Gendered Interests in Electrical, Computer, and Biomedical Engineering: Intersections With Career Outcome Expectations

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Abstract*—*Contribution: **The current study finds that female-identified students report stronger associations between "helping others" and interest in bioengineering/biomedical engineering than non-females, while they report less interest in electrical and computer engineering overall, with similar associations to factors such as "inventing/designing things" than non-females.**

Background: **While women have made gains in STEM, electrical and computer engineering programs award 13% of their Bachelor's degrees to women while bioengineering/biomedical engineering programs award over 40%. Prior work suggests that women's persistent under-representation in electrical and computer engingeering may be due to them being drawn into other disciplines. Women persist in engineering at similar rates as men, so a better understanding of early college attitudes is needed.**

Research Questions: **1) How are career outcome expectations associated to electrical engineering, computer engineering, and bioengineering/biomedical engineering? 2) What are females' interests in electrical engineering, computer engineering, and bioengineering/biomedical engineering? 3) Are outcome expectations and major interests distinct for female-identified students?**

Methodology: **Regression analyses were conducted on multiply-imputed data of introductory engineering students at four public universities in the U.S.**

Findings: **Students associate inventing/designing things and "developing new knowledge and skills" to electrical engineering, and associate inventing/designing things and "working with people" (negative) to computer engineering. Students associate helping others and "supervising others" (negative) to bioengineering/biomedical engineering. Female-identified students are less interested in electrical and computer engineering, more interested in bioengineering/biomedical engineering, and associate helping others to bioengineering/biomedical engineering more strongly.**

***Index Terms*—Biomedical engineering, computer engineering electrical engineering, gender, recruitment, undergraduate, underrepresentation.**

Manuscript received May 31, 2017; revised September 25, 2017 and March 31, 2018; accepted June 11, 2018. Date of publication August 13, 2018; date of current version October 29, 2018. This work was supported by the National Science Foundation under Award EEC-1428523 and Award EEC-1428689. *(Corresponding author: Geoff Potvin.)*

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Digital Object Identifier 10.1109/TE.2018.2859825

I. Introduction

THE PERSISTENT lack of women in several engineering disciplines in the United States has long been observed [1]. While women have gained incrementally across a host of STEM disciplines in the past 25 years, several fields, including electrical and computer engineering, continue to award less than 15% of their Bachelor's degrees to women. By contrast, biomedical engineering reported awarding 41% of its degrees to women in the same reporting period [1]. This divide in representation appears to stem from issues arising before the beginning of college, with women who enter engineering majors completing degrees at roughly the same rates as men [2], [3]. The current study contributes to understanding the problem of women's underrepresentation by conducting an examination of their early college attitudes towards, expectations for, and perceptions of engineering disciplines. This is when many students pick their college major, so understanding these perceptions can begin to inform engineering educators about how to address this problem.

II. Background

Electrical engineering developed to meet the social need for professionals trained in math and sciences to work with new technologies [4], [5]. As technologies changed, new specialties emerged within electrical engineering; a clear example is the emergence of computer engineering as a distinct strand of engineering in the early 1950s [4], [6]. The emergence of as many as 30 specialty areas within electrical engineering is referred to as the field's "identity crisis." This identity crisis also stems from concern over the stagnation of enrollment in electrical engineering, shortage of faculty, and shortage of personnel for industry [4], [7], [8]. A contemporary concern for electrical and computer engineering fields is balancing theoretical curricula with rapid changes in industry [4]. Although students believe that an electrical engineering degree will provide them with job opportunities, they are also reported to believe that the curriculum focuses on theoretical rather than applied knowledge, and that current teaching methods are obsolete given the demands of industry [9]. Thus understanding students' expectations and perceptions of the engineering education experience can help researchers and educators understand what to focus on in the classroom [9].

Although electrical engineering and computer engineering have similar curricula, the two majors have somewhat differing demographics and rates of attrition in the U.S. [10]. The stagnant growth in the field and the decline in numbers of electrical engineering degrees awarded has been a concern for electrical engineering educators and education researchers. Between 1987 and 2001, there was a 45% decline of the number of Bachelor's degrees awarded in electrical engineering, although since 1999 the number has remained fairly constant [4].

