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The impact of changing engineering perceptions on women's attitudes and behavioral intentions towards engineering pursuits

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Abstract

Background Women are underrepresented in the field of engineering within academic and professional settings. Based upon premises outlined by social role theory and goal congruity theory, a key factor that contributes to this underrepresentation is a gendered societal belief that there is a disconnect between engineering (seen as more agentic, or self-oriented) and women's values and abilities (which are believed to be more communal, or other-oriented). While there is evidence that this perceived disconnect influences women's pursuit of engineering, the extent to which an intervention could realistically counter these perceptions at key points along the engineering pathway has not been explored. Across two studies, we examine the impact of a communal-based intervention (in which we frame engineering majors and careers in more, though not exclusively, communally oriented ways) on women's engineering-related attitudes and behavioral intentions at two points along the academic-employment pathway: women's major selection and women's job selection.

Results Study 1 found that women with undeclared majors had more positive attitudes (confidence and interest) towards engineering majors when engineering major descriptions were framed as more communal versus more agentic. However, there was no impact on their behavioral intentions to pursue the major. Study 2 found that women with engineering majors were more confident in their ability to be successful in a job role and were more likely to apply when the job role was framed as more communal as compared to more agentic. However, they did not indicate greater interest in the job role.

Conclusions Testing this intervention on relevant populations advances the literature by providing greater evidence for the potential of such an intervention to meaningfully address women's underrepresentation at multiple points along the engineering pathway. Furthermore, this study provides evidence that a messaging-based intervention is impactful with a realistic representation of engineering as *both* an agentic and communally oriented field, which ensures that the retention of those attracted to the field is not negatively impacted by idealistic messaging. While addressing women's pursuit of engineering is important, work must continue to seek ways to always improve women's experience in engineering contexts as well.

Keywords Gender, Occupational choice, Engineering, Educational pursuits

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Background

Over the last several decades, women have closed the gender gap for many educational and professional outcomes. Yet, in some fields, such as engineering, the gap remains sizable in the United States due to gendered socialization that creates both internal and external barriers to women's educational and professional pursuits. While there is some variation across sub-disciplines (e.g., women comprise 35% of environmental engineers compared to only 18% of chemical engineers), collectively, women are vastly underrepresented in the field of engineering as a whole (Society of Women Engineers [SWE], 2023), with women earning less than a quarter of bachelor's degrees in engineering and comprising less than one-fifth of working engineers (Society of Women Engineers [SWE], 2018). This is reflected, in part, by the fact that women are less likely to select an engineering *major* (9.5%[a] versus 27.9% of men; Stolzenberg et al., 2017), and women who *do* major in engineering are still less likely to pursue an engineering *career* (8.9% versus 20.9% of men; Digest of Education Statistics, 2019). These figures represent *two* critical attrition points in the pathway supplying women engineers (Blickenstaf, 2005).

These critical attrition points have led universities and organizations to seek theoretically and empirically grounded ways to increase women's pursuit of engineering and provide women equal access to this lucrative field. Women's pursuit of engineering is particularly important as nations face a shortage of engineering talent, limiting global economic growth and human progress (QE Prize for Engineering Report, 2015; Schmader, 2023). A shortage that will persist if half the population continues to steer clear of engineering fields. Additionally, women's underrepresentation in this field likely limits the extent to which products and solutions are mindful of their impact on both men and women (Lopez, 2020), creating suboptimal, if not dangerous, realities for women with products and solutions failing to serve (and in some cases protect) women equally (e.g., Barry, 2021; Perez, 2019; Sugeman et al., 1997). To address these challenges, universities and organizations must seek to increase women's pursuit of the field.

While many barriers and factors contribute to women's disparate pursuit of engineering (Kanny et al., 2014), goal congruity theory highlights that a key underlying factor is the perceived disconnect between engineering (which is stereotypically seen as agentic [self-oriented]; National Academy of Engineering, 2008; Su & Rounds, 2015) and women's values (which are more, though not exclusively, communal [other-oriented]; Diekman et al.,, 2011, 2015, 2020; Eagly & Wood, 1999; Eagly, et al., 2020; Schmader, 2023; Schwartz, et al., 2005). Because individuals are driven to seek environments that allow them to manifest their values behaviorally, the perceived disconnect reduces women's pursuit of engineering both academically and professionally (Bonilla et al., 2023; Diekman et al., 2010, 2011; Hill et al., 2010; Schelfhout et al., 2021; Su et al., 2009; Webb et al., 2002).

Within this theoretical backdrop, we seek to test a communal-based intervention that aims to address this perceived disconnect by challenging engineering perceptions at two key points along the engineering pathway, advancing women towards engineering pursuits (e.g., major choice and job choice). By emphasizing communal qualities of the field (e.g., the collaborative nature of engineering work, how this work helps others), we sought to examine whether an intervention could align perceptions of engineering more with women's values and, therefore, increase their pursuit of the field (Bonilla et al., 2023; Corbett & Hill, 2015; Diekman et al., 2010; 2011, 2017, 2020; Eagly & Wood, 1999; Su & Rounds, 2015). More specifically, we sought to determine whether the intervention would meaningfully influence these two distinct groups of women (those in and outside of engineering fields) making two different, albeit critical choices (majors v. jobs). Previous evidence supports the potential for such an intervention to be effective (Belanger et al., 2017, 2020; Diekman & Steinberg, 2013; Diekman et al., 2017). However, while essential for theoretical and practical advancement, this previous work has not fully established the likelihood of success of these communal interventions for increasing women's pursuit of engineering.

We seek to build on this past work by providing a crucial test of the effectiveness of communal interventions in an engineering context[1] through methodology that is unique from prior work in three crucial respects. Specifically, our work: (1) targets populations that communal interventions are intended to influence (i.e., women with undeclared majors and women in engineering majors considering whether to pursue engineering jobs); (2) uses interventional materials that simultaneously highlight both the communal and agentic aspects of the field of engineering, which most realistically represents the field (as compared to intervention materials that only focuses on communal aspects of engineering); and (3) includes behavioral intentions regarding the pursuit of engineering as a field of study or a profession as an outcome variable at two pivotal points along the pathways to engineering pursuits (i.e., major selection, job selection).

[1] We note that extant research (e.g., Belenger et al., 2017) has been conducted in an engineering context. However, to the best of our knowledge, no prior work contains the three unique contributions we list here. We return to discuss the difference between our research and prior research in greater depth later in our introduction.

These three contributions allow our work to explore whether communal interventions are likely to be effective in the "real world" by studying their effects on populations for whom they are intended to target, using realistic materials, and assessing outcomes that, to date, are the closest to assessing whether we will see the behavioral changes necessary to increase women's representation in the field of engineering.

Testing communal interventions in the context of engineering is a timely and critical extension of previous work as campaigns centered on the reframing, or messaging, around engineering have gained traction in academic programs, organizations, and professional societies. These efforts assume that changing the 'conversation' around engineering will be an effective tactic to elicit the change they desperately seek (e.g., Alvarado & Dodds, 2010; Alvarado et al., 2012; Anita Borg Institute for Women & Technology, 2014; Corbett & Hill, 2015; DeJong-Okamoto et al., 2005; National Academy of Engineering, 2008; National Academies Press, 2008; Nilsson, 2015; Noble, 2020). We must confirm the effectiveness of such approaches before widespread implementation (Moss-Racusin et al., 2014; Rapport et al., 2018;).

Understanding theoretically women's underrepresentation in engineering

Social role theory [SRT] suggests that self-reported gender differences in communal and agentic values/attributes are due to societal expectations surrounding what women value or are expected to value (i.e., communal values/attributes). To briefly summarize the principles of this theory, SRT specifies that these societal gender expectations are the result of how our society has historically stratified itself by gender, positioning men and women in different social structures (Eagly & Wood, 2011). According to this theory, biological differences were the origin of a gendered division of labor (i.e., men as providers; women as caretakers) as labor roles were assigned in a manner evolutionarily beneficial for familial and societal functioning. As society developed, this gendered division of labor persisted through the forces of the local economy and social environment. These divided roles led to societal expectations for the values and attributes men and women hold (or should hold) as these matched the values/attributes of the labor roles men and women were in. Over time, women and men's assignment to these positions within the social structure (and corresponding expectations for women and men to hold values and attributes that matched these positions) led to observed gender differences in these attributes (Eagly et al., 2020) *and* preferences (i.e., values; Abele & Wojciszke, 2007; Gartzia, 2022; Judd et al., 2005). That is, matching societal expectations, we see a gender difference in these self-reported agentic and communal values/attributes, with men endorsing and possessing agentic (self-oriented) traits (e.g., independent, competitive, and ambitious) more strongly than women, and women endorsing and possessing communal (other-oriented) traits (e.g., supportive, helpful, and collaborative) more strongly than men.

Empirical work has supported these theorized gender differences, finding that while the gap in agentic values has diminished with time, with women endorsing more agentic values than they have in the past, gender differences in communal preference have remained stable, significant, and sizable (Diekman et al., 2011; Donnelly & Twenge, 2017; Eagly & Diekman, 2003; Gartzia, 2022; Hyde, 2005; Schmader, 2023). In fact, meta-analytic evidence demonstrates the largest gender differences along communal preferences finding that women were more interested in helping people ($d = -0.35$) and working with people ($d = -0.36$; Konrad et al., 2000; Su et al., 2009).

Goal congruity theory [GCT] further explains how these internalized and eternalized gendered expectations (as outlined by SRT) impact an individual's choices to pursue certain roles and not pursue others (Diekman et al., 2020). According to this theory, one's choice to pursue a role is dependent upon the extent to which the individual perceives that this role would fulfill or be congruent with their valued goals. A fundamental assumption being that the gender gap in different academic and professional roles can be understood by attending to which goals people value and see available in these roles. As such, this theory has been used to understand differences in women's pursuit of STEM fields, such as engineering.

