Predicting Interest in Engineering Majors: The Role of Critical Agency and Career Goals

Heather Perkins, Purdue University, West Lafayette

Heather entered the Applied Social and Community Psychology program in the fall of 2014, after completing her Bachelor of Science in Psychology from the University of Cincinnati. In Spring 2021, she defended her dissertation and began a post-doctoral research position at Purdue University. She has participated in various research projects examining the interaction between stereotypes and science interest and confidence, their influence upon womens' performance in school and the workplace, and their presence in the media and consequences for viewers. Her primary research interest is science identity, STEM education, and participation in online communities.

Ms. Brianna Shani Benedict, Purdue University, West Lafayette

Brianna Benedict is a Ph.D. Candidate in the School of Engineering Education at Purdue University. She earned her Bachelor's and Master's of Science in Industrial and Systems Engineering from North Carolina Agricultural and Technical State University. Her research focuses on understanding how hybrid spaces influence engineering students' identity development, belonging, and agency in interdisciplinary engineering education. She co-leads the CDEI virtual workshop team focused on building a community of educators passionate about expanding their knowledge concerning diversity, equity, and inclusion in engineering education. Her most recent accomplishment was being recognized as one of seven AAC&U 2019 K. Patricia Cross Scholars based on her commitment to teaching and learning and civic engagement.

Mr. Herman Ronald Clements III, Purdue University, West Lafayette

H. Ronald Clements is a postbaccalaureate research assistant in the STRIDE lab at Purdue University and an incumbent graduate student for the 2020-2021 year. He works on the project titled "CAREER: Actualizing Latent Diversity: Building Innovation through Engineering Students' Identity Development," assisting with narrative analysis and interviews, helping to understand the identity trajectories of latently diverse students. He received his Bachelor of Science in Psychology at Harding University with honors, where he participated in the Beyond Professional Identity (BPI) research group, studying frustration in first- and second-year undergraduate engineering students. He also served as the BPI lab manager during 2017-2018. He is also a Society of Personality and Social Psychology Undergraduate Research Fellow, through which he studied in the Stereotypes, Identity, and Belonging Lab (SIBL) at the University of Washington during the summer of 2018.

Dr. Allison Godwin, Purdue University, West Lafayette

Allison Godwin, Ph.D. is an Associate Professor of Engineering Education and Chemical Engineering at Purdue University. Her research focuses what factors influence diverse students to choose engineering and stay in engineering through their careers and how different experiences within the practice and culture of engineering foster or hinder belongingness and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science Education. Her research earned her a National Science Foundation CAREER Award focused on characterizing latent diversity, which includes diverse attitudes, mindsets, and approaches to learning, to understand engineering students' identity development. She has won several awards for her research including the 2016 American Society of Engineering Education Educational Research and Methods Division Best Paper Award and the 2018 Benjamin J. Dasher Best Paper Award for the IEEE Frontiers in Education Conference. She has also been recognized for the synergy of research and teaching as an invited participant of the 2016 National Academy of Engineering Frontiers of Engineering Education Symposium and the Purdue University 2018 recipient of School of Engineering Education Award for Excellence in Undergraduate Teaching and the 2018 College of Engineering Exceptional Early Career Teaching Award.

©American Society for Engineering Education, 2021

Predicting Interest in Engineering Majors: The Role of Critical Agency and Career Goals

Abstract

This research paper investigates how students' latent diversity influences students' disciplinary choices in engineering. Students bring interests, beliefs, and attitudes (i.e., latent diversity) to engineering education, shaping their environment and their classmates' experience. In turn, the cultural norms, standards, and structures within engineering culture convey implicit and explicit messages about particular ways of being, thinking, knowing that are valued. This dialectic process does not occur equitably; as students persist, the pressure to conform leads them to either norm, leave engineering, or labor to pioneer new spaces. And, this process is also entrenched in the history and process of engineering education that is raced, classed, and gendered.

To add an additional layer of complexity, engineering is not a monolith with varying rates of participation by race and gender across engineering disciplines. Each engineering discipline has a unique culture and better understanding these differences can provide useful ways to change engineering disciplines to be more inclusive. It is in this complex landscape that this research begins to investigate how latent diversity may be linked to students' disciplinary pathways. First, we can identify opportunities to nurture ways of being, thinking, and knowing that would otherwise be pushed out (forms of latent diversity that are difficult to see but foster equity and inclusion nonetheless). Second, it can allow us to better tailor courses to fit students' interests and needs, thus increasing student belonging, innovation, and adoption of new ideas.

To this end, we explore two research questions: (1) Do students' engineering beliefs, career priorities, and field interests predict interest across several disciplines of engineering?; and (2) Are the relationships between students' beliefs and discipline interests moderated by patterns of representation and parity?

Data for this study were collected from 32 U.S. ABET-accredited institutions, with a total sample size of 3,711 undergraduate engineering students. We focused on students' career priorities ("How important are the following factors for your future career satisfaction?"), field interests ("Rate the likelihood of you choosing a career in each of the following fields?"), and engineering agency beliefs ("Engineering can improve our society" and "Engineering knowledge is for the advancement of human welfare"). Students were also asked to rate their current interest in seventeen disciplines (e.g., "biomedical engineering" and "industrial engineering") and two additional categories ("other STEM-related" and "other non-STEM-related").

Our factor analysis identified nine constructs among the independent variables and clustered the disciplines into six categories. Regression analysis found some consistent relationships between variables, with the clearest connections between altruistic field and biochem-related engineering discipline interests ($b = .33$, $p < .001$) and commercial field and technology discipline interests ($b = .20$, $p < .001$). When focusing on technology and biochem disciplines, fields with opposing levels of gender parity, cis men reported a small positive relationship between altruistic field interests and technology discipline interest ($b = .06$, $p = .005$) while students with marginalized genders reported the opposite ($b = -.10$, $p = .002$).

Overall, these results suggest that there are some predictive patterns in students' beliefs, priorities, and field interests. Most effect sizes were small to medium, with R^2 values ranging from .09 to .30. Cis men and students with marginalized genders had generally parallel relationships, suggesting that beliefs, priorities, and field interests predict discipline interests similarly across gender groups, challenging some ideas about goal congruity and motivation. Additional results and potential implications will also be discussed in the paper.

Introduction

Early career engineering students bring interests, beliefs, and attitudes (i.e., latent diversity) to engineering education, which uniquely positions them to shape their environment. In turn, the cultural norms, standards, and structures within engineering culture convey implicit and explicit messages about particular ways of being, thinking, and knowing that are valued. This dialectic process does not occur equitably. As students persist, the pressure to conform leads them to either norm, leave engineering, or labor to pioneer new spaces. This process is also entrenched in the history, culture, and practices of engineering education that are raced, classed, and gendered. A significant body of work has emphasized how structural and cultural norms replicate Whiteness and masculinity in engineering, and this work emphasizes the need to dismantle structures that perpetuate inequity within engineering education [1-8]. Other work has examined how these norms are linked to particular ways of being, thinking, and knowing that continuously limit who can do engineering [9], who belongs in engineering [10], and what counts as engineering [11-12]. This enculturation often results in the underutilization of students' potential for innovation and creates exclusionary spaces for many engineering students.

Latent Diversity in Engineering

Prior research has indicated that students who do not match the privileged ways of being, thinking, and knowing in STEM often struggle to belong in these spaces. For example, Boaler and Greeno [13] found that students who saw themselves as creative thinkers and identified with this characteristic tended to have lower interest in traditionally taught math classes. They perceived these traditionally taught classes to inhibit their thinking and agency. These students had higher levels of satisfaction in reformed mathematics courses with students working together to solve mathematics problems. In contrast, students who identified as good rule-followers had the opposite experience in a reform-oriented classroom. The case study of "Inez," a student who wished she "belonged more in this whole engineering thing," illustrates the disenfranchising experiences of particular students with alternative ways of thinking and being [10]. She felt alienated by the traditional pedagogies taught in her engineering and science classrooms like problem-solving algorithms and balancing chemical equations but did well and generally enjoyed using hands-on skills and reasoning through problems in the classroom (practices that many would argue are more representative of successful engineering skills). While this student succeeded in the end, her pathway through engineering could have been easier, and her story may be similar to other students who do not make it through the gauntlet of engineering, and instead find fulfillment outside of engineering.

