self-efficacy and motivation (Freeman, Anderman, & Jensen, 2007). It is particularly concerning that students who belong to groups that are underrepresented in engineering feel less connected with their major, which is also generally related to problems with adjustment to the college environment (Dennis, Phinney, & Chuateco, 2005). To address the issues of retention in engineering majors, many colleges and universities have implemented programs to support students in their first year (Purdie & Rosser, 2011). This paper will describe our investigation of belonging as a factor that might underlie issues in retention and will consider the role of support programming in the formation of students' sense of belonging during the first year of college.

In the current study, we administered an online survey to first-year engineering students at two time points: (1) the week before they began college, and (2) March of their first year. In addition to more traditional programmatic assessments, our dataset includes a number of motivational and behavioral indicators. We assessed motivational dimensions such as goals, perceived costs of studying engineering, and mindset. Students also provided information about their use of campus resources, such as tutoring and peer mentoring, and reported on their career plans and their expectations for their future education. Our research team is interested in a number of questions related to describing the motivation and career intentions of current and former engineering students, understanding the ways that the programmatic elements in place support or undermine that motivation, and providing recommendations to guide the development and implementation of future supports for retention in engineering.

In the current paper, we focus on factors that underlie students' feelings of belonging in the Michigan State University (MSU) College of Engineering (CoE). One notable aspect of the MSU CoE is the CoRe Experience, a program that supports first-year engineering students academically, professionally, and personally through their transition to higher education and engineering coursework (Hinds, Walton, Urban-Lurain, & Briedis, 2014; Walton et al., 2013). Specifically, we examined the following research questions:

1. Are there differences between students who report low versus high belonging in the CoE in terms of (a) the degree to which potential sources of belonging (e.g. tutoring, residential halls, teamwork in courses) differentially predict students' overall sense of belonging in the CoE, (b) mean level of perceived support for belonging from the potential sources of belonging, (c) overall participation in support activities, and (d) gender and race/ethnicity?

2. For students who expressed low feelings of belonging in the CoE, what types of strategies do they report would make them feel more connected with the CoE?

### Description of sample

Our sample comprises 900 first-year engineering students. Of these, 653 (73%) were male, 235 (26%) were female, and 12 (1%) did not respond or indicated “other” for their gender. The majority of the students identified as White (69%), while the rest of the students were Asian (19%), Black (7%), multiracial (3%), unreported race (2%), American Indian or Alaska Native (less than 1%) or other (less than 1%). Eighty-five percent of the sample were students with at least one parent who had attended college, while 14% were first-generation students (1.5% of students did not respond to this question).

### Description of scales

We measured students’ *feelings of belonging* using an 8-item scale adapted from Mendoza-Denton, Downey, Purdie, Davis, and Pietrzak (2002). The belonging scale had three components: belonging with classmates (2 items; e.g. 1 = do NOT feel comfortable with them, 10 = feel comfortable with them,  $\alpha = .89$ ), belonging with professors (2 items; e.g. 1 = do NOT like them, 10 = like them,  $\alpha = .95$ ), and belonging in the CoE (4 items; e.g. 1 = do NOT fit in, 10 = definitely fit in,  $\alpha = .89$ ). To help validate the scale for the current sample, we conducted a confirmatory factor analysis (CFA) comparing a model with three sub-scales, as hypothesized, to a single factor model. CFA is a statistical method that allows one to test whether the underlying factor structure (based on participants’ responses to each item) is aligned with a hypothesized theoretical model in comparison to alternative models. Our confirmatory factor analyses indicated a satisfactory fit for the three-factor model, demonstrating that the three sub-components of this larger belonging scale do in fact represent three distinct constructs,  $\chi^2 (17) = 118.61, p < .001, CFI = .98, TLI = .97, RMSEA = .08 (\geq .77$  for standardized factor loadings). By contrast, a single-factor model did not fit the data well,  $\chi^2 (20) = 2240.74, p < .001, CFI = .64, TLI = .50, RMSEA = .34; \Delta\chi^2 = 2212.14, p < .001$ . Thus, the results of the confirmatory factor analyses provided support that our measurement was sound. Given our current focus on students’ feelings of belonging in the CoE, we focused our analyses on that subscale.