Not only has the stagnation of electrical engineering in the U.S. been a concern, but persistent underrepresentation problems have been noted [4]. Despite the steady increase of women in electrical engineering, from about 1% in the 1970's to about 13% in 1987, the percentage of women earning a Bachelor's degree in electrical engineering has remained relatively static since then, with a peak of 15% in 2003 before falling back below 13% in 2015 [1], [4]. Besides being a moral imperative, the inclusion of a more diverse population in electrical and computer engineering may help the field to address a wide variety of global challenges, and bring a new spirit of engagement and connectedness in the discipline [4]. Additional research is needed to understand recruitment and retention in electrical and computer engineering.

Scholars have argued that the decline/stagnation of women's participation in electrical engineering is because women are being drawn to other engineering fields; women make up nearly 20% of Bachelor's degrees across all engineering disciplines (which, of course, is still well below the representation of women in the college-age and U.S. populations) [1], [4]. And, as noted, particular disciplines award many of their degrees to women, including biomedical (41%), chemical (32%), and environmental engineering (50%).

The differences in the demographics of students completing degrees in different engineering disciplines strongly suggests that there are differences in the recruitment, support, and training of these students that impact these outcomes [10]. Thus, understanding the differences in the incoming student population in factors such as career expectations and goals (as well as identity, motivations, and personality traits) may help educators understand the challenges to diversifying engineering disciplines.

Other researchers have sought to understand the lack of participation of women in electrical and computer engineering. Past work in both a U.S. context and elsewhere has noted that older disciplines such as electrical engineering are considered "traditional," with a prevalence of negative stereotypes and masculine cultures (e.g., independence, risk-taking, aggression, rationality, and putting primacy on so-called "technical" prowess) [4], [11], [12]. These norms may be deeply entrenched and difficult to change, as they are entangled within curriculum and enrollment issues [4]. These cultures may cause a clash when the identities of female engineering students are put in apparent conflict with the norms of their engineering communities [12]. Also, research has found that female electrical and computer engineering students are perceived to be less competent in hands-on activities by students of all genders, and by some faculty [13]. Female electrical and computer engineering students also have been found, in U.S.-based [10] and other [13] studies, to have a lack of perceived confidence.

Outcome expectations have been considered extensively within the framework of social cognitive career theory (SCCT) [14], [15]. From the SCCT perspective, career outcome expectations are understood to be associated to, and influenced by, students' self-efficacy beliefs [16] and career-related choices in associated domains (that is, students base their career choices in part on their self-efficacy beliefs in the domain and the expected outcomes associated to pursuing that career). Relevant to the current study, research has shown that instructors may significantly influence students' career decisions and their outcome expectations [17], particularly for women [18]. Women may have depressed self-efficacy beliefs towards completing an engineering degree, and be more likely to report feeling support from their peers and by their families [18].

Hilpert *et al.* [19] explored gender differences in engineering students' perceptions of their future careers, finding that women describe fewer future professional events and more personal events than men. Explicitly addressing future career outcomes in the classroom may influence students' experiences in the classroom; women may benefit in particular from this exposure. It has been shown that an awareness of a service learning component in a course can increase students' beliefs that the course will achieve communal goals and increase the likelihood that students will take the course [20]. Other work has examined the career outcome expectations of adolescents and identified various expectations associated to engineering careers, including "relational" outcome expectations [21]. This work suggests that such expectations are associated to engineering even for young students, and that relational outcome expectations may be particularly important for recruiting women to engineering. The implication is that an emphasis on how engineering pursuits help to achieve such outcomes may help to attract greater numbers of women.

A limitation of the existing research, which the current paper seeks to address, is that the associations between career outcome expectations and interests in particular engineering disciplines are not well investigated, especially with an eye to understanding how these associations contribute to the underrepresentation of women in certain disciplines.

III. Research Questions

In this paper, the relationship between students' career outcome expectations [14]–[16], their interests in electrical, computer, and bioengineering/biomedical engineering, and female identification is considered. Specifically, this paper addresses the following research questions:

1) How are students' career outcome expectations associated to interests in electrical engineering, computer engineering, and bioengineering/biomedical engineering?
2) How is identifying as female associated to interest in electrical engineering, computer engineering, and bioengineering/biomedical engineering?
3) Are associations between career outcome expectations and major interests distinct for female-identified students?

