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Understanding the Changing Dynamics of the Gender Gap in Undergraduate Engineering Majors: 1971–2011

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Abstract In this paper we examine the level and determinants of entering college students' plans to major in engineering. While the overall level of interest in engineering has fluctuated between 1971 and 2011, a very large gender gap in freshman interest remains. We find that the percent of first-year women who plan to major in engineering is roughly the same today as in the early 1980s. We estimated the impact of predictor variables for five time points: 1976, 1986, 1996, 2006 and 2011. Independent variables were grouped into eight categories: personal inputs, background characteristics, learning experiences, self-efficacy, outcome expectations, interests, contextual influences, and choice goals. We present the findings in terms of those variables that have a consistent effect on the gender gap over time, and those whose effects vary over time.

Keywords STEM · Engineering · Gender · College major · Trends

Introduction

While research, practice, and policy have dedicated a great deal of effort in recent decades toward increasing women's representation in science, technology, engineering, and mathematics (STEM) fields, women remain underrepresented in most STEM fields, both in education and the workforce. Further, although there is evidence of increases in female representation among STEM occupations between 1970 and 1990, this growth has slowed in recent decades. In fact, the United States Census Bureau estimated that women made up

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26 % of the STEM workforce in 2011, despite representing over half of the general workforce (Landivar 2013).

Of notable concern is women's persistent underrepresentation in the engineering fields, where they earned fewer than 20 % of all bachelor's degrees in 2012 (National Science Foundation (NSF) 2013). Women's low representation in engineering stands in stark contrast to their majority representation (approximately 57 %) among all undergraduate college students (National Center for Education Statistics (NCES) 2013). Further, women are twice as likely as men to switch from engineering to other STEM majors (Cech et al. 2011). The consequences of such disparities in undergraduate engineering degree attainment are reflected in women's extreme underrepresentation in engineering careers; in 2011, women constituted just 13 % of engineers in the United States (Landivar 2013).

The gender gap in engineering presents a significant problem within the American educational and economic landscapes. In recent years, the U.S. federal government has consistently identified the field of engineering, among related science, technology, and mathematics fields, as an area of national need (Goan et al. 2006), asserting that a robust and well-prepared STEM workforce is "crucial to America's innovative capacity and global competitiveness" (Beede et al. 2011, p. 1). Applied within the engineering field, the substantially low proportion of women in engineering majors compared to higher education-at-large suggests that the field has not maximized the full potential of its would-be female members. In order for the United States to maintain and maximize its technological competiveness in the global market, diversifying the engineering workforce is vital to the nation's economic security (Augustine 2010; Corbett and Hill 2015; Riegle-Crumb and King 2010; Suresh 2007). Moreover, research has stressed the importance of diverse classroom and work environments, which tend to foster creativity and problem solving skills (Blickenstaff 2005; Carnevale et al. 2011; Corbett and Hill 2015; Hill et al. 2010; Lewis et al. 2000). Thus, the underrepresentation of women in engineering may inhibit the potential for productivity in a field that stands to benefit from a more diverse set of contributors.

Why do women remain underrepresented in engineering fields? Although a great deal of research has sought to understand the determinants of women's underrepresentation in the STEM fields in the aggregate, comparatively less empirical work has examined what predicts individuals' decisions to pursue *particular* STEM fields, such as engineering. This lack of specificity in the selection of STEM fields is problematic given that these fields are inherently distinct and may attract different types of students. It is certainly reasonable to presume, for example, that engineering majors may well differ from biology majors in their backgrounds and values. By differentiating between STEM fields, practitioners and policymakers may more effectively target gender gaps in particular areas of STEM.

Research that does exist regarding the determinants of majoring in engineering suggests that women choose not to pursue this field for a variety of reasons. These include a wide range of factors from demographic background characteristics such as race/ethnicity (Ohland et al. 2011), service orientation (Weinberger 2004), and measures of affect such as self-concept (Logel et al. 2009; Riegle-Crumb and King 2010; Williams and George-Jackson 2014). Still others have underscored the role of K-12 schooling experiences that favor men's interests and aspirations in engineering-related fields (Tully and Jacobs 2010). Importantly, this range of potential determinants and/or detractors related to women's participation in engineering are understood to occur across a wide range of experiences, contexts, and time-frames. A large body of research has conceptualized the compilation of such factors within the "leaking pipeline" metaphor, whereby the cumulative loss of women along the way to a STEM career is portrayed (Xie and Shauman 2003). It is important to note here, however, that alternative frameworks (e.g., the life-course perspective) also exist for understanding the gender gap in engineering, and STEM fields in general, and may provide more nuanced ways to consider how this range of factors operates in a non-linear, more intersectional manner (Blickenstaff 2005; Xie and Shauman 2003).

Despite these inroads to understanding the gender gap in engineering, a great deal more research is required to understand the complexities of what leads men and women to pursue an engineering degree in college. In particular, extant research has not yet considered whether and how the determinants of men's and women's engineering major aspirations have changed over time. Does engineering attract the same type of students today as in the past, or has there been an evolution in who seeks a degree in this field? Kanny et al. (2014) documented changing trends in the focus of research and literature dedicated to understanding the key determinants of the STEM gender gap. This work highlights the notion that researchers, scholars, and practitioners must avoid relying on potentially outdated and even stereotypical notions of what leads an individual to pursue a STEM career. Rather, and as in the case of this study, it is imperative to examine whether various oft-cited determinants of the gender gap in engineering continue to play the same role as they have in the past. In addition, it is important that research examine the roots of the persistent gender gap in engineering majors: does the gender gap result from differences between women and men in their preparation, values or other attributes? Or does the gap reflect gender differences in the salience of such attributes in predicting the choice of engineering major?

Accordingly, this study is guided by three primary aims. First, it documents *trends* in entering college students' aspirations to major in engineering with a focus on the gender gap. Second, it explores *predictors of aspirations to major in this field* separately by gender, and *whether these predictors have shifted* over time. Finally, it examines the *key determinants of the gender gap* in the intent to major in engineering major over time, with a specific focus on whether the gender gap is due to differences in men's and women's *traits* versus gender differences in the *salience* of such traits.

Review of the Literature

Engineering is "the professional art of applying science to the optimum conversion of the resources of nature to the uses of humankind" (Albuquerque 2000, p. 146). The field of engineering is often categorized into four main branches including chemical, civil, electrical, and mechanical, in which each of these have several distinct branches (Albuquerque 2000). There is a variety of jobs offered in engineering contingent upon the specialization (e.g., bioengineer, nuclear engineer, etc.), but other career options are available (Cover et al. 2011). These include business and management, finance, law, along with other alternative careers (Cech et al. 2011; Gaff and John 2013). Thus, while often considered a single field, engineering's knowledge base and practice are inherently interdisciplinary, spanning STEM fields as well as the liberal arts (Duderstadt 2008).

Thus far, engineering continues to be a male dominated field in both higher education and the workforce, with women making only modest gains in terms of their relative representation. While the number of engineering degrees awarded at both the undergraduate and graduate level has increased moderately in recent decades—with women making numerical gains at all engineering degree levels—the gender gap is far from closed (NCES

2013). Specifically, the proportion of engineering bachelor's, master's, and doctoral degrees awarded to women has increased from approximately 1 % (at each degree level) in the 1970s to 17.5 % of bachelor's, 23.1 % of master's, and 22.7 % of doctoral degrees in 2012–2013 (NCES 2013). However, women's numerical gains in engineering degree attainment have not automatically translated into the workplace. Women represent fewer than 11 % of practicing engineers, a figure which has remained relatively stable for 20 years (Landivar 2013). Gender disparities in the workforce are even more apparent among specific engineering fields: women employed as mechanical engineers comprise only 7.2 % of the workforce, whereas 17.2 % of industrial engineers, including health and safety, are women (United States Bureau of Labor Statistics 2013). Thus, despite some gains with respect to women's representation in engineering across higher education, gender inequalities remain a persistent issue there, as well as in the engineering workforce.

Understanding the Determinants of Women's Participation in Engineering

Though a notable amount of research is devoted to understanding the determinants of women's comparatively low levels of participation in engineering in particular, the majority of literature on the topic remains focused on women's representation across STEM fields in the aggregate. Considering this limitation of prior research, as well as the interdisciplinary nature of engineering in both academia and industry (Duderstadt 2008), this section reviews extant literature related to the gender gap in engineering in light of what is known regarding determinants of STEM gender gap in the aggregate.

Background Characteristics

Much of the research related to understanding the STEM gender gap has focused on how student-level background characteristics relate to men's and women's interest and persistence in STEM majors. Race/ethnicity has been posited as a key factor in STEM persistence and degree attainment. Students from underrepresented racial minority (URM) backgrounds, namely black, Latino, and Native American students, demonstrate similar levels of interest in the STEM fields as their non-URM peers, both during high school (Huang et al. 2000) and upon entering higher education (Anderson and Kim 2006; NSF 2013; Riegle-Crumb and King 2010). However, URM students are far less likely to persist through STEM majors than white and Asian students (Anderson and Kim 2006; Huang et al. 2000; NCES 2013). One of the most oft-cited reasons for these racial differences in "leakage" rates is academic preparation: on average, URM students take significantly fewer math and science courses than their white and Asian peers, before even entering college (Huang et al. 2000; Tyson et al. 2007). Moreover, reflecting race-related disparities in academic opportunities, URM students are less likely to attend high schools that offer rigorous curricula that would prepare them for college level STEM courses (Adelman 2006; College Board 2008) Additionally, researchers have attributed differential persistence rates to factors such as attendance status and amount of time spent working while in college (Anderson and Kim 2006). Findings also suggest the utility of addressing STEM persistence at the intersection of gender and race. Huang et al. (2000) logistic regression results, for example, indicated that racial/ethnic gaps in entering science and engineering (S&E) programs is only evident among men, and that the gender gap in S&E majors exists primarily among Asian and white students.

Family Influences and Expectations

The role of family influences and expectations has also been found to predict students' decisions to pursue the STEM fields. Families act as one of the earliest sources of influence in students' exposure to and interest in STEM-related activities and areas of study. Parents may serve as role models through participation in their own STEM-related careers, or they might provide support or encouragement for their children with respect to STEM-related interests and achievement (Astin and Sax 1996; Moakler and Kim 2014). In contrast, they might send more implicit messages regarding the acceptability or potential for their children to pursue STEM as an academic and career endeavor (Aschbacher et al. 2010).

Research has also identified family influences on engineering outcomes. Huang et al. (2000) concluded that parental characteristics such as educational attainment and expectations for their children's college education could explain part of what had been previously attributed to race and gender effects in science and engineering disparities.