Additionally, an extensive body of research shows that students' personal epistemologies–how they think about the nature of knowledge and knowing – affect how they approach learning in science, mathematics, and engineering [14-19]. A disconnect between how students perceive knowledge and engineering pedagogy fosters a lack of belonging in engineering. For example, in one study, "Michael," a student who valued sense-making over memorization, felt different and isolated from his peers and community [11]. His approach to solving engineering problems resulted in a deeper understanding, more creative problem-solving strategies, and more innovative solutions; skills that engineering educators desire in all students. However, this approach to learning made him an outsider in his engineering classroom. What about other students with latent diversity of mindsets, like "Michael" or "Inez?" Students can feel out of place–they can experience tension between their identities and their engineering programs–for epistemological reasons and social or cultural reasons. Many of these students leave engineering; for those who stay, research suggests "what distinguished the survivors from those who left was the development of particular attitudes or coping strategies" [11, p. 30]. Our work examines how these norms inform how students navigate engineering, particularly those who enter engineering with diverse attitudes, beliefs, and mindsets, which are often invisible and ignored in the classroom.

In this study, three aspects of latent diversity are examined in relation to students' interest in various engineering disciplines. The first, critical engineering agency, is a concept adapted from a wider array of critical agency frameworks to examine how students' agency beliefs combine with their engineering engagement to affect their perception of engineering as a tool for change [20]. The second, students' career priorities, is an examination of students' expectations regarding their future careers and captures how important various factors (e.g., "making money" or "helping others") are to their anticipated career satisfaction. The third, students' field interests, captures their interest in a range of potential career fields (e.g., "academia," "entrepreneurship," or "engineering industry"). Together, these three factors help us understand students' visions of their possible future selves and their perceptions regarding the usefulness of engineering skills and careers. With this data, we can paint a picture of the ideals and long-term vision of engineering students, and when analyzed in tandem with students' interest in a range of engineering disciplines, we can examine how the culture of engineering provides affordances and shapes students in turn.

Disciplinary Differences in Engineering Education

Engineering disciplines are not monolithic, with varying cultures, norms, and populations. Few studies examine differences across disciplines [21-25], although this body of research is growing. For instance, a number several studies have been published on differences in student matriculation pathways [26, 27], attitudes [28], and experiences for students within individual disciplines [10,29]. Fewer studies compare across disciplines, such as Potvin et al. [22] who compared disciplinary differences of eight engineering majors (i.e., bioengineering/biomedical, chemical, civil, electrical/computer, environmental, industrial/systems, materials, and mechanical engineering). Studies like these highlight the latent diversity in engineering and how it is often characterized (and thus potentially nurtured or suppressed) by discipline culture. For instance, Potvin et al. [22] found that discipline relates to career interests (e.g., students interested in electrical/computer, materials, and mechanical engineering were significantly more likely to seek a career that involved inventing/designing things) and to motivation and interests (e.g., interest in electrical/computer engineering predicted interest in developing new knowledge and skills, while interest in environmental engineering predicted interest in solving societal problems in their careers).

Disciplinary differences have also been used to understand the variation in representation by gender and race across engineering. One such study examined attitudes and other characteristics of women who were interested in pursuing fields with varying levels of female representation [30]. When comparing women interested in electrical, mechanical, and aerospace engineering (all with below-average representation of women) to women interested in civil, computer, and materials engineering or environmental, biomedical, and chemical engineering (with average or high levels of gender parity, respectively) this study showed differences in attitudes aligned with masculine and feminine stereotypes. Another study examined disciplinary cultures in mechanical engineering and materials science uncovered gendered practices, emphasizing the need to not only support women in these disciplines but also to put forth an effort to change disciplinary cultures [31]. Similar patterns also appeared when focusing on race and ethnicity [32], with disciplines like civil/environmental and biological and agricultural engineering having nearly three times as many Black and African American tenure-track faculty than fields like petroleum engineering and computer science (4.2-3.6% compared to 1.6-1.4%; 33). Another study examining both race and gender found significant differences in student attitudes within a chemical engineering context [34]. These attitudinal differences highlight how educators must recognize the underlying differences among students minoritized in engineering and how diverse strategies are necessary to support and build upon students' incoming attitudes, mindsets, and beliefs that are integral to success in engineering. Together, these studies indicate that significant variation in the perceived and real difference by engineering disciplines may affect who engages with particular engineering degree pathways.

The Current Study

The current study explores aspects of latent diversity in a population of undergraduate engineering students with two broad goals. First, by identifying patterns in latent diversity we can develop better techniques for encouraging engagement and persistence in students who are minoritized in engineering. Developing a concrete understanding of what motivates students' interest in specific disciplines allows us to identify why other disciplines fail to do so, and what they may reveal about cultural messages, stereotypes, and students' perceptions of engineering disciplines. Similarly, in conjunction with studies of students throughout their education careers, this information can help us identify norming processes that lead students to conclude they do not belong in engineering and ultimately lead to their decision to leave the field. Second, this information also allows us to observe the characteristics that students bring to the field of engineering. Students, as new engineers, are changed by their engineering experiences and engineering culture, but engineering itself is created by engineers. Understanding students' goals and visions of the future is thus the first step in understanding how engineering can evolve, and thus how to continue broadening participation and interest. To these ends, we pursue two research questions:

1. Do students' critical engineering agency beliefs, career priorities, and field interests predict interest across several engineering disciplines?

2. Are the relationships between students' beliefs and discipline interests moderated by patterns of representation and parity?

To address these research questions, we conducted several regressions to examine the relationships between targeted variables and discipline interests and then examined the role of gender in these relationships in two majors with opposite levels of gender parity.

Methods

Participants

Data were collected from 32 U.S. ABET-accredited institutions, with a total sample size of 3,711 cleaned responses from undergraduate engineering students enrolled in comparable introductory engineering courses. All classes were first-year engineering courses and thus represented students' first exposure to the content. Only participants who responded to all of the measures listed below (excluding demographics) were included in this analysis (n = 2306). Additionally, multivariate outliers were screened for using Mahalanobis' distance, dropping an additional 231 participants, bringing the final sample to 2075 undergraduate engineering students. Participants were asked to report their demographics using multi-select options (i.e., "choose all that apply") and were provided with the option to write-in a response. The resulting sample was largely White (64%) and male (70.5%), with Asian (9.6%) and Latino/a/x (6.8%) making up the next largest racial/ethnic groups (see Table 1 for information on the full and analysis samples). This sample is consistent with representation in the field overall, as approximately 80% of bachelor's engineering degrees are awarded to men and 60% are awarded to White students [35].

Measures

Participants were asked to rate their career priorities (e.g., "How important are the following factors for your future career satisfaction?"), field interests (e.g., "Rate the likelihood of you choosing a career in each of the following fields?"), critical engineering agency beliefs (e.g., "Engineering can improve our society"), and interest in nineteen disciplines (e.g., "biomedical engineering" or "non-STEM"). We conducted an exploratory factor analysis to understand the underlying factor structure of these items (more information provided below), and ultimately 15 factors emerged. Of these newly identified factors, nine were used as predictors and six as outcomes in the regression analyses detailed below. The nine predictor variables were separated into three categories: engineering agency beliefs (includes critical agency and empowerment), career priorities (importance of financial income, leadership, and innovation opportunities in student's anticipated careers), and field interests (interest in careers across four fields). The six outcomes were derived from students' expressed interest in 19 majors, all but two of which (other STEM-related and other non-STEM-related) were located in the umbrella of engineering. The full list of items and their factor loadings can be found in Appendix 1.

Analysis

After screening the selected items for univariate normality (all skewness and kurtosis ≤ 2), exploratory factor analysis (EFA) was conducted to identify the underlying constructs. A scree plot was created, and parallel analysis was conducted to determine the best number of factors; the final analyses used oblique rotations to allow the factors to correlate with one another (all in the R package nFactors; 36). Once the latent variables were identified, composites were created of the original items and tested for multivariate normality using Mahalnobis' distance [37]. Univariate analysis of the resulting composite variables suggested that, although the skewness and kurtosis values were acceptable, the financial career priorities variable had a non-normal distribution not suited for regression analysis (see Figure 1 for the QQ-plot) and so this variable was dropped. Six regression models were run to examine the relationships between the remaining predictors and each of the outcome variables. All variables were standardized, and partial correlations were computed as a measure of effect size [38,39]. Two additional moderated models were also tested with technology and computing and biochem interests as outcome variables, and gender entered as a moderator for each of the predictors [40]. Participants were coded as either "cis men" or "marginalized genders." Marginalized genders includes transgender women, cisgender women, transgender men, non-binary individuals, and gender identities that have been systematically oppressed. We acknowledge that the groupings of multiple categories oversimplify some of the findings, but this approach allows us to conduct statistical analysis with enough power to detect differences while providing insight while providing insight into how gender, including those historically removed for low numbers, may play a role within our study. These models were tested in phases; since not all participants provided gender information, the dataset was limited to those who had, and the initial unmoderated regression was re-run to confirm that there were no major changes. Next, gender was added into a new model, and an ANOVA was used to compare the results to the previous analysis and confirm whether the increase in variability explained was significant.

