

Article

# Framing Engineering: The Role of College Website Descriptions

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**Abstract:** This study contributes to the literature on women in science, technology, engineering, and mathematics (STEM) by examining the framing of engineering on college websites, a major recruitment tool. We take websites to be key sources of textual data that can provide insights into the discourses surrounding the field of engineering. We ask whether women-only institutions (WOIs) frame engineering in ways that appeal more broadly to women. Our sample comprises the full range of WOIs offering engineering degrees in the US (14) and a comparison sample of 14 coeducational universities also offering engineering degrees. We employ established methods for discourse analysis, and both deductive and inductive coding processes in analyzing the textual data. Our main findings indicate that WOIs' framing of engineering places a greater emphasis on collaboration, supports for students, interdisciplinarity, and the potential for engineering to contribute to improvements for society. In contrast, co-ed institutions tend to place a greater emphasis on the financial returns and job security that result from majoring in engineering. We conclude that co-ed engineering programs should consider a broadening of the descriptions surrounding the engineering field, since the inclusion of a wider set of values could be appealing to women students.

**Keywords:** women-only institutions; coeducational institutions; discourse analysis; engineering; framing; gender; higher education; major selection; program selection; STEM

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## 1. Introduction

### 1.1. Women in Engineering

Engineering is often portrayed as vital for the global economic competitiveness of the United States, and science and math training in general are seen as important in accessing the best-paying and fastest-growing jobs in the US economy (Hill et al. 2010; National Academy of Science 2006). However, there is a shortage of individuals entering into science, technology, engineering, and mathematics (STEM) disciplines (Ehrenberg 2010). Within this context, women are less likely to enter into STEM fields than men (Hill et al. 2010), and fewer women than men go on to graduate with engineering degrees (National Center for Education and Statistics 2014). Therefore, with regard to engineering disciplines in particular, the shortage of women entering the discipline as undergraduates accounts at least in part for the shortage of individuals obtaining degrees in this field.

The National Center for Education and Statistics (2015) reports that only 20% of degrees awarded in engineering fields during the 2014–2015 academic year were to women. This is particularly concerning given that, overall, women account for 57% of undergraduate degrees conferred (Sax et al. 2016). The proportion of women graduating from engineering disciplines increased dramatically between 1950, when women accounted for 0.3% of all undergraduate engineering degrees conferred, and 2014, when women accounted for 18.4% of undergraduate engineering degrees (National Center for Education and Statistics 2014). However, improvements in more recent years have been slower.

In the 1990s, the proportion of all undergraduate engineering degrees conferred to women increased from 14.1% to 17.8%; in the 2000s, progress stalled and even reversed itself, with the proportion of degrees conferred to women decreasing from a high of 19.0% in 2002 to 16.5% in 2009, the lowest figure since 1996. Since then, the percentages have once again crept slowly upwards, stabilizing at 18.4% in 2014, which represents the same percentage of undergraduate degrees being conferred to women as for 2001 ([National Center for Education and Statistics 2014](#)).

Some engineering disciplines experience a particular paucity with regard to women's participation. For example, for the year 2014/2015, women accounted for only 10% of computer engineering graduates, 12.4% of electrical engineering graduates, and 12.8% of mechanical engineering graduates. In contrast, women accounted for close to half of all environmental engineering graduates (46.8%) and bioengineering graduates (40.8%) and were reasonably well represented among chemical engineering or chemical and biomolecular engineering graduates (32.0%). Civil engineering and materials engineering disciplines were in the middle in between these two extremes; women accounted for 22.6% of civil engineering graduates in 2014/2015 and 27.3% of materials engineering graduates in the same year<sup>1</sup> ([National Center for Education and Statistics 2015](#)).

Research suggests that women are less likely than men to opt into engineering disciplines from the outset of their college education ([Hill et al. 2010](#); [Mullen 2014](#); [Sax 2008](#)). Subtle situational cues such as the numerical representation of women within a space, or the use of "brilliance" language emphasizing the importance of innate talent in a field, have the potential to affect an individual's sense that she will belong ([Murphy et al. 2007](#)). It is possible that such environmental cues contribute to the lack of women in engineering.

### 1.2. Focus of the Study

This study focuses on websites developed by universities to advertise their multiple academic degrees and fields of study in engineering. Our study takes websites to be key sources of textual data that can provide an insight into the discourses surrounding the field of engineering.

In selecting websites as an important object of study, we are making several assumptions about their use by prospective students: (a) The websites are read carefully and they influence the student's decision to apply or not to a given engineering program. It is likely that students develop a sense of fit with the program after reading its detailed description; (b) Students engage in careful university shopping/selection by comparing various program descriptions within their area of interest; (c) The content of the websites is carefully crafted by the professors and administrators offering such a program, fully conscious that the wording and the program itself will appeal to the type of students they wish to reach; (d) Website descriptions can be considered a valid and reliable account of what the students will find after enrollment in the program.

Regarding the selection of websites to examine women's consideration of potential engineering programs, we hypothesize that since engineering is usually depicted as a demanding, competitive, and male-dominated field, its image as one that is not merely technical but sensitive to contributions from different fields, such as the social sciences, the arts, and the humanities, will appeal to women students. For these potential students, the anticipation of entering programs that are supportive and provide them with a wide range of experiences is assumed to be of substantial interest. In addition, we sought to explore whether women only institutions are more likely to present a broader understanding of the field of engineering. This argument stems from the fact that women only institutions exist to serve women in higher education, have a much closer link to principles derived from the liberal arts and the humanities, and may be more sensitive to issues influencing women students. In this study, we are not

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<sup>1</sup> These percentages were calculated by the authors using raw data from the National Center for Education and Statistics, which provides information on the total number of bachelor's degrees conferred to men and women students in each of these engineering disciplines.

testing or setting out to prove these assumptions. We simply state this as a rationale for considering websites as meaningful points of reference whose content deserves greater attention.

## 2. Review of the Relevant Research

Research on STEM interest and major choice among women suggests that environmental cues have large impacts on women's decisions regarding college major (Murphy et al. 2007). The literature suggests that these cues include (a) perceived lack of community orientation; (b) language that emphasizes innate talent rather than effort (referred to as the "brilliance emphasis" of the field, for simplicity), and (c) pedagogical methods not conducive to women's learning styles. The following sections explore the literature in each of these areas.

### 2.1. Community Orientation

Women are more likely than men to value helping others in their careers (Eccles 2006; Sax 2008). For instance, in one 2008 study, less than 60% of men stated that "helping others in difficulty" was a crucial part of their life goals, whereas over 70% of women expressed that helping others was vital to their life plan (Sax 2008). These differing values may be based on cultural customs and paradigms that suggest that women should be more interested in serving others than men (Eccles 2006).