Additionally, we assessed the *sources* of students’ feelings of belonging. The *Sources of the Feelings of Belonging* assessment consisted of nine items plus a free response opportunity for students to specify sources not included in our list (Appendix 1; Table 1). This assessment immediately followed the questions regarding belonging in the CoE. These items had the following stem: “Please rate the degree to which the following factors contributed to the feelings you reported above by selecting a number for each factor.” For this scale, we did not conduct CFA, as we intended to use each item within the scale as a unique indicator for each potential source of belonging.

Finally, we measured *participation in support services* using four items. The stem of the item was “Approximately how often did you use the activities or services provided to you by CoRe?” The answer choices were 1 = “Did not know this existed,” 2 = “Never,” 3 = “Once a semester,” 4 = “Two to three times a semester,” and 5 = “At least once a week.”

## **Research question 1: Quantitative analyses**

To address the first research question regarding differences between students with high versus low belonging in the CoE, we began by creating a composite score from the four items that addressed feelings of belonging in the CoE. Then, we split the sample based on the raw scores to generate a “low belonging” group comprised of students who responded between 1 - 5 and a “high belonging” group comprised of students who responded between 6 - 10. The high belonging group ( $n = 763$ ) was much larger than the low belonging group ( $n = 137$ ). We found this to be encouraging because it suggests that, of our survey respondents, most tended to find themselves feeling connected with the CoE.

### **Research question 1a.**

To examine how the various sources of belonging predicted students’ overall sense of belonging in the CoE, we conducted two multiple regression analyses: one for the high belonging group and one for the low belonging group. The dependent variable for each analysis was the overall level of belonging in the CoE. Nine predictors were entered into each of the regression analyses: (1) tutoring, (2) academic advising, (3) CoRe co-curricular programs, (4) professional development, (5) social activities, (6) my MSU residential neighborhood, (7) teamwork in courses and study groups, (8) athletics/intramurals, and (9) research. Regression analyses indicated that, indeed, reported sources of belonging differentially predicted students’ overall reported belonging in the CoE (Table 1). From a programmatic standpoint, we were interested in understanding whether these activities contributed to students’ sense of belonging or not; thus, in our analytical approach, we opted to retain all regression predictors in the analysis. Moreover, we did not have specific hypotheses regarding potential interactions among factors and thus focused on the main effects only.

For the low belonging group, the nine predictors explained 14% of the variance in belonging in the CoE ( $F(9, 116) = 2.01, p < .05$ ). Somewhat surprisingly, only one source of belonging (athletics/intramurals,  $\beta = .24, p < .05$ ) significantly predicted overall levels of belonging in the CoE among students who did not report that they belonged in the college. For the high belonging group, the nine predictors explained slightly more (18%) of the variance in belonging in the CoE ( $F(9, 711) = 16.74, p < .001$ ). Additionally, there were four sources of belonging that significantly predicted feelings of belonging among the high belonging group: academic advising ( $\beta = .14, p < .01$ ), CoRe co-curricular programs ( $\beta = .13, p < .05$ ), social activities ( $\beta = .17, p < .001$ ), and MSU residential neighborhoods ( $\beta = .12, p < .05$ ). These results suggest that, at least among the high belonging students, many of the institutional programs that were perceived as enhancing students’ overall sense of belonging with the CoE predicted their actual sense of belonging.

### **Research question 1b.**

We also examined the mean levels of sources of belonging across the two groups using independent samples t-tests in order to determine whether the high belonging group and the low belonging group reported different levels of the different sources. In each t-test, the independent variable was the belonging group and the dependent variable was the perceived source of belonging. There were significant differences in the scores for tutoring, academic advising, CoRe

co-curricular programs, social activities, MSU residential neighborhood, teamwork in courses/study groups, athletics/intramurals, and research (Table 2). Overall, people who reported high levels of belonging tended to report that all of the different sources of belonging contributed to their sense of belonging at a higher rate than did the people with low belonging, with the exception of the professional development activities, for which there was no significant difference (Table 2). This means that students who felt high levels of belonging were also more likely to report a variety of factors as contributing to their feelings of belonging.