Results

Factor Analyses

Discipline Interests. Factor analyses were conducted on three sets of variables. The first set, discipline interest, consisted of 19 variables in which students rated their interest in 17 engineering and 2 non-engineering disciplines (see Table 2 for the full list of items and means). Scree plot and parallel analysis indicated that four or five factors may best fit the data. A four-factor model using the oblique promax rotation was attempted, but the non-engineering interests were failing to load on any factor. The five-factor solution, also using the promax rotation, accommodated all of the items but also caused the MSE and nuclear discipline interests to cross-load across the second and third factors (populated by the aerospace, physics, and mechanical interests and the agricultural, biological, chemical, and environment interests, respectively). The four-factor model was used to create the main discipline interests (see Table 2 for factor loadings): technology/computing (computer engineering, electrical, computer science, and information technology), biochem (agricultural, biological, chemical, and environmental engineering), systems & structures (civil, construction, and industrial engineering), and physics

& mechanics (physics and aerospace and mechanical engineering). Information from both models was used to create the fifth factor for smaller and less-known disciplines (materials science and engineering, multidisciplinary engineering, nuclear engineering, and other STEM fields).

Career Priorities. The second set of items consisted of 8 variables derived from students' ratings regarding the importance of 8 factors to their future careers (see Table 3 for full list of items and means). Scree plot and parallel analysis recommended a three-factor solution. Two iterations of this model were tested, the first using an oblique promax rotation, the second using an orthogonal varimax rotation. The oblique solution had some issues, with two items (helping and financial security interests) failing to load on any factors, and one factor presenting with only a single item. The orthogonal solution provided a cleaner structure, with all items loading cleanly and the third factor with two items. Ultimately the three-factor orthogonal solution was used to create the variables for analyses (see Table 3 for factor loadings): financial priorities (having job security and making money), leadership priorities (becoming well known, supervising others, and working with people), and innovation priorities (inventing/designing new things, developing new knowledge and skills, and helping others).

Field Interests. The last set of items consisted of students' ratings regarding their interests in 8 career fields (see Table 4 for full list of items and means). Scree plot and parallel analysis recommended a two-factor solution. Two iterations of this model were attempted, using oblique and orthogonal rotation, and presented similar results with six of the eight items loading on one factor, one item loading on the second factor, and a final item (industry field interest) loading on neither. A three-factor solution produced better results, although the oblique rotation resulted in one item (non-profit field interest) not loading on any factor, while an orthogonal varimax rotation produced some cross-loading (see Table 4 for factor loadings). Four-factor models were also run but resulted in multiple single-item factors and no clear structure. Ultimately the three-factor, orthogonal rotation was used as the basis for the new variables, with the inclusion of an additional factor for theoretical fit: government field interests (government and law), education field interests (academia and K12), commercial field interests (industry and entrepreneurship), and altruistic field interests (non-profit and medical).

Regression Analyses

Results for all unmoderated regression analyses can be found in Table 5. The strongest findings emerged around the role of field interests, with fewer and weaker findings regarding engineering agency beliefs and career priorities. Biochem interest had the fewest significant relationships but also the strongest relationship with any of the predictors (altruistic field interests, b = .48, $p <$ .001). Commercial field interests were linked to interest in multiple majors: it was most related to technology and computing interest (b = .28, $p < .001$), but also predictive of systems and structures interest (b = .23, $p < .001$), physics and mechanics interest (b = .23, $p < .001$), and biochem interest (b = .05, $p = .036$). Overall, technology and computing interest and systems and structures interest related to the predictors similarly, with education and government field interests acting as weak predictors (b's between .12 and .16, all p's < .001) and commercial field interests playing a stronger role. Interest in smaller and less known majors also fit a similar profile, although altruistic field interests were also significant for this discipline (b = .10, $p <$

.001). Altruistic field interests had a similar relationship with physics and mechanics interest but in the opposite direction (b = -.11, $p < .001$).

Interest in non-engineering majors was also related to education, government, and altruistic field interests (all b's between .11 and .19, all *p*'s < .001), but not to commercial field interest (p = .059). Outside of the field interests, career priorities were significantly related to physics and mechanics interest (leadership: b = -.13, $p < .001$; innovation: b = .13, $p <.001$). Leadership career priorities were also negatively related to interest in smaller and less known majors (b = -.10, $p < .001$) and interest in technology and computing majors (b = -.07, $p = .006$). Students' empowerment beliefs were related to interest in five of the disciplines, with most of the effect sizes ranging from small to trivial (b's between .07 and .12, *r*'s between .04 and .08, all *p*'s < .05). However, the relationship between engineering empowerment beliefs and non-engineering interest is notably negative (b = -.08, $p = .036$), suggesting that as engineering empowerment beliefs increase interest in majors outside of engineering decreases. The relationship between students' critical agency beliefs and non-engineering interests was also significant, but this relationship was positive (b = .07, $p = .037$). A similarly powered relationship existed between critical agency beliefs and systems and structures interest, but it was in the opposite direction (b = -.09, $p = .010$).

Moderation Analyses

In regards to students' technology and computing interest, comparison of the previous analysis and the revised unmoderated analysis suggested no significant shifts, although some of the previously identified relationships became less significant and/or meaningful (see Table 6 for all results). Entering gender into the model did not impact most of the predictors, but it did significantly moderate the effect of altruistic field interests on technology and computing interest. The predictor, which was previously non-significant ($p = .385$), evidenced a trivial, marginally-significant relationship with technology and computing interest for cis men (b = .06, $p = .049$) and a larger relationship with technology and computing interest for students with marginalized genders (b = -.12, $p = .019$; see Figure 2 for a visualization). This result suggests that altruistic field interests are moderated by gender in their impact on technology and computing interests. For cis men, the effect of altruistic field interests is slightly positive, while it is more meaningfully negative for students with marginalized genders.

In regards to biochem interest, the shift to the smaller dataset did produce some changes in the unmoderated model (see Table 7 for all results). Students' engineering empowerment beliefs became non-significant ($p = .064$) as did commercial field interests (p = .125), while education field interests became marginally significant (b = .04, $p = .049$). Entering gender into the model produced a few changes. Gender significantly predicted biochem interest (b = .16, $p < .001$), suggesting that students with marginalized genders are significantly more interested in biochem majors than cis men. Commercial field interests became marginally significant (b = .05, p = .054), while gender moderated the relationship between education field interests and biochem interest. Similar to technology and computing, men reported a significant but small positive relationship (b = .07, $p = .005$), while students with marginalized genders reported a larger and negative relationship (b = -.10, $p = .039$, see Figure 3 for a visualization). Like altruistic field interests and technology and computing interest, increased education field interests are linked to stronger biochem interest for cis men, but weaker interest for women. Analysis of the visualization demonstrates an important effect of this moderation; for students with lower education field interest, the effect of gender reported above can be observed (i.e., students with marginalized genders report higher biochem interest). However, as cis men's education field interests increase, this gap closes, and cis men report slightly higher interest in biochem majors than students with marginalized genders.

Discussion

The purpose of this paper is to understand how students' critical engineering agency beliefs, career priorities, and interest influences their disciplinary interest. While our analyses resulted in some predictive patterns in students' critical engineering agency beliefs, career priorities, and field interests on students' disciplinary interests, we also identified how gender plays a role in whether these factors increase interest in specific disciplines. Below, we discuss each construct separately and its connections to prior literature. Then, we discuss the potential implications for students and instructors interested in learning how to support students' awareness and interest in the broad array of engineering disciplines.