K-12 Experiences

The STEM gender gap literature has underscored the importance of experiences within the structural K-12 environment as predictors of men and women's future choice of a STEM major. In general, research has considered the roles of various aspects of the K-12 environment including schools, teachers, pedagogy, curriculum and preparation, achievement, classroom structure as determinant of peer interaction, and standardized tests. In the aggregate, STEM research has found that girls tend to be excluded at greater rates than their male counterparts when it comes to participation in STEM-related classroom activities that positively predict aspirations to major in a STEM field. Moreover, disparate test scores in math and science may be partly to blame for the college STEM major gender gap (Niederle and Vesterlund 2010).

This literature is generally replicated among the engineering-specific research pertaining to the gender gap. Studies often highlight the strong academic preparation among women who choose engineering programs. In addition to high GPA, women in engineering tend to have high expectations for their academic performance, high motivation to study, and strong study skills which were developed during the secondary school years (Felder et al. 1995; Huang et al. 2000; Vogt et al. 2007). Tully and Jacobs (2010) also proposed that this academic preparation and resilience might be attributable to secondary school experiences. They found that among their sample of female engineering students, a large proportion had attended single-gender secondary schools. Further, these students scored the highest in mathematics self-concept. The researchers suggested that the academically driven and supportive environment of girls' high schools may promote increased academic achievement, as well as positive perceptions of ability, notably in math-related fields.

Psychological Factors, Values, and Preferences

Perhaps no other set of STEM gender gap determinants has received as much attention as those related to psychological factors and individuals' values and preferences. For instance, a well-cited deterrent to women's participation in STEM is women's personality-orientation toward serving others. The literature has also cited gender differences in STEM interest, which may be the product of gender-role socialization, in predicting women's participation in STEM. This may also be in part due to women's perception that STEM fields tend not to hold real life applications for societal impact (Baker and Leary 1995; Hill et al. 2010; Sax 2001; Thompson and Windschitl 2002; Turner and Lapan 2005).

Whereas the STEM gender gap literature has focused greatly on these affective traits of women, the engineering-specific literature tends to highlight the importance of gender differences in how ability is considered. Namely, men and women tend to differ in their conceptions of ability. Female engineering students show greater tendency than their male counterparts to endorse the belief that engineering aptitude is a fixed entity as opposed to something that develops over time (Heyman et al. 2002). Felder et al. (1995) found that women were more likely than the men to attribute poor performance in engineering curriculum to their own lack of ability, while men were more likely to attribute it to a lack of hard work or being treated unfairly.

Men and women also differ in their perceived levels of ability. Male engineering students tend to self-report stronger analytical problem solving, computing, and critical thinking skills (Felder et al. 1995; Vogt et al. 2007). Further, the disparities between men and women in self-reported abilities grow over the course of the engineering program. Cech et al. (2011) introduced the concept of professional role confidence, or confidence in one's "ability to successfully perform the professional role and to enjoy and find fulfillment in that role" as an additional consideration for psychological predictors of the engineering gender gap. They found that all dimensions of "professional role confidence are cultivated more successfully among men than among women, leaving women less likely than men to continue in an engineering career" (p. 658).

Perceptions of the Field

Female perceptions of the field have also been related to the gender gap in STEM. This particular topical area takes a broad perspective on how women perceive of their prospects for academic, professional, and affective outcomes in STEM fields (e.g. Tolbert and Moen 1998). As such, determinants related to perceptions of the field might include women's views regarding STEM environments in college, graduate school, and the workplace. Role models have been found to play an important role in shaping women's perceptions of their future potential within STEM (Astin and Sax 1996; Blickenstaff 2005; Marx and Roman 2002; Nelson and Brammer 2010). The perception that STEM fields are male-dominated domains in which women are the distinct minority also negatively predicts female participation in STEM (Blickenstaff 2005; Carnevale et al. 2011; Fouad et al. 2011; Xie and Shauman 2003). Finally, much of the aggregated STEM literature has cited the dilemma of work-life balance within the STEM fields as deterrents to female participation (Han et al. 2007; Fouad et al. 2011; Kim et al. 2009; Williams and Ceci 2012).

Women's perceptions of the field of engineering tell a similar story. Logel et al. (2009) posited that because women are numerical minorities in fields such as engineering, their interactions within the field may prime them for social identity threat. In line with this hypothesis, they found that female engineering students indeed experienced stereotype threat, and performed lower on engineering tests after interacting with sexist male colleagues. Women may also perceive a hostile environment or differential treatment in prospective engineering programs. In general, female engineering students report greater discrimination than males—that they do not feel respected as equals, and that they more frequently experience discouraging interactions with faculty (Haines et al. 2001; Heyman et al. 2002; Shehab et al. 2007; Suresh 2007; Vogt et al. 2007).

Lastly, women's perceptions of the engineering profession may deter or redirect them from engineering studies. For example, unlike the biological sciences, engineering is not perceived to emphasize societal impact (Weinberger 2004; Wilson 2003). Even among students who report similar levels of satisfaction with their decision to pursue an engineering major, women are significantly less likely to report that long-term career plans in an engineering-related field (Amelink and Creamer 2010). This disparity in career plans is perhaps attributable to long-standing representations of masculinity in engineering perpetuated by corporate recruitment campaigns, or a more recent history of unequal pay and promotion (Bix 2004; Dey and Hill 2007). Reluctance to pursue an engineering career may also be related to workplace policies that fail to offer any challenge to the gender politics of the family (Franzway et al. 2009). That is, several decades after recognizing the challenge of balancing work and family, the field remains unable to support commitments to both.

Theoretical Framework

Given that this study focuses on students' intent to major in engineering and that the literature conceives career aspirations as a life-long process (Ginzberg et al. 1951; Gottfredson 1981; Super et al. 1990), Social Cognitive Career Theory (SCCT) frames this study (Lent et al. 1994, 2000). SCCT is particularly relevant for the study as it illustrates how the experiences students bring to college influence their major selection process (Fig. 1). Specifically, SCCT's Model of Career-Related Choice Behavior (MCRCB) posits that personal characteristics and backgrounds lead to learning experiences that influence one's perceived self-efficacy (the belief that one will be successful at a given task) and their expectations of career-related outcomes. All of these factors influence the determination to undertake specific pursuits, such as the choice of a college major or future career. The model conceptualizes these factors as closely interrelated and in constant recursive processes of influence (see Fig. 1).

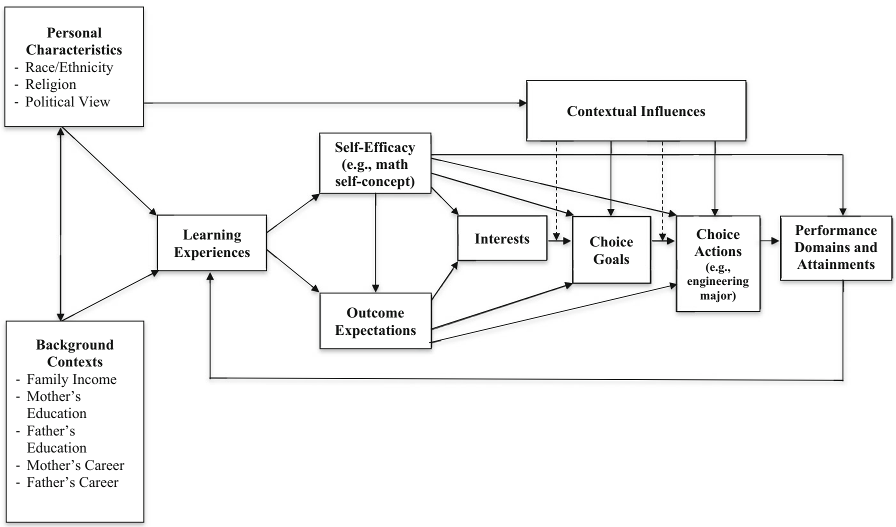

Fig. 1 Model of career-related choice behavior (adapted from Lent et al. 1994)

Thus, applied to the present study, an individual's expressed intent to major in an engineering field can be conceptualized as the result of myriad factors. These are one's personal and background characteristics as well as a range of learning experiences, perceptions of self and potential outcomes, interests, goals, and other contextual influences. Important to note here is that this study does not seek to test the MCRCB as a theoretical model for predicting men and women's pursuit of an engineering degree, nor is its chief endeavor to examine relationships between these independent variables. Rather, this study utilizes the MCRCB as a framework by which the study's independent variables were chosen for analysis. Given that the literature has identified various gender differences in the ways that men and women encounter such factors, the use of this model is particularly useful in framing how predictors of aspirations to major in engineering may not only look different between men and women, but also how their respective impacts may have evolved differently over time.

Objectives

This study utilizes national data on incoming college students collected over the past 40 years to address the following research questions:

(1) How has the gender gap in incoming college students' intent to major in engineering changed over the past four decades?
(2) What are the determinants of women's and men's decision to major in engineering versus all other fields? To what extent have these determinants and/or their salience changed over time for women and men?
(3) To what extent is the gender gap in the selection of engineering due to: (a) gender differences in student attributes, versus (b) gender differences in the salience of these attributes? How has this changed over time?

Thus, our inquiry focuses on understanding the changing nature of the gender gap in engineering major aspirations, but also on the extent to which that gap can be explained by the differences in both the nature and salience of characteristics that attract men and women to engineering.

Methods

Data Source and Sample

This study uses data from the Cooperative Institutional Research Program (CIRP), a research program housed at the Higher Education Research Institute at the University of California, Los Angeles. Introduced in 1966 at the American Council on Education, the CIRP Freshman Survey is a national longitudinal study of college students in the United States. The survey gathers information from entering college students regarding their demographic background, high school experiences, affective traits such as self-concepts and values, and goals and aspirations related to college and beyond. As such, data from CIRP are useful in analyzing the predictors of incoming students' intended major choice, such as engineering.

Data for this study were constrained to student responses to The Freshman Survey from 1225 baccalaureate-granting institutions between 1971 and 2011. The trend analysis was based on a sample of 8,038,061 respondents across the four decades (3,662,692 men and 4,375,369 women) and was weighted by student gender and institutional control, type, and selectivity so that the sample would reflect the population of first-time, full-time college students at all four-year institutions in the United States for each year [see Pryor et al. (2007) for a weighting scheme, in addition to validity, and reliability].

Regression analyses relied on unweighted data from five specific years: 1976, 1986, 1996, 2006, and 2011. These years were selected because they contained the most consistent set of survey items at evenly-spaced decade (and one half-decade) intervals. The regression sample across all years was composed of 93,616 students who indicated intent to major in engineering (16,995 women and 76,621 men) and 817,802 students (476,061 women and 341,741 men) from all other majors.