Considering both the multiple regression findings and mean-level analyses of the sources of belonging, our findings suggest important differences among students who report low versus high levels of belonging in the CoE. Among those who feel they belong, it appears that the support services designed as part of the first-year program are effective in supporting their feelings of belonging in the CoE. However, for those who do not belong, students are less likely to report that these sources are contributing to their feelings of belonging, and indeed, these sources are not significant predictors of their feelings of belonging. One potential explanation for these differences is that students with low levels of belonging are not engaging in any of these support services. Thus, we also examined the overall mean levels of participation in the support services for our next research question (1c).

### **Research question 1c.**

While we did not have data available about participation in all of the activities for our sources of feelings of belonging question, data were available for tutoring, academic advising, evening programs, and social activities. Since students responded to the participation questions on a categorical scale (ranging from “didn’t know this existed” to “at least once a week”), we treated the data as categorical rather than interval. Accordingly, chi-square tests of independence were conducted to compare students in the high versus low belonging groups for each variable (Figure 1a-d).

With respect to tutoring attendance (Figure 1a), there were no significant differences between the high and low belonging groups,  $\chi^2(4, 890) = 6.18, p = .19$ . This means that tutoring attendance was not related to whether a student felt high or low levels of belonging with the CoE.

A chi-square test indicated a significant association between academic advising attendance and high- or low-belonging group membership, though the effect size was small  $\chi^2(4, 887) = 9.78, p = .04, phi = .11$  (Figure 1b). Follow-up analyses indicated that students in the low belonging group were more likely to report that they did not know that academic advising existed than were students in the high belonging group,  $z = 2.5, p < .05$ . The proportion of students in the remaining categories for participation in advising did not significantly vary between the low and high belonging groups.

Similar to tutoring attendance, there was no significant association between evening program attendance and high- or low-belonging group membership,  $\chi^2(4, 894) = 12.15, p = .128$  (Figure 1c). This means that evening program attendance was not related to whether a student felt high or low levels of belonging with the CoE.

Finally, there was a significant association between social activity attendance and high- or low-belonging group membership, though again the effect size was small  $\chi^2(4, 894) = 12.15, p = .016, \phi = .12$  (Figure 1d). Students with low belonging were less likely to report attending social activities than students with high belonging, with the main difference arising in the number of students who reported attending social activities two to three times per semester. Fewer students in the low belonging group and more students in the high belonging group reported attending social activities two to three times per semester than expected ( $z = -2.5, p < .05$ ).

### **Research question 1d.**

Finally, we considered whether there were differences in race/ethnicity and gender between the students with high belonging versus low belonging in the CoE. A key question was whether there would be fewer women and members of traditionally underrepresented groups in the high belonging group. With respect to gender, a chi-square test indicated that there was no significant difference between the proportion of males and females in the high- or low-belonging groups,  $\chi^2(1, 888) = .148, p = .701$  (High belonging: 72% male, 28% female; low belonging: 73% male; 27% female). This suggests that males and females were equally likely to be in the high- or the low-belonging group. Overall, then, we did not find significant differences in belonging group membership as a function of gender.

Regarding the racial composition of the high belonging and low belonging groups, there were some differences, though the effect size was small,  $\chi^2(6, 883) = 16.78, p = .01, \phi = .14$  (Figure 2). Follow-up analyses indicated that the main difference between the low and high belonging groups was due to differences in distributions for both Asian and Caucasian students. Specifically, more Asian students appeared in the low belonging group than would be expected,  $z = 3.4, p < .05$ . In contrast, more Caucasian students were in the high belonging group than would be expected,  $z = -3.0, p < .05$ .

