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Recognizing Differences in Underrepresented Civil Engineering Students' Career Satisfaction Expectations and College Experiences

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Abstract: Student career satisfaction expectations and college experiences are an underutilized map toward attracting and sustaining the interest of underrepresented groups (URGs) in the civil engineering and construction industry. URGs provide indispensable contributions to the development of the built environment; however, URGs in civil engineering have not received sufficient attention to their unique expectations and experiences. Furthermore, diversity and inclusion efforts still are special practices in civil engineering, and are far from a conventional factor of professional respectability. Leveraging a national survey data set of responses from senior level undergraduate engineering students ($n = 4{,}605$), this study found measurable differences in career satisfaction expectations and college experiences between URGs and non-URGs in civil engineering. From the survey, 830 senior-level students majoring in civil engineering and construction related fields provided their career satisfaction expectations and undergraduate cocurricular experiences. Welch's *t-test* and Hedges' g were used to measure the significant differences in career satisfaction expectations between URGs and non-URGs. A frequency distribution was created and paired with chi-squared test for independence and Cramér's V to measure the difference in undergraduate participation in cocurricular activities between URGs and non-URGs. The results of this study showed URGs' career satisfaction expectations and cocurricular activities significantly differed from those of non-URGs. URG students reported more interest in helping others and in volunteering with charity groups in their careers. URG students also reported higher participation in cocurricular activities such as contributing as a member of an organization for women and/or minorities in engineering, acting as a member of an outreach club, and working a work-study or other type of job to pay for college. The findings presented in this paper highlight the need for the civil engineering profession to move beyond monolithic traditions, which can perpetuate exclusion. **DOI: 10.1061/(ASCE)ME.1943-5479.0000902.** *This work is made available under the terms of the Creative Commons Attribution 4.0 International license, https://creativecommons.org/licenses/by/4.0/.*

Introduction

Those who identify as Black, Hispanic/Latino, American Indian/Alaskan Native, or Native Hawaiian/Other Pacific Islander are considered to be underrepresented in engineering professions (National Science Foundation 2019; Kim 2011). Research (Adams et al. 2011; Van Aken et al. 1999; Hawkins Ash et al. 2018; London et al. 2020; Martin and Garza 2020) and programmatic efforts (Hackett and Martin 1998; Lee and Matusovich 2016) have offered insights and solutions that can improve the representation and inclusion of identities in engineering. Unfortunately, year after year, the graduating class of engineers across US institutions primarily are white and Asian, disproportionally representing the ethnic identities of the United States population (National Science Foundation 2019; Roy 2019). As a result, the civil engineering- and construction-related workforce lacks a diverse perspective. The lack of diversity in graduating classes specifically creates a critical work force problem at the Professional Engineer (PE) level. A lack of leaders who represent various cultures and communities at the design table is a problem highlighted by the development of inequitable and biased infrastructure systems (Katner et al. 2018; Wright Wendel et al. 2011; Wright 2011).

In addition to ethnic groups, those who identify as female also are disproportionately represented in civil engineering. Civil engineering is lagging far behind environmental engineering, which is a distinct but related field. Those who identify as female currently earn 50.6% of the bachelor's degrees awarded in environmental engineering. In civil engineering, those who identify as female currently earn 25.9% of bachelor degrees awarded (Roy 2019). Many academic departments across the nation group environmental and civil engineering students in the same academic department, yet student identities can differ. In the context of this study, students were provided the opportunity to self-identify their discipline instead of being grouped by the title of their department.

This self-identification process of field of study was critical for listening to the female students who may be in combined civil/environmental engineering departments but see themselves as environmental engineers based on their coursework and postcollege career opportunities. In previous studies, female students reported a higher interest in learning about sustainability than male did students (Klotz et al. 2014). Even after attracting students who identify as female, civil engineering has much work to do to create an inclusive environment, especially in construction-related fields (Azhar and Griffin 2014). Female civil engineers in construction

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have been excluded from leadership (Loosemore and Waters 2004), sexually harassed (Bagilhole et al. 2000), and encouraged to mimic males' aggressive behaviors (Dainty et al. 2000; Maskell-Pretz and Hopkins 1997). The current disproportionate representation limits the civil engineering profession's ability to solve technical problems (Smith-Doerr et al. 2017), but also its ability to solve social issues specifically the challenge of attracting, supporting, and elevating URGs (Simmons and Lord 2019).

The civil engineering profession can promote change through developing a shared sense of responsibility for Canon 8 of the ASCE Code of Ethics

> Engineers shall, in all matters related to their profession, treat all persons fairly and encourage equitable participation without regard to gender or gender identity, race, national origin, ethnicity, religion, age, sexual orientation, disability, political affiliation, or family, marital, or economic status. (ASCE 2017)

Harriet et al. (2019, p. 2) provided evidence that "a chilly climate exists when those perceived as other do not feel comfortable speaking about their minority identity with others." A chilly academic environment experienced by URG students will further discourage equitable participation in group activities, inhibit academic and social success, and lower retention rates (Harriet et al. 2019).

Responsibility falls on engineering schools and companies to adapt to the interests of students and employees by constructing inclusive environments, which requires understanding URG students. National survey data allow for an understanding of a population, and can provide accountability measures and evidence-based strategies for making engineering more inclusive [National Academies of Sciences, Engineering, and Medicine, Committee on Women in Science, Engineering, and Medicine, Policy and Global Affairs, National Academies of Sciences, Engineering, and Medicine, and Committee on Increasing the Number of Women in Science, Technology, Engineering, Mathematics, and Medicine (STEMM) 2020]. The policy of the United States is to encourage the equal participation of people in science and engineering according to (Pub. L. No. 96-516, sections 1885a and 1885b). This paper provides evidence to assist the civil engineering profession in becoming a profession that includes and encourages more participation of URGs.

Background

Barrow and Concannon (2008) provided evidence indicating that engineering students differ in terms of self-judgment of academic and career satisfaction expectations. However, 12 years after their study, the attitudes and experiences of civil engineering students' who identify as being from underrepresented racial/ethnic and gender groups still need much more attention in the academic literature. The National Academies of Sciences, Engineering, and Medicine stressed the importance of data collection for accountability and targeted intervention [National Academies of Sciences, Engineering, and Medicine, Committee on Women in Science, Engineering, and Medicine, Policy and Global Affairs, National Academies of Sciences, Engineering, and Medicine, and Committee on Increasing the Number of Women in Science, Technology, Engineering, Mathematics, and Medicine (STEMM) 2020]. Influential workforce factors such as career satisfaction expectations and cocurricular experiences have been discussed in the literature (Klotz et al. 2014; Lent et al. 2007; Mau 2003; Verdín and Godwin 2015), but specific studies of civil engineering students are needed on a continuous basis for accountability and strategic planning of targeted interventions.

Diversity of Diversity

One of the challenges in civil engineering is attracting and maintaining a structurally diverse student population. A structurally diverse population has a proportional representation of people from different demographic and intellectual backgrounds, which may have a beneficial impact on personal, societal, and educational outcomes (Denson and Chang 2009). However, structural diversity is not sufficient to achieve the full benefits of diversity (Karimi and Matous 2018). In addition to representation, meaningful and interpersonal interactions between peers from diverse groups (Pearson and Alexander 2020) and curricular or cocurricular diversity (Simmons et al. 2014) are needed. A critical step toward moving beyond the exclusive culture of civil engineering is understanding and addressing the wants and needs of those from URGs. The data from this study provides a snapshot of the perceptions and experiences of civil engineering students across the US who differ from their peers and from those who came before them.