IV. Data Collection and Analysis

This paper presents an analysis of data taken from a survey developed to probe several student attitudinal constructs, including identity (physics, mathematics, and engineering [22]), belongingness in engineering [23], [24], motivational constructs [25], [26], the "Big 5" personality traits [27], career outcome expectations [14]–[16], and student demographic indicators (including gender identity). Specific to the current analysis, the survey asked respondents to address three particular questions (numbered here as in the survey):

4. How important are the following factors for your future career satisfaction? *(0 – Not at all . . . 6 – Very much so)*
   a. Making money
   b. Becoming well known
   c. Helping others
   d. Supervising others
   e. Working with people
   f. Inventing/designing things
   g. Developing new knowledge and skills

14. Please rate your current interest in each of the following majors *(0 – Not at all interested . . . 6 – Extremely interested):*
   c. Bioengineering / Biomedical Engineering
   f. Computer Engineering
   h. Electrical Engineering
   [unused major choices not shown]

17. How do you describe your gender identity? *(Mark all that apply:)*
   O Female
   O Male
   O Genderqueer
   O Agender
   O Transgender
   O Cisgender
   O A gender not listed: ____________

A pilot survey was deployed in the spring of 2015 and given to 537 students [28] at three participating institutions. The items used in the current study were previously developed and validated in the Sustainability and Gender in Engineering (SaGE) study [22]. In addition, pilot data for the entire survey were analyzed using factor analysis to establish construct validity, and Cronbach's alpha was calculated to estimate the internal consistency of the several constructs measured in the survey. Further, the results of the factor analysis facilitated a reduction in the number of items to help shorten the survey completion time and lessen the cognitive load of respondents.

After survey development, piloting, and revision, the final survey was given to students enrolled in introductory engineering courses at four public institutions, during the first two weeks of the fall semester of 2015. The four institutions are all large universities and are geographically diverse, with one majority-serving southeastern institution, one Hispanic-serving southeastern institution, one majority-serving midwestern institution, and one majority-serving western institution.

The survey was administered before students had experienced most of their respective introductory engineering courses. In total, 2916 students responded. The response rate, as measured by number of responses divided by the total enrollments in these courses, is estimated to be above 50% at each institution.

As an overview of the analysis reported in the rest of this paper, the data set was first treated to account for missing responses using multiple imputation methods [29], and then analyzed using multiple linear regression methods [30], [31] to test for significant associations between the three engineering majors of interest, career outcome expectations, and female identification, as articulated by the research questions. The details of these methods follows below.

To account for missing student responses, multiple imputation methods were used [29]. Imputation in general is a practice for capturing non-response in data, thereby regaining lost statistical power and improving the reliability of inferences. Multiple imputation is a "best practices" set of methods to minimize the risk of biased sampling based on non-responses. Multiple complete data sets are created in an iterative process that models the patterns of missing responses followed by a weighted draw from the missingness model (hence, each imputed data set will differ slightly based on the weighted draws, but each will preserve the distributions present in the data). It should be noted that the common practice of listwise deletion (that is, simply ignoring missing cases in the analysis process) can poorly affect inference and is not recommended; in many cases listwise deletion will distort variances and distributions and thereby confound statistical inference. Earlier discussions of multiple imputation indicated that a small number of imputations (often less than ten imputed data sets) would be sufficient for typical missingness rates; however, more recently [32] it has been argued that several more imputations may be necessary to account for between-imputation variance. Further, recent advances in the availability of large computational power means creating greater numbers of imputations is a trivial task. Thus, in this paper, $m = 100$ independent imputations were generated using the Amelia II package [33], and each imputed data set was then modeled in parallel. Afterwards, the 100 resulting models were combined using Zelig [29]–[31]; the combined analyses are reported below.