Empirical studies have produced work consistent with the propositions outlined by GCT, finding that women's preferences, manifested as communal v. agentic values, are key drivers in decisions related to academic and vocational pursuits (Allen & Robbins, 2008; Bruch & Krieshok, 1981; Holland, 1997; Le & Robbins, 2016; Le et al., 2014; Leuwerke et al., 2004; Porter & Umbach, 2006; Rounds & Tracey, 1990; Schelfhout et al., 2021). Additionally, work has found that women are more likely to prefer careers that have a clear social purpose (Eccles, 2007; Jozefowicz et al., 1993; Lubinski & Benbow, 2006; Margolis et al., 1999). As such, scholars have come to agree that men and women's sizable differences in values may be one of the most important psychological mechanisms leading to gendered academic and career choices, including in STEM fields such as engineering (Brown et al., 2018; Ceci et al., 2009; Lubinski & Benbow, 1992; Schelfhout et al., 2021; Su et al., 2009).

GCT and engineering role perceptions

For decades, engineering has been inundated with stereotypes regarding the type of work it entails, the benefits gleaned from the work, and the type of people best suited for these roles—particularly in the United States (Brown et al., 2018). These stereotypes revolve around ideas such as engineers "must love math and science" or that "engineers sit at computers all day" leading to "social isolation" with an "intense focus on machinery" and that engineering is a "male profession" (Cheryan et al., 2015; Purdue Engineering, 2017). These stereotypes influence perceptions of engineering. In fact, when Diekman and colleagues (2010) had students rate the extent to which different careers would allow a person to fulfill communal goals, women rated engineering as significantly less likely to fulfill communal goals than other careers—including other male-dominated professions. These perceptions, in part, drive the large gender difference in interest in engineering ($d = 1.11$; Ceci & Williams, 2010; Cheryan et al., 2015; Eccles, 2009; Joyce & Farenga, 2009; Maltese & Tai, 2010; Su et al., 2009; Su & Rounds, 2015).

Further evidence of engineering's particularly dire percieved misalignment with women's values is that women's interest in, and pursuit of, other STEM fields have *not* all experienced a similar fate (Schmader, 2023; Yoder, 2013). In fact, women are well represented in STEM fields that are associated with helping others (i.e., life, medical, social sciences; Yoder, 2013). This may be because these fields are perceived as better aligned with women's gender roles due to their believed potential to afford an opportunity to fulfill communal values (Croft et al., 2015; Falk & Hermle, 2018); whereas a field such as engineering, which emphasizes building *things,* is assumed to be unlikely to afford an opportunity to fulfill communal values (Corbett & Hill, 2015; Diekman et al., 2010, 2011; McPherson & Park, 2021).

Communal intervention: changing women's perceptions of engineering

Engineering, being viewed as thing-oriented, less social, and less communal (Hill et al., 2010; Su et al., 2009; Webb et al., 2002), leads to the perception that engineering fields of study and careers do not allow women to fulfill their communal values subsequently impacting their pursuit of engineering roles (Corbett & Hill, 2015; Diekman et al., 2010, 2011; McPherson & Park, 2021; Su & Rounds, 2015). As such, scholars (i.e., Diekman et al., 2017; Eccles, 2009; Su & Rounds, 2015; Valla & Ceci, 2014) and practitioners (i.e., Corbett & Hill, 2015; National Academy of Engineering, 2008) propose that a potentially impactful intervention to increase women's pursuit of engineering may be to emphasize what engineering already is, but is not widely thought to be: communal.

While there is limited existing evidence that engineering is *actually* any less communal as compared to other fields (e.g., Fouad et al., 2017; Schmader, 2023), the *perception* remains that this field would not afford opportunities to fulfill communal values. In reality, engineers provide many communal-oriented services, such as improving the lives of other people (e.g., improving human health, safety, and function), and many engineers work in teams. In fact, one study found that engineers cited collaboration and coordination as critical in engineering work (Anderson et al., 2010), and another examined engineering education and noted that teamwork is a core component of engineering education (Beddoes et al., 2010; de Campos, et al., 2012; Purzer, 2011). Further, engineering's purpose as a field (as defined even in its professional code of ethics) centers around the responsibility to address societal issues and help people (Cech, 2014; Royal Academy of Engineering, 2022). Yet, people fail to see engineering as a communal field (Corbett & Hill, 2015).

So, while engineering is certainly aligned with agentic values and centered around 'things' (e.g., products, machines, etc.), it is not *exclusively* agentic. This means that the perceived disconnect between engineering fields and women's values may be plagued more by stereotypes than reality, creating this imagined barrier for women pursuing the field. Shifting perceptions of engineering to include communal characteristics would better align the field with women's gender identities and should lead women to consider it a field where they may behaviorally manifest gender-role congruent values. As such, we propose an intervention designed to highlight communal and people-oriented aspects of engineering, in addition to the traditional agentic aspects, to increase women's perception they would "fit" in engineering roles (Su & Rounds, 2015; Wang & Degol, 2013).

Empirical support for communal intervention

An intervention attempting to influence the academic and career choices of women at critical points along the engineering pathway has not been directly tested on the relevant populations. However, extant empirical work has provided support for the notion that we can increase women's interest in a job or career by highlighting communal properties.

A series of studies have established a relationship between communal values and perceptions of academic and career pursuits. Work by Belanger et al. (2020) found that STEM students, particularly women, who see their major fulfilling goals related to helping or working with others also reported greater belonging in their major. More specifically, Belanger et al. (2020) found that describing a typical day in a research lab in more collaborative ways leads STEM female students to be more interested in working in the lab in question. Additionally, McCarty et al. (2014) found that those who valued communal goals had negative reactions and evaluations of work environments low in communion. Further work has shown that women students have a greater interest in STEM fields that are believed to be more communal than those perceived to be agentic (Su & Rounds, 2015; Su et al., 2009). A similar study looked at communal cues via role models and demonstrated that exposure to scientist exemplars engaging in communal work significantly increased beliefs that science afforded communal goals, leading to more positive attitudes toward science careers (Clark et al., 2016). This finding is supported by a series of studies that find people feel more positively toward science careers when they perceive them as careers where they may help others (Weisgram & Bigler, 2006; Weisgram & Diekman, 2016). Additionally, work by Diekman et al. (2010) found that the endorsement of communal values significantly impeded the pursuit of STEM careers. Diekman et al. (2011) similarly found that female undergraduate psychology students' attitudes towards science professions were more positive when the role was framed in a communal way as compared to when it was framed in a more stereotypical (i.e., agentic) manner. However, scholars have noted that the evidence for an intervention like this is preliminary and limited to attitudinal changes versus behavioral intentions, and more research is needed—particularly before its application is implemented in other contexts (Corbett & Hill, 2015; Su & Rounds, 2015).

Belanger and colleagues (2017) were the first to move scholarship in this direction by looking at the impact of including a service-learning requirement in engineering classes on participant interest in taking the course and perceptions that the course fulfills communal values. They again found support for the communally oriented intervention—finding that this other-oriented course requirement significantly improved both outcomes for women.

However, even with this important step, this work, and the body of work upon which it is built, has limitations that must be addressed. Most importantly, past work has not tested the intervention using the populations it was designed to influence—limiting our ability to conclude the ability to meaningfully influence the distinctly different *relevant* populations of women at *multiple* points along the engineering pathway (women outside and already within engineering). Most of the related previous work has used samples of convenience (e.g., students within a psychology course, Mturk), many of whom have already established non-engineering majors, meaning we would have no reason to believe these students would realistically consider engineering as a field of study or career path. Even within the context of engineering specifically, Belanger et al.(2017) did not apply their intervention to the populations of interest—with the first study utilizing a convenience sample of Mturk-sourced college students and a second through the psychology subject pool (which included those who had already declared majors both within and outside of STEM fields). In the present study, we use the two populations our intervention is designed to influence—women who have not yet declared majors and women who are presently in engineering but have not yet selected job roles. These are students who are positioned to pursue an engineering major (e.g., with undefined majors) or an engineering career (e.g., engineering majors who will decide whether to pursue an engineering role post-graduation), which are two critical junctures where women are underrepresented in the pathway supplying women engineers.

Second, past manipulations have designed interventions that compare exclusively communal to exclusively agentic descriptions of STEM fields. While a critical step to determine the potential positive influence of communally oriented interventions—the practicality of such an intervention may be limited as it does not realistically represent engineering as a field that has both communal and agentic qualities. A realistic representation is critical for engineering as denying the agentic traits of the field would be an inaccurate representation of it—which would likely have negative consequences on retention (Earnest et al., 2011). Instead, materials in our intervention simultaneously highlight both the communal and agentic aspects of the field of engineering, which more realistically represents the field. This design allows us to understand the potential impact of a less saturated—and therefore more realistic—communally oriented intervention.

Third, the present study builds on the past literature by moving beyond attitudinal changes to indicators of behavioral intentions. While much of the past work has looked at how impressions (i.e., attitudes) of STEM fields change, the present study goes beyond attitudinal outcomes and looks at behavioral intentions to pursue the field of engineering both as a field of study and a professional pursuit. While Belanger et al. (2017)—included a behavioral indicator as well—this was limited to participants reporting whether they would take a course in engineering, which, while a critical advancement of the previous literature, does not fully capture the more consequential—and impactful—decision of pursuing engineering as a major and career. While students selecting engineering courses could be an important bridge to increasing the number of women selecting engineering majors—the level of commitment to pursue a course and a major are vastly different. We seek to determine whether such an intervention has the potential to influence a behavioral choice that requires a greater commitment due to an inherently greater consequence.

Lastly, we highlight the importance of our work for building further evidence of the effectiveness of such an intervention within the field of engineering as, to our knowledge, Belanger and colleagues (2017) represent the only work to explore communally based interventions within the context of engineering. Further work is warranted as engineering is uniquely positioned among other STEM disciplines as a field that has remained stagnant despite increased attention toward increasing women's representation in STEM. In other words, it appears immune to strategies that have proven effective for other STEM fields, warranting investigation as to whether communal interventions would prove as effective for engineering as they have for other STEM fields. So, while past work has been pivotal in understanding women's pursuit of STEM fields—further work is needed.

