

Unseen Barriers: The Persistent Reality of Gender Discrimination  
in Education and the Workplace in Engineering Fields

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## **Abstract**

Women comprise half of the population but continue to be underrepresented in STEM fields, especially engineering. This study explores the factors (individual, contextual, and barrier) influencing a woman's decision to pursue engineering as a college major and as a post-graduation career. A total of 47 questions covering 7 sections were developed in Google Forms and distributed via the Society of Women Engineers' social media platform plus Reddit's u/womenEngineers. Ninety-three people responded in total, with 86 classified as valid responses. The survey results were analyzed and it showed that in general, there was little to no gender discrimination on campus but there was in the workforce. In addition, using ANOVA, it was found that there were significant differences in the perception of gender discrimination, work-life balance, and engineering choice among different demographic groups. Structural Equation Model (SEM) was used to analyze the relationships between the questions and underlying factors and found that interest in engineering is a significant factor in women's decisions to stay in the field. The findings underscore the importance of having an interest in engineering as well as having organizations implement policies to address gender discrimination and work-life balance issues.

## Introduction

Engineering integrates principles from math, science, and technology to invent and refine machines and structures. The engineering field is multifaceted and encompasses a wide range of subcategories with each having different responsibilities and involving different skills. For example, Electric Engineering deals with designing and producing chips for computers and smartphones. Mechanical Engineering is responsible for designing and producing tools and machines. Chemical Engineering focuses on converting raw materials into useful products through chemical processes. All these fields contribute significantly to societal advancement and the advancement of human life.

Despite its beneficial impact on society, men outnumber women in the global engineering workforce 86.3% to 13.7% (Evans, 2024). Women represent more than half the population and 46 percent of the US workforce, but only 10 percent of the engineering workforce (Muller, 2003). The number of women in engineering roles has doubled (25,000 to over 50,000 from 2011 to 2021) but the percentage split between men and women is still low (Dent, 2021). According to Women in Science and Engineering (WISE), a community interest group that encourages women into STEM education and industries, for the third year in a row in 2021, just 14 percent of engineering graduates were female (Dent, 2021). In other fields, like business, women-owned businesses make up 42% of all businesses in the United States (Brandt, 2024). Despite women's success in the business world, this shows the need for more targeted efforts to close the gender gap in technical fields like engineering. Women have been severely underrepresented in this field and this points to the possibility of certain barriers preventing them from choosing to major in engineering or choosing to work in the engineering field. This gap can lead to losing their unique perspectives and contributions, which can affect the results and innovations that emerge from these fields.

Having gender diversity is important because the workforce needs diverse viewpoints which can only happen if there is variety in workers (Chan, 2021). Many studies show that diverse teams produce better outcomes than homogeneous ones. For example, one study showed that a diverse group outperforms a group of the best problem solvers (Hong & Page, 2004). Another study showed companies with greater diversity have significantly higher profitability than those without it (First Citizens Bank, 2022). Additionally, a product designed by mostly males can lead to biased outcomes. For example, cars predominantly engineered by men have been found to overlook the physiological differences and safety needs of women, resulting in potentially hazardous oversights. Examples include airbag systems positioned in a manner that poses a more significant risk to women, seats designed to prevent whiplash in men but not lighter women, and seat belts that fit differently on average-sized women, compromising their effectiveness in a crash (Firm, 2020).

Integrating more women into STEM fields could mitigate such oversights as a more comprehensive array of perspectives is considered, leading to safer and more inclusive products.

The objective of this research is to examine how various factors, particularly engineering interest, faculty support, gender discrimination, and work-life balance, influence a woman's choice in choosing to major in engineering and how they vary among different demographic groups. Many studies focus on either students or professionals but do not compare across different career stages. This study aims to fill in this gap by comparing across high school, college, and work to see how perceptions can evolve over the course of one's career. The goal of this study is to uncover areas that need support to help retain and increase the representation of women in engineering.