In contrast, men are more likely to emphasize potential earnings as a primary factor in their major selection (Mullen 2014). For economically privileged students, women are unlikely to consider post-graduation salary as a primary determining factor in their major choice decision and more likely to emphasize the potential to be happy with their career (Mullen 2014). Interestingly, of the few women who did place an emphasis on earnings potential in Mullen's (2014) study, all were from lower socioeconomic backgrounds.

Regardless of the underlying reasons, women's community orientation may deter them from considering engineering majors, because both women and men tend to perceive engineering majors as not being "communal" in nature (Diekman et al. 2010). This is despite the fact that engineering majors can and do serve society. For example, computer scientists and engineers contribute to advances in national security, emergency communication, and education, among other areas (Ruesink 2015). Biomedical engineers, working alongside physical scientists and engineers, have drastically improved healthcare through technologies like kidney dialysis, artificial body parts and magnetic resonance imaging (MRI) technologies (Benderly 2010).

Despite the community-oriented impacts that engineers can have on society, research suggests that stereotypically "feminine" fields such as education, health, and law tend to be perceived as more communal than stereotypically "masculine" fields such as engineering and computer science (Diekman et al. 2010). It is therefore not surprising that students who display strong community orientation are less likely to opt into engineering fields (Diekman et al. 2010). Fortunately, the degree to which a communal focus deters women from pursuing engineering has been decreasing over time (Sax et al. 2016). This may be due to increased attempts to emphasize the benefits that engineers bring to society.

### 2.2. Brilliance Emphasis

Since individuals are likely to opt into fields in which they believe that they can be successful (Eccles 2006), women's low self-efficacy may contribute to a lack of women in majors that place an emphasis on innate talent or skill (Leslie et al. 2015). Women have been shown to have lower levels of self-efficacy, or "belief in one's agentive capabilities that one can produce given levels of attainment" (Bandura 1997, p. 382), than men (Colbeck et al. 2001; Pajares 2005; Sax 2008). This holds true even when women's performance is at levels equivalent to or higher than men's performance (Colbeck et al. 2001; Sax 2008). When women experience setbacks, they are more likely than men to internalize failures as being indicative of an inability to be successful in a given endeavor (Felder et al. 1995).

In their study, Leslie et al. (2015) examined how an emphasis on raw talent may affect the ratio of women to men in a variety of fields. Analyzing Ph.D. students, they found that when a field places

a higher emphasis on “brilliance,” the ratio of women to men in that field tends to be lower. These results were also supported at the undergraduate level in a follow-up study (Storage et al. 2016). Storage et al. (2016) set out to analyze whether the frequency of the words “brilliant” and “genius” in student teaching evaluations within STEM disciplines would be related to the number of female Ph.Ds. and undergraduate students within a given STEM discipline. The researchers used these word frequency counts as a proxy for a field’s focus on innate talent and found that a greater frequency of these words was correlated with fewer female Ph.Ds. within the field. Similarly, although not statistically significant, the number of female undergraduate students also trended downwards as comments about “brilliant” and “genius” professors increased. Although this proxy data was not statistically significant at the undergraduate level, the researchers also assessed survey data and found that when fields place a higher value on raw talent, women’s undergraduate representation within the field tends to be lower (Storage et al. 2016).

### 2.3. Pedagogies

Teaching styles can affect women and men differently (Colbeck et al. 2001) and may be one reason why women are less likely to opt into engineering fields. Experiential learning theory provides a framework for understanding how pedagogical methods are perceived differently by male and female students (Kolb and Kolb 2005). The framework consists of four different learning “modes” including abstract conceptualization, reflective observation, concrete experience, and active experimentation (Kolb and Kolb 2005). Learners who operate through concrete experience tend to prefer learning on an emotional level. Alternatively, learners who absorb information by way of abstract conceptualization take an objective approach to processing information. Active experimenters prefer to engage in action to learn whereas observational learners prefer to observe others to obtain information (Kulturel-Konak et al. 2011).

Research suggests that preferred learning styles differ between men and women (Philbin et al. 1995; Severiens and Ten Dam 1994). In a study utilizing survey-based methodologies, nearly 50% of men preferred the assimilator learning style (Philbin et al. 1995), which is most often linked to mathematics and science disciplines (Kulturel-Konak et al. 2011). In contrast, only 20% of women preferred this style, suggesting that women may be less likely than men to favor the pedagogical methods used in engineering classrooms. Furthermore, men were particularly unlikely to favor the diverger learning style (Philbin et al. 1995), which is most often associated with liberal arts disciplines (Kulturel-Konak et al. 2011). Severiens and Ten Dam (1994) found similar results, noting that men tend to prefer abstract conceptualization whereas women tend to favor concrete experience-based learning. Given this, we can infer that women may be more drawn to fields that emphasize learning by way of action or taking a creative approach to solving problems.

In addition to their findings regarding learning style preferences, Severiens and Ten Dam (1994) found that women are generally more intrinsically motivated to learn than men, whereas men tend to be extrinsically motivated to learn. Because competitive projects may decrease intrinsic motivation by providing an external force that drives behavior (Ryan and Deci 2000), competitive classroom environments may serve as a benefit to men and a detriment to women. Unfortunately, STEM classrooms often involve the use of competitive projects as a means to improve students’ performance (Kulturel-Konak et al. 2011). Moreover, STEM careers, particularly research careers, are often portrayed as highly competitive and rapidly evolving due to constant technological advances and changes. If the competitive environments and analytical, objective pedagogical methods common in engineering classrooms (Kulturel-Konak et al. 2011) are advertised in the discourse used to draw students into engineering spaces, it is likely that women will be deterred from those spaces.

### 2.4. Summary

The extant research literature on STEM allows us to identify three key types of environmental cues that can affect women’s sense of belonging and decisions about whether or not to engage in an

engineering environment. These can relate to the framing of the engineering discipline in program websites in the following ways: (1) Community orientation can refer to the degree to which engineering is framed as a discipline or career through which one can help others and society, and have a positive impact on their local and global community. The research suggests that framing engineering as having a strong community orientation would be of importance to women. This may be in contrast to framing engineering as a field with benefits for the individual, for example in terms of career prospects or financial returns; (2) Brilliance language refers to the framing of the engineering student or professional as innately talented or gifted, rather than as someone with skills and aptitudes that can be developed through hard work and dedication in a supportive learning environment. The research suggests that the framing of engineering as a field that emphasizes raw talent would be detrimental to the recruitment of women students; (3) Pedagogies refers to the ways in which the teaching and imparting of knowledge in engineering is done. The research suggests that women students may be drawn to concrete learning experiences that can include project-based learning, hands-on research experiences, and real-life applications of the theories they are engaged in learning. The research also suggests that women may prefer a collaborative learning environment where they feel supported by peers, faculty and other mentors, rather than competitive learning environments.