Variables

Student's self-reported intent to major in engineering (versus all other fields) serves as the outcome measure of this study. Given that this study is focused on how the determinants of majoring in engineering have evolved over time, time serves as a chief independent variable. The selection of other independent variables included in these analyses was informed by Lent et al. (1994) Model of Career Related Choice Behavior (MCRCB). In order to understand predictors of enrollment into an engineering major, the independent variables were first reduced using factor analysis and then arranged in temporally sequenced blocks in correspondence with the following eight MCRCB components which are conceptualized as having an impact on choice actions (e.g., the intent to pursue an engineering major) in the model: personal inputs, background characteristics, learning experiences, self-efficacy, outcome expectations, interests, contextual influences, and choice goals. Variables were further constrained to those only asked across each of the five years (1976, 1986, 1996, 2006, and 2011), resulting in a final set of 41 variables considered within the study (see Table 5 in Appendix for a complete list of independent variables and their coding schemes.)

Factor Analysis Procedures

As mentioned previously, exploratory factor analysis was used to reduce the number of independent variables and determine which factors would be included in the regression analysis. Factor construction was based primarily on Astin's (1993) and Sax's (2008) personality and college-going types. In order to maximize the strength of each unique factor, principal axis factoring with Promax rotation was used. Seven factors were created from among the 65 single indicator variables considered for analysis. (See Table 6 in Appendix for a list of factors, their loadings, and reliability.)

Data Analysis

With respect to Research Question 1, trends analysis was used to examine how the gender gap has evolved over time since 1971 regarding entering college students' intent to major in engineering. Specifically, the proportions of men and women reporting plans to major in an engineering field were compared across the forty-year trend data.

Research Question 2 examined predictors of choosing an engineering major and whether their predictive power changed over time. Analyses involved the use of binary logistic regression, whereby the dichotomous dependent variable was defined as a student indicating intent to major in engineering versus intent to major in any other field. Specifically, a logistic regression model that included 41 independent variables was run separately by gender to identify significant predictors of selecting an engineering major (at the $p < .001$ level). Variables that were not significant for either gender were removed from the model, and a subsequent logistic regression was run with the remaining variables, using identical models for women and men. Following this, a final model was run for each gender that added a time*variable interaction terms to identify if and how the salience of each variable changed over time for each gender. Results for men and women were then compared across these models.

Finally, Research Question 3 sought to understand the extent to which the engineering major gender gap can be attributed to gender differences in the *attributes* of men and women as opposed to gender differences in the relative *salience* of these attributes for men and women. This question necessitated the use of a regression-based decomposition technique designed for non-linear models (Fairlie 2005), which uses mean replacement to understand how populations change over time. This technique has been used in research on gender and STEM careers (Xie and Shauman 2003). This study utilized Blinder–Oaxaca approach to decomposition analysis, which is a method often used to identify the unique contributions of group differences to observed outcome gaps (e.g., those based on gender or race) (Blinder 1973; Fairlie 2005; Oaxaca 1973). That is, an outcome difference between groups (i.e., male versus female undergraduates' intent to major in engineering) is effectively decomposed into two components: (1) the part attributable to differences in average characteristics between the groups, and (2) the part attributable to the group differences in the salience (coefficient) of the characteristics, and which includes residual errors due to bias from variables not included. Respectively, these two components are referred to as the "explained" and "unexplained" portions of the gender gap.

Because choice of engineering major is a binary measure, the standard Blinder-Oaxaca decomposition cannot be directly used (Fairlie 2005). Therefore, we turned to the non-linear extension of Blinder-Oaxaca (Fairlie 2005), which can handle decomposition for binary outcomes, especially when the outcome is extreme (i.e., not located near the middle of distribution). In addition, while decomposition can be performed from the "perspective" of one group or another (e.g., choosing either male or female as a base group), this study used coefficient estimates from a pooled sample of the two gender groups, as suggested by Oaxaca and Ransom (1994).

Results

Trends Over Time

In addressing research question 1, Fig. 2 depicts intent to major in engineering among first-year women and men between 1971 and 2011. Women's representation among first-year students who plan to major in engineering has increased markedly since the early 1970s. Between 1971 and 1982, the percent female among prospective engineering majors increased from 2.4 to 17.6 %. After a lull during the 1980s, the gender composition of first-

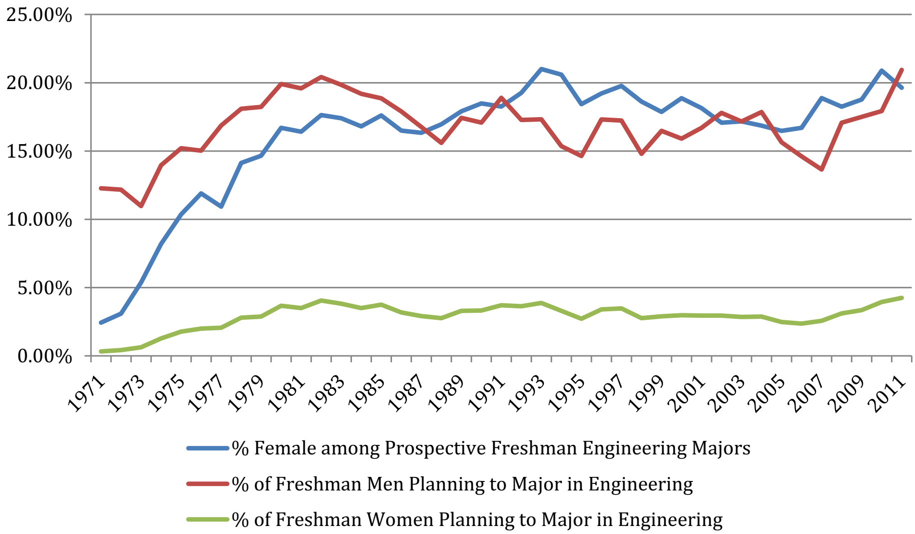

Fig. 2 Trends in first-year students' engineering plans, by gender

year students interested in engineering hit a new high in 1993, reaching 21.0 % female. After a steady decline during the 1990s and early 2000s, women's representation among freshmen in engineering rebounded to 20.9 by 2010.

There is another way of looking at these data, however, which puts this slow but positive trend in a less favorable light: Specifically, the fraction of women interested in engineering has remained extremely low. The percentage of women who plan to major in engineering has surpassed 4 % only twice—in 1982 and 2011. While women's interest in engineering has rebounded slightly since 2006, the positive top-line trend has generally not resulted from substantially greater interest on the part of women.

Then what does account for the growing share of women among engineering majors? There are two principal components that account for this change. The first is a gradual decline in interest on the part of men. While interest in engineering fluctuates from year to year, and has rebounded in recent years, there was a clear downward trend in interest in engineering between 1980 and 2007. In other words, the decline in men's representation, rather than the forward strides of women, is a significant contributor to women's growing share of prospective engineers.

The other main factor that has driven women's increased share is the fact that women now represent 57 % of college graduates. While 21 % female for engineers represents relative progress, when this figure is compared with the 57 % female college population, it does not seem quite as high. Thus, a combination of declining interest on the part of men (despite a recent resurgence) and increasing numbers of women in college accounts for the growing share of women in engineering, rather than a substantial increase in the fraction of female college students who express an interest in this field.

Table 1 Logistic regression predicting choice of engineering major (compared to all other majors) among women across years (n = 493,056)

Variables	Main effects model			Conditional effects model		
	b	SE	Ex(B)	b	SE	Exp(B)
Year (continuous)	−.044	.008	**.957**	.524	.093	**1.688**
Personal inputs						
Religion (vs. protestant)						
Catholic	.165	.021	**1.180**	.302	.053	**1.353**
Jewish	−.526	.058	**.591**	−.875	.150	**.417**
Other	.099	.033	1.104	.173	.087	1.189
No religion	.072	.026	1.075	−.002	.073	.998
Race (vs. white)						
Other/multi	.330	.033	**1.391**	.445	.116	**1.560**
Asian/Pacific Islander	.384	.030	**1.469**	.520	.097	**1.683**
Black	.899	.039	**2.457**	1.578	.099	**4.844**
Latino/a	.676	.043	**1.966**	.613	.159	**1.846**
Political views	−.103	.012	**.902**	−.090	.033	.914
Background characteristics						
Mother's education	.037	.005	**1.038**	−.014	.014	.986
Family income	.013	.008	1.013	.016	.020	1.017
Father's career: STEM	.419	.020	**1.520**	.498	.053	**1.645**
Mother's career: STEM	.059	.024	1.061	−.080	.071	.923
Learning experiences						
High school GPA	.238	.009	**1.269**	.274	.022	**1.315**
Self-efficacy						
Self-rating: math ability	1.044	.012	**2.840**	1.260	.032	**3.527**
Scholar (factor)	−.080	.011	**.923**	−.006	.029	.994
Outcome expectations						
Future act: change major field	.019	.010	1.019	.056	.025	1.057
Future act: make at least a 'B' avg.	−.227	.016	**.797**	−.322	.043	**.725**
Interests						
Goal: meaningful philosophy	−.028	.010	.973	.042	.026	1.043
Goal: theoretical scientific contrib.	.759	.010	**2.137**	.851	.027	**2.342**
Goal: raising a family	−.136	.009	**.873**	−.096	.024	**.908**
Social activist (factor)	−.202	.011	**.817**	−.312	.031	**.732**
Artistic (factor)	−.171	.010	**.843**	−.171	.028	**.843**
Status striver (factor)	−.112	.010	**.894**	−.082	.028	.922
Educ. reasons for college (factor)	−.135	.010	**.874**	−.277	.026	**.758**
Extrins. reasons for college (factor)	.226	.010	**1.253**	.291	.027	**1.338**
Contextual influences proximal to choice behavior						
Distance of institution from home	.123	.007	**1.131**	.122	.019	**1.129**
Number of institutions applied to	.020	.004	**1.020**	.028	.012	1.029
Financial concern for college	.000	.014	1.000	−.004	.036	.996
Student-to-faculty ratio	−.049	.003	**.952**	.018	.007	1.018
Institutional type: university	.324	.025	**1.383**	−.129	.063	.879