The present study

Based on the theoretical underpinnings of *SRT* and *GCT*––the present study seeks to examine the impact of highlighting communal and agentic components of engineering on women's perceptions (i.e., attitudes) and behavioral intentions toward engineering majors and jobs. Specifically, the present study examines the impact of reorienting how engineering is described on women's attitudes towards engineering majors/jobs and their behavioral intentions to pursue them. Ultimately, we predict that presenting engineering majors and job opportunities in *more* communal ways will lead to more favorable attitudes, ultimately leading women to report a greater likeliness to pursue engineering as a major and career. More specifically, we hypothesize:

Women exposed to a framing that emphasizes communal qualities while also acknowledging the agentic aspects of the field as compared to an exclusively agentic framing will report (H1) greater interest, (H2) greater confidence, and (H3) a greater intention to select an engineering major/job.

Methods

The present study sought to test the hypotheses noted above across two studies with two distinct populations at two points in the engineering pipeline. In Study 1, we examine the impact of describing engineering major opportunities in a more communal and people-oriented way (as compared to the more traditional, agentic descriptions) on women in undeclared majors. In Study 2, we examine the impact of describing engineering job roles in a more communal and people-oriented way (as compared to the more traditional, agentic descriptions) on women in engineering majors.

Study 1: Undeclared women's evaluation of and intention to pursue engineering major

Participants

Participants were 268 female students who had not yet declared a major or were in an exploratory studies program at a large Midwestern public university. It is important to note that this university had an exploratory studies program that allowed students to delay declaring a specific major. Participants were either recruited through an elective introductory psychology pool ($N=76$) or directly through the exploratory studies program ($N=192$)—though only women in these populations with undeclared majors were included in the study. Most participants identified as White (79.9%), 6.7% identified as Asian, 3.7% identified as Black, 7.5% identified as Latinx, and 2.2% identified as other. The average age was 18.43 years old, with 97.4% of participants being first years or sophomores. As fulfillment of their introductory psychology course requirements, participants were provided course credit in exchange for their participation, while exploratory studies majors were given a five-dollar Amazon gift card for their participation.

Materials

Two versions of materials were created for each engineering field of study: an exclusively agentic version and a version that emphasized communal qualities (though not exclusively). The agentic condition materials were minimally adapted based upon *EducatingEngineers.com* major descriptions and the university's own descriptions representing traditional ways of describing the major (see "Appendix A"). The experimental version of the descriptions varied from the agentic versions by adding a communal focus to them (e.g., emphasizing collaboration, helping others) based on items contained in well-validated communal goal endorsement measures (Diekman et al., 2010) and communal linguistic dictionaries (Pietraszkiewicz et al., 2019). We intentionally did not *remove* agentic qualities for these versions, but rather *deemphasized* agentic qualities while making communal additions (see "Appendix A"). This was done to reflect a more realistic description of the major, as the aforementioned research would suggest that it is not the presence of agentic qualities that is deterring women but rather the absence of communal qualities.

Content validity evidence of study 1 intervention stimuli A number of examinations were conducted to ensure that manipulations reflected the desired communal and agentic qualities. First, manifest qualitative

Table 1 Study 1 major descriptions content analysis

	% Comm manual	% Comm LIWC	% Agentic manual	% Agentic LIWC	Total word count
Communal text	11.80	6.37	5.44	3.25	1508
Agentic text	0.61	0.77	11.49	6.82	1305

Comm communal, % number of relevant terms based divided the total number of words in the text, *Manual* manually coded based on author established dictionary of terms, *LIWC* computer coded based on external established dictionary of terms

analysis was conducted to determine the representation of communal/agentic words within the created text for the major descriptions. Manifest qualitative analysis is a form of summative qualitative analyses—or rather, identifying and quantifying of certain words or content in a text in order to explore the usage of particular words (Hsieh & Shannon, 2005; Potter & Levine-Donnerstein, 1999). Data analysis involved searching for specific sets of words representing these topics. This was done both for words representing communal and agentic themes (see Table 1). This task was completed independently by two trained coders who compared their findings until a complete agreement was reached. This process concludes by counting the number of times relevant words appeared in the text (Morgan, 1993). Results of this manual coding indicated that the "communal major descriptions" had a greater percentage of words that were communal, while the "agentic major descriptions" had a greater percentage of words that were agentic (see Table 1).

An additional set of analyses were conducted using the LIWC2015 software (Pennebaker et al., 2015). The software counts and classifies terms against two well-validated custom dictionaries, one agentic and another communal, created by Pietraszkiewicz et al. (2019). Using these dictionaries, the LIWC2015 software quantifies the words in a job posting as either communal or agentic. This produced an output with the percentage of the posting containing each. Results of this computer coding again indicated that the "communal major descriptions" had a greater percentage of words that were communal while the "agentic major descriptions" had a greater percentage of words that were agentic (see Table 1).

We chose to examine the text both manually and computer-aided to increase the reliability of our conclusions. The benefit of the computer-aided process is that it was able to search for a greater number of words. However, its drawback is that it does not consider the context (the way in which the word is used), nor is it able to consider relevant phrases (e.g., working with people) which as equivalent meaning as words that were found in the dictionary (e.g., collaborating). The manual coding, while narrower in its search, is able to consider context and search for phrases and not just words. Together, we felt they provided a well-rounded examination of the content validity of the manipulations.

Procedure

For the experiment, participants were asked to complete an online survey in which they reviewed several engineering major descriptions. Participants were told that the study was interested in learning more about those with an undeclared major's interest in pursuing different majors. Participants were randomly assigned through the Qualtrics platform to either the communal or agentic condition, where they were given either descriptions that emphasized communal aspects of the engineering majors or ones that exclusively emphasized agentic aspects of the engineering majors. They were then asked to complete a series of questions regarding their attitudes and behavioral intentions towards engineering majors overall.

Measures Students were asked with a single item to rate (1) interest in "an engineering major" on an anchored scale ranging from 1 (not at all interested) to 7 (extremely interested); (2) confidence they could succeed in an engineering major rated on an anchored scale ranging from 1 (not at all confident) to 7 (extremely confident); and (3) how likely they would be to select engineering as their field of study on an anchored scale ranging from 1 (not at all likely) to 7 (extremely likely). In addition, participants reported their prior consideration of engineering, their age, their ethnicity, and their year in college. Participants were also asked to complete communal v. agentic values measures and person v. thing interest profiles to ensure our two groups did not meaningfully differ on these outcomes.

Results for Study 1

First, we examined the extent to which the randomly assigned groups differed on initial measures, including demographics, values, and pre-existing attitudes towards engineering, all of which did not significantly differ (p's > 0.05; see "Appendix C").

To test *Hypothesis 1, 2,* and *3*, we performed one-way analysis of variance tests comparing participants' mean perceptions of engineering majors in the agentic framing

Table 2 Means, standard deviations, and one-way analysis of variance in Study 1 outcomes

Outcome	Agentic condition (*N* = 153)		Communal condition (*N* = 115)		*F* (1, 266)	η^2
	M	SD	*M*	SD		
Interest	3.294	1.842	3.774	1.612	4.952**	0.018
Confidence	2.386	1.522	2.939	1.618	8.221***	0.030
Intention to select	2.190	1.645	2.565	1.792	3.169*	0.012

M mean, *SD* standard deviation, *N* the number of participants in the condition, η^2 sum of squares between groups divided by total sum of squares; *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$. Differences in sample sizes across conditions were due to an error in the Qualtrics survey that did not ensure *balanced* random assignment across the two conditions

condition compared to the communal framing (i.e., the communal intervention that still contained agentic components) condition (see Table 2). In support of *H1*, there was a statistically significant difference between conditions as determined by a one-way ANOVA (F (1, 266) = 4.952, $p = 0.027$; $d = 0.277$), such that women in the communal condition ($M = 3.774$; SD = 1.612) reported greater interest in engineering majors than women in the agentic condition ($M = 3.294$; SD = 1.842). In support of *H2*, there was a statistically significant difference between conditions as determined by a one-way ANOVA (F (1, 266) = 8.221, $p = 0.004$; $d = 0.352$), such that women in the communal condition ($M = 2.939$; SD = 1.618) reported greater confidence in their ability to be successful in engineering majors than women in the agentic condition ($M = 2.386$; SD = 1.522). Failing to support *H3*, there was not a statistically significant difference between conditions as determined by a one-way ANOVA (F (1, 266) = 3.169, $p = 0.076$; $d = 0.218$), where women in the communal condition did not significantly differ from women in the agentic condition in their intention to select an engineering major; however, the result did trend in the anticipated direction.

Discussion for Study 1

Based on the conclusions of Study 1, there is initial support that a communal framing intervention positively impacts women's attitudes toward engineering majors—though it did not appear to have an effect on behavioral intentions. Our finding that a communal intervention positively influenced women's attitudes toward engineering majors aligns with the premise outlined by *GCT* that the extent to which a role (in this case, the role is an engineering major) is presented as aligning with communal goals should result in women's more positive impressions (e.g., attitudes) towards the role. However, contrary to our original hypothesis (*H3*), we did not find strong evidence that this intervention had a significant effect on behavioral intentions toward pursuing engineering majors despite having the power to detect such an effect.[2] This is an important distinction and leads us to question whether additional precision should be added to GCT that could influence our understanding of women's behaviors within male-dominated contexts. We return to this point in further depth in our general discussion.