### 3. Data Sources and Methodology

#### 3.1. Institutional Selection

This article is based on textual data gathered from university websites describing their engineering degrees and programs of study. The functions of a website are to describe, in short and precise ways, the major features of their programs of study for a given field. They usually present visual representations of their campus to provide a vivid and current picture of their settings. There is no standard for how program websites are constructed and organized, and a wide variety of presentation styles and content organization can be seen. Often, program websites consist of a home page featuring an introduction to the program and general program information. This page may link to an “about us” page, which includes information on the different programs of study, and a more specific description of the program and course requirements. However, many program websites simply link to other pages specifying program requirements, admission, and financial aid information. For our research purposes, we focused on the website components that included information regarding the engineering program. These included main engineering webpages, “about us” webpages, and “program requirements” webpages. In some isolated cases, program webpages included a welcome letter from the program director or dean; these letters were also included in our analysis because they offered important insights into the framing of the engineering discipline in the words of a leading program administrator. Not included in our analysis were pages that dealt exclusively with admissions and financial aid information, or that simply listed the courses available under the program. The descriptions of programs in websites are not extensive; therefore, our coding dealt mostly with brief sentences and short paragraphs selected for their clear and pertinent meaning. The objective of the study was to see whether women-only universities present themselves in ways that might be more appealing to women students, since engineering is generally perceived as a very demanding and competitive field, characterized by masculinist orientations that are characterized by the adherence to and promotion of attitudes, values, opinions and habits that are regarded as typical of men and boys. As discussed in our review of the research literature, this includes (but may not be limited to) a focus on individual benefits and financial returns of a career in engineering, an emphasis on innate talent and brilliance as being integral to success in the field, and pedagogies that emphasize a high degree of competition and abstract rather than applied, experiential learning.

The institutions we selected for inclusion in our study comprise the full range of women’s-only colleges and universities offering engineering degrees (14) and a comparison sample

of 14 coeducational universities also offering engineering degrees<sup>2</sup>. The coeducational programs were chosen on the basis of ranking, with the top eleven ranked engineering programs in the USA for which a doctorate is the highest degree, having been chosen from the 2017 US News and World Report rankings. In addition, the top three liberal arts colleges in the USA, according to the US News and World Report, that offer engineering degrees were also selected for comparison. While women's colleges are not ranked separately in the US News and World Report, it is important to note that many of the women's colleges in our sample are highly respected institutions. For example, eight out of the 14 women's colleges in our study are featured in a Forbes (2009) list of the top ten all-women's colleges in the US. In addition, two of the 14 are ranked among the top 20 liberal arts colleges in the US according to the 2017 US News and World Report.

With the exception of Smith and Sweet Briar's Colleges, which have Accreditation Board for Engineering and Technology accredited engineering programs, all the women's programs included in this study are dual degree programs offered in conjunction with a second institution. Many of these second institutions happen to also be highly ranked engineering programs from larger research universities, including institutions from our sample of co-ed universities such as GaTech, CalTech, and MIT. This is due to the fact that without accreditation, the vast majority of women's colleges are unable to confer engineering degrees.

Most of the dual degree programs are offered under a 3–2 structure, whereby students spend the first three years studying at the women's college before transferring into a second institution for the remaining two years. Upon completion of these five years of study, students receive two college degrees: one from the women's college, in a liberal arts major of their choice, and the other in engineering, from the accredited engineering program. While there is usually a degree of flexibility in selecting their liberal arts major, many programs encourage women to select a science major, so that more of their credits can be used to fulfill engineering requirements.

### 3.2. Coding Procedures

The authors employed established methods for discourse analysis to examine the textual data. The initial coding process was a deductive one, which relied on the findings of the literature review to guide the creation of predetermined coding categories surrounding the themes of community orientation, brilliance language, and pedagogies. As new themes emerged, an inductive coding process allowed us to discern new similarities and patterns not initially covered in our review of the literature. Each of the authors coded the website data individually in its entirety. Once individual coding was completed, the authors reviewed all codes together to check for consistency in a joint coding exercise. Thus the final coding relied on insights from both researchers in discussion with one another. Recurring themes that were uncovered are presented in the findings section of this paper, below. Not all categories were found to apply to both women-only and coeducational engineering programs.

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<sup>2</sup> The women's colleges included in this study are: Agnes Scott College, Barnard College, Bryn Mawr College, Clemson College, Converse College, Meredith College, Mills College, Mount Holyoke College, Scripps College, Smith College, Spelman College, St. Mary's College, Sweet Briar College, and Wellesley College. The coeducational institutions included for comparison are: California Institute of Technology (CalTech); Carnegie Mellon University; Cornell University; Georgia Institute of Technology (GaTech); Harvey Mudd College; Lafayette College; Massachusetts Institute of Technology (MIT); Princeton University (Princeton); Purdue University; Stanford University; Swarthmore College; University of California, Berkeley (UC Berkeley); University of Illinois at Urbana-Champaign (UIUC); and University of Michigan, Ann Arbor (UMich).

## 4. Findings

### 4.1. Women-Only Institutions

We identified several themes across the webpages of women-only institutions that relate to the status of women in STEM fields, community orientation in engineering, emphasis on raw talent, and pedagogical methods.

#### 4.1.1. Specific Statement of the Problematic Situation Regarding Women

The websites of women-only institutions (WOIs herein) tend to be very explicit about the current underrepresentation of women either as engineering students or as professionals with an engineering degree, noting that the number of women engineers is not only small but even decreasing in the some specializations. Such an assertion is usually accompanied by reference to statistical data, such as in the statement made by Mount Holyoke:

Did you know that, according to a 1999 Federal Bureau of Statistics report, women hold just 10.6 percent of all engineering jobs, while male graduates of baccalaureate engineering programs outnumber their female peers by a ratio of 4 to 1? Mount Holyoke is committed to narrowing the gender gap in engineering and other technically advanced fields.

The St. Mary's College website also provides specific statistics: "Nationwide, about 17 percent of engineering students are women. At Notre Dame [the partner organization], about 23 percent of engineering students are women".

Problematizing the underrepresentation of women, the WOIs argued for the importance of women in shaping the world. Smith College remarked, "Our economic strength requires the full inclusion of women engineers at all levels of the profession". Other colleges, such as Converse and Clemson's colleges sought the representation of women "because as a woman you bring different perspectives and methods to a traditionally male-dominated field". Thus, the argument was not only for gender parity reasons but also for the expectation that women would infuse alternative ways of seeing technical problems in the world.

The notion of producing more women engineers was supported by the WOIs' evidence of graduates who have distinguished themselves in the field. Smith says that "For more than 130 years, Smith alumnae have made outstanding contributions to their professions and communities, and Smith is recognized as one of the top institutions whose graduates earn doctoral degrees in the sciences". While many of the WOIs problematize the low numbers of women in engineering fields, Spelman College website is the only program that recognizes the intersection between gender and race, noting that African-American minorities continue to be underrepresented.