Encouraging Career Satisfaction

The working conditions of individuals are a part of the contextual influences on personal satisfaction and career actions (Lent et al. 2000; Martínez-León et al. 2018). Management culture, employee involvement and empowerment, compensation and benefits, and degree of autonomy in decision-making are factors of job satisfaction, which is an attribute of productivity and retention (Youngblood Ortiz et al. 2015). Social cognitive career theory (SCCT) was used to frame career interest and development in this study (Lent et al. 1994). Looking at educational environments through a constructivist lens, SCCT considers the individual to have the capacity to influence their development and surroundings (Lent et al. 2007). Students' self-efficacy beliefs, outcome expectations, and personal goals are the three foundational social cognitive mechanisms that interconnect to describe career development. Previous SCCT studies asserted that people are likely to develop interest in activities in which favorable outcomes are expected (Lent et al. 2001). Surveys allow for large groups to provide responses to their expectations and interests from which the civil engineering profession can learn.

Previous studies provided insights into the engineering education literature through using surveys on career outcomes, student experiences, and demographic identities. Across engineering disciplines, sustainability career goals and interests were shown to be significantly different across gender and racial/ethnic groups, and to be predictors of career choice (Klotz et al. 2014). Students who identified as female and non-White were more likely to select a career related to sustainability (Valdes-Vasquez et al. 2014). Among students interested in civil engineering, those who identified as female had a significantly higher innovation self-efficacy (Verdín et al. 2020).

Placing URG students in a social climate in which they do not feel welcomed can have a negative impact on students' perceptions of career satisfaction in civil engineering. Coleman et al. (2020) used survey data, including the survey data utilized in the present study, to show that senior engineering students are significantly worse in feedback-seeking and experimenting compared with freshmen. Coleman et al.'s findings point to the possibility of negative impacts that the engineering education environment can have on the critical skill development of students in a profession that requires feedback from the work community. The present study builds upon previous survey work that explored career satisfaction

(Coleman et al. 2020; Hazari et al. 2010; Shealy et al. 2016), and adds a unique contribution by focusing on the current perceptions and cocurricular experiences of URG in civil engineering.

Cocurricular Experiences

Cocurricular experiences offer a place for social engagement as well as academic and professional development (Astin 1984; Kuh et al. 2008). URGs in engineering have benefitted from participating in cocurricular activities, according to previous studies. For example, African American students' involvement in cocurricular activities has a positive influence on their grade point average, vocational development, and the development of *Engineer of 2020* attributes (Simmons et al. 2018; Simmons and Martin 2011).

Poor and Brown (2013) found that mentoring programs designed for women in engineering provided networking opportunities which built student confidence and increased retention (Skvoretz et al. 2020). Lee and Matusovich (2016) found particular areas of students' cocurricular experiences that positively affected experiences and persistence for URGs, including interactions with peers and faculty, academic support, and professional development.

URG students are like non-URG students in terms of benefitting from furthering the development of their career interest through clubs specific to their major. The major difference is in how and how much engagement occurs between groups. At least 25 studies provided evidence for improving engineering student retention through cocurricular activities (Geisinger and Raman 2013), but many were outside of the domain of civil engineering or did not center the experience of URG students. Engineering schools may increase retention and attraction rates if they provide URG students with experiences that fit their personal interests.

Purpose

The purpose of this study was to measure the differences between career satisfaction expectations and cocurricular experiences of civil engineering students across gender and racial/ethnic groups in civil engineering. The data used for this study were taken from a nationally representative 2018 survey of fourth-year engineering students in a senior design course (Shealy et al. 2017). The following research questions contribute to the body of knowledge about broadening participation in civil engineering:

1. What are the differences in career satisfaction expectations between URGs and non-URGs in civil engineering?
2. What is the frequency of participation in cocurricular activities by URGs compared with non-URGs in civil engineering?

Method

Data Sources and Variables of Interest

The data used for this analysis were taken from a 2018 national survey entitled (Coleman et al. 2018) The survey included 40 questions split into 5 sections: (1) Your Career Goals, (2) People and the Planet, (3) About You, (4) Your College Experiences, and (5) Demographic Questions. The survey included some items from two previous national surveys: (1) Sustainability and Gender in Engineering (Sage) (Klotz et al. 2014) and (2) Persistence Research in Science & Engineering (PRiSE) (Hazari et al. 2010). The career goals, college experiences, and demographic responses of civil engineering students were used to answer the research questions in the present paper.

The sample population from the 2018 national survey included 4,605 senior engineering students. A total of 830 senior civil engineering students responded to the survey, and their responses were used in the analysis. Students who responded by selecting one of the four civil engineering and construction related engineering disciplines as their current major of study, including civil engineering (non-structural), construction engineering and management, environmental/ecological engineering, and structural/architectural engineering, were included in the data analysis for this paper. Underrepresented groups (URG) in civil engineering were grouped by gender and ethnicity. Students who identify as female were compared to students who identify as male. Options for ethnicity included African-American or Black, Caucasian or White, South Asian, East Asian, Other Asian, Native Hawaiian or Pacific Islander, American Indian or Alaskan Native, and Hispanic/Latino. Students identifying as South Asian, East Asian, and Other Asian were grouped as Asian for this study. Seven civil engineering students identified as Middle Eastern or Arab. Students identifying as Middle Eastern and Arab were grouped together and were classified as White according to the US Department of Education's guidelines on race and ethnicity (National Academies of Sciences, Engineering, and Medicine, Committee on Effective Mentoring in STEMM, Board on Higher Education and Workforce, and Policy and Global Affairs 2019). Students were classified as underrepresented ethnic identities (UREI) if they selected a racial or ethnic identity other than White. Tables 1 and 2 give the distribution of students in each gender and ethnic group, respectively. Tables 3 and 4 provide the survey questions pertaining to career satisfaction and undergraduate experiences.

The survey questions for cocurricular activities originally had five response options: never, limited, half a semester, one full semester, and more than one full semester. A chi-squared test for independence produced an approximation error for the chi-squared test warning of expected frequencies lower than 5. Two error messages occurred when conducting the test for gender groups and nine for ethnic identities. Combining the response options improved the strength of the statistical analysis and created clearer groupings of the Likert-scale responses. The response groupings were based on temporal similarity of amount of experience. Never remained a response option by itself, limited and half a semester were combined, and one full semester and more than one full semester were combined, to create three distinct response groups. After conducting the chi-squared test with the new grouping, only two approximation errors appeared for ethnic identities.

Table 1. Civil engineering student sample by gender identity and discipline

Gender identity	Civil engineering (nonstructural)		Construction engineering and management		Environmental and ecological engineering		Structural and architectural engineering		Total
	N	Percentage (%)	*N*	Percentage (%)	*N*	Percentage (%)	*N*	Percentage (%)	
Male	414	70.1	45	7.6	52	8.8	80	13.5	591
Female	150	62.8	7	2.9	60	25.1	22	9.2	239
Total	564	68	52	6	112	13	102	12	830

Table 2. Civil engineering student sample by ethnic/racial identity and discipline

Ethnic/racial identities	Civil engineering (nonstructural)		Construction engineering and management		Environmental and ecological engineering		Structural and architectural engineering		Total
	N	Percentage (%)	*N*	Percentage (%)	*N*	Percentage (%)	*N*	Percentage (%)	
Asian	50	70	3	4	11	15	7	10	71
American Indian/Alaskan Native	5	71	0	0	1	14	1	14	7
African American/Black	23	88	0	0	1	4	2	8	26
Hispanic/Latino	51	74	1	1	4	6	13	19	69
Native Hawaiian/Pacific Islander	2	100	0	0	0	0	0	0	2
Other	0	0	0	0	1	100	0	0	1
White	433	67	48	7	94	15	79	12	647
Total	564	68	52	6	112	13	102	12	830

Statistical Analysis

The analyses conducted for this study used R version 1.2.5033 statistical software language. Welch's *t-test* and a chi-squared test were used to evaluate significant differences between students.