### **Research question 2: Qualitative analyses**

To address the second research question, we examined the responses of people who were in the low belonging group to the free-response item: “What would make you feel more connected to the CoE?” Some students did not answer this question; of the 137 people who were in the low belonging group, only 45 provided a text response. However, the responses of those 45 people who did answer showed some thought-provoking patterns. Some students mentioned the first-year coursework, citing a desire for more group projects or for student groups that would bring the first-year students together. One student wrote “hands-on programs,” while another wrote “more team-building activities.”

Four students said they would feel more connected if given the opportunity to hear from guest speakers more frequently. One student wrote that it would help enhance connectedness with the college if they could have “recent engineering graduates speak to us about our options and different career paths they have chosen and why.” Other students echoed this sentiment, wanting to hear more from people who are currently working in their desired field.

Very few comments were about the demographic composition of the CoE, save this one: “seeing more minorities in my classes would make me feel more connected.” It is possible that other students had similar thoughts, but that they did not reply to this item.

From these qualitative analyses, we conclude that both teamwork with classmates and hearing from current professionals are two things that are highly valued by first-year engineering students. One possible explanation of these findings is that first-year students are in the midst of deciding whether their chosen major is right for them, so they seek information about what their future careers might be like - both in the aspect of teamwork and through experiences from practicing professionals.

## **Conclusion**

This study offers meaningful insight into supports for belonging during the first year. Given prior research linking belonging to retention and attrition (Good et al., 2012), understanding what factors support belonging may be key for supporting persistence in engineering majors. Past work has shown the first year to be an important time in determining a student’s likelihood of success in the major. Here we examined feelings of belonging and particular sources that would contribute to that perceived fit in the college. Specifically, the sources we considered were: (1) tutoring, (2) academic advising, (3) CoRe co-curricular programs, (4) professional development, (5) social activities, (6) my MSU residential neighborhood, (7) teamwork in courses and study groups, (8) athletics/intramurals, and (9) research. Our findings indicate that there are important differences in the factors that contribute to a low sense of belonging in the CoE compared with a high sense of belonging in the CoE. Specifically, academic advising, CoRe co-curricular programs, social activities, and MSU residential neighborhoods all contributed to sense of belonging for students in the high belonging group, whereas athletics/intramurals was the only factor that contributed to feelings of belonging for those in the low belonging group.

One limitation of this work is that it was conducted at a single university, and the sample, while large, comprises only one year’s data. Future studies will expand this work by adopting a longitudinal design and determining how feelings of belonging might change across the four- or five-year trajectory of a typical engineering student. Indeed, our data collection is ongoing, and the goal is to follow up with students in their sophomore, junior, and senior years to expand and supplement the current study. Thus, in future years, we will be able to better consider the long-term impact of early feelings of belonging on actual persistence in engineering. Additionally, it is important to note that our first-year engineering students predominantly (> 85%) live in an on-campus living-learning community. While we see this as a strength, and our analyses indicate that students feel supported by such programs, it may also diminish generalizability to other university contexts, especially universities at which on-campus or cohort-oriented living is not the norm for first-year students.

These findings suggest that universities might consider dedicating resources to on-campus support programs such as extracurricular engineering department programs, the residential hall experience, on-site academic advising, and social activities to foster high levels of connectedness among their students. Students who felt less connected to the CoE reported that they would feel more connected if given more opportunities for collaborative work and if they heard more often

from guest speakers currently working in the industry. Listening to the voices of these students who did not feel connected is an important first step toward fostering a sense of belonging among all first-year engineering students.



**Table 1***Regression Analysis Summary Predicting Belonging in the College of Engineering*

Variable	Belonging in College of Engineering (For the Low Belonging group)				Belonging in College of Engineering (For the High Belonging group)			
	<i>b</i>	SE	$\beta$	$R^2$	<i>b</i>	SE	$\beta$	$R^2$
<b>Overall Model</b>	.14*				.18***			
Tutoring	.14	.08	.19		-.06	.03	-.07	
Academic Advising	.07	.08	.10		.12	.04	.14**	
CoRe Co-Curricular Programs	-.002	.10	-.002		.11	.04	.13**	
Professional Development	-.007	.13	-.009		-.03	.04	-.04	
Social Activities	-.06	.10	-.08		.15	.04	.17***	
MSU Residential Neighborhood	-.14	.09	-.21		.11	.04	.12**	
Teamwork in Courses/Study Groups	.12	.07	.17		.03	.04	.03	
Athletics/Intramurals	.18	.08	.24*		.07	.03	.08	
Research	-.08	.10	-.10		-.003	.03	-.04	