It can be remarked that, while recognizing that there are few women in engineering, the websites' descriptions do not associate this with the low intellectual capacity of women to study engineering. Thus, the Smith College website begins its website narrative by stating, "Our brilliant and unmistakable Class of 2017!"

#### 4.1.2. Portrayal of the Program as Small and Cohesive

There is a tendency among WOIs to present their engineering programs as challenging, yet they commonly add that their programs offer a supportive environment, in which communities—designed to be small and highly connected—can work in close coordination with faculty and peers in the development of engineering projects. For instance, Sweet Briar made reference to life "beyond the classroom, at informal dinners with liberal arts advisers, casual lunches with study teams and conversations in the halls or by email". Another WOI, St. Mary's, noted that although it offers a dual degree, which implies transition to another university that will then focus on the engineering component, its program provides "on-campus housing to program participants for all five years, allowing the strong friendships and networks they develop to support them throughout". Often, the



supportive environment that is promised comes accompanied by a liberal arts foundation, whose aim was to enhance communication skills and writing as well as opportunities to develop critical thinking and problem-solving skills.

#### 4.1.3. Special Attention and Support

Also typical of WOIs is reference to having small classes, which would enable students to receive personalized attention. This promise of support is accompanied by the desire to foster excellence in the students, not just a space to do well. In this respect, the website of Saint Mary's promises that the small classes and the personal attention from faculty will help students "to thrive in demanding science, mathematics, and general education courses". As noted in this sentence, while acknowledging that the programs will be challenging, it also assures that the small classes and the personalized attention will create a balance between academic rigor and student support.

At the same time, the proposed supportive environment is cast as going beyond only faculty and peers in engineering. Thus, Smith refers to the creation of a support environment that is not limited to engineers. It argues that "every student needs to be literate in engineering, math, and science" and adds that "as responsible citizens in today's society, all students must be technologically literate. The Picker [School of Engineering] program offers courses that include engineering majors and non-majors; we all benefit from the inclusion of committed students with diverse skills and interests". The various supportive environments are created not only by networks of peers and faculty, but are further enhanced by the use of successful women graduates as role models who come and visit the students in the dual-degree programs and by enabling the design of a flexible curriculum.

#### 4.1.4. The Engineering Mindset

The engineering mindset as portrayed by women's colleges tends to emphasize academic rigor, with students portrayed as dedicated, focused, and hard-working rather than brilliant or innately talented. As an example, Smith College's Picker School of Engineering describes a "challenging" environment of "academic rigor" and "committed students". Often, in commenting on the challenges and difficulty of the engineering discipline, women's colleges counterbalance these with statements about their supportive environments in the very same sentence. Thus the difficulties and challenges of the engineering major are portrayed as coming alongside concomitant supports that work to compensate for the perceived rigor of the discipline. For example, such phrases included Sweet Briar College's "challenging yet supportive environment" and Saint Mary College's claim that "personal attention from faculty ... [helps] students thrive in demanding science, mathematics and general education courses".

#### 4.1.5. Pathways in Engineering

Women's colleges emphasize a multitude and diversity of engineering pathways, portraying engineers as people with a variety of interests, talents and backgrounds. This diversity is found at three levels in their trajectory: (1) the many roads that lead students into engineering as a discipline; (2) the diversity of internal pathways, through both flexible curricula that can be adjusted to student interests, and engaging pedagogies that appeal to a diversity of learning styles; and (3) the broad range of directions open to engineers beyond college, whether through graduate programs, industry jobs, or other careers in diverse fields.

It is of interest to observe that, while encouraging women students to become engineers, the websites also consider that some either will not succeed or will change their minds about this field. Converse College, for instance, encourages students to take "more time to explore and confirm your long-term career goals before committing to an irreversible path". Smith College provides specific alternatives by noting that it offers not only a bachelor of science in engineering but also a bachelor's degree in Engineering Arts (A.B.) "for women who do not intend to practice as engineers, but recognize



the increasing importance of science and technology in today's world." Smith also provides another approach, as "some students may wish to complement their major and supplement their education".

At Wellesley College, the Wellesley Engineering Laboratory (We-Lab) "encourages all students to explore engineering" and "develop engineering habits of mind" through engineering courses with few prerequisites and an emphasis on "engineering as a humanitarian endeavor". This creates the potential for students who are just curious about engineering, or uncertain about their commitment to pursuing it as a major, to explore and engage with the field. Through We-Lab and other programs, Wellesley College provides several engineering-related possibilities: volunteer and paid positions in research and engineering; a less technical bachelor of arts in Engineering Arts; and several "introductory engineering courses with few pre-requisites for students interested in adding a technical component to their liberal arts education or preparing for further engineering study". Wellesley also provides a certificate program in engineering, arranged through Olin; a certificate in sustainability through the Babson–Olin–Wellesley Three-College Collaboration; and a certificate in engineering leadership through the Bernard M. Gordon MIT Engineering Leadership (GEL) Program. Some universities also provide informal learning opportunities in engineering for students who do not wish to enroll in a formal engineering program.

At Barnard College, prospective engineering students are encouraged to find their own path with help from the Career Development Office. They are also exposed to "career paths they may not have considered" through "alumnae and other professionals who provide real-world insight" and visit the campus as guest speakers and hold informal chats with students. From this narrative, it is clear that contacts with former students and persons in other professions are utilized to facilitate the exploration of diverse paths open to students.

With regard to pathways through their engineering programs, WOIs tend to emphasize the hands-on, experiential nature of their curriculum. Tied to the hands-on emphasis presented in the WOIs' narratives is the description of classes as being interactive. Such preference is presented, for instance, at Sweet Briar College where "abstract topics in textbooks are turned into hands-on lab experiences." At Wellesley students are encouraged to "participate in engineering activities outside of the classroom," and at Agnes Scott College the emphasis is on "exciting subjects through both classroom and applied learning opportunities".

This connection is highlighted through references to study abroad as part of the program and to the fact that many of the best-known role models graduating from the engineering programs have been persons familiar with other countries and their respective cultures. In this sense, the website for Sweet Briar announces that students and faculty have traveled to Brazil to deliver student-designed assistive devices. Smith College observes that students and faculty also designed a water supply system for a small village in Guatemala.

When Spelman College introduces its most notable alumnae, it notes that one of them had spent a summer in France at a technology program that conducted research in nonlinear optics, and was also able to travel across Europe. This graduate is quoted as saying, "I think that exposure was immeasurable, because I experienced a variety of different cultures". An experience abroad in Japan is linked to another very creative woman engineer.

The diversity of pathways taken by students as they enter and progress through programs is also reflected in WOIs' discourse on the variety of career trajectories taken by alumnae. Sweet Briar states that its alumnae are making their mark in fields as diverse as technology, manufacturing, and the military, in addition to going on to a variety of graduate programs. Barnard emphasizes a "broad range of careers and industries", and the importance of finding one's own path.