The primary inferential tool used in this paper is multiple linear regression [30], [31], which fits a set of predictors onto an outcome of interest, with an assumed linear relationship between each predictor and the outcome. For example, a two-predictor model may look like:

$$y = B_0 + B_1 x_1 + B_2 x_2 + B_3 x_1 x_2 + \epsilon$$

TABLE I
ELECTRICAL ENGINEERING MAJOR INTEREST PREDICTED BY CAREER INTEREST IN "INVENTING/DESIGNING THINGS" (0...6), "DEVELOPING NEW KNOWLEDGE AND SKILLS" (0...6), AND FEMALE GENDER IDENTITY (0/1). THE **ESTIMATE** COLUMN IS THE ESTIMATED REGRESSION COEFFICIENT WITH ASSOCIATED STATISTICAL ERROR INDICATED IN THE **STD. ERR.** COLUMN. THE STATISTICAL SIGNIFICANCE IS ESTIMATED AS A P-VALUE IN THE **SIG.** COLUMN. NOTE THAT *: $p < 0.01$, **: $p < 0.001$, N/S: NON-SIGNIFICANT

	Estimate	Std. Err.	Sig.
Intercept	+1.80	0.24	**
Inventing/designing things	+0.13	0.04	**
Developing new knowledge and skills	+0.14	0.05	*
Female gender identity	-0.93	0.08	**

where y is an outcome of interest, B_0 is the intercept accounting for uncontrolled variance, x_1 and x_2 are two (assumed independent) predictors, B_1, B_2 and B_3 are the regression coefficients to be statistically fit, and ϵ is the error term. Note also that the term $B_3 x_1 x_2$ represents a "second order" interaction between the two predictors x_1 and x_2. Multiple regression is a widely used modeling technique to identify significant associations in data while simultaneously accounting for multiple effects. In the work reported here, the outcomes of interest were students' reported career interest in electrical, computer, and bioengineering/biomedical engineering, respectively (i.e., Questions 14c, f, h, quoted above), while the predictors considered were students' reported career outcome expectations (Question 4a – g above) and female gender self-identification (responses to Question 17a above). Importantly, all students who responded in the affirmative to Question 17a were identified as female in the subsequent analysis, independent of any other gender self-identification (that is, other responses in Question 17). A backwards elimination approach was used to construct each model, by first including all seven factors from Question 4, and then iteratively eliminating non-significant predictors. In addition, female gender identity was incorporated into each model throughout. After the significant linear effects had been identified, the interaction (that is, the second-order effect) between gender and each outcome expectation was tested. The α level, the maximum allowed chance of Type-I error (e.g., the chance of a false positive), was set at 1% throughout this process. All analyses were conducted using the **R** statistical language [34], including the packages Zelig [30], [31], Amelia II [33], and ggplot2 [35].

V. FINDINGS

Three linear regression models were constructed (separately) to explore associations between students' reported career interests in electrical engineering, computer engineering, and bioengineering/biomedical engineering, using the seven career outcome expectations (Question 4) after having multiply imputed the survey data, as described above. The final models are reported in Tables I–IV, and relevant parts are illustrated in Figs. 1–3.

The final model for electrical engineering, Table I, indicates two outcome expectations are associated to interest in electrical engineering as a major: "Inventing/designing things"

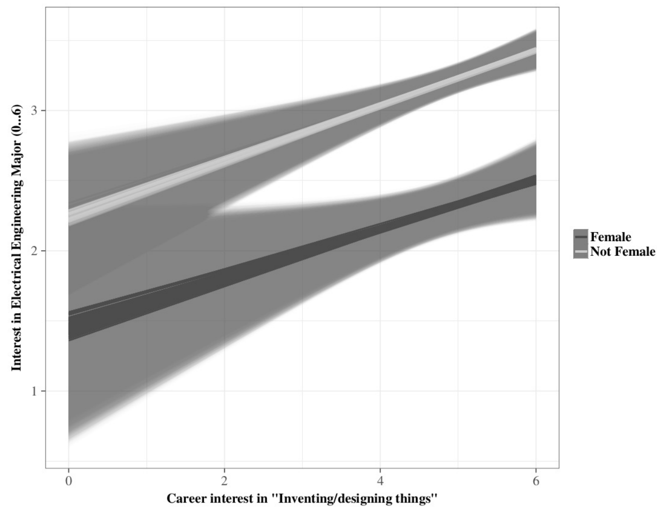

Fig. 1. Electrical engineering major interest plotted against career interests in "Inventing/designing things", disaggregated by gender. The horizontal scale is from "0 – Not at all" to "Very much so" while the vertical scale is from "0 – Not at all interested" to "6 – Extremely interested". Responses of female-identified students appear in dark gray, while non-female-identified students appear in light gray. Wide bands represent 99% confidence intervals for each line.