The factors were selected based on the belief that they could impact women's engineering choices. Interest in the field of engineering is important for the initial attraction into and desire to stay within the field. Faculty support may be a mechanism that assists students through their college life and into the professional setting but the lack of it could also stop them from going into engineering. Finally, gender discrimination at the workplace and work-life balance considerations can also be critical in the understanding of how one enters the field and contribute to one's ability to stay in the field.

It was hypothesized that individual and contextual factors, such as personal interest in engineering and campus experience, will influence women's perception of gender discrimination and the decision of whether to pursue the engineering field. Demographic factors, such as age, degree, work duration, type of workplace, and gender of colleagues and collaborators, may also play an important role. Based on the survey data, this research explores the relationships among these factors.

## **Literature Review**

### **Impact of Individual Factors**

Being interested in engineering is crucial for females to decide to pursue and persist in this field. Research indicates that girls who develop an interest in engineering as well as other STEM subjects at a young age will be more likely to choose these fields in college and the work field. After qualitatively analyzing 25 interviews of female STEM professionals in regional Australia, the results reveal that a strong interest is a highly influential factor in whether women enter STEM fields and was considered an important internal motivator to join STEM fields (Prieto-Rodriguez et al., 2022). The study highlights that this interest, along with resilience and determination are key factors for "surviving" structural barriers.

## **Impact of Contextual Factors from College**

A supportive campus environment can influence a woman to stay in the engineering field. Female students can have professional guidance to go through challenges. One study that surveyed 282 students across four institutions showed that in general, women showed similar trajectories of discouragement across all schools (Mazur, Chorlton, & Gales, 2018). In addition, women were more likely than men to interact with their instructors through online means or through someone else. They also self-reported having a reduced chance of securing opportunities in their program compared to men (Mazur et al., 2018). Such experiences can make women feel less supported and can discourage them from continuing in the field.

## **Impact of Barriers**

Barriers for women to pursue the engineering field appeared in different forms. One barrier is gender discrimination, which means giving an unfair advantage to members of one gender over another. For example, because of their gender, an employee or a job applicant could be treated differently or less favorably. Gender discrimination decreases the satisfaction, motivation, commitment, and enthusiasm levels of employees. It also increases the stress level in the employees (Channar, Abbassi, & Ujan, 2011).

Another form of barrier is work-life balance, which encompasses the harmony and interference that occurs between paid work and non-work domains (Brue, 2019). The meaning of work-life balance may vary among individuals. For example, what one person considers a balanced lifestyle may not align with another's definition of balance. A study done by the Society of Women Engineers (SWE) found that women who left the engineering field were much more likely to cite work-life balance issues (18 percent) than men (3 percent) (Frehill, 2009). Many engineering companies have implemented strategies to try and retain women during the childbearing years. While these accommodations may be present, the low number of women in the engineering workplace causes them to feel like they are being evaluated more closely so they may be quite self-conscious about making use of these accommodations (Frehill, 2009).

# **Methods**

## **Research Questions**

To study how various factors impact a woman's decision to pursue engineering as a college major and as a post-graduation career, four research questions were formulated first. A survey was designed to answer the four research questions (RQ) below:

- RQ1: How do contextual factors influence women's perception of gender discrimination in engineering education?
- RQ2: How do demographic factors influence women's perception of gender discrimination and work-life balance at the workplace?
- RQ3: How do demographic factors influence women to choose engineering in college and career?
- RQ4: How do individual factors influence women to choose engineering in college and career?

## **Participants**

Upon Institutional Review Board (IRB) approval, participants were recruited from the Society of Women Engineers (SWE)'s social media pages (LinkedIn, Facebook, Instagram, and X) and Reddit's WomenEngineers page. The screening criteria were female, above 18 years old, and majored in engineering in college. Participation was completely voluntary. A total of 93 participants, including both students and working women, responded to the survey.

## **Survey Design**

The created survey consisted of 47 questions covering 7 groups: I) 3 screening questions, II) 5 demographic information questions, III) 10 engineering interests questions, IV) 10 campus experience questions, V) 5 gender discrimination at the workplace questions, VI) 10 work-life balance questions, and VII) 4 engineering choices questions. The answer choices were based on a 5-point Likert scale with 1 as strongly disagree and 5 as strongly agree. A complete list of questions is given in the appendix. The survey was distributed as a Google form through the Society of Women Engineers (SWE) social media and Reddit's \womenEngineers.