#### 4.1.6. Interdisciplinary Programs

With the exception of Smith and Sweet Briar colleges, all the WOIs offer a dual degree program: that is, an education in the liberal arts that lasts about two years, and focuses on training in engineering for another two years in conjunction with another university that specializes in engineering degrees.

The two universities join strengths to offer two bachelor's degrees, one in the liberal arts and one in engineering.

The WOIs' engineering programs were described as "interdisciplinary in nature", meaning that the student would be given the possibility to combine the liberal arts with the applied sciences represented by engineering. This interdisciplinarity occurs by bridging very different analytical perspectives—that derived from the liberal arts and those attached to the physical disciplines. As we will show later in this article, the interdisciplinarity offered by co-ed universities moves among cognate disciplines.

An example of the explicit connection between the liberal arts and engineering is provided by Smith College, which explains that, as a "creative endeavor" engineering looks at "the intersection of design, science, and mathematics, engineering [and draws] on nearly all aspects of the human experience, including our history, politics, economics, arts, and societal aspirations". This connectivity between the liberal arts and engineering appears related to the solution of problems using innovative perspectives of analysis and design.

The benefits of combining liberal arts are well articulated. For example, "Saint Mary's students also benefit from the uniquely challenging and supportive environment of a women's college. Their liberal arts foundation gives them strong critical thinking, problem-solving, writing, and communications skills". For its part, Wellesley notes, "Just as an effective engineer requires outstanding communication skills, a liberal arts major can be far more influential in her discipline if she understands the technical aspects of worldwide challenges such as energy, hunger, and medicine". Repeatedly, the website descriptions of WOIs spoke about bringing together the strengths of the two fields, a process that was described as promoting self-discovery and socially responsible decision making. In this context, some of the descriptions made reference to fostering "a global citizenship as engineers of a sustainable future".

The dual-degree program descriptions are usually accompanied by a narrative that indicates that the engineering university partnering with the liberal arts college will continue to provide advice and personalized attention. In only one WOI description, Bryn-Mawr College's, could we observe a description that was entirely technical, with little mention of the continuation of a supportive environment.

It is to be noted that most of the engineering programs working with a liberal arts college to provide the dual-degree program were programs of significant prestige, such as the California Institute of Technology, MIT, or the Georgia Institute of Technology. The WOIs were conscious of this and, as one such institute remarked, they offered "the best of both worlds."

#### 4.1.7. Engineering and the Solution of Social Problems

The WOIs' narratives depict a concrete approach to engineering, with many hands-on opportunities. This is evident in a statement made by Smith College: "The reasons for starting an engineering program at an all-women's college are compelling. The work of engineers both exacerbates and offers solutions to some of our gravest societal problems, including climate change, disease, resource limitations, and conflict".

Wellesley College also makes reference to concrete experience in engineering problems by stating, "The Wellesley Engineering Laboratory (We-Lab) encourages all students at Wellesley College to explore engineering". It further adds, "The We-Lab gives all students at the college the opportunity to develop engineering habits of mind and to understand the role technology has to play in improving our world. We-Lab emphasizes engineering as a humanitarian endeavor, addressing needs of under-served populations internationally and locally". These assertions present engineering as a field that must be socially embedded; moreover, the nature of the social problem extends beyond national frontiers.

#### 4.1.8. Partnerships with Industry

While WOI programs emphasize a broad education that combines technical (engineering) and humanistic (liberal arts) education, the WOI site descriptions are not oblivious to the need for graduates

to find jobs. The possibility of employment is materialized through the use of internships with various industrial firms. Sweet Briar states,

All Sweet Briar engineering majors gain valuable exposure to industry through guaranteed co-op experiences. We team with Region 2000, Central Virginia's Economic Development Partnership, to provide opportunities and have developed partnerships with regional companies to facilitate co-op experiences. As undergraduates, they have opportunities to participate in meaningful research, [and] hold a wide variety of internships.

The Sweet Briar description further adds its engineering graduates can be found at leading companies and organizations, including: AREVA, BWX Technologies, Glad Manufacturing, the U.S. Navy, General Atomics, IBM and AMTI. "Many have studied in a wide range of graduate engineering programs, including Dartmouth, University of Virginia, Johns Hopkins, and Virginia Tech, to name a few."

Summarizing this section on WOIs, their websites tend to be friendly to potential women students and very supportive in cases of unresolved personal needs. These websites also feature substantial program flexibility, enable students to explore other fields, and even successfully graduate from another program after failing in an engineering program. While liberal arts colleges prepare students to adopt a more critical voice of their environment, it is also clear that negotiations and partnerships with business are frequent and justified as a way of securing prompt and well-remunerated employment.

#### 4.2. Co-Educational Institutions

Engineering programs in co-educational institutions have been historically open to both men and women, yet very few women had entered the field by 1950. It is only in recent decades that women have increased their participation in such programs. Since engineering programs in co-educational universities continue to be dominated by men, the descriptions of such programs may retain self-definitions that set them quite apart from the engineering programs offered by women's liberal arts colleges. In this section of the article, we focused on 10 universities and three liberal arts colleges with prestigious engineering programs.

##### 4.2.1. Engineering as a Superior Field

Among co-ed engineering programs, there is a strong tendency to depict engineering as a field superior to others. The Harvey Mudd website asks rhetorically, "What's engineering?", and it responds:

Since prehistoric times when the caveman invented the wheel, engineers have played a vital role in society. Using theories and applications of science and mathematics, engineers work to design, create and improve things to solve problems and benefit the world at large. Their work ranges from designing and building bridges to making business deals, researching new methods of production and testing manufactured products for quality and safety assurance.

UC Berkeley presents engineering as fundamental to many other fields, calling it "the liberal arts of the 21st century". Further, Berkeley says of its program, "We're making a world of difference", and promises that its students will have "direct access to top faculty, who happen to be some of the brightest minds in their professions. They're hands-on in the lab or studio. And they're all driven to find the most innovative, impactful ways to change the world".

Adding to the frequent use of superlatives, Stanford University asserts that "engineering has been at the forefront of innovation for nearly a century, creating pivotal technologies that have transformed the worlds of information technology, communications, health care, energy, business and beyond". Similarly, UIUC claims that "as one of the top ranked engineering programs, our students, faculty, and alumni set the standard for excellence. We drive the economy, reimagine engineering education, and bring revolutionary ideas to the world". Other programs—from MIT to Georgia Tech—assert

that engineering produces leaders who will create new knowledge in key areas. As stated by Cornell, “engineering is the catalyst for bringing disciplines together and pushing forward amazing advances made possible by these collaborations”.

To some extent, the use of superlatives and the portrayal of engineering as a superior field are used to construct a sense of the engineering field as enjoying a certain power and privilege. The implication is that individuals who pursue an engineering degree will reap the benefits of this status that the discipline enjoys.