Table 3. Survey questions pertaining to career satisfaction expectations

Q4: How important are the following factors to your future career satisfaction?
a: Making money
b: Becoming well known
c: Helping others
d: Supervising others
e: Having job security and opportunities
f: Working with people
g: Inventing/designing things
h: Developing new knowledge and skills
i: Having lots of personal and family time
j: Having an easy job
k: Being in an exciting environment
l: Solving societal problems
m: Making use of my talents and abilities
n: Doing hands-on work
o: Applying math and science
p: Volunteering with charity groups

Table 4. Survey questions pertaining to undergraduate experiences

Q6: While an undergraduate, have you done (or are your currently doing) any of the following?
a: Conducted engineering research with a faculty member
b: Participated in study abroad
c: Contributed to a disciplinary-specific society
d: Worked or volunteered in a developing country
e: Worked for an engineering company as an intern/co-op
f: Lived in a residential or dorm-based engineering program/engineering living-learning community
g: Contributed as a member of an organization for women and/or minorities in engineering
h: Acted as a member of an outreach club (e.g., Habitat for Humanity, Big Brothers Big Sisters)
i: Traveled with an international service group (e.g., Engineers Without Borders, Students Helping Honduras, Bridges to Prosperity)
j: Participated in an organization that focuses on environmental sustainability
k: Work-study or other type of job to pay for college

Welch's *t-test* was used to compare responses to the question about career satisfaction. Welch's *t-test* was chosen because it is the most appropriate test for ordinal data (Likert scale) with unequal variance. The variance between subsets, subsets based on gender and ethnicity, had unequal population variances. Effect size measurements following the Welch's *t-test* were calculated using Hedges' g statistic. Hedges' g measures the magnitude of variance between two sample populations that differ in size. Hedges' g statistic is used instead of Cohen's d when the sample sizes differ. The effect size for Hedges' g is categorized according to the following scale: small = 0.2–0.5, medium = 0.5–0.8, and large $\geq$ 0.8 (Cohen 2013). A chi-squared test was used to compare differences in frequency distribution of responses to the question about cocurricular experiences. Cramér's V then was used to measure effect size. The effect size for Cramér's V is categorized according to the following scale: small = 0.07–0.21, medium = 0.21–0.35, and large $\geq$ 0.35 (Kim 2017). The scale is based on the degrees of freedom being 2, which is calculated automatically when conducting the chi-squared test in R statistical software language. For both the Welch's *t-test* and the chi-squared test, the level of significance was set to $\alpha = 0.05$.

Results

Welch's *t-test* and Hedges' g revealed several differences in career satisfaction expectations between ethnic/racial identities and gender identities (Tables 5 and 7 and Figs. 1 and 2). Participation in cocurricular experiences revealed statistically significant differences in the frequency distributions between ethnic/racial and gender identities (Tables 6 and 8 and Figs. 3 and 4). Each URG was compared with the corresponding non-URG identity to determine a difference for each subquestion.

UREI versus Non-UREI Career Satisfaction Expectations

UREI students on average ranked all the career satisfaction expectations to be more important than did non-UREI students (Table 5). Despite the higher ranking by UREI students, not all the differences in career satisfaction expectations were significantly different between groups. The survey items helping others ($p < 0.001$, $g = 0.41$) and volunteering with charity groups ($p < 0.001$, $g = 0.48$) were rated significantly higher by UREI students than by non-UREI students. Hedges' g was the largest for these survey items compared with the other career satisfaction expectations. The difference in rating of importance also was significant for survey items, working with people, inventing/designing things,

Table 5. Welch's *t-test* comparison of career satisfaction expectations by ethnic and racial identity

Subquestion item	Non-UREI	UREI	p-value	Significance level	Hedges' g	Effect size
Q4a: Making money	3.33	3.64	0.69	N/A	0.04	N/A
Q4b: Becoming well known	2.55	2.68	0.01	[a]	0.28	S
Q4c: Helping others	3.03	3.33	0.00	[b]	0.41	S
Q4d: Supervising others	2.33	2.81	0.24	N/A	0.13	N/A
Q4e: Having job security and opportunities	2.67	2.97	0.96	N/A	0.01	N/A
Q4f: Working with people	2.70	3.01	0.00	[c]	0.34	S
Q4g: Inventing/designing things	3.44	3.57	0.00	[c]	0.30	S
Q4h: Developing new knowledge and skills	3.07	3.26	0.01	[c]	0.28	S
Q4i: Having lots of personal and family time	2.82	3.13	0.32	N/A	0.10	N/A
Q4j: Having an easy job	3.30	3.33	0.03	[a]	0.28	S
Q4k: Being in an exciting environment	2.18	2.47	0.35	N/A	0.10	N/A
Q4l: Solving societal problems	3.30	3.38	0.00	[c]	0.31	S
Q4m: Making use of my talents and abilities	1.81	2.07	0.09	N/A	0.18	N/A
Q4n: Doing hands-on work	3.20	3.28	0.03	[a]	0.22	S
Q4o: Applying math and science	3.64	3.64	0.00	[c]	0.34	S
Q4p: Volunteering with charity groups	3.32	3.54	0.00	[b]	0.48	S

Note: L = large effect size; M = medium effect size; and S = small effect size.
[a]Statistical significance less than 0.05 but greater than or equal to 0.01.
[b]Statistical significance <0.001.
[c]Statistical significance less than 0.01 but greater than or equal 0.001.

developing new knowledge and skills, solving societal problems, and applying math and science ($p < 0.01$). Hedges' g ranged from 0.28 to 0.34 for these survey item. Other items that were significant were becoming well known, having an easy job, and doing hands-on work ($p < 0.05$).

UREI versus Non-UREI Cocurricular Experiences

A higher percentage of UREI students had no experience for the survey item participated in study abroad and worked for an engineering company as an intern/co-op (Table 6). In contrast, a higher percentage of UREI students had experience with conducted engineering research with a faculty member, contributed to a disciplinary-specific society, lived in a residential or dorm-based engineering program/engineering living-learning community, contributed as a member organization for women and/or minorities in engineering, acted as a member of an outreach club, traveled with an international service group, and work-study or other type of job to help pay for your college education (Fig. 3). There were statistically significant differences between the experiences of non-UREI and UREI students who worked or volunteered in a developing country ($p < 0.05$, $V = 0.11$), worked for an engineering company as an intern/co-op ($p < 0.01$, $V = 0.13$), contributed as a member of an organization for women and/or minorities in engineering ($p < 0.001$, $V = 0.16$), acted as a member of an outreach club ($p < 0.05$, $V = 0.01$), and work-study or other type of job to pay for college ($p < 0.01$, $V = 0.1$) (Table 6).

Career Satisfaction Expectations by Gender

Becoming well-known ($p < 0.001$, $g = 0.30$) and volunteering with charity groups ($p < 0.001$, $g = 0.26$) had the highest significance level and effect size when comparing the differences between gender groups (Table 7). Male students had a higher average response for the importance of becoming well-known, whereas female students reported a higher average response for the importance of volunteering with charity groups. Helping others ($p < 0.01$, $g = 0.23$) was a career satisfaction category in which female students reported a higher level of importance, and a statistically significant difference was calculated between the responses of gender groups, with a small effect size.

Male versus Female Cocurricular Experiences

Females were significantly more likely to have conducted engineering research with a faculty member ($p < 0.001$, $V = 0.15$), to contribute as a member of an organization for women and/or minorities in engineering ($p < 0.001$, $V = 0.50$), and to act as a member of an outreach club ($p < 0.001$, $V = 0.14$) (Table 8). A higher percentage of female students also participated in study abroad ($p < 0.01$, $V = 0.12$), contributed to a disciplinary specific society ($p < 0.01$, $V = 0.11$), worked or volunteered in a developing country ($p < 0.05$, $V = 0.09$), and worked study or other type of job to pay for college ($p = 0.01$, $V = 0.11$). Furthermore, 87% of students who identified as male never contributed as a member of an organization for women and/minorities in engineering (Table 8). A smaller percentage of students who identified as female compared with those who identified as male reported that they worked for an engineering company as an intern/co-op (Fig. 4).