Engineering Agency Beliefs

Overall, engineering agency beliefs were not strongly related to discipline interest. Empowerment beliefs were weakly related to interest in most disciplines, while critical agency had weak links to interest in disciplines related to systems and structures (i.e., civil, construction, and industrial engineering) and non-engineering majors. Gender did not significantly moderate the relationship between engineering beliefs and interest in any discipline, suggesting that it functions similarly for all students. These findings are somewhat unexpected, given previous research establishing the importance of communal goals and students' interest in engineering [41,42]. However, a closer examination of univariate normality indicates that while both factors have acceptable amounts of skewness and kurtosis, students' ratings of critical agency and empowerment are quite high, with possible indications of a ceiling effect (Figure 4). Taken alongside the above results, this finding suggests that students' agency and empowerment beliefs are high regardless of discipline interest, and so they have little to no predictive power. Thus, it may be that students generally enter engineering with high agency and empowerment beliefs, and these beliefs interact with students' goals as they progress in their studies to impact their persistence and retention.

Career Priorities

Similar to engineering agency beliefs, career priorities were not linked strongly to interest in any particular discipline. The financial career priority variable was dropped early in the study due to non-normality in the variable; like the engineering agency beliefs described above, there are indications of a possible ceiling effect (Figure 5). This finding is consistent with previous work that suggests the promise of financial stability and high earning potential is one of the primary forces driving student interest in engineering. However, it is important to highlight how students' motivation to pursue and persist in engineering due to their financial potential manifest differently as a result of the perceived utility of an engineering degree [43]. For example, some students may be interested in the potential financial impact of a career in engineering to ensure personal financial stability or to provide for their family, both of which may be tied to low interest and connection to the field. Leadership and innovation interests were weakly linked to interest in physics & mechanics majors (this includes aerospace, physics, and mechanical engineering), but in opposite directions, with leadership priorities negatively predicting interest, and innovation priorities positively predicting interest. This result may be due to physics-heavy fields being considered more cerebral, privileging and valuing a "mind/body split" prioritizing logic and reason [44,45]. There are two potential takeaways from this finding. The first is that career priorities are unrelated to discipline interest for new students who are still determining their priorities and figuring out how they can be fulfilled in engineering careers. In this case, similar studies with more advanced students might see stronger effects. The second is that engineering students are extrinsically motivated, and thus their interests do not drive their discipline interests (a finding supported by previous research, 46). In this case, future work that analyzes students' reports of their motivations more qualitatively might determine where students' discipline interests derive from, instead of focusing on quantitative measurements of what their discipline interests are.

Field Interests

Among the predictors examined in this study, field interests were the most consistently linked to discipline interest. This finding is consistent with previous work in which professional interests in engineering practice are helpful predictors of engineering identity in undergraduate populations rather than academic factors alone [47].

Commercial Field Interests. Commercial interests (e.g., industry and entrepreneurship) were positively linked to interest in all disciplines except biochem and non-engineering majors, and many of these relationships were small to medium in effect size. This finding suggests that commercial interests are not only a predictor of discipline interest but one of the forces (alongside other factors like future time perspective [48]) by which students organize themselves within engineering, thus deciding "what kind" of engineer they are. Education and government interests were weakly linked to all fields except biochem, with education interests most strongly linked to non-engineering majors and government interests most strongly linked to smaller and less-known fields. These results may indicate an abiding interest in these factors that are not strongly linked to any particular discipline. However, future work may see these relationships become more meaningful over time.

Altruistic Field Interests. In contrast, altruistic field interests (nonprofit and medical fields) had one strong link to biochem interest (positive, medium to large) and smaller links to non-engineering interest, smaller and less known fields, and negative interest in physics & mechanics. This finding, in some ways, mirrors the results above from commercial field interests, suggesting the importance of altruistic field interests in driving students' discipline interests, but this importance was much less uniformly felt, and in some cases negative, suggesting a more polarizing effect. Overall these findings are consistent with previous work examining the influence of communal goals on engineering interest, but it is noteworthy that they emerged in this measure of field interests rather than in career priorities or engineering agency. This result may also be an artifact of the measures used; the innovation career priority variable includes an item for “helping others,” while the leadership priority variable includes one for “working with people,” and so it may be that the effect was split across the two variables and thus did not emerge. It may also be an artifact of students’ lack of clarity regarding their potential futures in engineering. Discussing the concrete factors of a potential career, like the tasks being performed or the financial incentives, may be more difficult to articulate or envision than a simple preference for a larger field.

Gender & Field Interests. The relationships between field interests and discipline interests are also where the moderating effects of gender emerged. For technology & computing interest, gender did not moderate most of the relationships tested in the previous model, except for altruistic field interests. Students with marginalized genders reported a significant negative relationship between altruistic interests and technology & computing interests, although the effect size of this relationship indicates it is potentially trivial. For biochem interest, gender also moderated only one relationship, in this case, education interests. Students with marginalized genders reported a significant negative relationship between education and biochem interests, while cis men reported a significant positive relationship, although both effect sizes indicate the relationships are potentially trivial. These findings imply that interests in altruism and education function differently for cis men and students with marginalized genders. For cis men, stronger interests in these areas result in increased interest in specific areas of engineering. For students with marginalized genders, the effect is the opposite, possibly because students with marginalized genders with strong interests in these areas are less likely to seek enrollment in engineering (and thus were not part of the study population). Moreover, these students may not pursue engineering as a career choice because they may not perceive engineering as a field to fulfill their altruistic aspirations. This result suggests that this population—students with marginalized genders with stronger altruistic and education interests—are more vulnerable to attrition, either because engineering does not help them fulfill their goals or because careers in other areas are perceived as less competitive [49].

Conclusion

In conclusion, this study found some links between specific aspects of latent diversity and discipline interest. Critical engineering agency beliefs were not strong predictors, while field interests and career priorities were more reliable and had larger effects. Gender did moderate some relationships between field and discipline interests, but outside of two specific cases did not have a large effect. These findings demonstrate the potential use of latent diversity as a method for understanding and explaining discipline interests and the need to consider these factors in context and in tandem with other variables, as a great deal of variability remains unexplained. These findings should also be considered in context with the study’s limitations, such as the decision to treat multiple genders as a single group and the lack of attention to race and ethnicity issues in the analysis. This study offers some interesting findings and should be considered a starting place for ongoing work rather than a conclusive end to the discussion.

References

[1] Major, J. C. (2020). To cross the picket line or join it: Facing engineering education's role in the socioeconomic exploitation of marginalized peoples to further a discipline.

[2] Pawley, A. L. (2019). Learning from small numbers: Studying ruling relations that gender and race the structure of US engineering education. Journal of Engineering Education, 108(1), 13-31.

[3] Frehill, L.M., "The Gendered Construction of the Engineering Profession in the United States, 1893–1920," Men and Masculinities, Vol. 6, No. 4, 2004, pp. 383–403.

[4] Bix, A.S., "From 'Engineeresses' to 'Girl Engineers' to 'Good Engineers': A History of Women's U.S. Engineering Education," National Women's Studies Association Journal, Vol. 16, No. 1, 2004, pp. 27–49.

[5] Miller, G.E., "Frontier Masculinity in the Oil Industry: The Experiences of Women Engineers," Gender, Work and Organization, Vol. 11, No. 1, 2004, pp. 47–73.

[6] Kline, R., "Construing 'Technology' as 'Applied Science': Public Rhetoric of Scientists and Engineers in the United States, 1880-1945," Isis, Vol. 86, No. 2, 1995, pp. 194–221.

[7] Drybaugh, H., "Work Hard, Play Hard: Women and Professionalization in Engineering-Adapting to the Culture," Gender and Society, Vol. 13, No. 5, 1999, pp. 664–682

[8] Strutz, M. L., Orr, M. K., & Ohland, M. W. (2012). Chapter 7: Low socioeconomic status individuals: an invisible minority in engineering. Engineering and social justice: In the university and beyond, 143.

[9] Rohde, J., Satterfield, D. J., Rodriguez, M., Godwin, A., Potvin, G., Benson, L., & Kirn, A. (2020). Anyone, but not Everyone: Undergraduate Engineering Students' Claims of Who Can Do Engineering. Engineering Studies, 12(2), 82-103.

[10] Foor, C. E., Walden, S. E., & Trytten, D. A. (2007). "I wish that I belonged more in this whole engineering group:" Achieving individual diversity. Journal of Engineering Education, 96(2), 103-115.

[11] Danielak, B. A., Gupta, A., & Elby, A. (2014). Marginalized identities of sense-makers: Reframing engineering student retention. Journal of Engineering Education, 103(1), 8-44.

[12] Riley, D. (2017). Rigor/Us: Building boundaries and disciplining diversity with standards of merit. Engineering Studies, 9(3), 249-265.