#### 4.2.2. Excellence as a Key Descriptor

In the same way that engineering is described as a superior field, the engineering program at each of the co-ed universities in the study is presented in superlative ways. Some examples are:

- “MIT is the best place in the world to be an engineer”
- “There are many reasons why Berkeley Engineering is ranked among the top three engineering schools in the world: Because we challenge conventional thinking and value creativity and imagination. And because our students and faculty are driven by social commitment and want to change the world”.
- “Whether you want to cure diseases, build computers, or make cities more sustainable, you’ll find a program to fit you at the College [Georgia Tech]”.

References to program rankings are common, with descriptors selected that paint the programs in the best light possible. Hence, UC Berkeley masks its third-place status by claiming instead that it is “ranked among the top three” engineering schools. Purdue chooses to highlight a slightly different ranking system in claiming that its program was “ranked second in the nation in preparing its students for the work force”, according to a 2010 Wall Street Journal survey of corporate recruiters.

“Excellence” not only touches the engineering program; it also touches the faculty and the students. Thus, Berkeley notes,

Berkeley engineers brought water to California’s vast agricultural industry and helped to build the previously unbuildable with structures like the Hoover Dam and the Golden Gate Bridge. We pioneered the microelectronics that seeded Silicon Valley and the information technology that created the Internet. Today, Berkeley engineers remain at the nexus of innovation worldwide.

Similar claims are made by the Stanford engineering program: “The school’s faculty, students and alumni have established thousands of companies and laid the technological and business foundations for Silicon Valley”. Lafayette College of Engineering says “For 150 years, Lafayette has been known for its excellent engineering programs that blend a world-class technical education with the broad education of a liberal arts college”.

As each engineering program is positioned as one of the best in the country, if not the world, a common narrative, in turn, defines the engineering student as the best possible college student. Thus, MIT proudly asserts, “We strive to attract the most talented people in the world: to create, to innovate, and to see the unseen. Our kind of engineer views praise as an invitation to tackle the next problem—and the harder, the better. Relentlessly inventing ourselves”. And such is the mass of bright people at MIT that it claims that “advances in 3D printing, nanofabrication, robotics, and other technologies happen here every day”. These contributions are made not only by very intelligent people but people who work very hard. MIT, for instance, adds that monumental discoveries “require rigor, passion, and a breakthrough, or two, or three”.

In defining excellence in the field of engineering, the websites of co-ed institutions emphasize outside recognition and status in the form of rankings that confer prestige to the program and legitimize claims of superiority. They also tend to define excellence in engineering through the products of engineering work, be these products specific recognizable structures (such as the Hoover Dam), broad

technological advances (such as nanofabrication or 3D printing), or contributions to economic growth (such as the establishment of Silicon Valley as a hub for business and innovation). In defining excellence for individuals in the field, the focus is on innate talent and creativity, as well as ambition and grit.

#### 4.2.3. Society and the World

Often, the engineering programs at the co-ed universities refer to contributions by engineers across time in favor of society and global benefits. Curiously, there is little elaboration of what “society” and the “world” are. The Georgia Institute of Technology says, “GaTech has built a strong reputation in the United States and abroad, and graduates leave with skills, knowledge, and global savvy for a world increasingly dependent on engineering.” For its part, Stanford claims that, “Our mission is to seek solutions to important global problems and educate leaders who will make the world a better place by using the power of engineering principles, techniques and systems”. Swarthmore similarly presents a discourse that does not cite specifics despite the length of the statement:

The pervasiveness of advanced technology within our economic and social infrastructures demands that engineers more fully recognize and take into account the potential economic and social consequences that may occur when significant and analytically well-defined technical issues are resolved. A responsibly educated engineer must not only be in confident command of current analytic and design techniques but also have a thorough understanding of social and economic influences and an abiding appreciation for cultural and humanistic traditions.

Berkeley is the only university representing an exception to this tendency, when it specifies that its innovations seek to make “a significant impact on health, sustainability, poverty and other global challenges”. Although several co-ed institutions emphasize social commitment and making a key difference, a key divergence from the discourse of WOIs lies in the lack of specifics that help to elaborate on and concretize the goals surrounding this social commitment.

#### 4.2.4. Interdisciplinary Programs

This program feature stands as one of the most-often invoked. All programs hold that they are strongly multidisciplinary and cut across disciplines and departments. The texts that appear in this regard, however, show that while there is substantial reference to “crossing” fields, these linkages occur primarily within engineering. MIT mentions working with “quantum computing, self-healing materials, programming bacteria to fix atmospheric nitrogen, desalinization and the development of autonomous vehicles”. For its part, Berkeley notes that its engineering program enables student access to a “robust, multidisciplinary education”, but its examples talk about “pursuing your specific passion, from bioengineering to nuclear technologies”.

Another feature surrounding the reference to interdisciplinarity is the limited or null definition of the term. Harvey Mudd presents its engineering program as “notable for its breadth and technical excellence” and “emphasizes an interdisciplinary approach to problem solving”; it goes on to say the following:

The engineering sciences courses (E82, E83, E84, E85 and E86) establish a broad base of fundamental knowledge needed by an engineer practicing in the field. The sequence of systems courses (E79 and E101-102) provide analysis and design tools to model and interpret the behavior of general engineering systems. These courses are multidisciplinary in approach, enabling students to gain a unified view of the entire spectrum of engineering disciplines.

The statement by CalTech captures quite well the tendency to present a narrative that does not provide details on what interdisciplinarity might imply:

The mission of the California Institute of Technology is to expand human knowledge and benefit society through research integrated with education. We investigate the most challenging, fundamental problems in science and technology in a singularly collegial, interdisciplinary atmosphere, while educating outstanding students to become creative members of society.

Amid this limited version of interdisciplinarity, Swarthmore also seems to be an exceptional case in that it maintains that its engineering department has “a unique perspective that integrates technical and nontechnical factors in the design of solutions to multifaceted problems.” Princeton also distinguishes itself from other co-ed programs in remarking, “Problems related to energy, environment, health, sustainable development, security, and privacy all entail a mix of technological, political, economic and cultural factors”. This expands the boundaries of interdisciplinary away from engineering and other scientific disciplines to acknowledge the importance of expertise in a diversity of fields for solving complex societal issues.

In all, the inter- or multidisciplinary that is invoked by the co-educational engineering programs revolves around a narrow set of skills, for there is no boundary crossing with the social sciences, much less the humanities. Boundary crossing into non-STEM disciplines generally happens only in the field of business, with entrepreneurial and managerial skills being emphasized as important in harnessing the economic potential of engineering innovations. At GaTech, for example, the focuses on “innovation and entrepreneurship” come together in preparing students to “create inventions, start businesses and design solutions to global problems.” The ties of engineering with economic and business development are commonly seen across the websites of co-ed institutions, with both Berkeley and Stanford emphasizing how they have contributed to the economic success of Silicon Valley. In a similar vein, Purdue offers the opportunity for certain engineering majors to pursue an MBA along with their BS in engineering in an integrated 5-year program.