While Study 1 found that a communal intervention influenced attitudinal (if not behavioral intentions) toward engineering degrees for undergraduate students with undeclared majors, questions remain as to whether such an intervention would still be impactful further down the talent supply pathway as women have had greater, more extended exposure to the often more agentic realities of engineering as a field. Rather, women already in engineering fields may be less convinced by changes to language alone if the language does not reflect their lived experience of their field of study. As such, Study 2 seeks to examine a similar intervention on women engineering students to determine the extent to which communal framing of job opportunities may positively impact their attitudes and behavioral intentions towards the job role. This study serves both as a replication of the primary design of the intervention (i.e., communal framing), as well as an extension that applies the framing intervention to a unique population of women (those who have already chosen engineering majors and have been extensively exposed to engineering) and unique context (job descriptions) compared to previous research. This extension is critical as it allows us to further understand the strength of such an intervention for a population presumably more aware of the realities of engineering and potentially more open to, and interested in, the agentic characteristics of the field (based on their choice to pursue it as a major). This allows us to test the extent to which such an intervention would address an additional point of attrition in the academic-employment pathway.

[2] A power analysis was conducted using G*power based upon the effect size found in Belanger et al. (2017), which has the greatest similarities to the present work. Based on their effect size of $d = 0.73$, a sample size of 55 was required.

Table 3 Study 2 job role descriptions content analysis

	% Comm manual	% Comm LIWC	% Agentic manual	% Agentic LIWC	Total word count
ME communal	10.25	7.95	2.93	2.93	478
ME agentic	1.42	2.37	5.21	4.98	422
BM communal/	11.09	10.70	3.34	6.98	430
BM agentic	3.21	6.43	7.78	9.65	373
CEE communal	8.40	7.14	5.46	5.46	238
CEE agentic	0.43	1.73	6.93	7.79	231

ME mechanical engineering, *BM* biomedical engineering, *CEE* computer electrical engineering, *Comm* communal, % number of relevant terms based divided the total number of words in the text, *Manual* manually coded based on author established dictionary of terms, *LIWC* computer coded based on external established dictionary of terms

Study 2: Engineering majors evaluation and intention to pursue engineering job role

Participants

Participants were 76 female students who declared engineering majors in either (a) biomedical engineering ($N = 9$); (b) computer and electrical engineering ($N = 30$), or (c) mechanical engineering ($N = 37$; the three most common engineering majors) at a large Midwestern public university. The three most common majors were chosen to increase the potential participant pool—rather than to inform any differences across majors, which sample sizes preclude us from doing. Participants were recruited through a college newsletter as well as directly through their engineering courses. Most participants identified as White (51.3%), 28.4% identified as Asian, 2.7% identified as Black, 9.5% identified as Latinx, and 6.8% identified as other. The average age was 20.93 years old, with 85.6% of participants being juniors or seniors. Participants were given an Amazon gift card for their participation since their participation was completely voluntary rather than a part of their required coursework, as was the case for participants in Study 1 who were recruited through the exploratory studies program.

Materials

Engineering position descriptions were created based on actual job postings found online. Two versions were created for each engineering subfield (biomedical, computer and electrical engineering, mechanical engineering): an agentic and a communal version. The agentic condition materials were adapted with minimal changes from the original job descriptions representing traditional ways of describing engineering (see "Appendix B"). The experimental version of the descriptions varied from the agentic versions by adding a communal focus to them (e.g., emphasizing collaboration, helping others, emphasizing clients, people, community; see "Appendix B"). Again, the communal and agentic additions and changes were based on the items noted in Study 1.

Content validity evidence of intervention stimuli Study 2 Manifest analyses were conducted using the same procedures used in Study 1. Results of this manual coding indicated that the "communal job descriptions" had a greater percentage of words that were communal, while the "agentic job descriptions" had a greater percentage of words that were agentic (see Table 3).

As was true in Study 1, an additional set of analyses were conducted using the LIWC2015 software (Pennebaker et al., 2015). Results of this computer coding again indicated that the "communal major descriptions" had a greater percentage of words that were communal while the "agentic major descriptions" had a greater percentage of words that were agentic (see Table 3).

Procedure

For the experiment, participants were asked to complete an online survey in which they reviewed an engineering job description. Participants were told that the study was interested in understanding the type of engineering roles engineering majors were interested in pursuing. Participants were randomly assigned through the Qualtrics platform to either the communal or agentic condition, where they were given either a communal (with agentic components) or an exclusively agentic job description for the area of engineering in which they were majoring. They were then asked to complete a series of questions regarding their attitudes and behavioral intentions toward the engineering job.

Measures Students were asked with a single item to rate (1) interest in the job on an anchored scale ranging from 1 (not at all interested) to 7 (extremely interested); (2) confidence they could succeed in the job rated on an anchored scale ranging from 1 (not at all confident) to 7

Table 4 Means, standard deviations, and one-way analysis of variance in Study 2 outcomes

Outcome	Agentic condition (*N* = 50)		Communal condition (*N* = 26)		*F* (1, 74)	η^2
	M	SD	*M*	SD		
Interest	4.380	1.794	4.692	1.289	0.619	0.008
Confidence	4.560	1.580	5.308	1.050	4.722**	0.060
Intention to select	3.960	1.989	4.846	1.642	3.804**	0.049

M mean, *SD* standard deviation, *N* the number of participants in the condition, η^2 sum of squares between groups divided by total sum of squares

**Statistically significant difference between communal and agentic conditions ($p < .05$, One Way ANOVA). Different sample sizes across conditions were due to an error in the Qualtrics survey that did not ensure balanced random assignment across the two conditions

(extremely confident); and (3) how likely they would be to apply to this job on an anchored scale ranging from 1 (not at all likely) to 7 (extremely likely). Additionally, the same measures used in the first study were also used in the present study, including demographics and values measures to ensure our groups (i.e., across majors and conditions) did not meaningfully differ on these variables.

Study 2 Results

Prior to conducting the primary analyses, we examined the extent to which the randomly assigned groups differed significantly on initial demographics and values. We also examined the extent to which students in the various majors significantly differed from one another. Results indicated that students in the different conditions and majors did not significantly differ from one another on these variables (see "Appendix D" and "Appendix E", respectively).

To test *Hypothesis 1, 2,* and *3,* we performed a one-way analysis of variance tests comparing participants' perceptions of engineering positions across the two conditions (exclusively agentic framing versus communal [with agentic components] framing; see Table 4). Failing to support *H1*, there was not a statistically significant difference in interest between conditions as determined by a one-way ANOVA (F (1, 74 = 0.619, p = 0.434; d = 0.200), such that women in the communal condition did not report greater interest in engineering positions than women in the agentic condition. In support of *H2*, there was a statistically significant difference between conditions as determined by a one-way ANOVA (F (1, 74) = 4.722, p = 0.033; d = 0.558), such that women in the communal condition (M = 5.308; SD = 1.050) reported greater confidence in their ability to be successful in engineering position than women in the agentic condition (M = 4.560; SD = 1.580). In support of *H3*, there was a statistically significant difference between conditions as determined by a one-way ANOVA (F (1, 74) = 3.804, p = 0.055; d = 0.485), with women in the communal condition (M = 4.846; SD = 1.642) significantly differing from women in the agentic condition (M = 3.960; SD = 1.989) in their intention to apply to the engineering position.

Discussion for Study 2

Our Study 2 results provide further support that a communal framing intervention positively impacts women's attitudes towards three specific engineering role pursuits—though it did not influence both interest and confidence as it did in Study 1.[3] More specifically, the communal intervention increased women in engineering major's confidence in the engineering job role, but not their interest in the role. Of further consideration, diverting from Study 1 conclusions, Study 2 also found that the intervention positively influenced women's behavioral intentions. These results generally align with premises outlined by *GCT* as the specific engineering job role elicited more positive impressions (e.g., attitudes) and behavioral intentions from women when framed in more communal ways. This provides additional support for the basic principle of such an intervention—that framing—or rather drawing clearer connections to communal values—is impactful on women's attitudes and behavioral intentions across multiple, real-world contexts (educational and professional)—though evidence from this study is limited to the three types of engineering roles we explored. However, the fact that our intervention did not unequivocally predict better outcomes for women, and the type of outcome predicted varied based on the population, suggests that *GCT* could be updated to consider nuances that accompany the psychological states and behaviors of women depending on the context. We expand on this suggestion below.

Overall discussion

Building on past empirical work (Belanger et al., 2020; Diekman & Steinberg, 2013; Diekman et al., 2017), we sought to test a communal intervention at two junctures in the academic-employment pathway leading women towards engineering: (1) women selecting a major and (2) women selecting a full-time position (within three specific engineering subfields; Blickenstaf, 2005). This

[3] Based upon the same power analysis using G*power, we concluded we again had a sufficient same size on which to base our conclusions.

allowed us to examine the potential of the intervention to meaningfully change interests, confidence, and behavioral intentions to pursue engineering for the women these interventions are designed to influence. Specifically, we sought to examine whether describing engineering (i.e., major, job openings) in more communal ways would influence women's pursuit of engineering as a field of study as well as a career. Using the two relevant populations—women with undeclared majors and women within three specific engineering majors approaching graduation—we sought to examine how the framing of majors and specific engineering jobs as either exclusively agentic or as also communal would influence women's attitudes (i.e., interest, confidence) and their behavioral intentions (i.e., to select an engineering major, to apply to an engineering job). We hypothesized that women—in both populations—when exposed to a framing that emphasized communal qualities (in either a major description or job description), as compared to a framing that exclusively focused on agentic qualities, would report greater interest in the major/job (*H1*), greater confidence in their ability to be successful in the major/job (*H2*), and a greater intention to select an engineering major/job (*H3*).

The pattern of our results suggests that our communal intervention more robustly predicted some outcomes more than others for women at two critical junction points along the engineering pathway. It seems our intervention consistently improves women's confidence in pursuing engineering, suggesting that engineering self-efficacy is easier to influence using these methods. However, our results suggest that interest and behavioral intentions are more challenging to reliably impact using such an intervention. These distinct patterns of results may be reflective of important differences in how we can understand women's attitudes and behaviors, enabling us to better understand boundary conditions for the potential effectiveness of such an intervention. In turn, these results also suggest nuances that can be introduced to GCT.