Discussion

The findings of this study revealed the different career satisfaction expectations and undergraduate cocurricular experiences of URGs in civil engineering. Significant differences in rating of importance, and differing frequency distributions of experience, provide insight into the research questions posed in this study. The following section discusses opportunities to promote inclusion of differences within the civil engineering culture.

Comparing Career Satisfaction Expectations by Ethnicity/Race

When prospective civil engineering students look at the undergraduate offerings of civil engineering departments, they should see a carefully curated program which prepares students with educational training through hands-on activities, engineering design, and public policy analysis (ABET 2019). UREI students reported a higher importance for helping others than did non-UREI students. Additionally, UREI students reported a higher importance for working with people and solving societal problems than did non-UREI students, showing an interest in engaging in service to others.

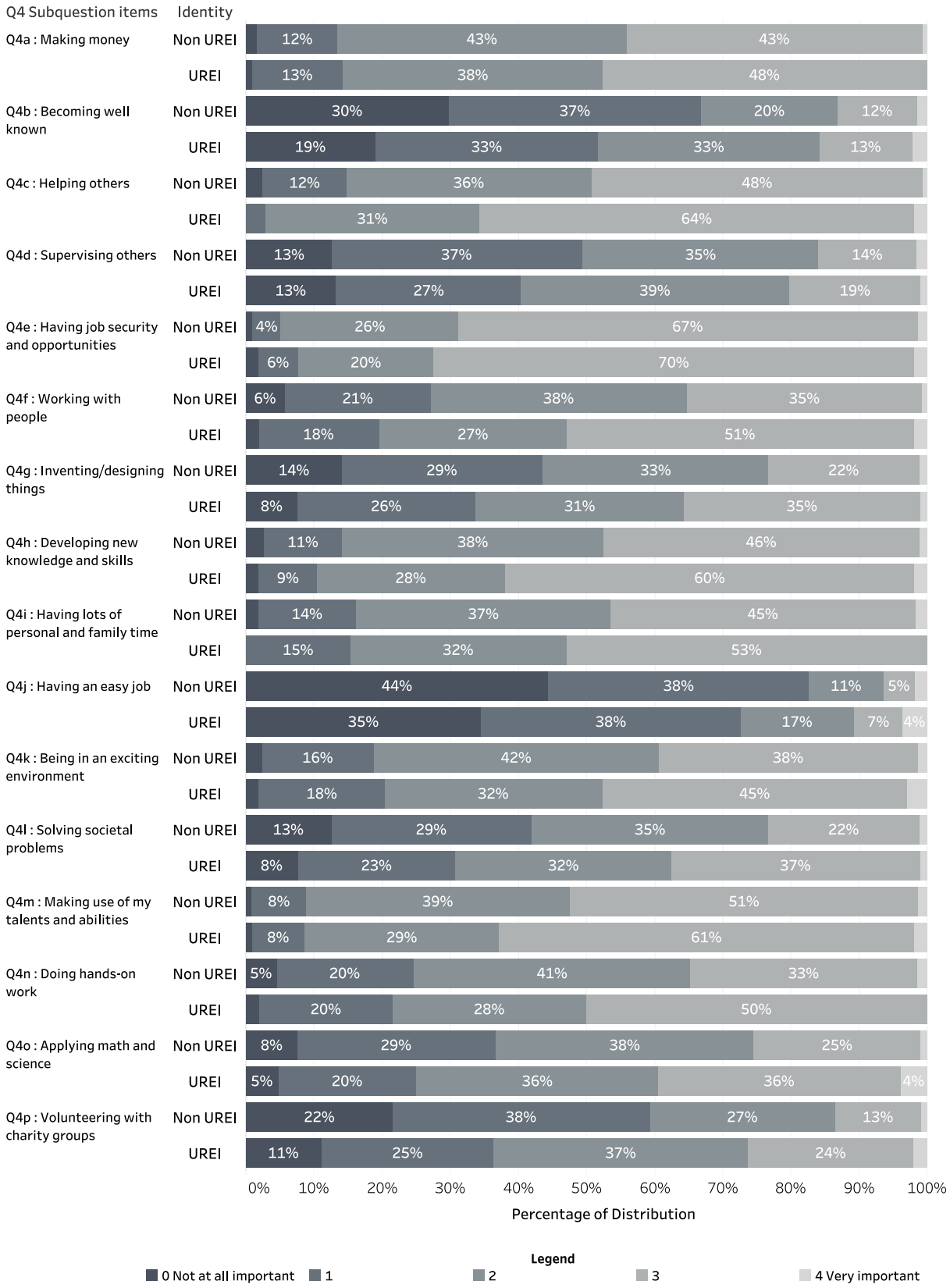

Fig. 1. Percentage of career satisfaction expectations by ethnic and racial identity.

These results support the findings of Klotz et al. (2014) suggesting that sustainability may be an effective strategy to attract the interest of URG students into engineering through their interest in helping others.

Civil engineering companies can provide URG students with opportunities to help others through service activities. To be effective in service efforts, civil engineers must be empowered and resourced. Smith-Doerr et al. (2017) suggested that corporate