Table 1 continued

Variables	Main effects model			Conditional effects model		
	b	SE	Ex(B)	b	SE	Exp(B)
Institutional type: religious	−.625	.034	**.535**	−.457	.088	**.633**
Institutional type: HBCU	−.004	.064	.996	−.954	.160	**.385**
Institutional control: public	.328	.026	**1.388**	−.291	.070	**.748**
Choice goals						
Degree aspirations (vs. BA)						
Ph.D.	−.237	.028	**.789**	.010	.074	1.010
Law degree	−1.043	.068	**.352**	−1.219	.191	**.296**
Medical degree	−1.643	.038	**.193**	−1.974	.110	**.139**
Master's degree/M.Div.	.264	.023	**1.302**	.391	.055	**1.478**
Interaction terms						
Catholic × time				−.047	.016	.954
Jewish × time				.105	.042	1.111
Other × time				−.033	.026	.967
No religion × time				.015	.020	1.015
Other/multi × time				−.034	.029	.967
Asian/Pacific Islander × time				−.041	.025	.960
Black × time				−.208	.029	**.812**
Latino/a × time				.019	.040	1.020
Political views × time				−.005	.009	.995
Mother's education × time				.016	.004	**1.016**
Family income × time				−.002	.006	.998
Father's career: STEM × time				−.024	.015	.977
Mother's career: STEM × time				.039	.019	1.039
High school GPA × time				−.014	.007	.986
Self-rating: math ability × time				−.065	.009	**.937**
Scholar (factor) × time				−.023	.008	.977
Future act: change major field × time				−.013	.007	.988
Future act: make 'B' average × time				.027	.012	1.028
Goal: meaningful philosophy × time				−.022	.007	.978
Goal: theoretical scientific contrib. × Time				−.027	.007	**.973**
Goal: raising a family × time				−.011	.007	.989
Social activist (factor) × time				.033	.009	**1.034**
Artistic (factor) × time				.001	.008	1.001
Status striver (factor) × time				−.007	.008	.993
Educ. reasons for college (factor) × time				.043	.008	**1.044**
Extrin. reasons for college (factor) × time				−.021	.008	.980
Distance of institution from home × time				.000	.005	1.000
Number of institutions applied to × time				−.002	.003	.998
Financial concern for college × time				.001	.010	1.001
Student-to-faculty ratio × time				−.020	.002	**.980**
Institutional type: university × time				.146	.019	**1.157**
Institutional type: religious × time				−.046	.026	.955

Table 1 continued

Variables	Main effects model			Conditional effects model		
	b	SE	Ex(B)	b	SE	Exp(B)
Institutional type: HBCU × time				.295	.046	**1.342**
Institutional control: public × time				.187	.020	**1.206**
Ph.D. × time				−.076	.021	**.927**
Law × time				.046	.052	1.047
Medical degree × time				.088	.030	1.092
Master's degree/MDiv × time				−.044	.016	.957

Bold indicates $p < .001$

Logistic Regression Results

Research question 2 examines the student characteristics that predict men's and women's decision to major in engineering, and tests whether the salience of these predictors has changed over time. Of the 41 variables included in the initial regression, 39 emerged as significant ($p < .001$) for either women or men; these 39 variables were then included in the final logistic regression models run separately by gender. The results presented below underscore the applicability of the SCCT framework and the MCRCB in revealing the salience of students' backgrounds, self-efficacy, goals, expectations and contexts in shaping their career-related decisions.

Tables 1 and 2 display results for women and men in terms of two models: Model 1, which represents the main effects of independent variables across all years combined, and Model 2, which reflects the main effects of independent variables in the base year 1976, along with interaction terms to indicate shifts over time in the predictive power of independent variables. For the sake of clarity, a significant positive interaction term denotes a positive effect that has grown stronger with time or a negative effect that has weakened over time. Conversely, a significant negative interaction term indicates a positive effect that have grown weaker over time *or* a negative effect that has strengthened with time.

Given the central purpose of this study—examining change over time in women's and men's engineering interests—this presentation of results is organized into four major categories: (1) predictors that remain stable over time for both genders; (2) predictors that have changed in salience for both genders (3) predictors that have changed in salience only for women; and (4) predictors that have changed in salience only for men.

Predictors Remaining Stable Over Time for Both Genders

Across the time frame examined, several student characteristics emerge as consistent predictors of men's and women's decision to major in engineering. These include the positive effects of background characteristics such as having a father with a career in STEM, identifying as Asian/Pacific Islander, Latino/a, or other/multiracial, and being Catholic. Students who earned higher grades in high school and who aspire to earn a terminal master's degree also are more likely to pursue engineering. In addition, compared to students in other majors, men and women majoring in engineering have consistently attended colleges that are located farther from their families.

Table 2 Logistic regression predicting choice of engineering major (compared to all other majors) among men across years (n = 418,362)

Variables	Main effects model			Conditional effects model		
	b	SE	Ex(B)	b	SE	Exp(B)
Year (continuous)	−.117	.004	**.889**	−.226	.044	**.798**
Personal inputs						
Religion (vs. protestant)						
Catholic	.082	.011	**1.086**	.148	.026	**1.160**
Jewish	−.668	.030	**.513**	−.733	.066	**.481**
Other	.005	.019	1.005	−.125	.047	.883
No religion	−.091	.014	**.913**	−.153	.035	**.858**
Race (vs. white)						
Other/multi	.215	.020	**1.240**	.263	.061	**1.301**
Asian/Pacific Islander	.280	.019	**1.323**	.578	.057	**1.782**
Black	.486	.026	**1.627**	.604	.066	**1.830**
Latino/a	.413	.026	**1.511**	.233	.084	1.263
Political views	−.112	.006	**.894**	−.089	.014	**.915**
Background characteristics						
Mother's education	−.006	.003	.994	−.056	.007	**.945**
Family income	−.045	.004	**.956**	−.009	.010	.991
Father's career: STEM	.373	.011	**1.452**	.429	.028	**1.536**
Mother's career: STEM	.080	.013	**1.083**	.012	.037	1.012
Learning experiences						
High school GPA	.176	.004	**1.193**	.156	.009	**1.168**
Self-efficacy						
Self-rating: math ability	.741	.006	**2.099**	.729	.016	**2.072**
Scholar (factor)	−.187	.006	**.830**	−.133	.015	**.876**
Outcome expectations						
Future act: change major field	−.137	.005	**.872**	−.133	.013	**.876**
Future act: make at least a 'B' avg.	−.124	.008	**.883**	−.234	.021	**.791**
Interests						
Goal: meaningful philosophy	−.031	.005	**.970**	.009	.013	1.009
Goal: theoretical scientific contrib.	.691	.006	**1.996**	.763	.014	**2.144**
Goal: raising a family	.042	.005	**1.043**	.038	.013	1.038
Social activist (factor)	−.250	.006	**.779**	−.269	.015	**.764**
Artistic (factor)	−.184	.006	**.832**	−.172	.015	**.842**
Status striver (factor)	−.164	.006	**.849**	−.230	.014	**.794**
Educ. reasons for college (factor)	−.054	.005	**.947**	−.103	.012	**.903**
Extrins. reasons for college (factor)	.233	.006	**1.263**	.312	.013	**1.366**
Contextual influences proximal to choice behavior						
Distance of institution from home	.103	.004	**1.108**	.097	.009	**1.102**
Number of institutions applied to	.000	.002	1.000	.018	.006	1.018
Financial concern for college	−.032	.008	**.968**	−.067	.018	**.935**
Student-to-faculty ratio	−.018	.001	**.982**	.022	.003	**1.022**
Institutional type: university	.120	.012	**1.128**	−.286	.028	**.751**

Table 2 continued

Variables	Main effects model			Conditional effects model		
	b	SE	Ex(B)	b	SE	Exp(B)
Institutional type: religious	−.505	.018	**.603**	−.677	.043	**.508**
Institutional type: HBCU	.144	.043	**1.155**	−.955	.104	**.385**
Institutional control: public	.423	.014	**1.527**	−.187	.034	**.829**
Choice goals						
Degree aspirations (vs. BA)						
Ph.D.	−.503	.015	**.604**	−.449	.036	**.638**
Law degree	−1.766	.039	**.171**	−1.726	.085	**.178**
Medical degree	−2.432	.026	**.088**	−2.786	.063	**.062**
Master's degree/M.Div.	.139	.011	**1.149**	.176	.026	**1.193**
Interaction terms						
Catholic × time				−.026	.008	.975
Jewish × time				.020	.021	1.020
Other × time				.045	.015	1.046
No religion × time				.019	.010	1.019
Other/multi × time				−.015	.016	.986
Asian/Pacific Islander × time				−.090	.015	**.914**
Black × Time				−.034	.019	.966
Latino/a × time				.057	.022	1.059
Political views × time				−.009	.004	.991
Mother's education × time				.017	.002	**1.017**
Family income × time				−.013	.003	**.987**
Father's career: STEM × time				−.020	.008	.981
Mother's career: STEM × time				.021	.010	1.021
High school GPA × time				.006	.003	1.006
Self-rating: math ability × time				.004	.005	1.004
Scholar (factor) × time				−.018	.004	**.983**
Future act: change major field × time				−.002	.004	.998
Future act: make 'B' average × time				.037	.006	**1.037**
Goal: meaningful philosophy × time				−.014	.004	**.986**
Goal: theoretical scientific contrib. × time				−.023	.004	**.977**
Goal: raising a family × time				.001	.004	1.001
Social activist (factor) × time				.006	.004	1.007
Artistic (factor) × time				−.002	.004	.998
Status striver (factor) × time				.022	.004	**1.022**
Educ. reasons for college (factor) × time				.016	.004	**1.016**
Extrin. reasons for college (factor) × time				−.027	.004	**.974**
Distance of institution from home × time				.001	.003	1.001
Number of institutions applied to × time				−.005	.002	.995
Financial concern for college × time				.012	.006	1.012
Student-to-faculty ratio × time				−.013	.001	**.987**
Institutional type: university × time				.138	.009	**1.148**
Institutional type: religious × time				.062	.013	**1.064**

Table 2 continued

Variables	Main effects model			Conditional effects model		
	b	SE	Ex(B)	b	SE	Exp(B)
Institutional type: HBCU × time				.361	.030	**1.435**
Institutional control: public × time				.204	.010	**1.226**
Ph.D. × time				−.020	.011	.980
Law × time				−.014	.027	.986
Medical degree × time				.114	.018	**1.121**
Master's degree/MDiv × time				−.014	.008	.986

Bold indicates $p < .001$

Some characteristics have consistently diverted students from engineering. These include having an artistic orientation or more liberal political views. In other words, men and women who are more artistic, creative, and politically liberal have consistently chosen to pursue fields other than engineering in college.

In some cases, predictors of engineering major are stable and significant for one gender, but both stable and insignificant for the other. For example, having a mother whose career is in STEM has consistently predicted plans to major in engineering for men, but has shown not to predict engineering majors for women. Alternatively, applying to a greater number of colleges is associated with an increased likelihood of majoring in engineering for women, but not for men. Interestingly, one variable reveals an *opposite* effect on women and men: Men who place greater importance on raising a family are more likely to major in engineering, whereas family goals have consistently reduced the likelihood that women will pursue engineering in college.