First, regarding potential boundary conditions of such an intervention, our results suggest that the power to influence these distinct decisions may differ. For example, decisions on one's major may be perceived as a bigger (i.e., more important/permanent) decision as compared to deciding to apply to a particular job. More specifically, students may view the potential negative ramifications of selecting the wrong major as negatively impacting one's entire career, whereas selecting the wrong job would not have these same long-term consequences and would be easily reversible. As such, these differences in our results may suggest that this type of intervention be more limited for more significant (irreversible) decisions like major choice—as the greater consequence associated with making the wrong decision may limit the intervention's potential to meaningfully influence behavioral intentions. Relatedly, it is possible that for women selecting a major, it is not just perceptions of the major itself that matter (which is what was manipulated), but also their perceptions of what an engineering career may entail if one wishes to move the needle on behavioral intentions for this population. Along these same lines, there is the potential that such a manipulation in a career context may led women to infer additional information about the job role that may impact their attitudes differently than in an educational context—particularly perceptions regarding pay or status. More specifically, because communality in a job is associated with lower social status compared to agency (e.g., Agut et al., 2022), respondents may have perceived these career options in the communal intervention conditions as similarly devalued, or less financially lucrative, which may uniquely temper interest in this particular context for women already within an engineering field (engineering majors), which highlights a second important difference across these two populations to note.

Beyond potential differences in the weight of the decision or inferences drawn at different stages across the engineering pathway, there are also important differences in the women at these different stages along the pathway. At a minimum—one population (women with undeclared majors) has not yet made any choice related to a pursuit of engineering—whereas the other population (current engineering majors within one of three engineering subfields) has already made one choice to pursue engineering. At a deeper level—we suspected that women from these two different populations might differ on personally held values, particularly in terms of their communal and agentic values. That is, we suspected that women who are engineering majors would have lower levels of communal goal endorsement and/or higher agentic goal endorsement as they had already made the decision to pursue the stereotypically agentic field of engineering. This may reflect that they have been socialized to these goal orientations over time or have unique perceptions of engineering based on classroom or internship experiences that allowed them to recognize the potential communality of engineering as a profession. A post hoc analysis supported the former suspicion in part. While our two samples did not differ significantly in their communal goal endorsement ($t(342) = 0.833$, $p = 0.405$), women in engineering majors had significantly higher levels of agentic goal endorsement ($M = 5.103$, $SD = 0.833$) as compared to women with undeclared majors ($M = 4.843$, $SD = 1.004$; $t(342) = -2.060$, $p = 0.040$). However, we must acknowledge that the reason for this difference being initial value differences across the two populations is speculative and may instead reflect the influence of an achievement-oriented context such as college (participation in the engineering major specifically) meaningfully shifting one's values. However, it may indicate too that the usefulness of the intervention is driven by the endorsement of the communal versus agentic values—whereas populations with higher agentic values may require less convincing of the potential fit of a chosen path. Though difficult to parse, the interaction between the population's values and the type of decision may also explain differences in results across the studies. For example, women with engineering majors may be using these cues in different ways than women who have not yet declared their majors. Whereas women with undeclared majors are looking for cues related to their ability to fulfill their values and goals, women with engineering majors may already perceive the field as adequately fulfilling their values (based on the fact they selected into the major). Instead, they may be looking at cues to inform whether they will be welcomed and valued in a particular workplace. It is possible the communal cues imply to them that they, as women, would be less likely to face barriers associated with traditional agentic workplaces (Belanger et al., 2020).

Theoretical and practical implications

In terms of theoretical implications, this work provided a foundational experimental test of a communal-based intervention grounded in *GCT* for a particularly critical, and stagnant (in terms of gender equality), STEM field: engineering (Gandhi-Lee et al., 2015; SWE, 2018; Yang & Barth, 2015). While past empirical work has provided evidence that perceptions towards different roles may be positively influenced through communal-focused interventions (e.g., Belanger et al., 2017, 2020; Clark et al., 2016; Diekman et al., 2010, 2011; McCarty et al., 2014; Su and Rounds 2015; Su et al. 2009; Weisgram and Bigler 2006; Weisgram and Diekman 2014), the present work extends the context for which evidence of communal interventions' effectiveness exists. More specifically, the present study examined the extent to which these theoretical principles may be used to inform interventions aimed at changing the attitudes and behavioral intentions of women at two critical points along the engineering pathway. While these theories are used to explain discrepancies in the field, they have not been empirically tested to determine whether their application is appropriate for populations of women across the engineering pathways.

Broadly, this work provided further evidence for the relevance of GCT on the study of women's underrepresentation in engineering in terms of recruitment. While numerous theories and factors have been put forth to understand women's underrepresentation in engineering, this work provides evidence that gender roles and socialization on women's values and orientations may be key in understanding how to help improve the state of women in engineering fields, specifically.

However, this study suggests that these theories cannot be applied equally across all situations. For example, our results suggest there is notable heterogeneity among women across the engineering pathway, particularly related to their agency goal endorsement, which may uniquely influence the impact of such an intervention. This is informative as it demonstrates the theoretical power, and limitations, of these mechanisms to influence attitudes and behavioral intentions in unique ways across different populations of women. Secondly, while not the primary interest of this current work, we did find evidence that communal interventions may impact different outcomes in different ways. More specifically, we find that *confidence* appears to be more robustly predicted by communal-based interventions than interest and behavioral intentions. This may suggest that (1) interest and behavioral intentions are not as easily influenced for populations that may be considering different engineering choices or (2) that other factors influence interest and behavioral intent beyond communal perceptions of the major/job. Exploring why some outcomes (e.g., confidence) appear more easily impacted by communal interventions may be an important question for future theoretical work. Thirdly, it is important to note that this intervention tested the influence on women's perception of engineering as a whole—rather than perceptions of individual fields within engineering. It should be noted that this type of intervention may be more easily applied to the more people-focused fields of engineering, such as biomedical engineering, as compared to more inherently things-focused fields such as civil engineering—a potential limitation that should be explored further in future work. Collectively, our work suggests that further nuance and consideration of boundary characteristics of *GCT* is required.

In terms of practicality, this work answers the call of universities and organizations seeking theoretically and empirically grounded interventions to improve women's representation in engineering (Corbett & Hill, 2015; Su & Rounds, 2015). We provide empirical evidence for an idea that has been widely endorsed by higher education institutions (i.e., Alvarado & Dodds, 2010; Anita Borg Institute for Women & Technology, 2014), workplaces (Nilsson, 2015; Nobel, 2020), social change organizations (i.e., National Academy of Engineering, 2008), and scholars (i.e., Corbett & Hill, 2015)—that the key to increasing women's recruitment in engineering is to change the conversation around engineering to focus on communal qualities. Importantly, we did not pit agentic qualities against communal qualities in the design of our manipulation. Recognizing agentic qualities as a critical part of engineering educational and professional pursuits, our manipulations did not remove agentic qualities in their entirety—but rather de-emphasized them while emphasizing communal qualities. Based on the results of this study, there is evidence for the effectiveness of changing the way we describe engineering, both in academic settings (i.e., major descriptions) as well as organizational settings (e.g., job descriptions). More specifically, describing engineering as a field and engineering roles in ways that include communal qualities—and minimize the focus on agentic qualities—may be an intervention worthy of investment. For example, employers wishing to attract a more diverse pool of applicants may emphasize communal goals and deemphasize agentic goals in their job postings, though great care must be taken to ensure that this does not unintentionally negatively impact perceptions of the job's value or that agentic goals important to engineering are not removed entirely. Further, this certainly should not be the only investment that is made by those looking to increase the representation of women in engineering—particularly as confidence was the only outcome that was robustly impacted.

Limitations and future directions

While this work has promising implications, there are important limitations and related future directions. First, while the ability to fulfill one's communal values appears to be an impactful factor for women's pursuit of engineering, this alone cannot explain women's underrepresentation across all stages of the academic/employment lifecycle. While gender differences in communal values play a role, they certainly do not fully explain women's underrepresentation in engineering or other STEM disciplines (Corbett & Hill, 2015). There are numerous other factors, such as a lack of role models and discrimination, that contribute to their underrepresentation that need to be explored alongside women's choices (Corbett & Hill, 2015). It will be important to directly test the extent to which communal values explain women's underrepresentation above and beyond other prominent factors in the literature to ensure that this explains and addresses a unique aspect of the problem.

Second, while we offer experimental evidence for the effectiveness of our communal intervention in Study 1 and Study 2, the generalizability and long-term impact of these interventions are unknown—particularly as the samples for our present study were comparatively small, lacked substantial demographic diversity, and relied on single item measures. As such, it is critical that this study be replicated in other contexts with larger, more diverse samples and with multidimensional measures, as this would allow one to generalize these results to other samples, to other geographical areas, and across different types of programs. Future research should examine the impact of this intervention over time with longitudinal work to determine the longevity of the effect and whether the manipulation impacts actual behavior. Such work may also benefit the literature in this area by exploring how the variables of interest in the present study influence one another—rather than being examined independently. While theoretical, there are competing perspectives on how these variables may interact with one another. Future work may explore this using an inductive method to explore these variables in context with one another. Additionally, because we chose to focus exclusively on women, as that was the population of interest, future work may benefit from seeing how the intervention changes *men's* perceptions regarding women's fit in engineering. Further, with men dominating the field of engineering—particularly among the ranks of leadership (i.e., decision-makers)—a potential extension of this work could be to understand how changing the descriptions of engineering roles, might influence decision-makers' choices related to hiring and selection.

Lastly, while experimental in nature, this study only manipulates how engineering fields are described rather than changing experiences within engineering. While addressing perceptions is important and mirrors the focus of numerous organizations' attempts to change the conversation surrounding engineering, perceptions can only be so impactful. Future work should seek to explore the impact of changing actual experiences within engineering to be more communal in nature to test further the power of goal congruity. Again, while engineering majors and careers *do* have communal qualities (Beddoes et al., 2010; Cech, 2014; de Campos, et al., 2012; Purzer, 2011; Royal Academy of Engineering, 2022), higher education and organizations may benefit from further supporting and prioritizing them. More specifically, future work should attempt to apply the same study design within engineering coursework and careers to understand how changing the work to be more collaborative and to more directly designed to help others.