The provision of a specialized curriculum is justifiable from the perspective of creating engineers with high levels of expertise. On the other hand, engineering programs, by focusing on a narrow curriculum, are not responding to the new challenges presented by both globalization and “glocalization”<sup>3</sup>, which call for greater community level engagement in the solution of global problems.

#### 4.2.5. Engineering and the Solution of Social Problems

Another salient feature of the co-educational engineering programs is their concrete application of engineering knowledge. MIT explains that it produces “real products” and not “moon shoots”: “The notion of making a better world is not sloganeering. It’s what we do. It’s what we have always done”. Harvey Mudd explains that it follows a hands-on approach based on the premise that design is the distinguishing feature of engineering. Thus, its engineering program “includes applied research as early as students’ first year, a curriculum covering applied sciences, systems, and design and professional practice, as well as the ClinicProgram—an internationally recognized model of experiential learning”. GaTech tells its undergraduates,

[P]art of what makes our programs so valuable is that your education won’t be confined to the classroom. In Fall 2016, 25% of our undergraduate engineering students participated in our co-op program, which gives you work experience in your field for three tuition-free semesters—all while earning a paycheck from your new employer.

It is worth noting further what GaTech promises: a program that “focuses on innovation and entrepreneurship to give students an edge, allowing them to create inventions, start businesses, and

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<sup>3</sup> As defined by sociologist Roland Robertson in a 1997 conference on Globalization and Indigenous Culture, “glocalization” refers to the “simultaneity . . . of both universalizing and particularizing tendencies”, i.e., the tendency of global processes to interact with local settings and thus be adapted to specific local contexts.

design solutions to global problems—all before graduation”. For its part, the engineering program at Stanford reminds its readers that its school of engineering makes contributions to everyday life and that “Today, the school continues to seek solutions to important global problems and educate leaders who will make the world a better place”. The other co-ed engineering programs make similar points.

The engineering programs in the co-educational universities also encourage individual agency in the development of companies, an agency that is often described as one developed through internships and contacts with surrounding industrial firms.

#### 4.2.6. Monetary Rewards

Closely connected to the practical features of their engineering programs, the co-educational university programs often present the possibility of high economic returns to education. GaTech affirms that, “Engineering is constantly ranked among the highest-paying college majors, and Georgia Tech is one of the best universities at which to study it, adding that its Institute “offers excellent returns on investment to all its students, whether they come from Georgia or elsewhere” and notes that “the starting salary for a College of Engineering graduate is about \$65,000”. At UIUC, the website highlights that the “average starting salary for full-time employment [is] approximately 9% above national average” at \$69,475 for undergraduates”.

#### 4.2.7. Supportive Environment

As in the case of the engineering programs in women’s liberal arts colleges, the co-ed programs also aim at providing an immersive and friendly residential living and learning environment. This supportive environment focuses on providing a well-rounded student life that functions independently of the engineering program. MIT, for instance, offers “a thriving arts and humanities scene, athletics (20 percent of undergrads play varsity), and, of course, hacks, round out student life”. Such enriching activities are presented, however, as complementary to the engineering program, but not inserted into the program of studies. Only one co-ed institution, Princeton, mentions its “collaborative” and “close-knit campus” community as being supportive of building the “critical connections” that students will need to “make a positive difference in the world”. At Princeton, the emphasis is placed on the engineering school as being “in the heart of a great liberal arts university,” emphasizing the important connections that can be fostered between engineering and other disciplines, as well as the collegial atmosphere that can make such collaborations possible.

#### 4.2.8. Collaboration and Flexibility

The co-ed engineering programs frequently mention team effort and collaboration. The collaboration that is invoked, however, is basically for instrumental reasons: to achieve greater technical innovation. The collaboration may take the form of an active “hub”. This innovation is also linked to the ability to generate revenues, regarding which MIT notes that “engineering generates more than half of the sponsored research at MIT”.

Program flexibility appears as a desirable feature in several of the engineering programs in the co-educational university websites. MIT poses it this way: “Want to build your own course of study? Check out our flexible degree options in chemical engineering, and mechanical engineering. Or take advantage of MISTI and globalize your learning”. In another section of the website, it says, “Want to make something? Go to the Maker Lodge and get trained to use the best equipment available anywhere, or starting in 2018, take your idea to MIT.nano and build it one atom at a time. Want to start a company? Go to MIT Sandbox Innovation Fund Program, and we’ll give you a little money to catapult your idea. Entrepreneurship highly promoted”.

The Stanford description also shows great flexibility when it argues that “We believe it is essential to educate engineers who possess not only deep technical excellence, but the creativity, cultural awareness and entrepreneurial skills that come from exposure to the liberal arts, business, medicine and other disciplines that are an integral part of the Stanford experience”. While the Stanford website



talks about giving the students exposure to other fields, this argument is not elaborated upon and the integrations with the soft sciences is left to student initiative. In summary, it can be seen that these programs encourage flexibility, but as in the case of interdisciplinarity, such program flexibility occurs within very narrow borders.

#### 4.2.9. Educating Global Citizens

Co-educational engineering programs make common reference to the need to form engineers who will have a solid understanding of our changing world. Many of these references are made in connection with study abroad, implying that the experience of having studied in another country, no matter how briefly, will create a global consciousness. Swarthmore says “A responsibly educated engineer must not only be in confident command of current analytic and design techniques but also have a thorough understanding of social and economic influences and an abiding appreciation for cultural and humanistic traditions”.

Georgia Tech states that it “sends more than 1200 students abroad each year through exchange programs and faculty-led trips, meaning engineering students have dozens of opportunities for international travel”. The University of Michigan posits, “Today’s engineers must . . . feel confident working in a global marketplace”. Such descriptions are connected with the possibility of “pursu[ing] internships and co-ops abroad, earning work experience and foreign-language skills that will stand out on resumes,” as stated at Georgia Tech.

Few co-educational engineering programs deal with the issue of financial support. One exception is Georgia Tech, which offers its undergraduates more than \$105 million in need- and merit-based aid. It promises further financial support as needed: “If you are accepted to Tech, advisors in the Office of Scholarships and Financial Aid (OSFA) will work with you to make your degree attainable”.

### 5. Discussion

Our study contributes to the broader literature on women in STEM fields by looking at the framing discourse surrounding the field of engineering. We examine this discourse as an antecedent to women’s actual experiences within the engineering major, thus examining it as an experience of engineering that can precede actual college experience in the discipline. This is significant because a majority of studies focus on women’s actual experiences in STEM classrooms, examining how hostile STEM environments can lead to attrition at different stages in the academic pipeline. However, in such studies the analysis of textual data and other discourses surrounding STEM is scant. In this study, we posit that website descriptions are important discursive spaces in which women students come to understand engineering as a discipline and a career path, and also come to understand what qualities and attributes are valued in engineers.