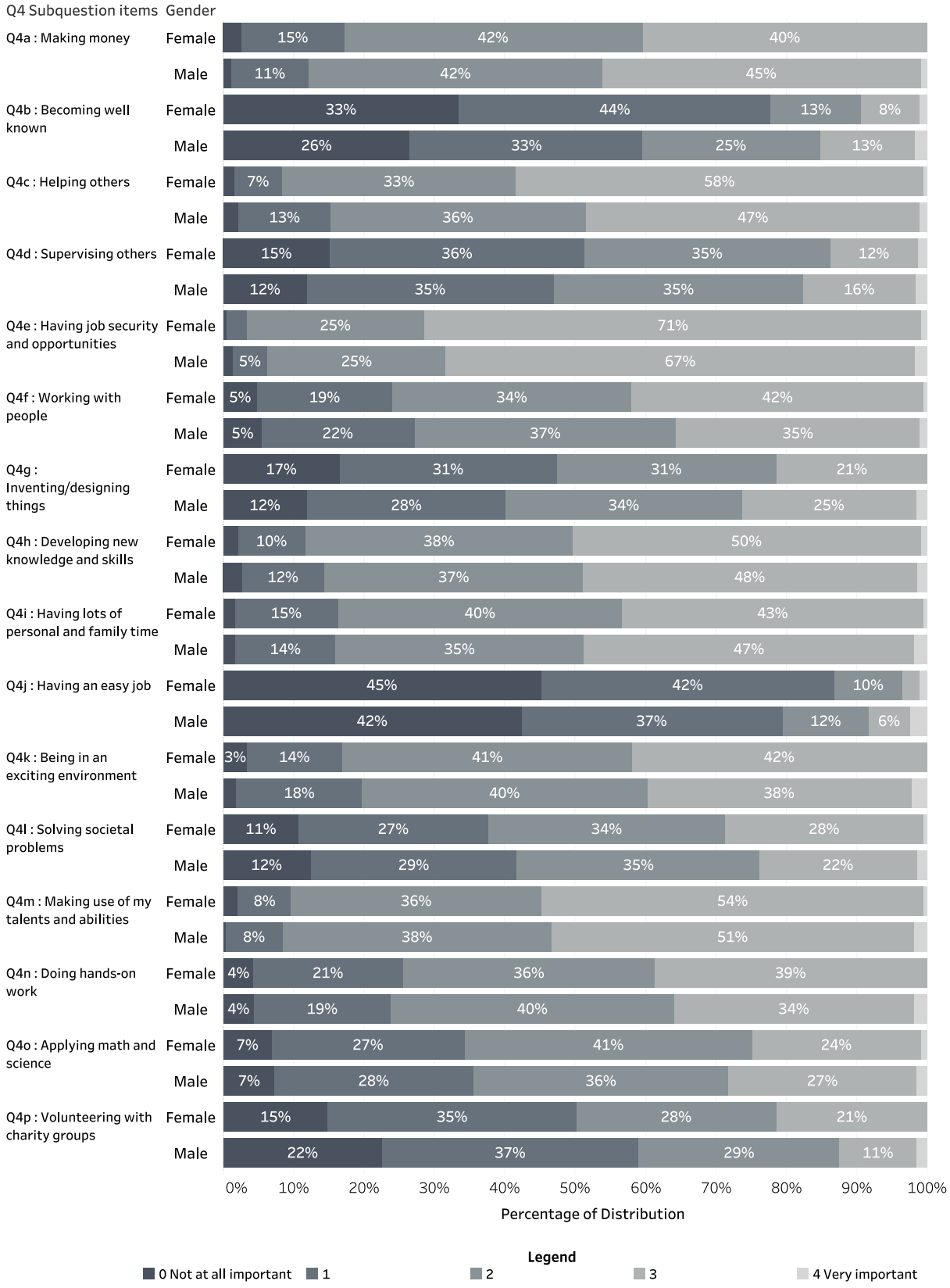

Fig. 2. Percentage of career satisfaction expectations females versus males.

decision-makers should develop integrated and diverse teams with female and UREI managers who are provided with training and mentorship. Civil engineering professionals are leaders in highly resourced sustainable infrastructure projects, and have a responsibility to provide effective and innovative solutions for enhancing human welfare (ASCE 2018, 2017). Sustainable development projects may provide URG students with opportunities toward which they gravitate. Becoming a licensed Professional

Table 6. Frequency of responses for cocurricular experience by racial/ethnic identity

Racial/ethnic identity	Never		Limited		One full semester or more		Sum	p-value	Significance level	Cramér's V	Effect size
	N	Percentage (%)	N	Percentage (%)	N	Percentage (%)					
Q6a: Conducted engineering research with a faculty member											
Non-UREI	479	67.1	99	13.9	136	19.0	714	0.33	N/A	0.05	N/A
UREI	63	60.0	19	18.1	23	21.9	105				
Sum	542	66.2	118	14.4	159	19.4	819	—	—	—	—
Q6b: Participated in study abroad											
Non-UREI	577	80.8	77	10.8	60	8.4	714	0.40	N/A	0.05	N/A
UREI	90	85.7	7	6.7	8	7.6	105				
Sum	667	81.4	84	10.3	68	8.3	819	—	—	—	—
Q6c: Contributed to a disciplinary-specific society											
Non-UREI	348	50.0	141	20.3	207	29.7	696	0.69	N/A	0.03	N/A
UREI	47	47.0	19	19.0	34	34.0	100				
Sum	395	49.6	160	20.1	241	30.3	796	—	—	—	—
Q6d: Worked or volunteered in a developing country											
Non-UREI	568	83.9	83	12.3	26	3.8	677	0.01	[a]	0.11	S
UREI	77	75.5	14	13.7	11	10.8	102				
Sum	645	82.8	97	12.5	37	4.7	779	—	—	—	—
Q6e: Worked for an engineering company as an intern/co-op											
Non-UREI	167	23.5	108	15.2	437	61.4	712	0.00	[a]	0.13	S
UREI	40	40.0	11	11.0	49	49.0	100				
Sum	207	25.5	119	14.7	486	59.9	812	—	—	—	—
Q6f: Lived in a residential or dorm-based engineering program/engineering living-learning community											
Non-UREI	537	75.7	38	5.4	134	18.9	709	0.62	N/A	0.04	N/A
UREI	76	73.8	4	3.9	23	22.3	103				
Sum	613	75.5	42	5.2	157	19.3	812	—	—	—	—
Q6g: Contributed as a member of an organization for women and/or minorities in engineering											
Non-UREI	538	75.7	88	12.4	85	12.0	711	0.00	[b]	0.16	S
UREI	57	55.3	18	17.5	28	27.2	103				
Sum	595	73.1	106	13.0	113	13.9	814	—	—	—	—
Q6h: Acted as a member of an outreach club (e.g., Habitat for Humanity, Big Brothers Big Sisters)											
Non-UREI	496	69.6	116	16.3	101	14.2	713	0.03	[c]	0.10	S
UREI	61	59.2	17	16.5	25	24.3	103				
Sum	557	68.3	133	16.3	126	15.4	816	—	—	—	—
Q6i: Traveled with an international service group (e.g., Engineers Without Borders, Students Helping Honduras, Bridges to Prosperity)											
Non-UREI	658	92.5	35	4.9	18	2.5	711	0.97	N/A	0.01	N/A
UREI	95	92.2	5	4.9	3	2.9	103				
Sum	753	92.5	40	4.9	21	2.6	814	—	—	—	—
Q6j: Participated in an organization that focuses on environmental sustainability											
Non-UREI	464	65.3	145	20.4	102	14.3	711	0.69	N/A	0.03	N/A
UREI	64	62.1	21	20.4	18	17.5	103				
Sum	528	64.9	166	20.4	120	14.7	814	—	—	—	—
Q6k: Work-study or other type of job to pay for college											
Non-UREI	301	42.0	65	9.1	350	48.9	716	0.01	[c]	0.10	S
UREI	32	31.1	5	4.9	66	64.1	103				
Sum	333	40.7	70	8.5	416	50.8	819	—	—	—	—

Note: L = large effect size; M = medium effect size; and S = small effect size.
[a]Statistical significance less than 0.01 but greater than or equal 0.001.
[b]Statistical significance <0.001.
[c]Statistical significance less than 0.05 but greater than or equal to 0.01.

Engineer or Envision Sustainability Professional can be connected to what is important to URG students, which is using their position and training to help others (Rulifson and Bielefeldt 2019).

Comparing Cocurricular Experiences by Ethnicity/Race

Contributed as a member of an organization for women/minorities in engineering was a cocurricular activity in which UREI students reported having a higher percentage of involvement than did non-UREI students. UREI students' greater amount of experience contributing to UREI organizations was expected, because these affinity organizations are designed to be a warm space inside a chilly environment. UREI organizations give marginalized groups a source of centralized attention (du Maine and Freeman 2003) to garner a sense of belonging. A sense of belonging is needed when environments such as engineering classrooms or programs make