($p < 0.001$) and "Developing new knowledge and skills" ($p < 0.01$). Both are positively associated to electrical engineering major, with students indicating a greater interest in addressing either of these career outcomes also indicating a greater interest, on average, in pursuing electrical engineering. Further, those students who identified as female are, on average, nearly a full point below the rest of the population on their interest in electrical engineering (0.93 points on a seven-point scale, $p < 0.001$). No significant interactions between gender and career outcome expectations were found; that is, the positive association between these two outcome expectations and electrical engineering interest is statistically equivalent for females and non-females (that is, the slopes of the two lines indicated in Fig. 1 are statistically equivalent). As an illustration of this model, Fig. 1 indicates the relationship between "Inventing/designing things" (horizontal axis) and electrical engineering interests (vertical axis), broken down by gender (female is dark gray, non-female is light gray). Note that each of the 100 imputed data sets are represented separately on this plot (hence, the "width" of the central lines), and the wide bands indicate the 99% confidence intervals for each. In all figures, student responses tend to be at the high end of the scales; hence the narrower confidence intervals at that end.

Similarly, the model of computer engineering, Table II and Fig. 2, shows two outcome expectations to be significantly associated to interest in computer engineering: "Inventing/designing things" is again a positive predictor ($p < 0.001$) and "Working with people" is a small, but **negative** predictor ($p < 0.001$). Also, similar to the first model, students who identified as female are significantly lower in their computer engineering interests (by 0.89 points on a seven-point scale, $p < 0.001$) with no significant gender interactions. Fig. 2 plots computer engineering interest versus interest in "Inventing/designing things", by gender.

TABLE II
COMPUTER ENGINEERING MAJOR INTEREST PREDICTED BY CAREER INTEREST IN "INVENTING/DESIGNING THINGS" (0...6), "WORKING WITH PEOPLE" (0...6), AND FEMALE GENDER IDENTITY (0/1). THE **ESTIMATE** COLUMN IS THE ESTIMATED REGRESSION COEFFICIENT WITH ASSOCIATED STATISTICAL ERROR INDICATED IN THE **STD. ERR.** COLUMN. THE STATISTICAL SIGNIFICANCE IS ESTIMATED AS A P-VALUE IN THE **SIG.** COLUMN. NOTE THAT *: $p < 0.01$, **: $p < 0.001$, N/S: NON-SIGNIFICANT

	Estimate	Std. Err.	Sig.
Intercept	+2.26	0.19	**
Inventing/designing things	+0.26	0.03	**
Working with people	-0.10	0.03	**
Female gender identity	-0.89	0.09	**

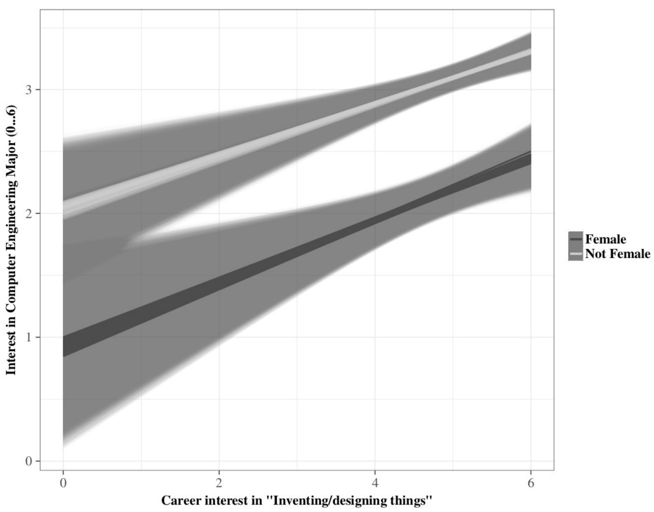

Fig. 2. Computer engineering major interest plotted against career interests in "Inventing/designing things", disaggregated by gender. The horizontal scale is from "0 – Not at all" to "Very much so" while the vertical scale is from "0 – Not at all interested" to "6 – Extremely interested". Responses of female-identified students appear in dark gray, while non-female-identified students appear in light gray. Wide bands represent 99% confidence intervals for each line.