Predictors Changing in Salience for Both Genders

Despite the stability noted above for many predictors of majoring in engineering, the predictive power of several other variables has evolved over time. Those which have become more salient over time for both genders all reflect characteristics of institutions: the increasingly positive predictive power of attending research universities, public institutions, and historically black college or universities (HBCUs); and the increasingly negative role played by attending institutions with a larger student-faculty ratio.

Predictors that have become less salient over time for both genders reflect students' interests. The first is that students' commitment to making a theoretical contribution to science has slightly weakened over time as a predictor of majoring in engineering. In other words, students majoring in engineering have become somewhat less motivated by the possibility of themselves contributing to the advancement of science. Also weakening in importance over time for both genders is the negative effect of attending college for educational reasons. This suggests that even though engineering majors have tended not to be motivated by the intellectual benefits of college, this has been less true over time.

Predictors Changing in Salience Only for Women

Thus far, the results have focused on predictors whose trajectory of salience has been identical for both genders—either remaining stable or becoming more/less salient over time. However, some variables reveal patterns over time that are distinct for each gender. We begin with shifts that have occurred only for women.

Earlier we noted the positive (and stable) effect of membership in certain racial/ethnic minority groups. The remaining group—Black/African–American—also shows a stable (and positive) effect, but for men only. For women, the positive effect of being Black/African American has significantly weakened over time. In light of the increasingly positive role played by attending HBCUs (noted earlier), this result suggest that after taking into account institutional type, African American women have become relatively less represented in engineering programs at the majority of institutions.[1]

Next, one of the more notable results of this study is that self-rating of mathematical ability—historically an important predictor of majoring in engineering—has become a less salient predictor over time for women only. In other words, women's relatively low math self-confidence has become less of a deterrent to their decision to pursue engineering. Another noteworthy shift is that social activist orientations—which have historically deterred both genders from majoring in engineering—have become less salient for women. This suggests that engineering—while still tending not to attract students desiring to help those in difficulty or influence social values—has over time become relatively more appealing to activist-minded women.

Predictors Changing in Salience Only for Men

Across all years, the engineering major has tended to attract men who are lower-income, report less interest in developing a meaningful philosophy of life, who score lower on measures of scholarly orientation, and who are not Jewish; over time, the predictive power of these variables has grown stronger. However, other traits have become less powerful predictors of the decision to major in engineering for men, such as attending college for extrinsic reasons (e.g., to get a better job). Similarly, having a "status striving" orientation, while negatively associated with majoring in engineering, has become a less salient deterrent over time.

Regression Decomposition Results

Whereas research question 2 focuses on the predictors of engineering major selection for women and men, research question 3 focuses on the determinants of the gender gap itself. During the years used in the multivariate analysis (1976, 1986, 1996, 2006, and 2011), the gender gap in the selection of engineering majors (i.e., the difference in the percentage of students from each gender selecting this major) ranged from a low of 13 % (1996) to a high of 17 % (1986). For each year, Table 3 shows the proportion of the gap that is attributable to differences in the mean characteristics of women and men who opt for this field (explained portion), versus gender differences in the *salience* of the variables that predict choice of engineering (unexplained portion),

Over time, the majority of the gender gap (55–57 %) is attributable to the fact that the predictors of majoring in engineering operate differently for each gender (the unexplained portion). This is further confirmation of the logistic regression results presented for research question 2. The remainder of the gender gap in selection of engineering majors

[1] Indeed, further investigation of the data shows that the increase in African American women's representation in engineering programs has occurred *primarily* within HBCUs, with their representation in non-HBCU engineering programs declining markedly since the mid-1990s.

Table 3 Decomposition of gender gap in intent to major in engineering

	1976 (%)	1986 (%)	1996 (%)	2006 (%)	2011 (%)
Explained	42.88	45.24	43.28	44.36	43.19
Unexplained	57.12	54.76	56.72	55.64	56.81
Total gap	100.0	100.0	100.0	100.0	100.0
	(n = 167,654)	(n = 149,640)	(n = 198,840)	(n = 233,455)	(n = 167,543)

(43–45 %) is attributable to differences in mean-level characteristics of women and men (explained portion). Table 4 provides additional detail on this explained portion by showing the proportion of the overall gap that is due to specific student characteristics. Most of the time, the percent is indicated as a positive number; however, occasionally it is negative, which indicates that the gender gap in engineering would have been even larger if not for gender differences on the particular characteristic.

Across all years, two variables stand out as the most prominent explanations for the gender gap in engineering major (i.e., those that account for at least 5 % of the overall gap). The first is women's consistently lower self-ratings of their own mathematical ability, which account for roughly 20 % of the gender gap in the likelihood of majoring in engineering each year. The second is women's tendency to place less importance than men on "making a theoretical contribution to science" as an important life goal. Notably, gender differences in the stated commitment to science contributed to more of the gap in earlier years (11.6 % in 1976 and 15.0 % in 1986), than in later years, when only 6 % of the overall engineering gender gap was attributable to differences in men's and women's scientific orientation. Only one other variable explained >5 % of the gender gap in selection of engineering majors: students' commitment to social activism. In this case, in 1996 approximately 6 % of the gender gap in engineering was attributable to the fact that women tend to be more committed to values such as helping others in difficulty or influencing social values. The mid-1990s marks the peak in the prominence social activist orientations as an explanation for the gender gap in engineering. Many other variables in Table 4 are considered statistically significant determinants of the gender gap in engineering, but represent only a very small portion of the explanation.

Limitations

While this study contributes new knowledge about the source of the gender gap in engineering and its evolution over time, it is important to acknowledge several key limitations. First, the dependent variable only considers students' intention to major in engineering at the point of college matriculation. Therefore, we are unable to consider whether or not that intention actually leads to completion of an engineering degree. Our results are thus unable to consider any factors which cause students to leave engineering during their studies; however, we are still able to understand what elements predict declared interest in undertaking engineering as a major.

A second limitation is that the study did not include all variables known to be important to STEM major selection. Because we were only able to consider survey items that were available in five different time points over four decades, structural factors such as gender-

Table 4 Detailed regression decomposition of intent to major in engineering, by year

	1976 (N = 167,654)	1986 (N = 149,640)	1996 (N = 198,840)	2006 (N = 233,455)	2011 (N = 167,543)
Probability, men	0.1880 (N = 83476)	0.2070 (N = 70830)	0.1620 (N = 88125)	0.1700 (N = 103637)	0.1978 (N = 74842)
Probability, women	0.0272 (N = 84178)	0.0380 (N = 78810)	0.0316 (N = 110613)	0.0317 (N = 129547)	0.0451 (N = 92133)
Difference in probability	0.1609	0.1691	0.1304	0.1382	0.1527
	Raw (%)	Raw (%)	Raw (%)	Raw (%)	Raw (%)
Total difference	0.1609 (100.00)	0.1691 (100.00)	0.1304 (100.00)	0.1382 (100.00)	0.1527 (100.00)
Unexplained	0.0919 (57.12)	0.0926 (54.76)	0.0740 (56.72)	0.0769 (55.64)	0.0868 (56.81)
Explained	0.0690 (42.88)	0.0765 (45.24)	0.0564 (43.28)	0.0613 (44.36)	0.0660 (43.19)
	% of total	% of total	% of total	% of total	% of total
Personal inputs					
Religion (vs. protestant)					
Catholic	0.02	−0.04	−0.05	−0.03	−0.06**
Jewish	−0.16***	−0.25***	−0.18***	−0.14***	−0.07**
Other	0.00	0.11*	−0.01	0.02	0.03
No religion	0.06	−0.13	−0.04	−0.03	0.05
Race (vs. white)					
Other/multi	0.06***	0.00	−0.06***	−0.05**	−0.04**
Asian/Pacific Islander	0.06***	0.27***	0.28***	0.07**	0.01
Black	−0.66***	−0.80***	−0.71***	−0.37***	−0.44***
Latino/a	0.01	−0.01	0.01	−0.22***	−0.20***
Political views	0.18***	0.96***	1.86***	1.17***	0.81***
Background characteristics					
Mother's education	0.03	−0.06*	0.12**	0.12***	0.15
Family income	−0.09	−0.33***	−0.36***	−0.53*	−0.26
Father's career: STEM	0.12***	0.11***	0.30***	0.29***	0.29*
Mother's career: STEM	0.01	0.02*	0.03	0.03**	0.04*
Learning experiences					
High school GPA	−0.27*	−0.69***	−1.10***	−0.71***	−0.35***
Self-efficacy					
Self-rating: math ability	21.18***	20.83***	21.10***	19.99***	20.85**
Scholar (factor)	−0.56**	−0.26	−0.82***	−1.06***	−1.38***
Outcome expectations					
Future act: change major field	0.01	0.43***	0.21***	0.15***	0.07***
Future act: make at least a 'B' avg.	−0.36***	−0.29***	−0.06	0.11**	0.03
Interests					
Goal: meaningful philosophy	0.23*	0.03	−0.02	−0.01	−0.02
Goal: theoretical scientific contrib.	11.58***	15.01***	6.96***	6.18***	6.44***
Goal: raising a family	0.04**	−0.03	0.00	0.05	0.02
Social activist (factor)	1.66***	2.58***	5.90***	4.57***	3.15

Table 4 continued

	% of total	% of total	% of total	% of total	% of total
Artistic (factor)	3.24***	0.75***	0.32***	1.83***	1.48***
Status striver (factor)	−0.43*	−1.29***	−0.46***	−0.25**	−0.61***
Educ. reasons for college (factor)	4.59***	3.99***	2.75***	3.19***	2.23***
Extrins. reasons for college (factor)	2.30***	1.01***	1.05***	0.83***	0.46***
Contextual influences proximal to choice behavior					
Distance of institution from home	0.55***	0.70***	0.99***	0.59***	0.20***
Number of institutions applied to	0.55***	0.62***	0.02	0.09*	0.24***
Financial concern for college	1.01***	0.92***	0.99***	1.07***	0.40**
Student-to-faculty ratio	0.00	0.02	0.05	0.19*	0.43*
Institutional type: university	−0.06	0.00	−0.10	1.07***	1.11***
Institutional type: religious	1.61***	1.15***	1.52***	1.92***	1.48***
Institutional type: HBCU	0.61***	0.03	0.04	−0.09*	−0.35***
Institutional control: public	−0.02	0.15*	0.99***	1.01***	3.62***
Choice goals					
Degree aspirations (vs. BA)					
Ph.D.	−0.74***	−0.88***	−0.48	−0.13	0.15
Law degree	−1.22***	−0.28***	−0.03	0.17	−0.01
Medical degree	−2.32***	0.88***	2.36	3.19	3.13***
Master's and M.Div degree	0.08	0.00	−0.04	0.09	0.06

* $p < .01$; ** $p < .001$; *** $p < .0001$

role socialization and certain experiences in K-12 (such as STEM coursework in high school) could not be considered.