## **Analytic Methods**

Once the survey data were collected, ANOVA method was applied first to find relationships among various factors. Because many of them are correlated, factor analysis and Structure Equation Modeling methods were used to simplify the factor structures and determine how they were related to women's choices of choosing and staying in the engineering field. The analysis was conducted by using both SPSS and R with lavaan package (Rosseel, 2012).

# Results

## Data Cleanup

Seven records were removed from the sample due to either being under the age of 18 (1), not majoring in engineering (5), or declining to participate (1). This resulted in a total of 86 valid participant records. Based on the extra screening question after the campus experience section, two of the participants did not work in the engineering field, so their records were not used for the analyses on gender discrimination in the workplace and work-life balance.

## Demographic Results

Table 1 shows the demographic results of 86 participants. They were almost equally distributed among three age groups: 35% were of ages 18-29, 36% were of ages 30-39, and 29% were of ages 40 and over. The majority of participants had their highest degree as either undergraduate (64%) or Master (25.6%). Only a small percentage had their highest degree as Ph.D. (9.3%) or Associate (1.2%) degrees. Similar to age, work duration was also almost equally distributed: 23.3% of people worked <1 year in their current organization, 33.7% worked 1-4 years, 16.3% worked 5-10 years, and 24.4% had worked over 10 years. More people worked in the private sector (64%) versus public (29.1%) sector. About 84.7% of participants collaborated mostly with men and 88.1% of participants said their colleagues were made up mostly of men.

## Reliability Results

The reliability tests of four survey constructs (III to VI in section Survey Design) were conducted to validate their internal consistency and reliability. All four constructs reached an acceptable reliability (Cronbach's Alpha >0.70). Table 2 shows Cronbach's Alpha along with the mean and standard deviations of each construct.

## Survey Results

### *Results of Engineering Interest*

Figure 1 shows the mean of each Engineering Interest question. The overall average was 4.29 out of 5, showing that women, who participated in the survey, generally enjoyed engineering and were interested in this field. The questions with the highest mean were Q4 (I like thinking about the implications and future applications of findings in engineering-related areas) and Q9 (I find it exciting to develop creative ways