*Note: Significant results are indicated with asterisks on the standardized regression coefficients: \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .*

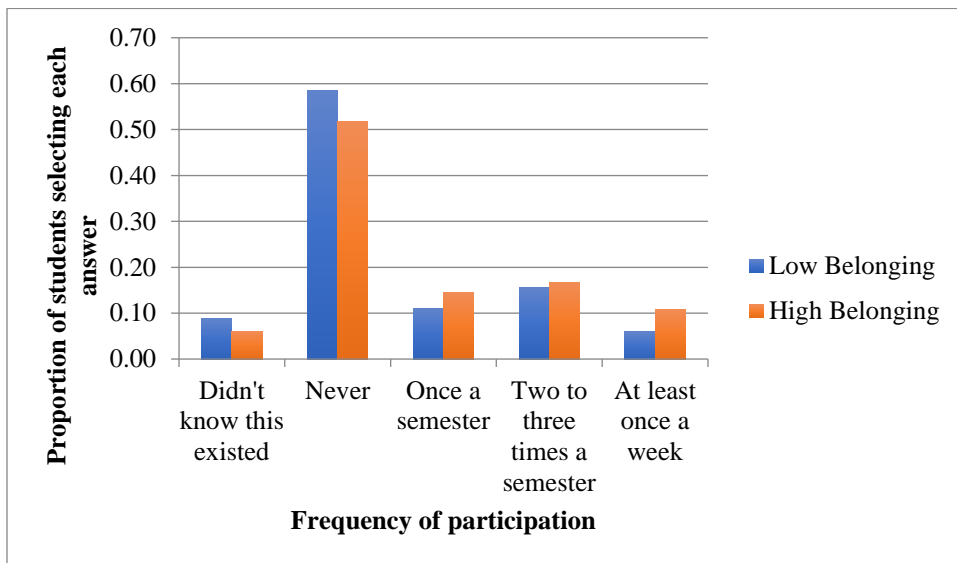
**Table 2**

*T-tests comparing mean levels of perceived sources of belonging across low and high belonging groups*

	<b>Belonging</b>		<i>t</i>	<i>df</i>
	<b>Low M (SD)</b>	<b>High M (SD)</b>		
Tutoring	2.26	2.57	-2.62**	197
	(1.24)	(1.41)		
Academic Advising	2.63	3.13	-4.11***	890
	(1.22)	(1.28)		
CoRe Co-Curricular Programs	2.18	2.69	-4.20***	882
	(1.18)	(1.31)		
Professional Development	2.16	2.36	-1.81	198
	(1.20)	(1.35)		
Social Activities	2.40	2.95	-4.57***	886
	(1.18)	(1.30)		
MSU Residential Neighborhood	2.66	3.38	-5.91***	887
	(1.33)	(1.28)		
Teamwork in Courses/ Study Groups	2.86	3.58	-5.95***	168
	(1.31)	(1.13)		
Athletics/Intramurals	2.19	2.70	-4.30***	204
	(1.23)	(1.46)		
Research	2.02	2.44	-3.85***	204
	(1.14)	(1.35)		