Thirdly, and in notable contrast to the first two models, the model for bioengineering/biomedical engineering, Table III, shows significant associations to the outcome expectations of "Helping others" (a positive association, $p < 0.001$) and "Supervising others" (a negative association, $p < 0.001$). Further, females are, on average, *more interested* in this major ($p < 0.001$), and there is a statistically significant interaction between gender and "Helping others" ($p < 0.01$): the association to "Helping others" is more dramatic for female-identified students, as seen in the extended model in Table IV. Fig. 3 clearly illustrates these trends; while the slope of both lines positive, the line for females is much more positive than for non-females. In addition to involving two distinct career outcome expectations compared to the electrical and computer engineering models (all of the significant predictors from the earlier models are non-significant in this case), the gender structure in this situation is substantially different with female-identified students showing a much stronger association between "Helping others" and their interest in bioengineering/biomedical engineering by comparison to non-female-identified students.

TABLE III
BIOENGINEERING/BIOMEDICAL ENGINEERING MAJOR INTEREST PREDICTED BY CAREER INTEREST IN "HELPING OTHERS" (0...6), "SUPERVISING OTHERS" (0...6), AND FEMALE GENDER IDENTITY (0/1). THE **ESTIMATE** COLUMN IS THE ESTIMATED REGRESSION COEFFICIENT WITH ASSOCIATED STATISTICAL ERROR INDICATED IN THE **STD. ERR.** COLUMN. THE STATISTICAL SIGNIFICANCE IS ESTIMATED AS A P-VALUE IN THE **SIG.** COLUMN. NOTE THAT *: $p < 0.01$, **: $p < 0.001$, N/S: NON-SIGNIFICANT

	Estimate	Std. Err.	Sig.
Intercept	+1.56	0.19	**
Helping others	+0.28	0.04	**
Supervising others	-0.08	0.03	**
Female gender identity	+0.77	0.09	**

TABLE IV
BIOENGINEERING/BIOMEDICAL ENGINEERING MAJOR INTEREST PREDICTED BY CAREER INTEREST IN "HELPING OTHERS" (0...6), "SUPERVISING OTHERS" (0...6), AND FEMALE GENDER IDENTITY (0/1), WITH INTERACTION BETWEEN GENDER AND "HELPING OTHERS". THE **ESTIMATE** COLUMN IS THE ESTIMATED REGRESSION COEFFICIENT WITH ASSOCIATED STATISTICAL ERROR INDICATED IN THE **STD. ERR.** COLUMN. THE STATISTICAL SIGNIFICANCE IS ESTIMATED AS A P-VALUE IN THE **SIG.** COLUMN. NOTE THAT *: $p < 0.01$, **: $p < 0.001$, N/S: NON-SIGNIFICANT

	Estimate	Std. Err.	Sig.
Intercept	+1.81	0.21	**
Helping others	+0.23	0.04	**
Supervising others	-0.08	0.03	**
Female gender identity	-0.56	0.49	n/s
Gender $\times$ Helping others	0.25	0.09	*

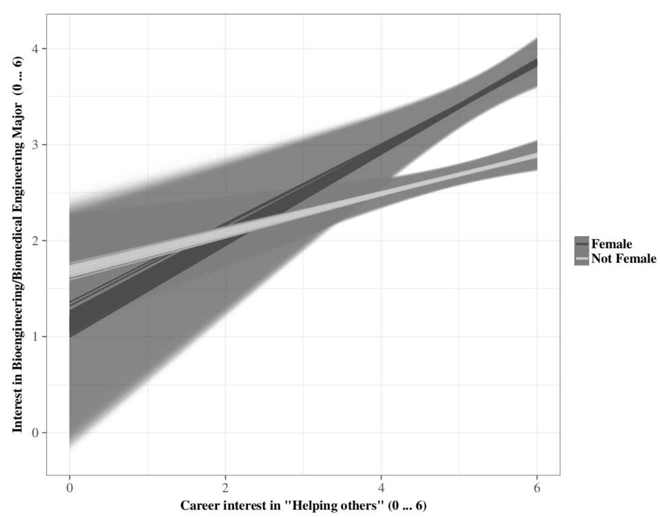

Fig. 3. Bioengineering/Biomedical engineering major interest plotted against career interests in "Helping others", disaggregated by gender. The horizontal scale is from "0 – Not at all" to "Very much so" while the vertical scale is from "0 – Not at all interested" to "6 – Extremely interested". Responses of female-identified students appear in dark gray, while non-female-identified students appear in light gray. Wide bands represent 99% confidence intervals for each line.