Third, by including only selected years in the multivariate analysis, we may overlook important changes in the intervening years. Furthermore, the time variable is coded to only capture linear changes in salience of the relevant variables. The popularity of a given STEM field may experience non-linear fluctuations over time, and our model is unable to capture such effects. In addition, our model may miss non-linear changes in the salience of predictors.

Finally, these data only reflect first-time full-time students entering baccalaureate institutions and therefore do not capture any predictors of majoring in engineering that may be unique to community college students. In fact, 44 % of students who earn bachelor's degrees in STEM began their college careers at community colleges (Tsapogas 2004). This limitation is especially important for a study on gender disparities given that women are over-represented in community colleges, earning an even greater share of associate's degrees (61.6 %) than bachelor's degrees (56.6 %) in all fields (NSF/NCES 2013). Future research will need to consider the characteristics that predict engineering major aspirations among students who begin in community colleges.

Summary and Discussion

This paper uses a four-decade lens to examine the changing characteristics of aspiring engineering majors at four-year colleges and universities in the United States between 1971 and 2011. The results first document a sizeable and persistent gender gap among incoming college students planning to major in engineering. While students' interest in engineering has ebbed and flowed over the years—and has increased notably since 2007—men's interest remains stronger than women's. Among entering college students in 2011, more than one in five men—and fewer than one in twenty women—declared their intent to major in engineering. Further, the trends reveal that over time the gender gap in undergraduate engineering programs tends to expand as overall interest in engineering grows. In other words, as engineering becomes more popular, men's interest in the field tends to rise faster than women's. These results are consistent with national degree attainment trends for engineering (NSF 2013), but are unique because the focus here is on "intent" to major in engineering. Nevertheless, prior research has shown that there is a very high correlation between engineering major aspirations and subsequent bachelor's degree attainment 4 years later, especially among women (Jacobs and Sax 2014). Thus, the trends reflect a longstanding and considerable underrepresentation of women in engineering, a condition that does not bode well for adding much-needed diversity to the engineering workforce nor to strengthening the nation's economic competitiveness.

This study also identified key attributes of incoming male and female engineering majors, and whether the salience of these attributes has changed over time. Variables representing all categories of the Model of Career-Related Choice Behavior (MCRCB) proved to be significant for both women and men; however, fewer than half of the variables examined were shown to be stable forces in predicting both women's and men's interest in engineering. For example, students who have higher high school GPAs, whose father has a STEM career, who define themselves as more politically conservative, and who rate themselves lower on artistic/creative abilities are more likely to plan to major in engineering, and this has held true regardless of gender for the past four decades.

Some effects of race/ethnicity are also consistent over time for both genders, including the positive predictive power of being Asian/Pacific Islander, Latino/a or multiracial. While the finding for Asian students was consistent with racial/ethnic data on engineering degree attainment (NCES 2013), the results for Latino/a students were not, perhaps due to the fact that this study measures *intent* to major in engineering whereas NCES data reflect degree *attainment;* in fact, research has shown Latino/a students to be less likely than majority students to persist in the engineering major (Hughes et al. 2013). Further, the results for multiracial students are difficult to compare with other data sources given (a) the lack of reliable national data on multiracial students (Renn 2011) and (b) the fact that the multiracial category includes a broad constellation of racial/ethnic combinations, some of which are better represented in engineering than others.

One additional noteworthy "stable" finding is one that has actually produced results that function in the opposite direction for women and men. That is, placing greater priority on the goal of raising a family raises the odds that men will pursue an engineering major, but decreases those odds for women. This result is consistent with literature documenting concerns over work-life balance as a deterrent to women's pursuit of engineering careers (e.g., Williams and Ceci 2012) but raises a new question as to whether traditional family orientations serve to encourage men to pursue a traditionally male field such as engineering.

Of particular importance to this study are the variables whose salience have changed over time, becoming either stronger or weaker predictors of men's or women's plans to major in engineering. For the most part, the shifting salience was dissimilar for the two genders, suggesting that the characteristics of women and men aspiring to major in engineering have shifted in slightly different ways through the years. Below we highlight three variables that emerged from the decomposition analysis as the most prominent explanations for the underrepresentation of women among engineering majors, all of which proved to have become less salient over time, as indicated by the logistic regressions.

Among the more noteworthy shifts is the changing importance of mathematical self-concept. Although gender differences in self-rated math ability remain the chief explanation for the gender gap in engineering (as revealed in the decomposition analysis), the fact is that women's relatively lower math confidence has become less consequential. Given the longstanding, unwavering gender gap in math self-concept and women's persistent under-rating of their math abilities (Sax 2008), this shift may represent good news in efforts to recruit a broader spectrum of women into engineering and ultimately reduce the gender gap in the field. In other words, math confidence—which is not necessarily commensurate with math ability (especially for women)—has become a weaker "prerequisite" for selecting the engineering major. Notably, other research using this dataset has shown mathematical self-concept to have become a less salient predictor of women's intent to major in several other STEM fields as well (Sax et al. 2015).

A second important shift for women is in the relationship between social activist goals and interest in engineering. While activist orientations tend to deter students of both genders from engineering, and exist among the more important explanations for the field's underrepresentation of women (as revealed in the decomposition analysis), over time they have become slightly less important to women's choice of engineering major. This is to say, women today who place value on helping others and effecting social change are relatively more likely than women in the past to pursue the field of engineering. This finding is encouraging given calls for engineering and other STEM careers to more squarely emphasize their social relevance (Corbett and Hill 2015), though it presently remains unknown whether the trends observed in this study resulted from of any concerted effort to rebrand the field.

A third key finding relates to the role played by students' scientific orientations. As the decomposition analysis showed, the lower value that women have historically placed on making a "theoretical contribution to science" has been a chief explanation for the gender gap in engineering. However, as scientific commitment has become a weaker force in both women's and men's decision to pursue engineering, such gender differences in scientific orientation now matter less in contributing to women's underrepresentation in the field. Like the weakening forces described above, this finding also suggests that undergraduate engineering programs are starting to attract a more diverse pool of women, and in this case, not just those who see themselves in the most narrow and traditional image of a scientist. In fact, one might argue that the importance of making "theoretical" contribution to science is being replaced by a desire to make more "practical" contributions; this interpretation is consistent with the field's growing ability to attract women with stronger social activist orientations, as described above.

Together, these findings suggest that some of the chief reasons for women's underrepresentation in engineering—their comparatively low math confidence, less theoretical orientation to science, and greater commitment to social activism—may be losing traction. Such trends point towards the field of engineering attracting a more diverse range of female students than in the past. These results also underscore Kanny et al.'s (2014) assertion that our scholarly understanding of who pursues STEM must account for changes across time as well as differentiation across STEM subfields. As discussed in the next section, such trends have implications both for future research as well as for efforts aimed at recruiting more women into the field.

Implications

This study contributes to research, policy, and practice as it relates to women's pursuit of undergraduate engineering degrees. From a research standpoint, the study demonstrates the value of disaggregating STEM fields by highlighting the student characteristics that predict interest in engineering specifically. Future research should continue to examine STEM subfields as distinct, but should also account for variations *within* individual STEM subfields. In the case of engineering, for example, the gender gap in degree attainment varies widely across subfields, with very large gender gaps observed in mechanical and electrical engineering, but smaller gender gaps found among degree earners in environmental and biomedical engineering (Corbett and Hill 2015). Further, given engineering's inherently disciplinary nature (Duderstadt 2008), future research ought to consider how students' engineering aspirations relate to their exposure to or understanding of engineering's multidisciplinary connections.

This study also contributes to the literature on engineering and STEM more broadly through its focus on the element of time. While the trend analyses affirm what other research has documented in terms of engineering degree attainment (NSF 2013), the logistic and decomposition analyses address a unique question of how the characteristics that predict students' intent to major in engineering may have evolved over the past four decades. This approach challenges a static notion of who pursues engineering, and in fact demonstrates that several factors tending to promote the gender gap in engineering (e.g., women's lower mathematical self-concept and greater social activist orientation) have become less potent over time. Such findings underscore the mutability of the gender gap in engineering.

Moreover, the results of this study lend themselves to the consideration of the oft-cited "pipeline" metaphor used to illustrate the attrition of women from a STEM field. Researchers disagree as to when in the engineering pipeline the gender gap manifests—for example, disproportionate recruitment into engineering majors (Ohland et al. 2011) versus dropping out of the major (Cech et al. 2011; Felder et al. 1995). While the latter "leak" is beyond the scope of this study, our results underscore the utility of further investigating the former phenomenon—college major selection—as a key point of divergence between men and women in engineering. Furthermore, that this leak is evident at entry to college suggests the utility of broadening research to integrate a K-16 pipeline perspective.

This study also has several implications for policy and practice aimed at boosting women's representation in undergraduate engineering. The fact that some of the most important explanations for the gender gap in engineering have become less salient over time suggest that outreach efforts ought to focus on more active recruitment and perhaps "rebranding" in order to even further encourage the consideration of engineering among talented women who might initially lack an outward sense of self-confidence or who have altruistic, activist inclinations. Ultimately, administrators and policy-makers who seek to bring more women into engineering should focus their efforts on encouraging women with diverse experiences and attributes to consider entering the field, rather than simply trying to recruit entering college women who share traits with men who have traditionally majored in engineering. These suggestions are consistent with the American Association of University Women's recently-released strategies for increasing women's representation in engineering, including emphasizing the social relevance and impact of engineering work, promoting the notion that learned skills—not innate ability—are important to the field, and challenging stereotypes about who becomes an engineer (Corbett and Hill 2015).

However, as long as women remain vastly underrepresented in undergraduate engineering, such efforts at the college level may be difficult to implement. Engineering departments striving to attract more women should recognize that there is a great deal of gender socialization that needs to be overcome to encourage women's interest in the field. In other words, even if engineering programs were completely gender neutral, the field would still face a sizeable gender gap because only a small fraction of young women enter college with an interest in pursuing engineering. Corbett and Hill (2015) suggest specific strategies that engineering department can take to combat the effects of prior gender socialization, such as promoting a welcoming and supportive environment for women and all students who might not conform to conventional notions of who is an engineer, or teaching with examples that extend beyond the "stereotypical male applications such as cars or rockets" (p. 106).