Our findings reveal that WOIs and co-ed institutions differ in their overall portrayal of engineering. WOIs acknowledge and address the dearth of women in engineering and express a commitment to facilitating the entry, retention, and advancement of women in engineering. These institutions then go about providing assurances of support and encouragement for women interested in engineering through peer and faculty mentorship programs, connections with alumnae, and strong career development. Both formal (faculty advisors, career offices, etc.) and informal structures (guest speakers, luncheons, chats with visiting alumnae, etc.) are extensively mentioned, reassuring women that while they face the challenges of a demanding discipline, support will be provided at every step of the way. These support structures come paired with flexible curricula, a collaborative learning atmosphere, and an emphasis on concrete learning experiences that the research literature supports as being of importance to women (Kulturel-Konak et al. 2011; Philbin et al. 1995; Severiens and Ten Dam 1994).

Finally, WOIs stress the interdisciplinarity of the engineering field in ways that help to portray the strengths, preferences, and career trajectories of engineers as broad and diverse. Engineering is portrayed as a field that values not only strong technical skills but also “soft skills” such as cultural competency, oral and written communication skills, foreign languages, and artistic talents.

The problems that engineers help to solve are shown to be embedded in social, political and historical contexts that rely on expertise in the humanities and social sciences as well as in technical disciplines in order to reach effective solutions. Thus the framing of the engineering discipline by WOIs is extremely broad, potentially appealing to a diverse audience of potential students.

In contrast, the majority of co-ed programs are very concerned with the products of engineering and the monetary and personal payoff of the field. There is a much narrower definition of interdisciplinarity in the co-ed context, in which the possibilities of connections between disciplines is more limited by cross-overs between engineering disciplines themselves, collaborations with other STEM fields, or overlaps with business and entrepreneurial studies. Within this discourse, the engineer is imagined as an individual with a much narrower set of skills and interests. While the engineer might be at once a creative geek and a successful entrepreneur, the portrayal rarely extends to artistic talents, humanistic endeavors, or a deep understanding of politics and culture. As put by UC Berkeley, engineering “is the liberal arts of the 21st century” and can thus stand alone as a sufficiently interdisciplinary endeavor. Even where a global citizenship is highlighted, it is largely framed as a marketable asset that would look good on a resume.

Questions of diversity in engineering are barely addressed in the main engineering pages of co-ed engineering programs. Only one of the co-ed institutions (UIUC) mentions diversity at all in its main engineering webpages, and this is just a passing claim to having a “diverse student body”, remaining vague as to what this actually means and what it is relative to. Accessing statements on diversity, information on the composition of the student body, or information on programs geared towards underrepresented students requires clicking on links that lead to pages other than the main engineering or “about us” pages.

Despite these observed trends, it is important to acknowledge that WOIs and co-ed institutions do not exist on a strict binary basis. Instead, there appears to be a spectrum along which different programs fall when it comes to their framing of engineering. One observation is that co-ed liberal arts colleges and some universities with strong liberal arts traditions, such as Princeton, seem to fall somewhere in-between the WOIs and other co-ed universities when it comes to their framing of engineering. For example, Swarthmore and Princeton both evoked discourses much more in line with WOIs in stressing the importance of a true interdisciplinarity that is inclusive of the humanities and social sciences, in developing successful engineering innovations. It is interesting to observe that the dean of undergraduate engineering at Princeton is a woman, and that many of the quoted statements on interdisciplinarity and collaboration drawn from the Princeton data emerge from the prominent “Welcome from the Dean”. Our sample of institutions included a very small number of co-ed liberal arts colleges; it would be interesting for a future study to examine whether co-ed liberal arts programs in engineering have produced a distinctive framing of engineering of their own.

Given women’s colleges’ constraints in conferring degrees in engineering, it is perhaps unsurprising that these colleges engage in a discourse that emphasizes the importance of a liberal arts education to engineering. In seeking to attract young women who aspire to work in engineering fields, women’s colleges construct discourses that broaden the definition of what it means to be successful in engineering, with an emphasis on soft skills such as communication, teamwork, and critical thinking, as well as arguments for the importance of knowledge of the humanities and social sciences in solving problems through engineering.

It could be argued that women’s colleges’ broader framing of the engineering field stems from their own self-interest in promoting the importance of the liberal arts to potential future engineers, who would otherwise not feel compelled to enroll in their programs at all. It should be noted also that the women only institutions included in our sample are, on average, smaller than the co-ed institutions, which could explain the emphasis on program flexibility and greater collegiality. Regardless of this, we posit in this paper that their reframing of engineering as a field could be valuable in attracting a broader diversity of students into the engineering field as undergraduates. In creating a different discourse of engineering, women’s colleges may have some lessons for co-ed programs seeking to

recruit and retain undergraduate engineering majors from underrepresented groups. A reimagining and reframing of the field of engineering has the potential to help this field appeal to a broader variety of students.

On the whole, the appeal of engineering programs at WOIs appears to be broader than those at co-ed institutions, enabling them to attract students with a greater diversity of dispositions, talents, and interests. WOIs offer more flexible programs, more built-in supports for students, and are more responsive to varying degrees of success for individuals in the field.

## 6. Conclusions

This current study has established some interesting trends and patterns when it comes to the framing of engineering by WOIs and co-ed institutions. However, this study has some limitations in the types of conclusions it can draw, especially since it relies on several key assumptions about the behavior of prospective undergraduate students, particularly women students, as they undergo their college research and make decisions regarding their program and major choice. A useful follow-up study could involve assessing the extent to which prospective students use college websites in the selection of their programs of study and intended majors. It would also be useful to test the differential responses of men and women students to the different engineering discourses, gauging how the framing of engineering can affect students' sense of belonging and willingness to engage with the discipline.

Assuming that the recruitment of women is important to engineering programs, co-ed engineering programs should consider a broadening of the descriptions surrounding the engineering field. The inclusion of a broader set of values could be appealing to women students, who may have experienced hostile or unwelcoming STEM environments in the past. Our examination and analysis of engineering webpages reveals that women-only and coeducational institutions differ in their presentation of the engineering field and the benefits that engineering provides.

The WOIs are not so bent on claiming superiority of the field or of their programs and partners; they focus on showing a more balanced view of engineering and on elucidating more concretely the types of problems that engineering can solve in society. They are also more open to acknowledging a wider diversity of career trajectories and future possibilities for engineering degree holders, emphasizing the development of a broad skill-set that can be a valuable asset in a variety of professional contexts. If coeducational engineering programs are committed to increasing the participation of women students, they would benefit from framing themselves as well as the field of engineering in a more friendly and accessible way.

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