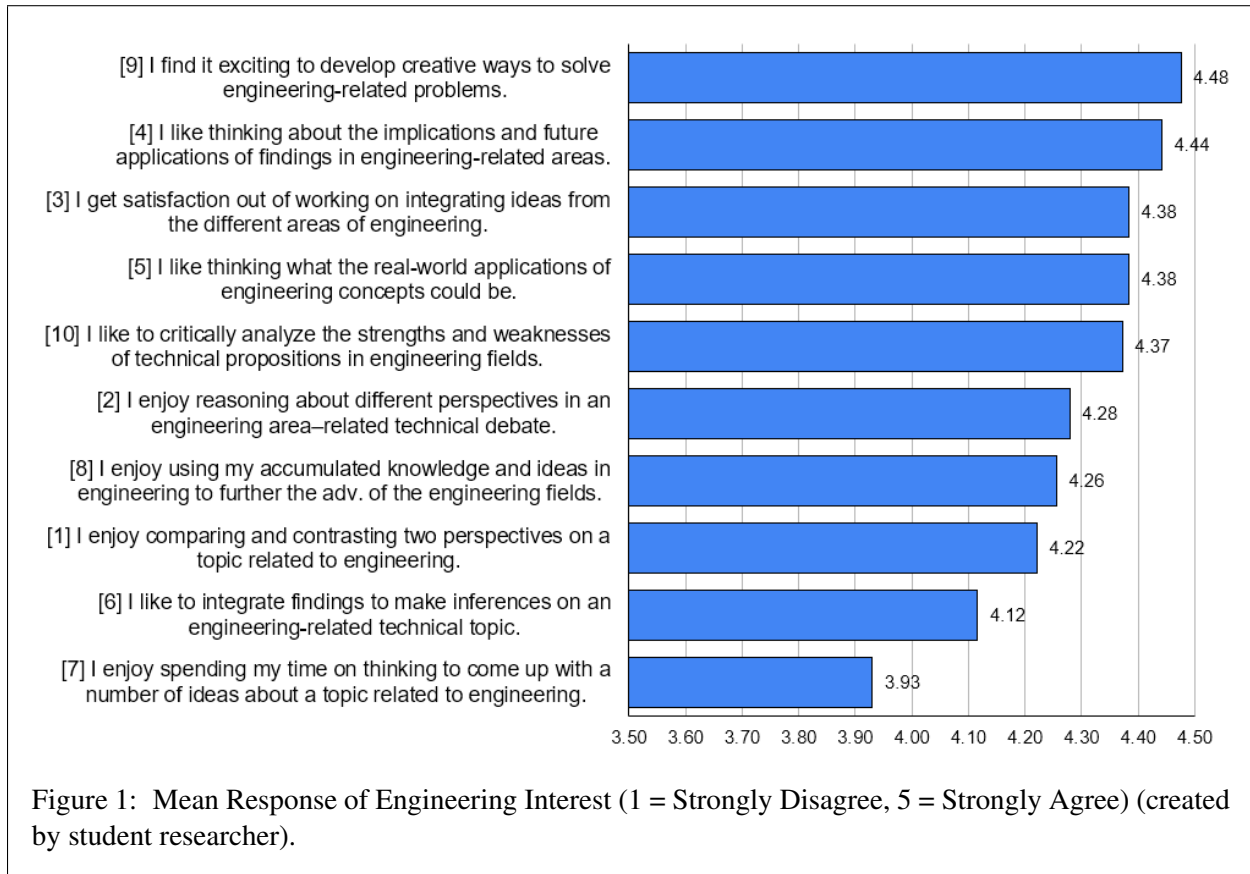
Table 1: Demographic Results (created by student researcher).

| Measure                      | Item          | Count | Percentage |
|------------------------------|---------------|-------|------------|
| Age                          | 8-29          | 30    | 35%        |
|                              | 30-39         | 31    | 36%        |
|                              | >40           | 25    | 29%        |
| Degree                       | Associate     | 1     | 1.2%       |
|                              | Undergraduate | 55    | 64%        |
|                              | Master        | 22    | 25.6%      |
|                              | Ph.D.         | 8     | 9.3%       |
| Years of Current Work        | <1 year       | 20    | 23.3%      |
|                              | 1-4 years     | 29    | 33.7%      |
|                              | 5-10 years    | 14    | 16.3%      |
|                              | > 10 years    | 21    | 24.4%      |
|                              | N/A           | 2     | 2.3%       |
| Type of Workplace            | Public        | 25    | 29.1%      |
|                              | Private       | 55    | 64%        |
|                              | NGO           | 1     | 1.2%       |
|                              | Others        | 3     | 3.6%       |
|                              | N/A           | 2     | 2.3%       |
| Who are their colleagues     | Mostly women  | 2     | 2.4%       |
|                              | Mostly men    | 74    | 84.7%      |
|                              | Almost Same   | 9     | 12.9%      |
|                              | N/A           | 1     | 1.2%       |
| Who to collaborate most with | Mostly women  | 2     | 2.4%       |
|                              | Mostly men    | 72    | 88.1%      |
|                              | Almost Same   | 11    | 9.5%       |
|                              | N/A           | 1     | 2.4%       |

Table 2: Cronbach's Alpha, Mean, and Standard Deviation of Four Survey Constructs (created by student researcher).

| Construct             | Cronbach's Alpha | Mean  | Std Dev |
|-----------------------|------------------|-------|---------|
| Engineering Interest  | 0.92             | 42.86 | 5.85    |
| Campus Experience     | 0.84             | 32.94 | 7.51    |
| Gender Discrimination | 0.83             | 13.95 | 5.03    |
| Work-life Balance     | 0.81             | 31.73 | 6.98    |