Finally, because it can be very difficult to switch into engineering (e.g., due to programmatic and curricular requirements), it would be worthwhile for engineering programs to consider offering alternative pathways into the major or double-major options for students who have already begun exploring other fields of study. Making engineering education more flexible in terms of being able to start later or switch into the major from another field of study would increase the potential pool of engineers for men as well as women.

Conclusion

Research on gender and STEM has long-documented the underrepresentation of women, and engineering has proven to have a particularly stubborn gender gap. This study advances our understanding of the gender gap in engineering by tracking its evolution over the past four decades and identifying the ways in which the men and women attracted to engineering have evolved over time. This research provides a springboard for future studies that consider the uniqueness of STEM subfields, the evolving nature of the gender gap, and the importance of acknowledging that our scholarly understanding of who pursues STEM cannot remain static.

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Appendix

See Tables 5 and 6.

Table 5 Variable list and coding

Dependent variable	
Intent to major in engineering	Dichotomous: 0 = All others, 1 = Engineering
Personal inputs	
Religion (vs. protestant)	
Catholic	Dichotomous: 0 = "No", 1 = "Yes"
Jewish	Dichotomous: 0 = "No", 1 = "Yes"
Other	Dichotomous: 0 = "No", 1 = "Yes"
None	Dichotomous: 0 = "No", 1 = "Yes"
Race (vs. white)	
African American	Dichotomous: 0 = "No", 1 = "Yes"
Asian American	Dichotomous: 0 = "No", 1 = "Yes"
Latino/Chicano	Dichotomous: 0 = "No", 1 = "Yes"
Native American	Dichotomous: 0 = "No", 1 = "Yes"
Political orientation	Five-point scale: 1 = "Far Right" to 5 = "Far Left"
Background characteristics	
Father's education	Eight-point scale: 1 = "Grammar school or less" to 8 = "Graduate Degree"
Mother's education	Eight-point scale: 1 = "Grammar school or less" to 8 = "Graduate Degree"
Family income	25-point scale: 1 = "less than $6,000" to 25 = "$250,000 or more"
Father's career: STEM	Dichotomous: 0 = "No", 1 = "Yes" (physician, engineer, health professional, nurse, research scientist or computer programmer)
Mother's career: STEM	Dichotomous: 0 = "No", 1 = "Yes" (physician, engineer, health professional, nurse, research scientist or computer programmer)
Learning experiences	
High school GPA (Avg. grade in H. S.)	Eight-point scale: 1= "D" to 8= "A or A+"
Self-efficacy	
Self-rated mathematical ability	Five-point scale: 1= "Lowest 10%" to 5= "Highest 10%"
Leader personality factor	See Table 6
Scholar personality factor	See Table 6
Outcome expectations	
Future activity: change major field	Four-point scale: 1 = "No Chance" to 4= "Very Good Chance"
Future activity: make at least a 'B' average	Four-point scale: 1 = "No Chance" to 4= "Very Good Chance"
Interests	
Goal: develop a meaningful philosophy of life	Four-point scale: 1 = "Not Important" to 4= "Essential"
Goal: make a theoretical contribution. to science	Four-point scale: 1 = "Not Important" to 4= "Essential"
Goal: raise a family	Four-point scale: 1 = "Not Important" to 4= "Essential"
Social activist personality factor	See Table 6
Artistic personality factor	See Table 6
Status striver personality factor	See Table 6
Education reasons for choosing a college factor	See Table 6

Table 5 continued

Extrinsic reasons for choosing a college factor	See Table 6
Contextual influences proximal to choice behavior	
Distance from home	Five-point scale: 1 = "10 miles or less" to 5 = "More than 500 miles"
Number of institutions applied	Five-point scale: 1 = "None" to 5 = "Four or More"
Concern about finances	Three-point scale: 1 = "None", 2="Some", 3 ="Major"
Student faculty ratio	
Institutional type: University/college	Dichotomous: 0 = College, 1 = University
Institutional type: Religious/non-sectarian	Dichotomous: 0 = Nonsectarian, 1 = Religious
Institutional type: HBCU	Dichotomous: 0 = Non-HBCU, 1 = HBCU
Control: public/private	Dichotomous: 0 = Private, 1 = Public
Choice goals	
Degree aspirations (vs. bachelor's or less)	
Ph.D	Dichotomous: 0 = All Others, 1 = PhD
Law	Dichotomous: 0 = All Others, 1 = Law
Medical degree	Dichotomous: 0 = All Others, 1 = Medical
Master's degree/M.Div.	Dichotomous: 0 = All Others, 1 = Master's or M.Div.

Table 6 Factor variables, loadings, and reliabilities

Factor	Factor loading		
	All	Men	Women
Leader personality	α = .65	α = .66	α = .65
Self-rating: drive to achieve[a]	.71	.72	.71
Self-rating: leadership ability[a]	.83	.83	.83
Self-rating: self-confidence (social)[a]	.76	.77	.75
Scholar personality	α = .64	α = .64	α = .64
Self-rated: academic ability[1]	.80	.80	.79
Self-rated: self-confidence (intellectual)[a]	.78	.78	.78
Self-rated: writing ability[1]	.72	.72	.73
Social activist personality	α = .74	α = .76	α = .72
Goal: influence social values[b]	.76	.77	.74
Goal: participate in a community action program[b]	.76	.76	.75
Goal: help others in difficulty[b]	.63	.65	.61
Goal: influence the political structure[b]	.69	.72	.69
Goal: becoming involved in programs to clean up the environment[b]	.65	.67	.64
Artistic Personality	α = .70	α = .72	α = .69
Goal: create artistic work[b]	.82	.83	.82
Self-rated: artistic ability[a]	.70	.66	.72
Goal: write original works[b]	.71	.75	.67
Goal: become accomplished in the performing arts[b]	.69	.73	.66
Status striver personality	α = .64	α = .64	α = .64

Table 6 continued

Factor	Factor loading		
	All	Men	Women
Goal: obtain recognition from colleagues[b]	.78	.78	.78
Goal: be very well-off financially[b]	.65	.64	.64
Goal: become authority in my field[b]	.75	.75	.74
Goal: be successful in a business of my own[b]	.62	.62	.62
Education reasons for choosing college	α = .63	α = .63	α = .60
Reason: to gain a general education and appreciation of ideas[c]	.78	.79	.76
Reason: to make me a more cultured person[c]	.78	.78	.77
Reason: learn more about things that interest me[c]	.73	.73	.73
Extrinsic reasons for choosing college	α = .66	α = .67	α = .66
Reason: to be able to get a better job[c]	.87	.87	.86
Reason: to be able to make more money[c]	.87	.87	.86

[a] Five-point scale: 1 = "lowest 10%," to 5 = "highest 10%"

[b] Four-point scale: 1 = "not important," to 4 = "essential"

[c] Three-point scale: 1 = "not important," to 3 = "very important"

References

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. Washington, DC: U.S. Department of Education.

Albuquerque, U. (2000). *Career opportunities in India for twenty-first century*. Hong Kong: C&C Offset Printing Co.

Amelink, C. T., & Creamer, E. G. (2010). Gender differences in elements of the undergraduate experience that influence satisfaction with the engineering major and the intent to pursue engineering as a career. *Journal of Engineering Education, 99*(1), 81–92. doi:10.1002/j.2168-9830.2010.tb01044.x.

Anderson, E. L., & Kim, D. (2006). *Increasing the success of minority students in science and technology* (No. 4). Washington, DC: American Council on Education.

Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching, 47*(5), 564–582. doi:10.1002/tea.20353.

Astin, A. W. (1993). *What matters in college? Four critical years revisited* (p. 482). San Francisco: Jossey-Bass.

Astin, H. S., & Sax, L. J. (1996). Developing scientific talent in undergraduate women. In C. Davis, A. B. Ginorio, C. S. Hollenshead, B. B. Lazarus, P. M. Rayman, & Associates (Eds.), *The equity equation: Fostering the advancement of women in the sciences, mathematics, and engineering* (pp. 96–121). San Francisco, CA: Jossey-Bass.

Augustine, N. R. (2010). *Rising above the gathering storm revisited: Rapidly approaching category 5*. Washington, DC: National Academy Press.

Baker, D., & Leary, R. (1995). Letting girls speak out about science. *Journal of Research in Science Teaching, 32*(1), 3–27.

Beede, D., Julian, T., Langdon, D., McKittrick, G., Khan, B., & Doms, M. (2011). Women in STEM: A gender gap to innovation (ESA Issue Brief #04-11). Retrieved from http://www.esa.doc.gov/sites/default/files/reports/documents/womeninstemagaptoinnovation8311.pdf.

Bix, A. S. (2004). From" engineeresses" to" girl engineers" to" good engineers": a history of women's US engineering education. *NWSA Journal, 16*(1), 27–49. doi:10.1353/nwsa.2004.0028.

Blickenstaff, J. C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education, 17*(4), 369–386. doi:10.1080/09540250500145072.

Blinder, A. S. (1973). Wage discrimination: Reduced form and structural estimates. *Journal of Human Resources, 8*(4), 436–455.

Carnevale, A. P., Smith, N., & Melton, M. (2011). STEM: Science Technology Engineering Mathematics. Washington, DC: Georgetown University Center on Education and the Workforce. Retrieved from http://files.eric.ed.gov/fulltext/ED525297.pdf.

Cech, E., Rubineau, B., Silbey, S., & Seron, C. (2011). Professional role confidence and gendered persistence in engineering. *American Sociological Review, 76*(5), 641–666. doi:10.1177/0003122411420815.

Corbett, C., & Hill, C. (2015). *Solving the equation: The variables for women's success in engineering and computer science*. Washington, DC: American Association of University Women.

Cover, B., Jones, J. I., & Watson, A. (2011). Science, technology, engineering, and mathematics (STEM) occupations: A visual essay. *Monthly Labor Review, 134*(5), 3–15. Retrieved from https://www.ccc.edu/departments/Documents/STEM_labor.pdf.

Dey, J. G., & Hill, C. (2007). *Behind the pay gap*. Washington, DC: American Association of University Women Educational Foundation.

Duderstadt, J. J. (2008). *Engineering for a changing world: A Roadmap to the future of engineering practice, research, and education.* Ann Arbor: The Millennium Project, the University of Michigan. Retrieved from http://milproj.dc.umich.edu/publications/EngFlex_report/download/EngFlex%20Report.pdf.

Fairlie, R. W. (2005). An extension of the Blinder-Oaxaca decomposition technique to logit and probit models. *Journal of Economic and Social Measurement, 30*(4), 305–316.