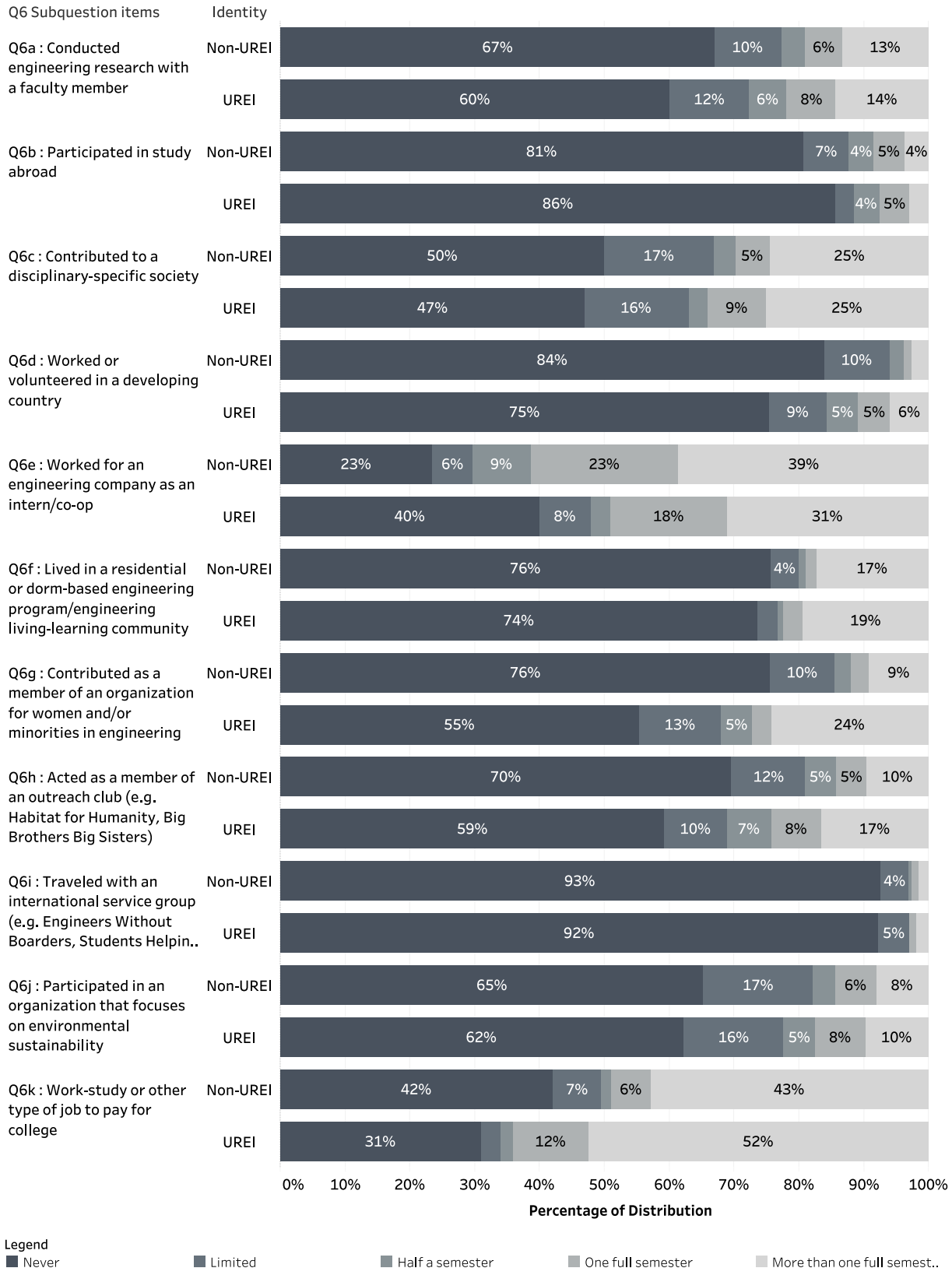

Fig. 3. Percentage of cocurricular activity participation of UREI versus non-UREI students.

students feel marginalized, unsupported, or unwelcomed (Godwin 2018).

Whereas non-UREI students should not overrepresent themselves in groups such as the National Society of Black Engineers (NSBE) or the Society of Hispanic Professional Engineers (SHPE), affinity groups should be supported by non-UREI students. Many times, UREI students are expected to participate in and support groups such as the ASCE student chapters, and

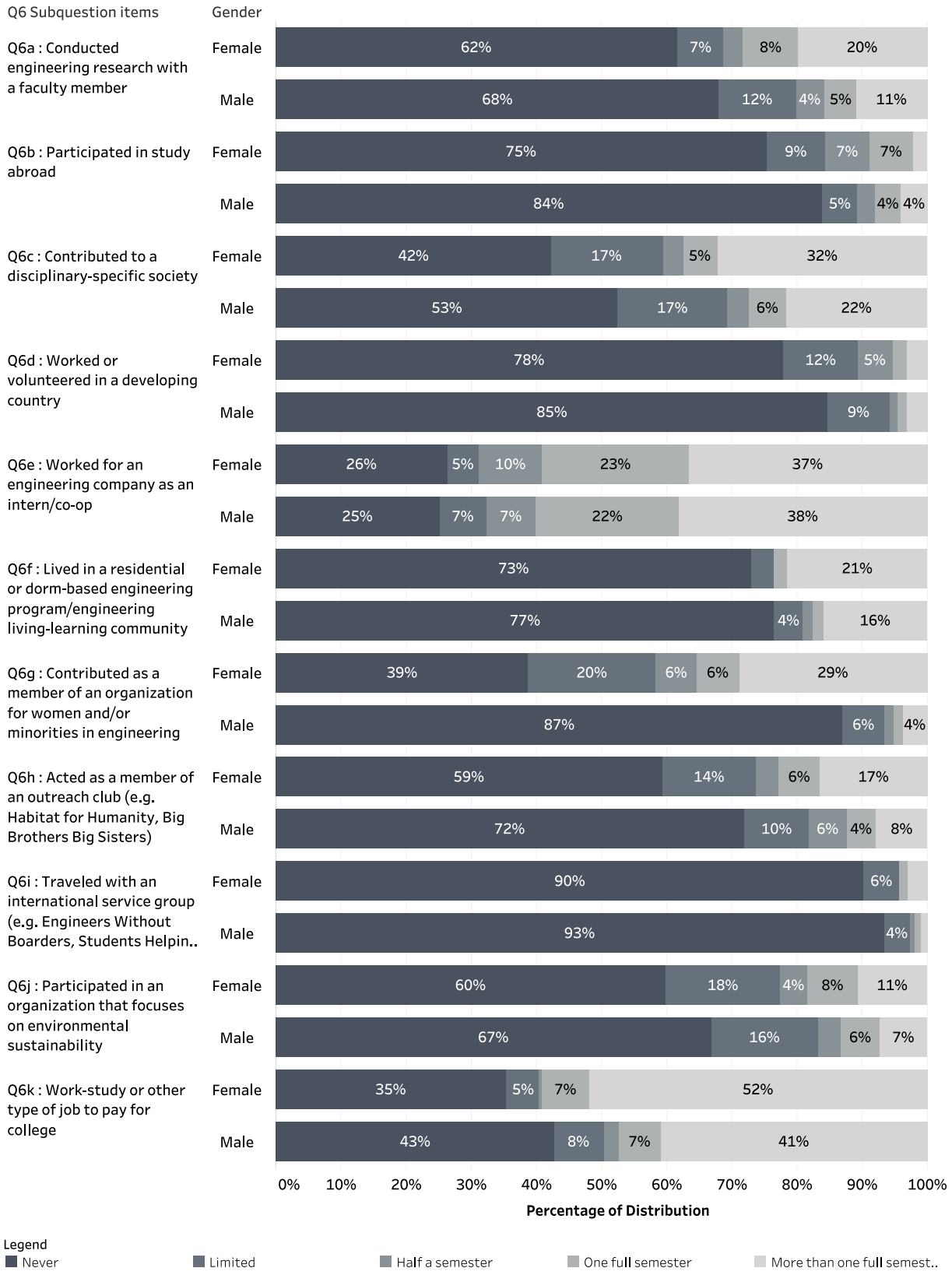

Fig. 4. Percentage of cocurricular activity participation females versus males.

a reciprocation of contribution would benefit all. ASCE has begun to establish reciprocal membership practices with partner organizations such as NSBE to lessen barriers for students and professionals. Further efforts can be made to connect the interests of people from different racial and ethnic identities together in civil engineering.