[13] Boaler, J., & Greeno, J. G. (2000). Identity, agency, and knowing in mathematics worlds. Multiple perspectives on mathematics teaching and learning, 1, 171-200.

[14] Hofer BK, Pintrich PR. The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. Rev Educ Res. 1997;67(1):88-140.51.

[15] Muis KR, Bendixen LD, Haerle FC. Domain-generality and domain-specificity in personal epistemology research: Philosophical and empirical reflections in the development of a theoretical framework. Educ Psychol Rev. 2006;18(1):3-54.52.

[16] Muis KR. Personal epistemology and mathematics: A critical review and synthesis of research. Rev Educ Res. 2004;74(3):317-377.53. Schoenfeld AH. Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. Handb Res Math Teach Learn. 1992:334-370.54.

[17] King BA, Magun-Jackson S. Epistemological beliefs of engineering students. J Technol Stud. 2009;35(2).55.

[18] Karataş FÖ, Bodner GM, Unal S. First-year engineering students' views of the nature of engineering: implications for engineering programmes. Eur J Eng Educ. 2015;(ahead-of-print):1-22.56.

[19] Sahin M. Effects of problem-based learning on university students' epistemological beliefs about physics and physics learning and conceptual understanding of Newtonian mechanics. J Sci Educ Technol. 2010;19(3):266-275.

[20] Godwin, A., Potvin, G., Hazari, Z., & Lock, R. (2016). Identity, critical agency, and engineering: An affective model for predicting engineering as a career choice. Journal of Engineering Education, 105(2), 312-340.

[21] E. Godfrey, Cultures within cultures: Welcoming or unwelcoming for women. Proceedings of the American Society for Engineering Education Annual Conference and Exposition, Honolulu, HI, USA, 2007.

[22] Potvin, G., Hazari, Z., Klotz, L., Godwin, A., Lock, R., Cribbs, J. D., & Barclay, N. (2013, June). Disciplinary differences in engineering students' aspirations and self-perceptions. In Proceedings of the ASEE Annual Conference & Exposition.

[23] Verdín, D., Godwin, A., Kirn, A., Benson, L., & Potvin, G. (2018). Engineering women's attitudes and goals in choosing disciplines with above and below average female representation. Social Sciences, 7(3), 44.

[24] Canney, N. E., & Bielefeldt, A. R. (2015). Differences in engineering students' views of social responsibility between disciplines. Journal of Professional Issues in Engineering Education and Practice, 141(4), 04015004.

[25] Bielefeldt, A. R., Polmear, M., Knight, D., Canney, N., & Swan, C. (2019). Disciplinary variations in ethics and societal impact topics taught in courses for engineering students. Journal of Professional Issues in Engineering Education and Practice, 145(4), 04019007.

[26] Pilotte, M., Ohland, M. W., Lord, S. M., Layton, R. A., & Orr, M. K. (2017). Student demographics, pathways, and outcomes in industrial engineering. International Journal of Engineering Education, 33(2), 506-518.

[27] Lord, S. M., Layton, R. A., & Ohland, M. W. (2014). Multi-institution study of student demographics and outcomes in electrical and computer engineering in the USA. IEEE Transactions on Education, 58(3), 141-150.

[28] Godwin, A., & Potvin, G. (2013). Chemical engineering students: A distinct group among engineers. Chemical Engineering Education, 47(3), 145-153.

[29] Evenhouse, D., Patel, N., Gerschutz, M., Stites, N. A., Rhoads, J. F., Berger, E., & DeBoer, J. (2018). Perspectives on pedagogical change: instructor and student experiences of a newly implemented undergraduate engineering dynamics curriculum. European Journal of Engineering Education, 43(5), 664-678.

[30] Potvin, G., McGough, C., Benson, L., Boone, H. J., Doyle, J., Godwin, A., ... & Verdin, D. (2018). Gendered interests in electrical, computer, and biomedical engineering: Intersections with career outcome expectations. IEEE Transactions on Education, 61(4), 298-304.

[31] Gilbert, A. F. (2009). Disciplinary cultures in mechanical engineering and materials science: Gendered/gendering practices?. Equal Opportunities International.

[32] Godwin, A., Verdín, D., Kirn, A., & Satterfield, D. (2018). The intersection of gender and race: Exploring chemical engineering students' attitudes. Chemical Engineering Education, 52(2), 89-97

[33] Roy, J. (2019). Engineering by the numbers. In American Society for Engineering Education (pp. 1-40).

[34] Godwin, A., Verdín, D., Kirn, A., & Satterfield, D. (2018). The intersection of gender and race: Exploring chemical engineering students' attitudes. Chemical Engineering Education, 52(2), 89-97.

[35] National Science Foundation, National Center for Science and Engineering Statistics. 2019. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019. Special Report NSF 19-304. Alexandria, VA. Available at https://www.nsf.gov/statistics/wmpd.

[36] Raiche, G., Magis, D., & Raiche, M. G. (2020). Package 'nFactors'.

[37] Filzmoser, P. (2004). A multivariate outlier detection method. In S. Aiva-zian, P. Filzmoser, & Y. Kharin (Eds.),Proceedings of the SeventhInternational Conference on Computer Data Analysis and Modeling:Vol. 1(pp. 18–22). Minsk, Belarus: Belarusian State University.

[38] Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). Using multivariate statistics (Vol. 5, pp. 481-498). Boston, MA: Pearson.

[39] Cohen, J. (1992). A power primer. Psychological bulletin, 112(1), 155.

[40] Hall, J., & Sammons, P. (2013). Mediation, moderation & interaction: Definitions, discrimination & (Some) means of testing. In Handbook of quantitative methods for educational research (pp. 267-286). Brill Sense.

[41] Espinosa, L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. Harvard Educational Review, 81(2), 209-241.

[42] Seymour, E., & Hunter, A. B. (2019). Talking about leaving revisited. Talking About Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education.

[43] Matusovich, H. M., Streveler, R. A., & Miller, R. L. (2010). Why do students choose engineering? A qualitative, longitudinal investigation of students' motivational values. Journal of Engineering Education, 99(4), 289-303.

[44] Lloyd, G. (1979). The man of reason. Metaphilosophy, 10(1), 18-37. Retrieved March 3, 2021, from http://www.jstor.org/stable/24435599

[45] Ottemo, A., Gonsalves, A. J., Danielsson, A. T. (2021) (Dis)embodied masculinity and the meaning of (non)style in physics and computer engineering education. Gender and Education. https://doi.org/10.1080/09540253.2021.1884197

[46] Masi, B. A., Hosoi, A. E., & Go, S. A. (2011). Re-engineering engineering education: A comparison of student motivation, ability development and career paths in traditional and cross-disciplinary engineering degree programs. In American Society for Engineering Education. American Society for Engineering Education.

[47] Choe, N. H., Martins, L. L., Borrego, M., & Kendall, M. R. (2019) Professional aspects of engineering: Improving prediction of undergraduates' engineering identity. Journal of Professional Issues in Engineering Education and Practice, 145(3).

[48] Godwin, A., & Kirn, A. (2020). Identity-based motivation: Connections between first-year students' engineering role identities and future-time perspectives. Journal of Engineering Education, 109(3), 362-383.

[49] Wang, M. T., Eccles, J. S., & Kenny, S. (2013). Not lack of ability but more choice: Individual and gender differences in choice of careers in science, technology, engineering, and mathematics. Psychological science, 24(5), 770-775.

Appendices

Figure 1. Q-Q Plot of financial career priorities variable showing non-normal distribution.