Conclusion

There is substantial evidence from educators and employers alike that women's underrepresentation in engineering is a critical economic issue for women and society as a whole that requires the attention of researchers and policymakers. To address this issue, one must understand how to attract women to engineering—repairing the pathways feeding the workforce. The present study sought to expand upon prior work to understand the implication of reorienting the way engineering majors and careers are described. This study intervenes on the perceived disconnect between what women value and what they believe engineering fields may provide by highlighting communal aspects of engineering majors and careers. This proved to be a successful intervention with partial support for its impact on interest (Study 1) and behavioral intentions (Study 2) to pursue engineering and robust support for its impact on confidence (Study 1 and Study 2). While addressing women's pursuit of engineering is important, further work must continue to seek theoretically and empirically grounded ways to improve women's experience in engineering across all stages of the academic and employment cycle.

Appendices

Appendix A: Study one major description materials—agentic condition

Could an engineering major be right for you?

If you are interested in fast-paced, challenging work that comes with a hefty salary, then working towards a degree in engineering may be the perfect chance to show off your skills! There are several major paths you can choose in an engineering program. Please review the information on the following engineering disciplines and then answer several questions regarding the discipline.

Aerospace engineering

Aerospace engineering is a field that involves designing, developing, and producing powerful aircraft and spacecraft. It is a very financially rewarding field within engineering.

Agricultural engineering

Agricultural engineering allows a person to use their skills to work on water and waste issues, improving the efficiency of the farming of foods and livestock, water farming, designing farming equipment to genetically designing corn or cows. Broadly, these engineers are recognized for their individual work to conserve, maintain, and improve natural resources and the environment.

Biological engineering

Biological engineers use their skills to solve many biologically based problems. They study the environment and how to conserve soil, water, and other natural resources, or how to design new equipment or methods used in medicine or consumer goods. There is great opportunity for self-direction and financial reward.

Biomedical engineering

Biomedical engineers work independently to analyze and design solutions that are used in medical practices. Biomedical engineers are also responsible for research and development of medical innovations like artificial organs and prosthesis as well as medical equipment like MRIs and microscopic surgical machines which compete with past technology. Biomedical engineers install, maintain and repair or provide technical support for medical machines and equipment to make sure that they are always running at peak efficiency. They also ensure that personnel in charge of the machine know how to use and care for it. A biomedical engineer uses their skill to solve novel life science and healthcare problems using the practical application of science and math. Biomedical engineers make well-respected products in healthcare.

Chemical engineering

Chemical engineers is a well-respected profession that utilizes their knowledge of the physical world to manipulate the interactions of individual atoms and molecules. Their talents and skills are generally employed in the research and development of new materials and are critical to numerous fields including nanotechnology, energy storage, and computing. They are also responsible for many processes that take raw materials and chemically transform them into products like gasoline, medicine, good, and other goods. They often work independently to solve challenging problems, chemical engineers are guaranteed to remain key leaders in securing our prosperity on this planet.

Civil engineering

Civil engineers are recognized for using their skills in road, bridge, buildings and water supply system design and construction. They often work independently, but at times direct construction workers. These professionals successfully ensure that every structure built is environmentally compliant and can withstand earthquakes and hurricanes. This is especially true in places where these natural calamities often strike. Civil engineers work wherever there is a need for expanding new structures or transportation systems and geotechnical engineering.

Construction engineering management

Construction engineers successfully design and execute processes for building and maintaining infrastructure in a competitive industry. Some construction engineers focus on the design aspect, while others focus on the actual build phase of each project. Responsibilities may include directing, planning, and overseeing the construction operations of a project, conducting site layout, organizing the work, designing both temporary and permanent structures, checking and modifying plans and specifications for constructability and efficiency.

Computer engineering

Computer engineers work independently to develop and improve the software programs and hardware that make computers run effectively for organizations. Computer engineers may specialize in either software or hardware. Hardware engineers develop the hardware of computers, including the motherboards, graphics and audio cards and drives that are later programmed by software engineers. These systems are critical in the functioning makes these professionals in very high demand and is financially rewarding. From operating system software, such as Windows and Linux, to individual computer programs, such as Photoshop and Microsoft Office, Software Engineers use their skills to turn piles of hardware into fully functional computers.

Electrical engineering

Electrical engineers specialize in power supply and generation. They work independently to design, develop, test and supervise electrical equipment manufacturing. They have also been trained to handle responsibilities like wiring and lighting installations in buildings, automobiles and aircraft. Moreover, electrical engineers are recognized for taking part in development and research. Many kinds of electronic equipment from portable music players to GPS devices pass through an electronic engineer's skilled hands. They come up with means to use electrical power to operate a certain product or to successfully improve its functions.

Environmental engineering

Environmental engineers use their skills and science and engineering principles to successfully protect and improve the environment. The quality of air, water, and soil is their primary focus. They seek solutions to waterborne disease, recycling challenges, and air pollution. They may also concentrate on global issues, acid rain, climate change, and causes of ozone depletion. They work independently to create advanced air and water treatment technologies, and look for sustainable energy sources. They also are recognized for addressing legal and business connections to environmental problems.

Industrial engineering

Industrial engineering is recognized for successfully optimizing complex processes or systems by reducing wastefulness in production. Industrial engineers design, analyze, and manage complex systems such as manufacturing systems, supply chain networks, and service systems. These systems typically consist of a combination of information, material, and equipment. In such systems industrial engineers work independently to determine how to optimize the system for maximum efficiency, effectiveness, or some other objective of interest to the stakeholders of the system. To achieve these objectives, an industrial engineer draws upon their skills and mastery of mathematics, along with engineering, management, and behavioral sciences to function as a problem-solver, innovator, designer, and system integrator.

Materials engineering

Materials engineering are recognized for the study, discovery, and successful creation of new physical materials for the purposes of research and quality control. These created materials are used in everything from medical industries, automotive industries, aerospace industries, and manufacturing industries for many different purposes and products. There is a heavy focus on independent work, attention to detail, critical thinking, and problem-solving skills.

Mechanical engineering

Mechanical engineering is the study of motion, energy and force. Mechanical engineers apply their skill to control these elements by using a combination of material, human and economic resources to successfully develop mechanical solutions. The most common job functions include designing products, researching new ideas and solutions to improve or expand older ideas and solutions, designing and building the machines, and managing the operations of a large system, such as a manufacturing facility or a power plant. Mechanical engineers must be comfortable making decisions and working independently. They decide the size, material and shape of every part of a machine or mechanical device. Some decisions are critical, such as those concerning the features of an industrial machine or a consumer product.

Nuclear engineering

Nuclear engineering is the most integrated of the engineering disciplines and very well-respected. The many components of nuclear systems (medical imaging, nuclear fission reactors, ultrasensitive contraband detectors, and fusion reactors) must all be understood as well as how they relate to one another. A Nuclear Engineer must understand the fundamentals of nuclear processes. This includes their production, interactions, and radiation measurements. This understanding allows them to independently design nuclear-based systems with a focus on energy and security impacts.

Engineering program outcomes

- An ability to identity, formulate and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to apply engineering design to produce products.
- An ability to communicate effectively.
- An ability to recognize responsibilities in engineering situations and make informed judgments.

- An ability to function effectively in an organization, establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Study one major description materials—communal condition

Could an engineering major be right for you?

If you are interested in collaborative, impactful work that helps improve people's lives and society broadly, then working towards a degree in engineering may be the perfect chance to show off your passion! There are several major paths you can choose in an engineering program. Please review the information on the following engineering disciplines and then answer several questions regarding the discipline.

Aerospace engineering

Aerospace engineering involves working with a team to design, develop, and produce aircraft that help people travel the world and spacecraft that helps society learn about our universe.

Agricultural engineering

Agricultural engineering ranges from helping solve water and waste issues in communities, improving the efficiency of the farming of foods and livestock for growing populations, water farming to help protect our natural resources, designing farming equipment to help local farmers to genetically designing corn or cows. Broadly, these engineers help conserve, maintain, and improve natural resources and the environment leading to numerous benefits for our society.

Biological engineering

A biological engineer works collaboratively to solve many biological based problems that society faces. They study the environment and ways to help conserve soil, water, and other natural resources, or how to design new equipment or methods used in medicine or consumer goods that aim to promote health and wellness. There is great opportunity to make a difference.

Biomedical engineering

Biomedical engineers work collaboratively to analyze and design solutions that will improve patient care. Biomedical engineers are also responsible for research and development of medical innovations like artificial organs and prosthesis as well as medical equipment like MRIs and microscopic surgical machines which have saved numerous lives. Biomedical engineers install, maintain and repair or provide technical support for medical machines and equipment to make sure that they are always running at peak efficiency and will not compromise patients' lives. They also ensure that personnel in charge of the machine know how to use and care for it.

A biomedical engineer helps solve novel life science and healthcare problems using the practical application of science and math. Biomedical engineers make a global impact by saving lives by improving the quality of healthcare.

Chemical engineering

Chemical engineers utilize their knowledge of the physical world to manipulate the interactions of individual atoms and molecules that make up everything in the world. Their talents are generally employed in the research and development of new materials that help numerous people in fields including nanotechnology, energy storage, and computing. They are also responsible for many processes that take raw materials and chemically transform them into products like gasoline, medicine, good, and other goods that touch people's lives daily. They often work alongside other engineers in interdisciplinary teams to solve humanity's greatest problems, chemical engineers are guaranteed to be important in securing our well-being on this planet.

Civil engineering

Civil engineers help make communities safe by specializing in road, bridge, buildings and water supply system design and construction. They collaborate with construction teams and work with other engineers. These professionals ensure that every structure built is environmentally compliant and can withstand earthquakes and hurricanes to help protect the people. This is especially true in places where these natural calamities often strike. Civil engineers work wherever there is a need for expanding new structures or transportation systems and geotechnical engineering and help build safe communities.