Felder, R. M., Felder, G. N., Mauney, M., Hamrin, C. E., & Dietz, E. J. (1995). A longitudinal study of engineering student performance and retention. III. Gender differences in student performance and attitudes. *Journal of Engineering Education, 84*(2), 151–163. doi:10.1002/j.2168-9830.1995.tb00162.x.

Fouad, N., Fitzpatrick, M., & Liu, J. P. (2011). Persistence of women in engineering careers: A qualitative study of current and former female engineers. *Journal of Women and Minorities in Science and Engineering, 17*(1), 69–96.

Franzway, S., Sharp, R., Mills, J. E., & Gill, J. (2009). Engineering ignorance: the problem of gender equity in engineering. *Frontiers: A Journal of Women Studies, 30*(1), 89–106. doi:10.1353/fro.0.0039.

Gaff, B. M., & John, J. S. (2013). Legal careers for engineers. *IEEE Computer Society, 46*(12), 11–13.

Ginzberg, E., Ginsburg, S. W., Axelrad, S., & Herma, J. L. (1951). *Occupational choice: An approach to a general theory*. New York, NY: Columbia University Press.

Goan, S., Cunningham, A., & Carroll, C. (2006). *Degree completions in areas of national need, 1996–97 and 2001–02. (NCES 2006-154)*. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Gottfredson, L. S. (1981). Circumscription and compromise: A developmental theory of occupational aspirations. *Journal of Counseling Psychology, 28*(6), 545. doi:10.1037/0022-0167.28.6.545.

Haines, V. A., Wallace, J. E., & Cannon, M. E. (2001). Exploring the gender gap in engineering: A re-specification and test of the hypothesis of cumulative advantages and disadvantages. *Journal of Engineering Education, 90*(4), 677–684. doi:10.1002/j.2168-9830.2001.tb00659.x.

Han, J. C., Sax, L. J., & Kim, K. (2007). Having the talk: Engaging engineering students in discussions on gender inequity. *The Journal of Women and Minorities in Science and Engineering, 13*(2), 145–163.

Heyman, G. D., Martyna, B., & Bhatia, S. (2002). Gender and achievement-related beliefs among engineering students. *Journal of Women and Minorities in Science and Engineering, 8*(1), 41–52.

Hill, C., Corbett, C., & St Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics*. Washington, DC: American Association of University Women.

Huang, G., Taddese, N., Walter, E., & Peng, S. S. (2000). Entry and persistence of women and minorities in college science and engineering education. U.S. Department of Education, National Center for Education Statistics. http://www.nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000601.

Hughes, B.E., Garibay, J. C., Hurtado, S., & Eagan, K. (2013). *Examining the tracks that cause derailment: Institutional contexts and engineering degree attainments*. Paper presented at the American Educational Research Association (AERA) annual meeting. San Francisco.

Jacobs, J. A. & Sax, L. J. (2014). *STEM majors, the liberal arts and the great recession.* Paper presented at the American Educational Research Association (AERA) annual meeting. Philadelphia.

Kanny, M. A., Sax, L. J., & Riggers-Piehl, T. A. (2014). Investigating forty years of STEM Research: How explanations for the gender gap have evolved over time. *Journal of Women and Minorities in Science and Engineering, 20*(2), 127–148.

Kim, Y. K., Chang, M. J., & Park, J. J. (2009). Engaging with faculty: Examining rates, predictors, and educational effects for Asian American undergraduates. *Journal of Diversity in Higher Education, 2*(4), 206–218. doi:10.1037/a0017890.

Landivar, L. C. (2013). Disparities in STEM employment by sex, race, and Hispanic origin. Washington, DC: American Community Survey Reports, ACS-24, U.S. Census Bureau. Retrieved from https://www.census.gov/content/dam/Census/library/publications/2013/acs/acs-24.pdf.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45*(1), 79–122. doi:10.1006/jvbe.1994.1027.

Lent, R. W., Brown, S. D., & Hackett, G. (2000). Contextual supports and barriers to career choice: A social cognitive analysis. *Journal of Counseling Psychology, 47*(1), 36.

Lewis, S., Harris, R., & Cox, B. (2000). *Engineering a better workplace: A diversity guide for the engineering profession*. Melbourne: National Centre for Gender and Cultural Diversity; Swinburne University of Technology.

Logel, C., Walton, G. M., Spencer, S. J., Iserman, E. C., von Hippel, W., & Bell, A. E. (2009). Interacting with sexist men triggers social identity threat among female engineers. *Journal of Personality and Social Psychology, 96*(6), 1089. doi:10.1037/a0015703.

Marx, D. M., & Roman, J. S. (2002). Female role models: Protecting women's math test performance. *Personality and Social Psychology Bulletin*, *28*(9), 1183–1193.

Moakler, M. W., & Kim, M. M. (2014). College major choice in STEM: Revisiting confidence and demographic factors. *The Career Development Quarterly, 62*, 128–142.

National Center for Education Statistics. (2013). *Digest of education statistics 2013*. Washington, DC: U.S. Department of Education.

National Science Foundation, National Center for Science and Engineering Statistics. (2013). *Women, minorities, and persons with disabilities in science and engineering: 2013*. Special Report NSF 13-304. Arlington. Available at http://www.nsf.gov/statistics/wmpd/.

Nelson, D. J., & Brammer, C. N. (2010). *A national analysis of minorities in science and engineering faculties at research universities*. Norman: University of Oklahoma.

Niederle, M., & Vesterlund, L. (2010). Explaining the gender gap in math test scores: The role of competition. *The Journal of Economic Perspectives, 24*(2), 129–144.

Oaxaca, R. (1973). Male-female wage differentials in urban labor markets. *International Economic Review, 14*, 693–709.

Oaxaca, R. L., & Ransom, M. R. (1994). On discrimination and the decomposition of wage differentials. *Journal of Econometrics, 61*(1), 5–21.

Ohland, M. W., Brawner, C. E., Camacho, M. M., Layton, R. A., Long, R. A., Lord, S. M., & Wasburn, M. H. (2011). Race, gender, and measures of success in engineering education. *Journal of Engineering Education, 100*(2), 225–252. doi:10.1002/j.2168-9830.2011.tb00012.x.

Pryor, J. H., Hurtado, S., Saenz, V. B., Santos, J. L., & Korn, W. S. (2007). The American freshman: Forty year trends (vol. 3). Los Angeles: Higher Education Research Institute. Available at http://heri.ucla.edu/PDFs/40TrendsManuscript.pdf.

Renn, K. A. (2011). Biracial and multiracial college students. In M. J. Cuyjet, M. F. Howard-Hamilton, & D. L. Cooper (Eds.), *Multiculturalism on campus: Theory, models, and practices for understanding diversity and creating inclusion* (pp. 191–212). Sterling: Stylus Publishing.

Riegle-Crumb, C., & King, B. (2010). Questioning a white male advantage in STEM: Examining disparities in college major by gender and race/ethnicity. *Educational Research, 39*(9), 656–664.

Sax, L. J. (2001). Undergraduate science majors: Gender differences in who goes to graduate school. *The Review of Higher Education, 24*(2), 153–172.

Sax, L. J. (2008). *The gender gap in college: Maximizing the developmental potential of women and men*. San Francisco: Jossey-Bass.

Sax, L. J., Kanny, A., Riggers-Piehl, T., Whang, H., & Paulson, L. (2015). But I'm not good at math": The changing salience of mathematical self-concept in shaping women's and men's STEM aspirations. *Research in Higher Education,*. doi:10.1007/s11162-015-9375-x.

Shehab, R., Murphy, T., Davidson, J., Foor, C., Reed Roads, T., Trytten, T., & Walden, S. (2007). Experiences as a non-majority engineering student. In *Annual meeting of the American Society for Engineering Education, Honolulu.*

Super, D. E., Savickas, M. L., Super, C. M., Brown, D., & Brooks, L. (1990). *Career choice and development* (pp. 197–261). San Francisco, CA: Jossey-Bass.

Suresh, R. (2007). The relationship between barrier courses and persistence in engineering. *Journal of College Student Development, 8*(2), 215–239.

The College Board. (2008). *Coming to our senses: Education and the American future*. Retrieved from https://professionals.collegeboard.com/profdownload/coming-to-our-senses-college-board-2008.pdf.

Thompson, J. J., & Windschitl, M. A. (2002). *Engagement in science learning among academically at-risk girls: Sense of self and motivation to learn across learning contexts*. In Annual Meeting of the American Educational Research Association, New Orleans.

Tolbert, P. S., & Moen, P. (1998). Men's and women's definitions of "good" jobs similarities and differences by age and across time. *Work and Occupations, 25*(2), 168–194.

Tsapogas, J. (2004). *The role of community colleges in the education of recent science and engineering graduates (Info Brief)*. Washington, DC: NSF.

Tully, D., & Jacobs, B. (2010). Effects of single-gender mathematics classrooms on self-perception of mathematical ability and postsecondary engineering paths: An Australian case study. *European Journal of Engineering Education, 35*(4), 455–467.

Turner, S. L., & Lapan, R. T. (2005). Evaluation of an intervention to increase non-traditional career interests and career-related self-efficacy among middle-school adolescents. *Journal of Vocational Behavior, 66*(3), 516–531.

Tyson, W., Lee, R., Borman, K. M., & Hanson, M. A. (2007). Science, technology, engineering, and mathematics (STEM) pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk*, *12*(3), 243–270.

United States Bureau of Labor Statistics. (2013). *Employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity*. Retrieved from http://www.bls.gov/cps/cpsaat11.pdf.

Vogt, C. M., Hocevar, D., & Hagedorn, L. S. (2007). A social cognitive construct validation: Determining women's and men's success in engineering programs. *The Journal of Higher Education, 78*(3), 337–364.

Weinberger, C. J. (2004). Just ask! Why surveyed women did not pursue IT courses or careers. *Technology and Society Magazine, IEEE, 23*(2), 28–35. doi:10.1109/MTAS.2004.1304399.

Williams, W. M., & Ceci, S. J. (2012). When scientists choose motherhood. *American Scientist, 100*(2), 138–145.

Williams, M. M., & George-Jackson, C. E. (2014). Using and doing science: Gender, self-efficacy, and science identity of undergraduate students in STEM. *Journal of Women and Minorities in Science and Engineering, 20*(2), 99–126.

Wilson, F. (2003). Can compute, won't compute: Women's participation in the culture of computing. *New Technology, Work, and Employment*, *18*(2), 127–142.

Xie, Y., & Shauman, K. A. (2003). *Women in science: Career processes and outcomes* (Vol. 26, No. 73.4). Cambridge, MA: Harvard University Press.