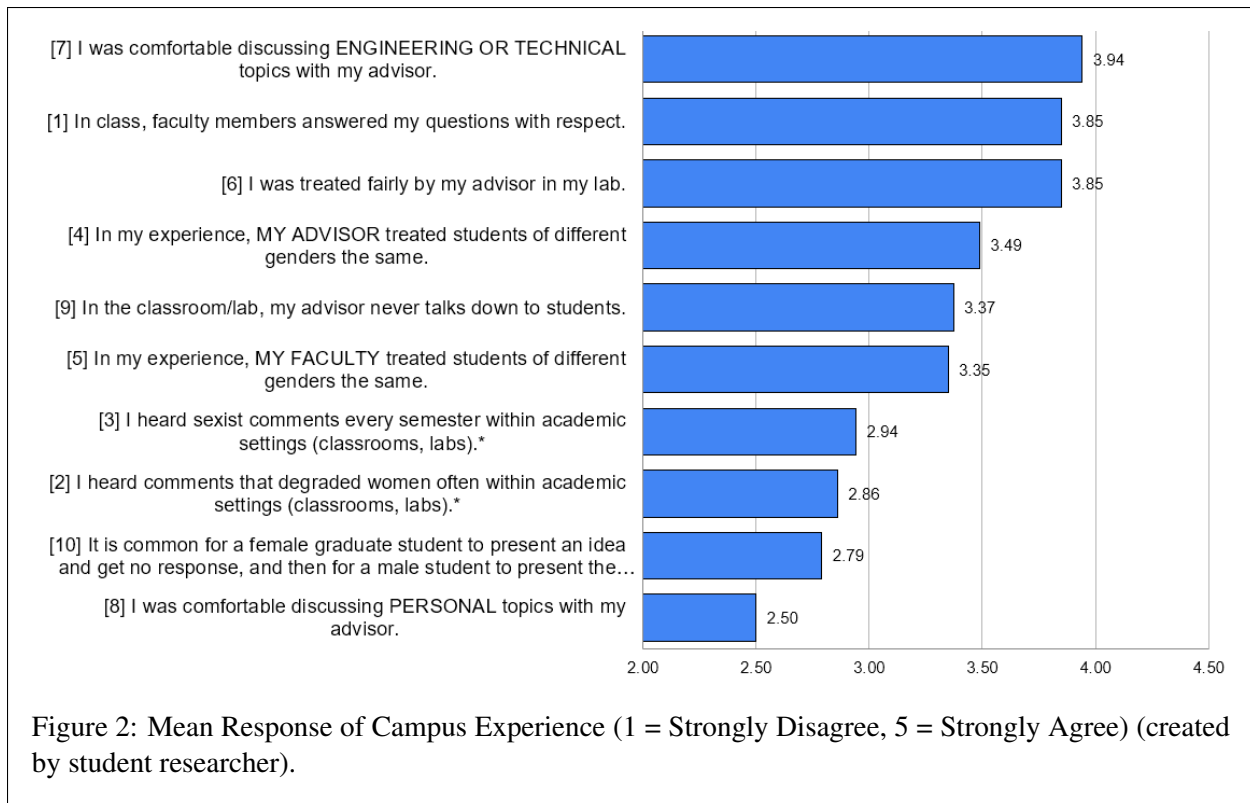
to solve engineering-related problems.), with means 4.44 and 4.48 respectively. This indicates that most people thought about engineering as application and technical-oriented. The lowest average was Q7 (I enjoy spending my time on thinking to come up with a number of ideas about a topic related to engineering) with an average of 3.93.



### *Results of Campus Experience*

As shown in Figure 2, the overall average campus experience was 3.29 out of 5. This showed that the campus experience was near neutral but more on the agreement side, meaning a positive campus experience. Q7 (I was comfortable discussing ENGINEERING OR TECHNICAL topics with my advisor) scored highest (mean = 3.90) indicating that participants were most comfortable talking about engineering or technical topics, but Q8 (I was comfortable discussing PERSONAL topics with my advisor) scored lowest (mean = 2.50) indicating participants were not comfortable discussing personal topics. Q1 (In class, faculty members answered my questions with respect) and Q6 (I was treated fairly by my advisor in college) both had a mean response of 3.85 showing that respondents felt respected and treated fairly.