Construction engineering management

Construction engineers help create communities by designing and executing processes for building and maintaining infrastructure that allow people to live and travel the world safely.

Some construction engineers focus on the design aspect, while others focus on the actual build phase of each project. Responsibilities may include working with a team to plan and oversee the construction operations of a project, conducting site layout, collaborating with the work crew, designing both temporary and permanent structures, and checking and modifying plans and specifications to ensure people's safety.

Computer engineering
Computer engineers work with teams to help develop and improve the software programs and hardware that make computers run in ways that improve people's ability to work and computer engineers may specialize in either software or hardware. Hardware engineers develop the hardware of computers which help, including the motherboards, graphics and audio cards and drives that are later programmed by software engineers. These systems are critical in the functioning of individual's lives. From operating system software, such as Windows and Linux, to individual computer programs, such as Photoshop and Microsoft Office, Software Engineers turn piles of hardware into fully functional computers that help people explore the world and connect across the globe.

Electrical engineering
Electrical engineers specialize in power supply and generation. They collaborate to design, develop, test and supervise electrical equipment manufacturing. They have also been trained to handle responsibilities like wiring and lighting installations in buildings, automobiles drive, and aircraft that people use around the world. Moreover, electrical engineers help with development and research. Many kinds of electronic equipment for people's fun and function such as portable music players to GPS devices pass through an electronic engineer's hands. They come up with means to use electrical power to operate a certain product or improve its functions ensuring the safety of people.

Environmental engineering
Environmental engineers use science and engineering principles to help protect and improve our environment. The quality of people's most important resources air, water, and soil is their primary focus. They seek solutions to water-borne disease, recycling challenges, and air pollution to maintain people and resource's wellness. They may also concentrate on global issues, acid rain, climate change, and causes of ozone depletion to help keep our planet healthy. They create advanced air and water treatment technologies, and look for sustainable energy sources. They work with others to address legal and business connections to environmental problems.

Industrial engineering
Industrial engineering helps to optimize complex processes or systems by reducing wastefulness in production. Industrial engineers design, analyze, and manage complex human-integrated systems such as manufacturing systems, supply chain networks, and service systems that touch the lives of numerous people. These systems typically consist of a combination of people, information, material, and equipment. In such systems industrial engineers work in teams to determine how to optimize systems for maximum efficiency, effectiveness, safety, or some other objective of interest to the people who use the system. To achieve these objectives, an industrial engineer draws upon knowledge of mathematics, along with engineering, management, and behavioral sciences to function as a problem-solver, innovator, designer, coordinator, and system integrator.

Materials engineering
Materials engineering focuses on the study, discovery, and creation of new physical materials for the purposes of research, quality control, or to increase material's safety for people's use. These created materials are used in everything from medical industries to help people's wellness, automotive and aerospace industries that allow people to safely travel the country or galaxy, and manufacturing industries. There is a heavy focus on collaboration, attention to detail, critical thinking, and problem-solving.

Mechanical engineering
Mechanical engineering is the study of motion, energy and force. Mechanical engineers seek to control these elements by using a combination of material, human and economic resources to develop mechanical solutions that help society. The most common jobs include designing products that help improve people's lives, researching new ideas and solutions or improve or expand older ideas and solutions to help society, designing and building the machines, and managing the operations of a large system, such as a manufacturing facility or a power plant. Mechanical engineers must be comfortable making decisions. They decide the size, material and shape of every part of a machine or mechanical device. Some decisions are critical to human life, such as those concerning the safety features of an industrial machine or a consumer product.

Nuclear engineering
Nuclear engineering is the most integrated of the engineering disciplines. The many components of nuclear systems (medical imaging, nuclear fission reactors, ultrasensitive contraband detectors, and fusion reactors) must all be understood as well as how they relate to one another to ensure this promising technology benefits society. A nuclear engineer must understand the fundamentals of nuclear processes to help solve societal challenges. This includes production, interactions, and radiation measurements. This understanding allows them to design nuclear-based systems with a focus on social, health, and energy and security impacts.

Engineering program outcomes

- An ability to identity, formulate and solve complex engineering problems that help society by applying principles of engineering, science, and mathematics.
- An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as ensuring the care and concern for relevant global, cultural, social, environmental and economic factors.
- An ability to communicate effectively with a range of people.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider how to make a positive impact with engineering solutions in global, economic, environmental, and societal contexts.
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals collectively, plan and delegate tasks, and work towards a better tomorrow.
- An ability to develop and conduct appropriate experimentation, and use engineering judgment to draw conclusions that help people travel the world and space.

Appendix B: Study two job postings materials—agentic condition

Mechanical engineer

Position description

Junior mechanical engineer

Harris Group is seeking an achievement-oriented, self-driven Junior Mechanical Engineer to join our Lafayette, California office.

We are seeking a Junior Mechanical Engineer to provide professional engineering expertise to our industrial projects that seek to be a competitive, powerful presence in the marketplace. The individual in this role will individually work on innovative designs for industrial facilities and will see diverse projects through development, detailed design, and construction support.

The Junior Mechanical Engineer primarily works on projects within life science (biopharmaceutical), laboratories (HVAC, Piping), fuel terminal piping and tanks, and industrial manufacturing. Additional projects may include work on projects within process industries, air and sea ports, energy, commercial development, and other business sectors. The incumbent will demonstrate skill and will have a high level of competence to support the growth of Harris Group.

Position requirements

Responsibilities

- *Define, organize, execute mechanical engineering assignments.*
- *Plan, organize, and oversee work.*
- *Serve as technical resource on complex design issues and advanced engineering theories, concepts, principles, and processes.*
- *Represent Harris Group in the marketplace.*
- *Perform mechanical design on specific projects in various areas.*
- *Prepare, review and approve complex engineering calculations and documentation that support the project design basis.*
- *Select and define scope of mechanical engineering and related problems to guide investigations. Plan and develop solutions to those problems that often require novel concepts and approaches.*
- *Interface at all points in the project process on relevant matters.*
- *Prepare mechanical drawings, through the use of designers or drafters, and develop specifications.*
- *Field information gathering and surveying.*
- *Work on issues regarding construction, installation, commissioning and start-up of equipment and systems.*
- *Research, design and specify equipment, controls and processes.*
- *Engaging in continuous learning and self-directed training programs.*

Requirements

Bachelor's degree in mechanical engineering

- *Advanced knowledge and demonstrated competence in mechanical engineering.*
- *Ability to apply mechanical engineering techniques commonly used in industrial capital projects.*
- *Ability to identify, interpret and apply relevant codes and standards to engineering designs.*
- *Leadership skills with the ability to work directly with existing and prospective clients, vendors, and constructors.*
- *Ability to use a computer and computer software programs related to the discipline, and Microsoft Word, Excel, and Outlook.*
- *Excellent written and verbal communication skills.*
- *Ability to pass Client badging and screening processes*

Harris Group is a Seattle-based engineering firm with locations across the US. Harris Group provides engineering in nearly every discipline and offers varied and diverse *projects across an array of industries that inspire personal development and fosters success.*

Computer/electrical engineering

The Boeing Company is seeking achievement-focused software engineers to join a company where software is critical to work on a variety of exciting opportunities with training systems products.

Software is an integral part of our products and these products are integral parts of the defense of multiple nations. If you come to work with us you will be responsible for demonstrating skill in the full life-cycle software development which means you will have a hand in defining the requirements; designing, implementing and testing the software; and supporting these products through delivery and in the field.

There are a number of possible job assignments, including:

- Pilot training simulators
- Maintenance training simulators
- Instructor operator stations
- Flight environment simulations

As a software engineer you will work often independently in a casual but professional environment where there is long-term potential for career growth into positions of status such as management or technical leadership positions.

Boeing is a manufacturer of commercial airplanes and defense, space and security systems. We are engineers and technicians. Skilled scientists. Bold innovators. Join us, and you can build something that will be recognized globally.

Basic qualifications (required)

- Experience in software development.
- Bachelors degree in computer science, computer engineering, or electrical engineering.
- Professional experience with C++, C#, and/or Java.
- Strong written and verbal communication skills and the ability and desire to work in an independent environment.

Biomedical engineering

Do you want to be a key component in an elite team? We are looking for an independent, competent, and achievement-focused professional to join our Customer Success Team. This role will work to ensure they continue clients receive the "white-glove" level of guidance that they have grown to recognize from our company.

In this role, you will get to apply your medical device expertise and skills every day while working with some of the most innovative medical device companies in the world. You will be a valuable source of power in bringing new medical device technologies to the competitive market.

Our innovative offering is poised to revolutionize the way that Medical Device companies invent, design, manufacture, sell, and support their products. As we grow and expand our current offerings, we can offer a truly unique and exciting opportunity for successful, competitive professionals to directly give form and shape to not only the products, but to the company itself.

Primary responsibilities:

Customer success

- On-boarding to ensure adoption of best practices.
- Create products that allows for more productive workflows within the application.
- Ensure retention and growth of product sales and utilization.
- Provide expertise and guidance on the product development to ensure products are competitive on the market.

Industry consulting service packages

- Provide leadership to maneuver the industry and our products.
- Conduct consulting services.
- Quality system training.
- Manage design controls, risk management, regulatory submissions.

Subject Matter Expert (SME)/thought leadership

- Representation of product roadmap garnered from the existing customer base.
- Coordinate with different resources (development team, other Customer Success team members, etc.) to help define future features.
- Continue to enhance and refine the tools / methodologies we use.
- Maintain your education on a wide variety of medical device areas.
- Become a thought leader in medical device Quality Management Systems and regulations for the good of the product.

Requirements

- Experience in medical device industry.
- Excellent time management and organizational skills.
- Prefer experience with project management.