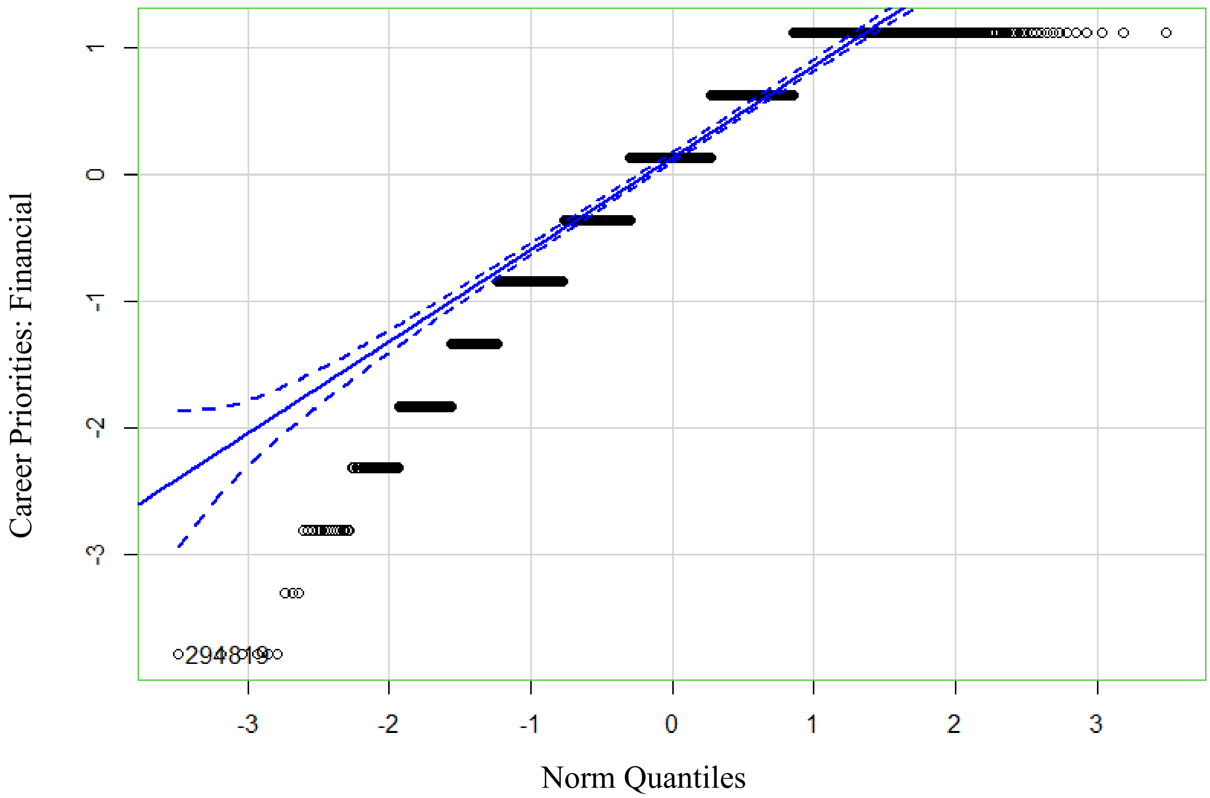

Figure 2. Moderated effect of altrustic field interests on technology and computing discipline interests.

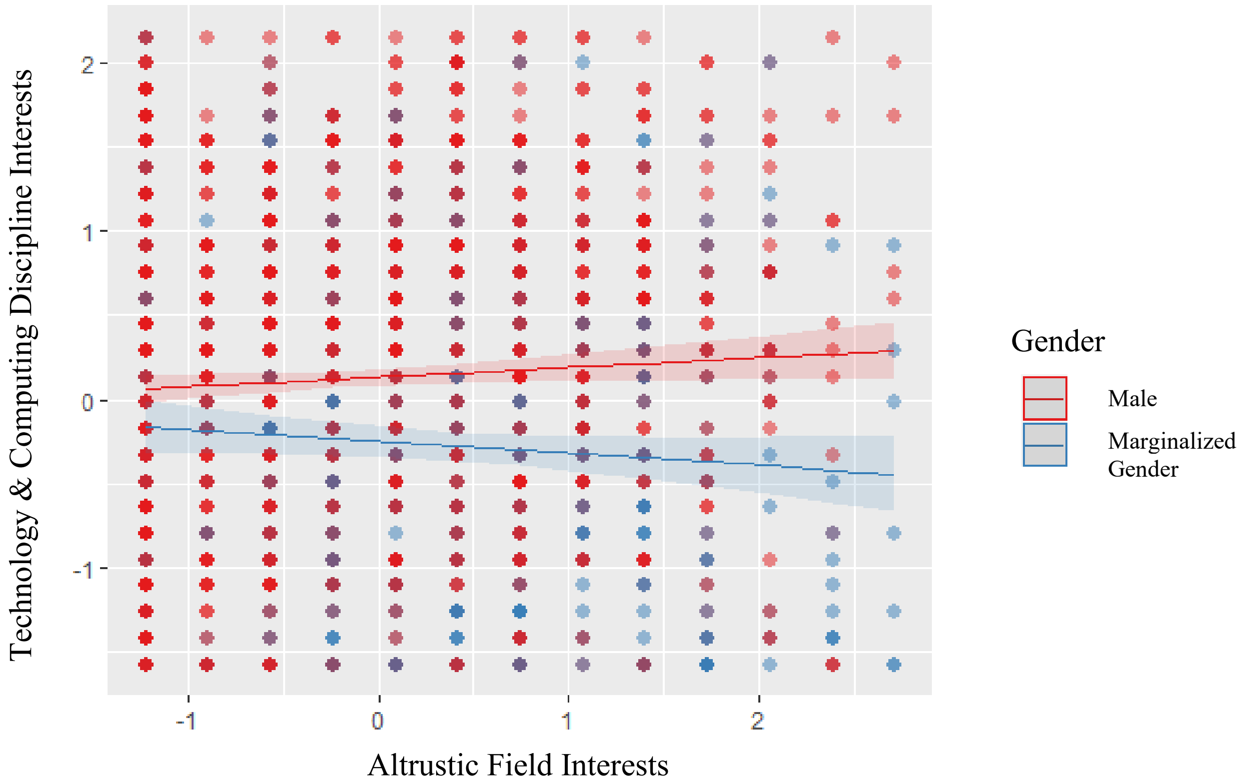

Figure 3. Moderated effect of education field interests on biochem discipline interests.

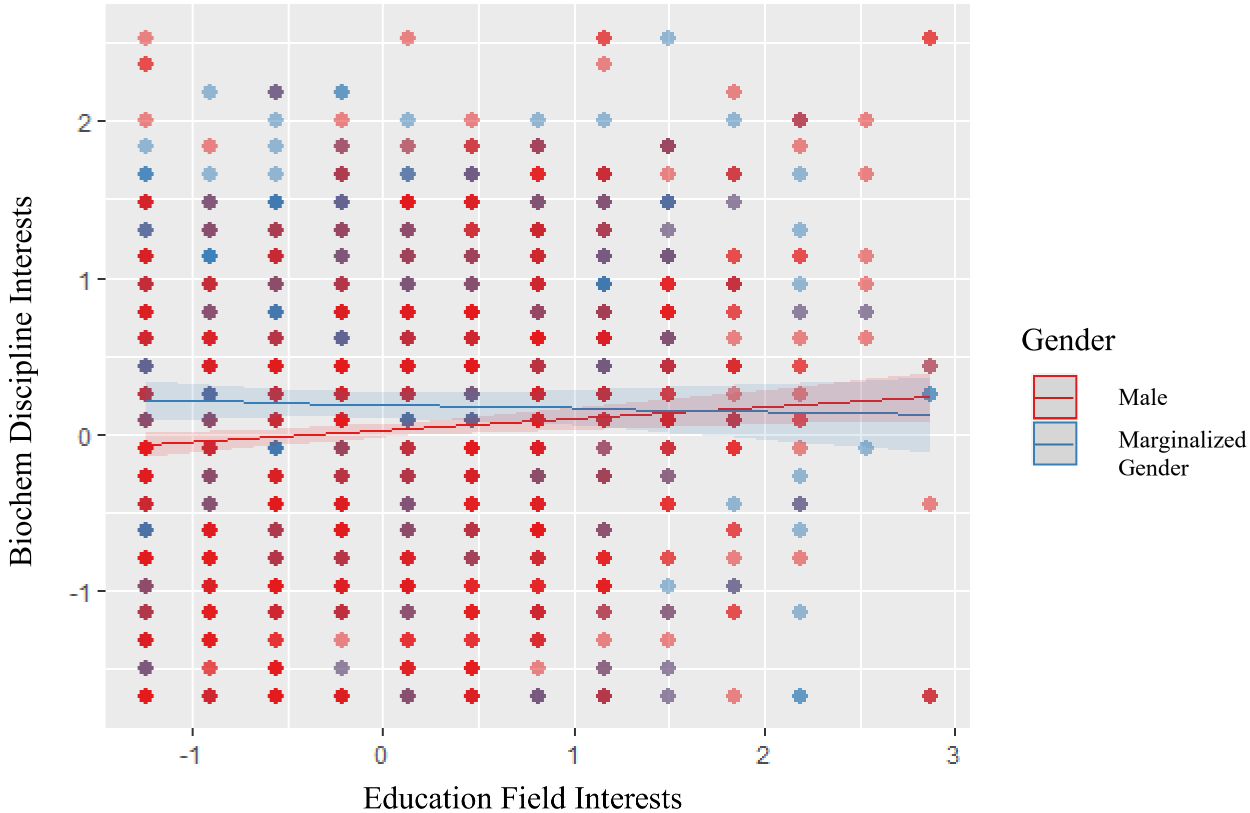

Figure 4. Histograms of engineering agency and empowerment belief scores, standardized.