Cocurricular opportunities such as worked or volunteered in developing countries and acted as a member of an outreach club offer

Table 7. Welch's *t-test* comparison of career satisfaction expectations of females and males

Subquestion item	Male	Female	*p*-value	Significance level	Hedges' g	Effect size
Q4a: Making money	3.32	3.49	0.03	[a]	0.17	N/A
Q4b: Becoming well known	2.60	2.51	0.00	[b]	0.30	S
Q4c: Helping others	3.05	3.14	0.00	[c]	0.23	S
Q4d: Supervising others	2.32	2.58	0.17	N/A	0.10	N/A
Q4e: Having job security and opportunities	2.77	2.59	0.17	N/A	0.10	N/A
Q4f: Working with people	2.71	2.82	0.20	N/A	0.10	N/A
Q4g: Inventing/designing things	3.48	3.44	0.02	[a]	0.18	N/A
Q4h: Developing new knowledge and skills	3.10	3.10	0.78	N/A	0.02	N/A
Q4i: Having lots of personal and family time	2.87	2.85	0.34	N/A	0.07	N/A
Q4j: Having an easy job	3.33	3.21	0.04	[a]	0.15	N/A
Q4k: Being in an exciting environment	2.30	2.00	0.80	N/A	0.02	N/A
Q4l: Solving societal problems	3.34	3.28	0.14	N/A	0.11	N/A
Q4m: Making use of my talents and abilities	1.87	1.73	0.53	N/A	0.05	N/A
Q4n: Doing hands-on work	3.20	3.21	0.94	N/A	0.01	N/A
Q4o: Applying math and science	3.62	3.68	0.83	N/A	0.02	N/A
Q4p: Volunteering with charity groups	3.35	3.36	0.00	[b]	0.26	S

Note: L = large effect size; M = medium effect size; and S = small effect size.
[a]Statistical significance less than 0.05 but greater than or equal to 0.01.
[b]Statistical significance <0.001.
[c]Statistical significance less than 0.01 but greater than or equal 0.001.

the opportunity for civil engineering students to meet their career satisfaction expectation of helping others during their undergraduate experience (Bielefeldt and Lima 2019; Paterson et al. 2014). UREI students reported having a higher percentage of involvement in volunteering in developing countries, but had similar rates of participation in international service group travel. The associate dean of Rutgers School of Engineering stated that "the mission of Bridge to Prosperity offers our students the opportunity to apply engineering in a very real-life, practical way" (Goldstein 2017).

UREI students' interest in applying their engineering skills and knowledge to provide care to others show themselves to be socially engaged engineers, which incorporates community, social, and human components (Litchfield and Javernick-Will 2017). Although the civil engineering field is technical, the profession involves engagement because the profession provides service to the community, making the field people-oriented. Civil engineering companies' involvement in service projects will not only attract UREI students but also can connect students to employers and communities in a meaningful manner. The globalization of the civil engineering industry will create more opportunities for students interested in civil engineering to travel and work abroad, which is limited during the undergraduate experience.

Whereas studying or working abroad typically is described in relation to international travel, domestic internships and co-ops are a great opportunity to introduce students to a new culture and community context. UREI students reported a lower amount of experience for worked for an engineering company as intern/co-op than did non-UREI students. Internships are a formative experience for engineers to understand what their future experience as a professional will be (Adams et al. 2011). Providing UREI students with internship opportunities will be a pivotal change in the culture of civil engineering to promote inclusion in civil engineering. Students appreciate internship opportunities provided to them through professional societies, faculty, staff, and mentors (Litzler and Samuelson 2013).

To help UREI students gain the same amount of internship/co-op experience as non-UREI students, companies and schools can provide targeted opportunities for UREI students. Programs such as the National Graduate Education for Minorities (GEM) Consortium introduce UREI students to the civil engineering profession through research, mentorship, networking, and career development opportunities. In 2018, civil engineering students represented 12.9% of GEM fellows (GEM 2019), and opportunities are exclusive to graduate students. Affinity groups such as NSBE hold conferences with job fairs and on-campus visits, but a consistent and strategic partnership model such as GEM is missing at the undergraduate level.

Comparing Career Satisfaction Expectations by Gender

Becoming well-known is a career-satisfaction expectation which male students rated more important than did female students. Although the ranking of importance was lower by female students, encouragement and support should be provided to diversify the leadership of civil engineering. Women have not been provided opportunities and resources which allow them to reach positions of prestige and recognition in civil engineering- and construction-related industries (Loosemore and Waters 2004). Eagly and Carli (2007) explained that women leaders in America no longer face a breakable glass ceiling, but a frustrating labyrinth of discrimination.

During their undergraduate experience, female engineering students are not provided enough opportunities to receive guidance from women in leadership positions given the current climate in higher education. In the US, only 30% of presidents of colleges and universities are women (McCullough 2020). In engineering, the structural diversity is much worse: only 12.3% of full professors in engineering are women (Roy 2019). Having role models and mentors is essential to career development (National Academies of Sciences, Engineering, and Medicine, Committee on Effective Mentoring in STEMM, Board on Higher Education and Workforce, and Policy and Global Affairs 2019). Bhatia and Amati (2010) provided evidence of the impact that women in science and engineering mentorship program had on developing women leaders in engineering.

The civil engineering profession will benefit from supporting the inclusion and growth of leadership traits provided by women (Wirth 2010). Leadership skills such as communication, team management, and organization will be valuable in industry as they lead a team of civil engineers to meet goals. The National Academies of Science, Engineering, and Medicine (2005) described the

Table 8. Comparison of frequency of responses for cocurricular experience by gender identity

Gender identities	Never		Limited		One full semester or more		Sum	p-value	Significance level	Cramér's V	Effect size
	N	Percentage (%)	N	Percentage (%)	N	Percentage (%)					
Q6a: Conducted engineering research with a faculty member											
Male	396	68.0	94	16.2	92	15.8	582	0.00	[a]	0.15	S
Female	146	61.6	24	10.1	67	28.3	237				
Sum	542	66.2	118	14.4	159	19.4	819	—	—	—	—
Q6b: Participated in study abroad											
Male	489	83.9	47	8.1	47	8.1	583	0.00	[b]	0.12	S
Female	178	75.4	37	15.7	21	8.9	236				
Sum	667	81.4	84	10.3	68	8.3	819	—	—	—	—
Q6c: Contributed to a disciplinary-specific society											
Male	299	52.5	114	20.0	156	27.4	569	0.01	[c]	0.11	S
Female	96	42.3	46	20.3	85	37.4	227				
Sum	395	49.6	160	20.1	241	30.3	796	—	—	—	—
Q6d: Worked or volunteered in a developing country											
Male	469	84.8	59	10.7	25	4.5	553	0.05	[c]	0.09	S
Female	176	77.9	38	16.8	12	5.3	226				
Sum	645	82.8	97	12.5	37	4.7	779	—	—	—	—
Q6e: Worked for an engineering company as an intern/co-op											
Male	145	25.1	85	14.7	347	60.1	577	0.93	N/A	0.01	N/A
Female	62	26.4	34	14.5	139	59.1	235				
Sum	207	25.5	119	14.7	486	59.9	812	—	—	—	—
Q6f: Lived in a residential or dorm-based engineering program/engineering living-learning community											
Male	443	76.5	34	5.9	102	17.6	579	0.07	N/A	0.08	S
Female	170	73.0	8	3.4	55	23.6	233				
Sum	613	75.5	42	5.2	157	19.3	812	—	—	—	—
Q6g: Contributed as a member of an organization for women and/or minorities in engineering											
Male	504	87.0	45	7.8	30	5.2	579	0.00	[a]	0.50	L
Female	91	38.7	61	26.0	83	35.3	235				
Sum	595	73.1	106	13.0	113	13.9	814	—	—	—	—
Q6h: Acted as a member of an outreach club (e.g., Habitat for Humanity, Big Brothers Big Sisters)											
Male	417	71.9	91	15.7	72	12.4	580	0.00	[a]	0.14	S
Female	140	59.3	42	17.8	54	22.9	236				
Sum	557	68.3	133	16.3	126	15.4	816	—	—	—	—
Q6i: Traveled with an international service group (e.g., Engineers Without Borders, Students Helping Honduras, Bridges to Prosperity)											
Male	540	93.4	27	4.7	11	1.9	578	0.14	N/A	0.07	N/A
Female	213	90.3	13	5.5	10	4.2	236				
Sum	753	92.5	40	4.9	21	2.6	814	—	—	—	—
Q6j: Participated in an organization that focuses on environmental sustainability											
Male	388	66.9	115	19.8	77	13.3	580	0.10	N/A	0.08	S
Female	140	59.8	51	21.8	43	18.4	234				
Sum	528	64.9	166	20.4	120	14.7	814	—	—	—	—
Q6k: Work-study or other type of job to pay for college											
Male	250	42.8	57	9.8	277	47.4	584	0.01	[b]	0.11	S
Female	83	35.3	13	5.5	139	59.1	235				
Sum	333	40.7	70	8.5	416	50.8	819	—	—	—	—

Note: L = large effect size; M = medium effect size; and S = small effect size.
[a]Statistical significance <0.001.
[b]Statistical significance less than 0.01 but greater than or equal 0.001.
[c]Statistical significance less than 0.05 but greater than or equal to 0.01.

importance of rewarding engineers who have mastered the principles of business and management with leadership roles. Given the history of exclusion, providing training and direct paths toward leadership for women in engineering is an important culture for civil engineering to build.