- Strong written and verbal communication skills both internally & externally.
- Ability to work effectively independently.
- Prior experience working in a fast-paced environment or related.
- Very strong technical skills with Google apps (Gmail, Gcal, Gdocs, Gdrive) and Microsoft Office (word/excel/powerpoint) required.
- Bachelor's Degree or equivalent in Biomedical Engineering.

Study two job postings materials—communal condition

Mechanical engineer

Position description

Junior mechanical engineer

Harris Group is seeking a dynamic, self-driven Mechanical Engineer to join our Lafayette, California office.

We are seeking a Junior Mechanical Engineer to provide professional engineering expertise to our industrial projects that seek to have a positive impact both the community and the environment. The individual in this role will work on innovative designs for clients in industrial facilities and will see diverse, impactful projects through development, detailed design and construction support.

The Junior Mechanical Engineer primarily works on projects within life science (biopharmaceutical), laboratories (HVAC, Piping), fuel terminal piping and tanks, and industrial manufacturing. Additional projects may include work on projects within process industries, air and sea ports, energy, commercial development, and other business sectors. The incumbent will be collaborative with other team members and will have a high level of communication with the clients and project managers to support the positive impact of Harris Group.

Position requirements

Responsibilities

- *Define, organize, execute and coordinate mechanical engineering assignments to help solve client challenges.*
- *Plan, organize, and oversee the work of engineers, designers and administrative staff supporting those assignments.*
- *Serve as technical resource on complex design issues and advanced engineering theories, concepts, principles, and processes to help team members across the organization.*
- *Connect at meetings with clients, contractors, and subcontractors.*
- *Perform mechanical design, working with other members of the mechanical staff, and coordinate with other disciplines on specific projects.*
- *Prepare, review and approve complex engineering calculations and documentation that support the potential impact of project design basis.*
- *Select and define scope of mechanical engineering and related problems to guide investigations. Plan and develop solutions to those problems that often require novel concepts and approaches that helps ensure we help our clients.*
- *Work with key client and project staff in formal, informal and project team meetings.*
- *Work with teams to prepare mechanical drawings, through the use of designers or drafters, and develop specifications.*
- *Attend to clients with assistance during construction, installation, commissioning and start-up of equipment and systems.*
- *Coaching and mentoring of junior staff.*

Requirements

Bachelor's degree in Mechanical Engineering

- *Advanced knowledge and demonstrated competence in mechanical engineering.*
- *Ability to apply mechanical engineering techniques commonly used in industrial capital projects.*
- *Ability to identify, interpret and apply relevant codes and standards to engineering designs.*
- *Leadership skills with the ability to work directly with existing and prospective clients, vendors, and constructors.*
- *Ability to use a computer and computer software programs related to the discipline, and Microsoft Word, Excel, and Outlook.*
- *Excellent written and verbal communication skills.*
- *Ability to pass Client badging and screening processes.*

Harris Group is a Seattle-based engineering firm with locations across the US. Harris Group provides engineering in nearly every discipline and offers varied and diverse projects across an array of industries that inspire one to serve communities and humanity.

Computer/electrical engineering

The Boeing Company is seeking Software Engineers to join a team where Software really matters to work on a variety of exciting opportunities with training systems products.

Software is an integral part of our products and these products are integral parts of the defense of multiple nations which are homes to billions of people. If you come to work with us you collaboratively work on the full life-cycle software development which means you will have a hand in defining the requirements; designing, implementing and testing the software; and supporting these products through delivery and in the field which serves our communities.

There are a number of possible job assignments which help people be enhanced through technology, including:

- Pilot training simulators.
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- Flight environment simulations.

As a software engineer you will work with a team in a casual but professional environment where there is long-term potential to make a difference.

Boeing is a manufacturer of commercial airplanes and defense, space and security systems. We are engineers and technicians. Caring scientists and thinkers. Bold innovators and dreamers. Join us, and you can build something better for our customers and for the world.

Basic qualifications (required):

- Experience in software development.
- Bachelors degree in computer science, computer engineering, or electrical engineering.
- Professional experience with C++, C#, and/or Java.
- Strong written and verbal communication skills and the ability and desire to work in a team environment.

Biomedical engineering

Do you want to be a key component in a service-focused team? We are looking for a motivated, passionate, and caring professional to join our Customer Success Team. This role will work alongside our customers to ensure they continue to receive the "white-glove" level of care that they have grown to love.

In this role, you will get to apply your medical device expertise every day while working with some medical devices that touch the lives of millions of people. You will be a valuable resource in helping to bring new medical device technologies to market to help improve the wellness and health of thousands of people.

Our innovative offering is poised to revolutionize the way that Medical Device companies invent, design, manufacture, sell, and support their products with a focus on the consumer. As we grow and expand our current offerings, we can offer a truly unique and exciting opportunity for service-minded professionals aiming to serve humanity by giving form and shape to not only the products, but to the culture and the company itself.

Primary responsibilities

Customer success

- On-boarding new customers to ensure adoption of best practices.
- Help our clients be more productive with workflows within the application.
- Touch points with existing customers to ensure retention and growth.
- Provide customer support by bridging customer needs with our Development team.

Industry consulting service packages

- Weekly meetings with customers to partner with them as they maneuver the industry and our platform.
- Conduct consulting services for our clients.
- Quality system training with customers.
- Provide guidance to teams on design controls, risk management, regulatory submissions.

Subject matter expert (SME)/thought leadership

- Representation of product roadmap garnered from the existing customer base.
- Collaborate with different resources (development team, other Customer Success team members, etc.) to help define future features.
- Work with your team to enhance and refine the tools/methodologies we use.
- Maintain your education to enable you to further help the team.
- Become a thought leader in medical device Quality Management Systems and regulations for the good of people.

Requirements

- Experience in medical device industry.
- Excellent time management and organizational skills.
- Prefer experience with project management.
- Strong written and verbal communication skills as well as the ability to easily connect with all types of people both internally and externally.
- Ability to work effectively on teams and independently.
- Prior experience working in a fast-paced environment or related (with 10–75 employees preferred).
- Very strong technical skills with Google apps (Gmail, Gcal, Gdocs, Gdrive) and Microsoft Office (word/excel/powerpoint) required.
- Bachelor's degree or equivalent in biomedical engineering.

Appendix C: Study one random assignment confirmation

See Table 5.

Table 5 *T*-test results study one random assignment confirmation

	Agentic condition (*N* = 153)		Communal condition (*N* = 115)		95% confidence interval of the difference		*t*-value	d*f*	*p*-value
	M	SD	*M*	SD	Lower	Upper			
Communal values	5.341	1.092	5.210	1.052	−0.130	0.393	0.991	266	0.323
Agentic values	4.944	1.033	4.709	0.952	−0.008	0.478	1.905	266	0.058
Person-oriented interests	4.864	0.928	4.753	0.805	−0.102	0.324	1.025	266	0.306
Thing-oriented interests	2.295	1.549	2.626	1.665	−0.719	0.058	−1.675	266	0.095
Science count	5.671	2.266	5.938	2.373	−0.833	0.299	−0.930	263	0.353
Math count	5.336	1.190	5.192	1.245	−0.154	0.441	0.950	262	0.343

M mean, *SD* standard deviation, *N* the number of participants in the condition, d*f* degrees of freedom, *Science and Math Class Count* total number of self-reported classes previously taken

Appendix D: Study two random assignment confirmation

See Table 6.

Table 6 T-test results study two random assignment confirmation

	Agentic condition (*N* = 50)		Communal condition (*N* = 26)		95% confidence interval of the difference		*t*-value	d*f*	*p*-value
	M	SD	*M*	SD	Lower	Upper			
Communal values	5.123	0.980	5.268	0.742	−0.582	0.291	−0.664	74	0.509
Agentic values	5.090	0.858	5.126	0.797	−0.439	0.369	−0.174	74	0.862
Person-oriented interests	4.735	0.668	4.766	1.037	−0.423	0.360	−0.161	74	0.873
Thing-oriented interests	5.056	1.448	5.431	1.244	−1.041	0.291	−1.121	74	0.266
Science count	11.563	6.675	9.577	6.001	−1.145	5.116	1.264	72	0.210
Math count	8.771	2.882	8.654	2.365	−1.200	1.434	0.177	72	0.860

M mean, *SD* standard deviation, *N* the number of participants in the condition. d*f* degrees of freedom, *Science and Math Class Count* total number of self-reported classes previously taken

Appendix E: Study two major comparisons

See Table 7.

Table 7 Mean, standard deviation, and analysis of variance results for study two comparison across majors

Variable	Mechanical engineering (*N* = 37)		Computer/electrical engineering (*N* = 30)		Biomedical engineering (*N* = 9)		F (2, 73)	η^2
	M	SD	*M*	SD	*M*	SD		
Communal values	5.128	0.844	5.064	0.971	5.717	0.796	1.945	0.051
Agentic values	5.079	0.666	5.093	0.971	5.231	1.032	0.121	0.003
Person-orientated interests	4.721	0.930	4.731	0.655	4.891	0.792	0.164	0.004
Thing-orientated interests	5.411	1.217	5.040	1.462	4.733	1.738	1.139	0.030
Science classes	10.189	5.825	11.214	7.729	12.556	4.746	0.542	0.015
Math classes	8.514	2.129	8.750	3.284	9.556	2.920	0.535	0.015

M mean, *SD* standard deviation, *N* the number of participants in the majors, *Science and Math Class* total number of self-reported classes previously taken, η^2 sum of squares between groups divided by total sum of squares

Author contributions
CBB designed the study, ran the experiments, analyzed data, and wrote the full draft. NS assisted in additional data collection, supported data analysis, and assisted in the finalization of the methods and results sections, as well as made meaningful edits and contributions to the literature review. LT served as an advisor on experimental design, analytical methods, and assisted in the manuscript draft.

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Availability of data and materials
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Research received approval from Purdue University IRB board and informed consent was provided to participants.

Competing interests
The authors have no conflict of interest to declare.

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