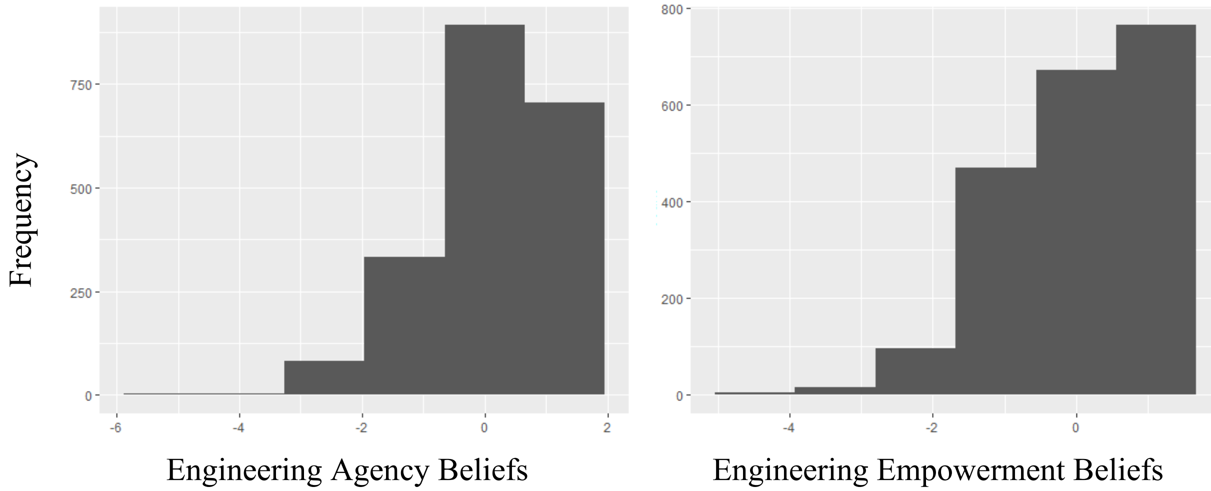

Figure 5. Histograms of financial career priority scores, standardized.

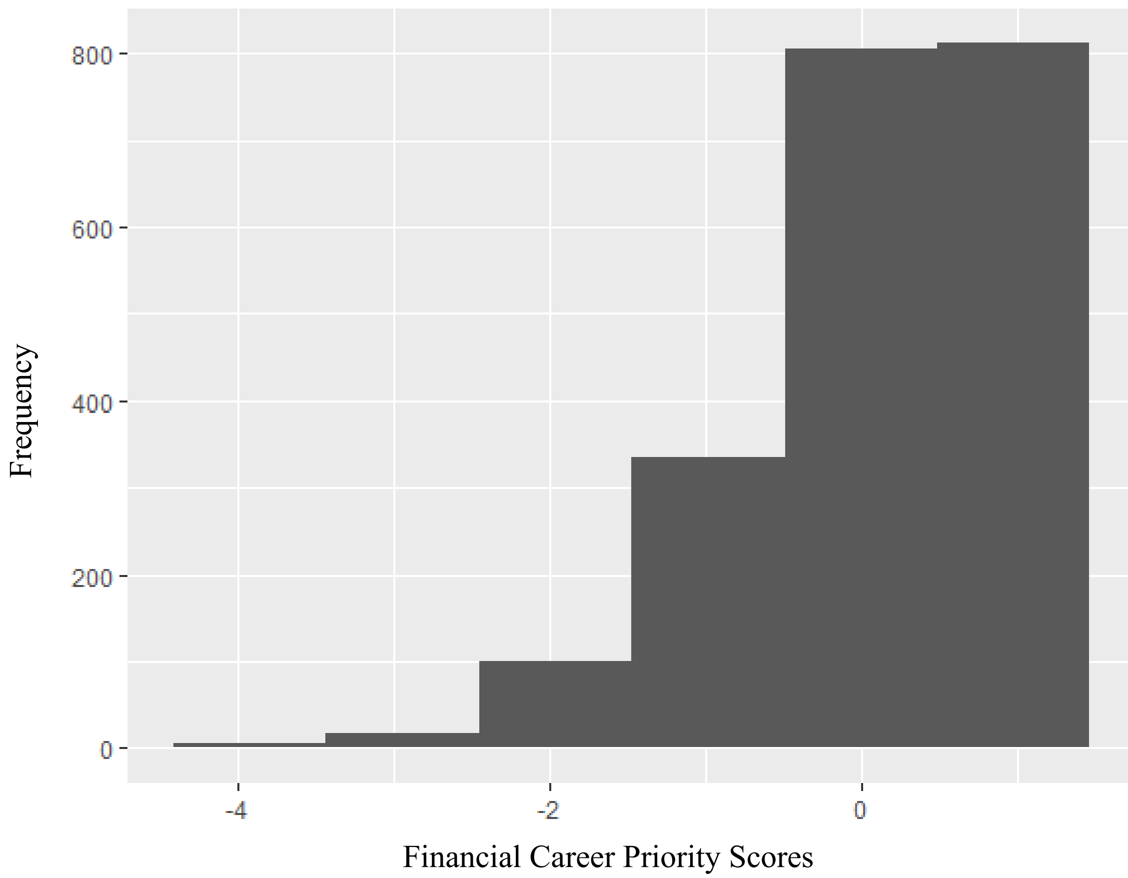

Table 1: Participants self-reported race/ethnicity and gender identity

Race/Ethnicity	Count	Percentage	Count	Percentage
Asian	299	8.19%	199	9.59%
Biracial	192	5.26%	112	5.40%
Black/African American	149	4.08%	87	4.19%
Latino/Latina/Latinx	231	6.33%	142	6.84%
Middle Eastern	36	0.99%	24	1.16%
Multiracial	39	1.07%	23	1.11%
Native American/Alaska Native	8	0.22%	8	0.39%
Native Hawaiian/Pacific Islander	7	0.19%	3	0.14%
White	1863	51.03%	1345	64.82%
Write-In	52	1.42%	24	1.16%
Not Answered	775	21.23%	108	5.20%
Gender Identity				
Agender	4	0.11%	2	0.10%
Female*	701	19.20%	467	22.51%
Male*	2089	57.22%	1463	70.51%
Genderqueer	7	0.19%	5	0.24%
Transgender	3	0.08%	3	0.14%
Not Answered	756	20.71%	98	4.72%
Spurious Entries**	91	2.49%	37	1.78%

* Includes students who explicitly identified as cis or trans and students who merely opted to identify as male (n = 2047) or female (n = 671)

** Students who used the write-in to provide non-serious or antagonistic comments (e.g., 'I identify as an attack helicopter')

Table 2. Factor loadings and means of the discipline interest variables.

Original Item	M	SD	Technology & Computing	Biochem	Systems & Structures	Physics & Mechanics	Smaller & Less Known
Electrical	2.87	1.96	0.466				
Information Technology	1.97	1.73	0.685				
Computer Engineering	2.7	1.97	0.928				
Computer Science	2.52	1.99	1.016				
Environmental	2.37	1.88		0.562			
Chemical	2.53	1.92		0.717			
Agricultural	2.06	1.75		0.756			
Biological	2.63	2.03		0.821			
Industrial	2.47	1.81			0.553		
Civil	2.83	1.91			0.765		
Construction	2.04	1.77			0.861		
Physics	2.6	1.82				0.601	
Aerospace	3.41	2.02				0.683	
Mechanical	3.82	1.96				0.844	
Materials Science & Engineering	2.56	1.78					0.413
Multidisciplinary	2.45	1.77					0.433
Nuclear	2.71	1.88					0.492
Other STEM	2.59	1.82					*
Non-STEM	2.06	1.8					

* This item was included in this variable despite the lack of factor loading due to theoretical fit.

Table 3. Factor loadings and means of the career priority variables.