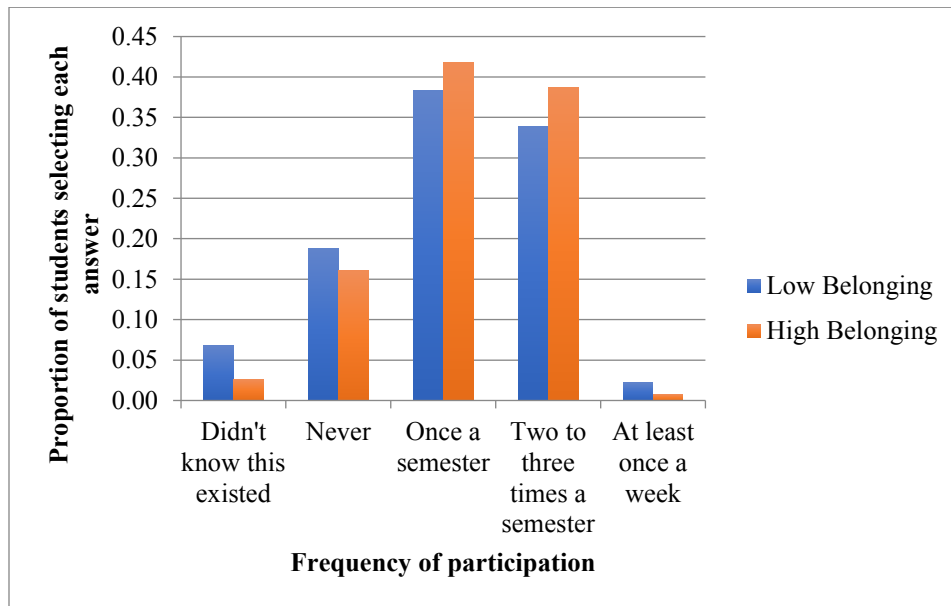
*Note: Significant results are indicated with asterisks on the t-statistics: \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ . The assumption of equality of variances was fulfilled for Academic Advising, CoRe Co-Curricular Programs, Social Activities, and MSU Residential Neighborhood, and was not fulfilled for Tutoring, Professional Development, Teamwork in Courses/Study Groups, Athletics/Intramurals, and Research. Degrees of freedom are reported accordingly.*