A strong leader learns how to help others to create sustainable business practices which meet the triple bottom line (Oswald Beiler and Evans 2015). Female students ranked helping others as more important to their career satisfaction expectations than did male students. Environmental/biological engineering has shown that integrating sustainability throughout an engineering curriculum is a successful strategy for attracting women into engineering. Although curricular change is slow and difficult, integrating activities across disciplinary boundaries and targeting areas of interest can be steps toward improve structural diversity, curricular/cocurricular diversity, and interaction diversity in civil

engineering (Denson and Chang 2009). Groups such as Engineers Without Borders provide a model for diversifying engineering which can be more beneficial through greater integration within engineering departments and professional organizations.

Comparing Cocurricular Experiences by Gender

Acted as a member of an outreach club and contributed as a member of an organization for women and/or minorities in engineering are cocurricular activities for which female students reported having a higher percentage of involvement than did male students. Women in Engineering (WIE), a female-centered program at Ryerson University, was developed to increase the participation of young women in engineering. WIE also functions as a support program for female engineering students postrecruitment (Anderson and Northwood 2002). WIE at Ryerson developed an annual conference connecting female engineering students with engineering professionals for networking and mentorship.

WIE has been duplicated at multiple universities, Georgia Tech being one example, and is very similar to programs of a different name such as Clemson's Women in Science and Engineering (WiSE) program. Civil engineering can provide support to WIE programs to engage with the next generation of female civil engineers. Meaningful resources such as scholarships, professional mentors, internship opportunities, and leadership training can be provided to the future leaders within of the civil engineering profession. Female civil engineering student's continuous development of their leadership skills will help add to the representation of females in leadership positions in school institutions and industry.

The Society of Women Engineers' (SWE) Executive Leadership Program (eXXec) is another opportunity with which the civil engineering industry can engage. Middle- and senior-level female executives in civil engineering can be provided with a holistic professional development opportunity which is not male-centric. Female leadership in civil engineering and construction companies is lacking, and work is needed to elevate the women who currently are marginalized (Loosemore and Waters 2004). The civil engineering and construction industry has the opportunity to act on the expectations outlined in Canon 7 of the ASCE Code of Ethics by providing women with professional development opportunities. Women should be supported during their professional careers in the civil engineering and construction community. Women are more than deserving of leadership positions, appropriate terms of employment, salaries, and fringe benefits.

A strategy that civil engineering companies can use to increase the representation of female engineers in leadership positions is to develop initiatives such as CH2M Hill's Women's Leadership Initiative. A cultural shift will be required in civil engineering to develop a diverse and inclusive workplace that supports the advancement of women. CH2M Hill's Women's Leadership Initiative includes programs and activities for mentoring and networking, recruiting new graduates and experienced hires who are women and people of color, and formal succession planning ensuring representation of women and people of color (Ibison and Bailey 2009). The success of the initiative was apparent between 2003 and 2008 when women's representation in leadership positions, notably as company executives, rose from 2.9% to 18% (Ibison and Bailey 2009).

Limitations and Future Work

The statistically significant findings provide a snapshot of female and UREI students' experiences and beliefs. The findings provide information from the perspective of students from the current data. Using the same variables, conducting a historical comparative study can reveal which career satisfaction expectations and cocurricular activities change over time for URGs in civil engineering. Due to sample-size restrictions, multiple ethnic groups were grouped together and considered as one group in our sample population. Future studies with targeted sampling efforts can further examine the career satisfaction expectations and cocurricular activities of individual ethnic groups and gender identities. Other methods such as interviews, observations, or reflections also can be used to collect information about student experiences from various ethnic groups and analyze how they differ.

Survey questions for career satisfaction expectations measured the importance of an outcome for students. Framing the questions for cocurricular experiences to measure students' perceptions of importance for their engineering careers would help determine differences between the experience of groups in engineering. This type of rich response in a future study could help to better explain the trends identified in this paper. For example, responses to questions about cocurricular experiences from Tables 5 and 7 indicated participation rates ranging from limited to one full semester or more. The frequency of responses for some of the cocurricular activities revealed female and UREI students' lack of participation in certain activities. The survey did not go far enough to understand why this might be the case. Lack of time, course scheduling, and lack of knowledge are potential contributing factors to the low amount of participation in cocurricular activities (Simmons et al. 2018).

Conclusion

Developing, diverse, equitable, inclusive, and respectful environments is essential to civil engineering. This study provides evidence that career satisfaction expectations and cocurricular experiences differ across demographic groups in civil engineering. The strategic execution of efforts to include females and UREIs within civil engineering can occur through appropriate data collection and accountability measures [National Academies of Sciences, Engineering, and Medicine, Committee on Women in Science, Engineering, and Medicine, Policy and Global Affairs, National Academies of Sciences, Engineering, and Medicine, and Committee on Increasing the Number of Women in Science, Technology, Engineering, Mathematics, and Medicine (STEMM) 2020].

Civil engineering and construction is an essential industry in modern society. The development of infrastructure is needed for a community to be successful. Civil engineers are global servants who connect people to life essentials such as shelter, food, water, and clean air. To establish and maintain infrastructure systems, a great deal of risk and responsibility is involved. To promote the development of sustainable infrastructure and equitable business practices worldwide, females and UREIs should be encouraged and supported in the civil engineering industry.

Maintaining a motivated, skilled, and ethical workforce requires a great deal of resources from the civil engineering industry. Changes can be made to improve the attrition rate of URGs in civil engineering. Female and UREI students reported more interest in working with people and helping others. Civil engineering provides many opportunities to serve, but the marketing of the profession needs improvement. Providing opportunities for advancement (Loosemore and Waters 2004), improving the recognition processes (Perrenoud et al. 2020), and strengthening the social capital of URGs for training and safety (Allison and Kaminsky 2017; Yates 2001) will move the civil engineering industry forward. By having a diverse set of leaders in civil engineering, future

generations of engineers will be able to see their career aspirations in mentors and role models.

Improving structural diversity by increasing the representation of URGs is advantageous for civil engineering. Breaking the cycle of inequity in the civil engineering community benefits those who use, develop, and maintain civil infrastructure. This paper provides quantitative evidence contributing to civil engineering companies' strategic plans for moving forward. Diversity and inclusion is not a special topic but an ethical standard. This study is one of many needed in the civil engineering body of knowledge. This study built upon previous work which highlighted the need for change in civil engineering. The findings and methods presented in this paper will benefit future studies, which are needed to improve policies to hold the civil engineering industry accountable to the eighth canon of the ASCE Code of Ethics.

Data Availability Statement

Some or all data, models, or code that support the findings of this study are available from the corresponding author upon reasonable request.

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