VI. IMPLICATIONS

The results provide evidence that incoming engineering students have particular associations between their expectations for their career (interests in achieving certain outcomes) and their interests in electrical, computer, and bioengineering/biomedical engineering, and that gender plays a significant but distinct role in each case. The factors that were found to be positively associated to electrical and computer engineering – primarily “Inventing/designing things” and “Developing new knowledge and skills” – indicate a different career emphasis for students interested in these disciplines by comparison to those interested in bioengineering/biomedical engineering (primarily, “Helping others”). The fact that “Working with people” was a *negative* predictor of computer engineering underlines this so-called “social/technical” divide.

Considering prior work in this domain (e.g., [18]–[20]), it can be understood why female-identified students may be poorly represented in electrical and computer engineering, and well represented in bioengineering/biomedical engineering. If students believe that the former two majors are associated to non-communal, non-relational outcomes, then women may be less likely to pursue them. As a reminder, female-identified students *did* show a positive association between the “technical” outcome expectations and electrical and computer engineering interests, but were significantly lower than non-females overall in their interests in these two disciplines, perhaps for these reasons.

Further, the association between “Helping others” and bioengineering/biomedical engineering interests provides a strong contrast to the other disciplines considered here. Note that the significant interaction term between female gender identity and the communal outcome expectation of “Helping others” in this model completely mediates the first-order effect of gender. That is to say, in the secondary model appearing in Table IV, the main linear effect of female gender identity is no longer statistically significant, in favor of the second-order term: this means that the particularly strong association between “Helping others” for female-identified students completely accounts for the gender differences found in this model. This shows the importance of this outcome expectation for females who are interested in bioengineering/biomedical engineering; this communal/relational outcome expectation is associated to bioengineering/biomedical engineering amongst all students, but the effect is particularly pronounced for female-identified students [20]. Again, the participation of women in this domain is much higher than in electrical engineering, computer engineering or, indeed, the overall engineering population.

These results suggest that a potential path to improved participation of women in electrical and computer engineering may be to recruit participants through an emphasis on the communal or relational importance of these domains. After all, these domains have had (and will continue to have) huge impacts on society and human lives in general, influencing the way in which people interact as well as the nature of their personal and professional lives [4]. By making a deliberate attempt to foreground such considerations in the recruitment of potential engineers, women may see more interesting and appealing careers for themselves in these areas, as has been suggested by others [20]. For undergraduate engineering educators, curricular reforms in this direction have been called for by others [20] and might include the incorporation of service learning components or project-based actvities based in real-world use or design cases. The current results add credibility to the potential benefit of these types of reforms.

This is not to suggest that “changing the conversation” in these ways is an easily accomplished goal; as emphasized by others [4], [11], [12], engineering cultures may be deeply entrenched in curricula and in standard recruitment practices. However, in order to make positive improvements in the gender diversity of electrical and computer engineering, just such efforts may be needed. It is worth remembering that some STEM fields and, indeed, some engineering disciplines such as bioengineering/biomedical engineering do have strong representation of women through the undergraduate years, and this representation has improved steadily in the past several decades.

The analysis reported here is limited to a correlational analysis, primarily due to the nature of the research design and data collected. That is, causal claims cannot be made between the associations identified here since the data are cross-sectional in nature and collected at a single time. For example, based on the regression models reported here, it is not possible to say whether beliefs in certain outcome expectations cause interest in the three engineering majors, or if interest in a major causes interest in certain outcome expectations. Future work should seek to understand more deeply the causal relationships suggested by the (strong) associations identified here by conducting, for example, intervention studies to experimentally establish how students’ beliefs are associated to interests in particular engineering majors.

Further, the data used in this study were collected at four public U.S. institutions, and so claims about the generalizability of the associations identified here to the entire U.S. engineering student population should be limited. However, the data contain nearly 3,000 students across a wide spectrum of engineering disciplines, so the models should give direction for future investigations. A future study which replicates this analysis using a data set representative of the nationwide college engineering population, that includes a wide breadth of engineering majors, similar to [22], would be highly desirable.

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