**Figure 1a**  
*Chi-square analysis for Tutoring Participation*

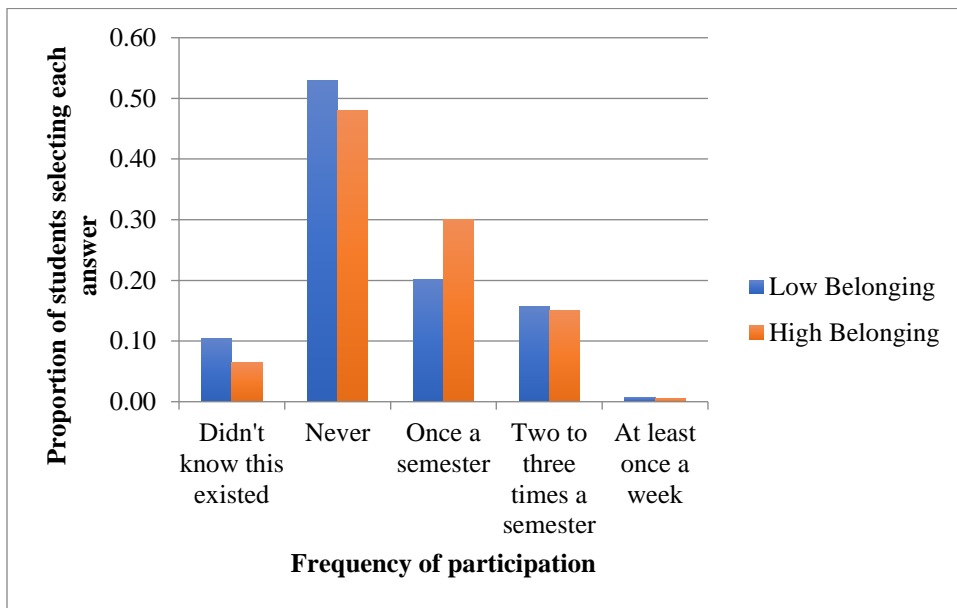


**Figure 1b**

*Chi-square analysis for Academic Advising Participation*

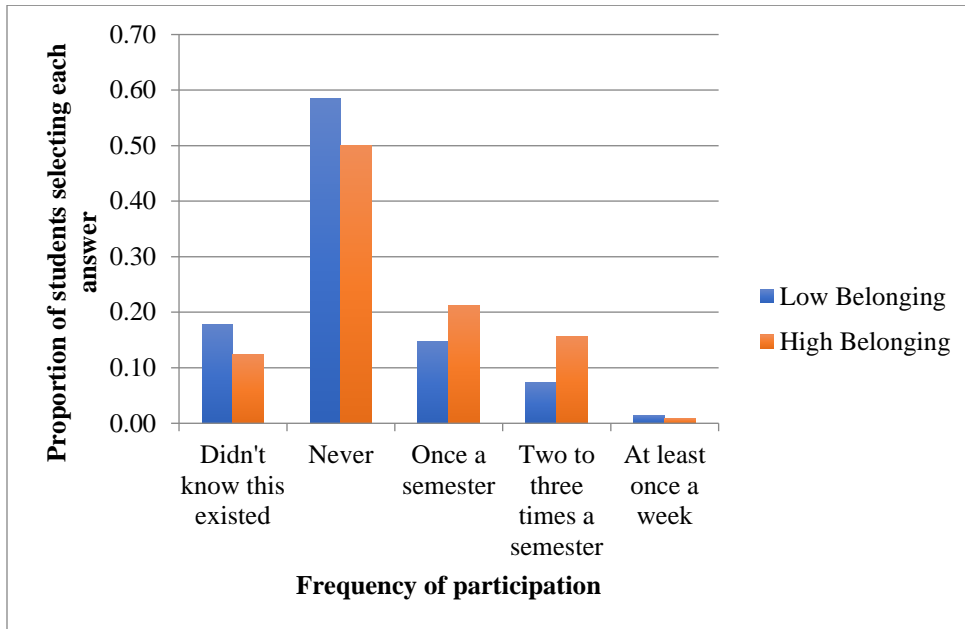


**Figure 1c**  
*Chi-square analysis for Evening Programs Participation*



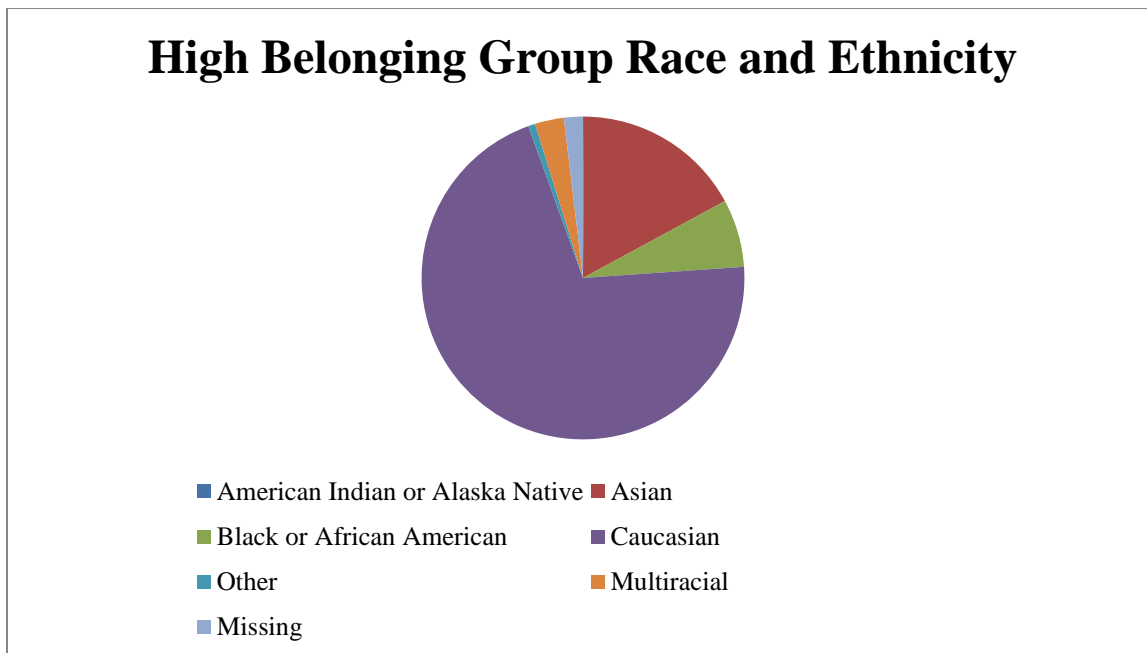
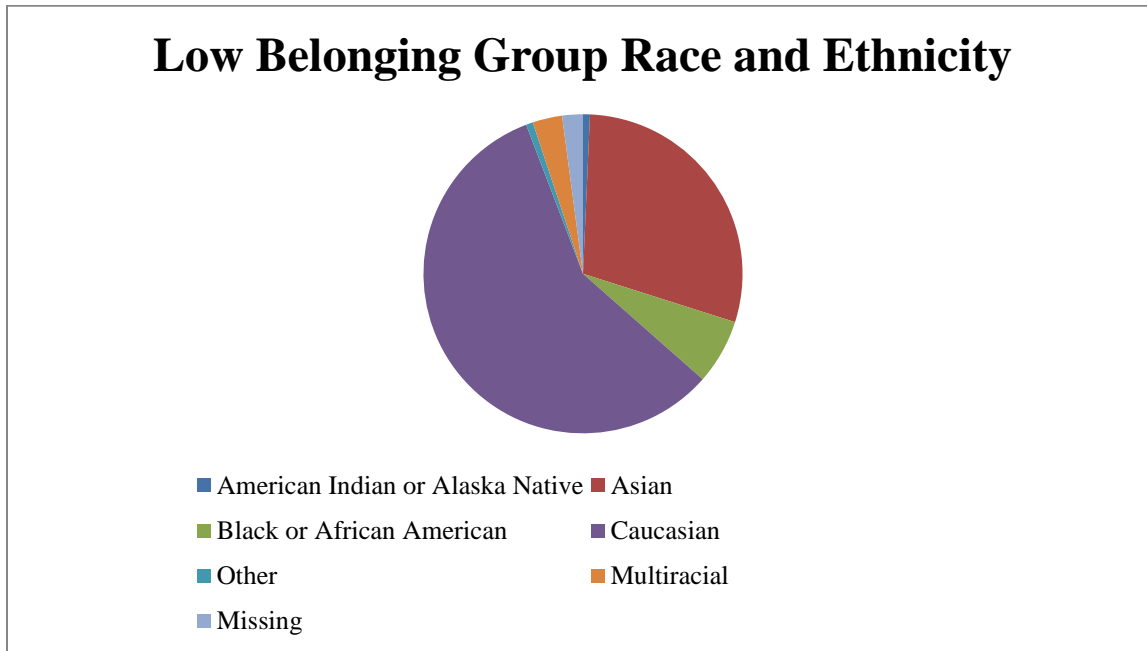
**Figure 1d**

*Chi-square analysis for Social Activities Participation*



**Figure 2**

*Race and Ethnicity of Low and High Belonging Group Members*



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## Appendix 1 – Feelings of Belonging in the College of Engineering Scale

Adapted from Mendoza-Denton, Downey, Purdie, Davis & Pietrzak, 2002

Circle the number that best describes your current feelings about XXX's College of Engineering.  
(TX\_BelE)

a) miserable OK thrilled to be here  
1      2      3      4      5      6      7      8      9      10

b) do NOT fit in sort of fit in definitely fit in  
1      2      3      4      5      6      7      8      9      10

c) NOT welcome sort of welcome very welcome  
1      2      3      4      5      6      7      8      9      10

d) very uncomfortable so-so feel very comfortable  
1      2      3      4      5      6      7      8      9      10

### Belonging Attributions

**Please rate the degree to which the following factors contributed to the feelings you reported above by selecting a number for each factor.**

Tutoring

Academic advising

CoRe co-curricular programs

Professional development activities (such as student chapters of ASME, AIChE, ASCE, etc.)

Social activities

My MSU residential neighborhood

Teamwork in my courses/study groups

Athletics/intramurals

Research

Other (please indicate)