Original Item	M	SD	Financial	Leadership	Innovation
Having job security and opportunity	5.1	1.09	0.405		
Making money	4.64	1.31	0.986		
Working with people	4.28	1.4		0.457	
Becoming well known	3.09	1.7		0.545	
Supervising others	3.35	1.55		0.761	
Helping others	4.75	1.3			0.444
Inventing/designing things	4.72	1.3			0.732
Developing new knowledge and skills	4.97	1.15			0.871

Note: Items are in response to the prompt: "How important are the following factors for your future career satisfaction?"

Table 4. Factor loadings and means of the field interest variables.

Original Item	M	SD	Education	Government	Commercial	Altruistic
Academia (Higher Education)	2.38	1.92	0.638			
Engineering Industry	4.9	1.35			0.5	
Entrepreneurship/Start a Company	3.26	1.87			0.51	
Government/Policy	2.06	1.85		0.43		
K-12 Education	1.2	1.55	0.508	0.384		
Law	1.25	1.56		0.735		
Medicine/Health	2.03	1.98		0.389		*
Non-Profit/NGO	1.67	1.72	0.332	0.393		*

Note: All items in response to the prompt: "Please rate the current likelihood of you choosing a career in each of the following fields.
* These items were included in a new factor of their own

Table 5: Predictors of interest in six categories of major, with standardized coefficients *b* and partial correlations *r*

		Dependent Variables											
		1. Technology & Computing				2. Biochem				3. Systems & Structures			
		b	CI	p	r	b	CI	p	r	b	CI	p	r
	(Intercept)	0.03	-0.01 – 0.07	0.094		0.05	0.01 – 0.08	0.008		0.03	-0.01 – 0.07	0.132	
Engineering Beliefs	Critical Agency	-0.04	-0.11 – 0.03	0.287	-0.02	0.00	-0.06 – 0.06	0.988	0.00	-0.09	-0.16 – -0.02	0.010	-0.06
	Empowerment	0.05	-0.03 – 0.12	0.227	0.03	0.07	0.00 – 0.13	0.046	0.04	0.12	0.04 – 0.19	0.002	0.07
Career Priorities	Leadership	-0.07	-0.12 – -0.02	0.006	-0.06	-0.02	-0.06 – 0.03	0.410	-0.02	0.05	-0.00 – 0.10	0.051	0.04
	Innovation	0.00	-0.06 – 0.06	0.981	0.00	0.02	-0.03 – 0.07	0.427	0.02	-0.05	-0.11 – 0.01	0.081	-0.04
Field Interests	Education	0.14	0.10 – 0.19	<0.001	0.14	0.04	-0.01 – 0.08	0.087	0.04	0.12	0.07 – 0.16	<0.001	0.11
	Government	0.12	0.07 – 0.17	<0.001	0.11	0.06	0.02 – 0.11	0.004	0.06	0.16	0.11 – 0.20	<0.001	0.14
	Altruistic	-0.01	-0.06 – 0.03	0.543	-0.01	0.48	0.44 – 0.53	<0.001	0.45	-0.01	-0.06 – 0.03	0.529	-0.01
	Commercial	0.28	0.23 – 0.33	<0.001	0.23	0.05	0.00 – 0.09	0.036	0.05	0.23	0.18 – 0.28	<0.001	0.20
		F(8,2003) = 33.01, p < .001				F(8,2003) = 103.4, p < .001				F(8,2003) = 36.03, p < .001			
		Adj. R2 = .1130				Adj. R2 = .2894				Adj. R2 = .1223			
		4. Physics & Mechanics				5. Smaller & Less Known				6. Non-Engineering			
		b	CI	p	r	b	CI	p	r	b	CI	p	r
	(Intercept)	0.07	0.03 – 0.10	0.001		0.06	0.03 – 0.10	0.001		0.01	-0.02 – 0.05	0.448	
Engineering Beliefs	Critical Agency	0.01	-0.06 – 0.07	0.849	0.00	0.02	-0.05 – 0.09	0.539	0.01	0.07	0.00 – 0.14	0.037	0.05
	Empowerment	0.12	0.05 – 0.20	0.001	0.08	0.08	0.01 – 0.15	0.026	0.05	-0.08	-0.15 – -0.01	0.036	-0.05
Career Priorities	Leadership	-0.13	-0.18 – -0.08	<0.001	-0.12	-0.10	-0.15 – -0.05	<0.001	-0.09	0.03	-0.02 – 0.08	0.240	0.03
	Innovation	0.13	0.07 – 0.18	<0.001	0.10	0.04	-0.02 – 0.09	0.198	0.03	-0.02	-0.07 – 0.04	0.569	-0.01
Field Interests	Education	0.17	0.12 – 0.21	<0.001	0.16	0.16	0.11 – 0.20	<0.001	0.15	0.19	0.14 – 0.23	<0.001	0.18
	Government	0.15	0.10 – 0.19	<0.001	0.14	0.17	0.12 – 0.21	<0.001	0.16	0.11	0.06 – 0.15	<0.001	0.10
	Altruistic	-0.11	-0.15 – -0.06	<0.001	-0.11	0.10	0.06 – 0.15	<0.001	0.10	0.18	0.14 – 0.23	<0.001	0.18
	Commercial	0.23	0.18 – 0.28	<0.001	0.20	0.18	0.13 – 0.23	<0.001	0.16	0.05	-0.00 – 0.09	0.059	0.04
		F(8,2003) = 48.24, p < .001				F(8,2003) = 47.62, p < .001				F(8,2003) = 42.74, p < .001			
		Adj. R2 = .1582				Adj. R2 = .1564				Adj. R2 = .1424			

Table 6: Predictors of interest in Technology & Computing majors, moderated by gender.

		Unmoderated			Controlling for Gender			Moderation Effect (Female & Non-Binary)		
		b	p	r	b	p	r	b	p	r
	(Intercept)	0.03	0.188		0.13	<0.001				
Engineering Beliefs	Critical Agency	-0.01	0.838	0.00	0.00	0.910	0.00	-0.04	0.616	-0.01
	Empowerment	0.02	0.531	0.01	0.04	0.386	0.02	-0.01	0.892	0
Career Priorities	Leadership	-0.06	0.016	-0.06	-0.06	0.044	-0.05	-0.02	0.699	-0.01
	Innovation	0.00	0.902	0.00	0.03	0.344	0.02	-0.06	0.383	-0.02
Field Interests	Education	0.15	<0.001	0.14	0.15	<0.001	0.12	-0.03	0.600	-0.01
	Government	0.13	<0.001	0.12	0.11	<0.001	0.09	0.02	0.725	0.01
	Altruistic	-0.02	0.385	-0.02	0.06	0.049	0.05	-0.12	0.019	-0.05
	Commercial	0.27	<0.001	0.23	0.25	<0.001	0.19	-0.07	0.282	-0.02
		F(8,1876) = 31.96, p < .001			F(17,1867) = 20.83, p < .001					
		Adj. R2 = .1162			Adj. R2 = .1518					
		F(9,1867) = 9.74, p < .001								

Table 7: Predictors of interest in Biochem majors, moderated by gender*.

		Unmoderated			Controlling for Gender			Moderation Effect (Female & Non-Binary)		
		b	p	r	b	p	r	b	p	r
	(Intercept)	0.05	0.006		0.01	0.615				
Engineering Beliefs	Critical Agency	0.01	0.682	0.01	0.01	0.713	0.01	0.03	0.746	0.01
	Empowerment	0.06	0.064	0.04	0.07	0.079	0.04	-0.06	0.505	-0.02
Career Priorities	Leadership	-0.02	0.299	-0.02	-0.01	0.608	-0.01	-0.03	0.622	-0.01
	Innovation	0.02	0.543	0.01	0.00	0.892	0.00	0.01	0.867	0.00
Field Interests	Education	0.04	0.049	0.05	0.07	0.005	0.06	-0.10	0.039	-0.05
	Government	0.06	0.006	0.06	0.08	0.003	0.07	-0.04	0.458	-0.02
	Altruistic	0.49	<0.001	0.46	0.45	<0.001	0.36	0.03	0.500	0.02
	Commercial	0.04	0.125	0.04	0.05	0.054	0.04	0.00	0.979	0.00
		F(8,1876) = 96.98, p < .001			F(17,1867) = 47.3, p < .001					
		Adj. R2 = .2895			Adj. R2 = .2939					
		F(9,1867) = 2.29, p = .015								

* There was also a main effect for gender: b = .16, p < .001, r = .08