Responses to questions related to gender discrimination varied. Q2 (I heard comments that degraded



women often within academic settings (classrooms, labs)), Q3 (I heard sexist comments every semester within academic settings (classrooms, labs)), and Q10 (It is common for a female graduate student to present an idea and get no response, and then for a male student to present the same idea and be acknowledged) were inverted in Figure 2 to make them consistent with other questions. They were all slightly below 3, meaning most people agreed there was some gender discrimination on campus. However, Q4 (In my experience, MY ADVISOR treated students of different genders the same) and Q5 (In my experience, FACULTY members treated students of different genders the same) were slightly above 3, showing that there was little discrimination.

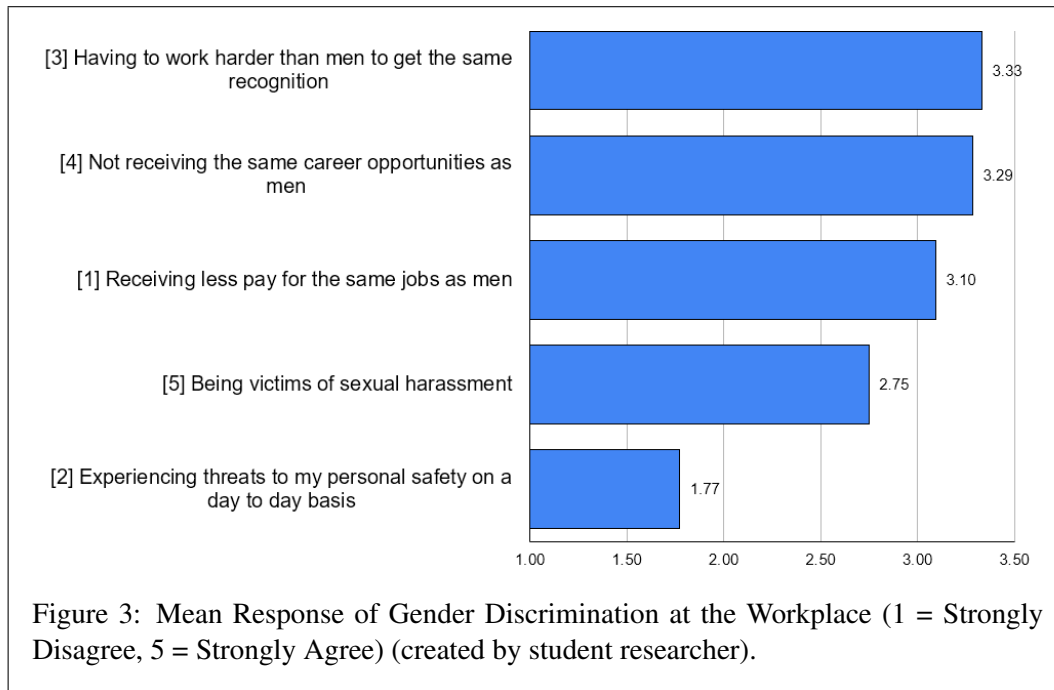
### ***Results of Gender Discrimination at the workplace***

The overall average of gender discrimination is 2.79 out of 5. The lower the score, the less discrimination there is. Since 2.79 is on the lower side, it is consistent with campus experience. The mean score of individual questions are shown in Figure 3. The least concern is personal safety threats with an average response score of 1.77. The highest scores are near neutral (3.33). However, looking into details, for Q3 (having to work harder than men to get the same recognition) and Q4 (not receiving the same career opportunities as men), the majority of respondents responded agree and strongly agree rather than disagree

Table 3: Response to Gender Discrimination at the workplace Questions 3 and 4. Majority of respondents responded agree and strongly agree.

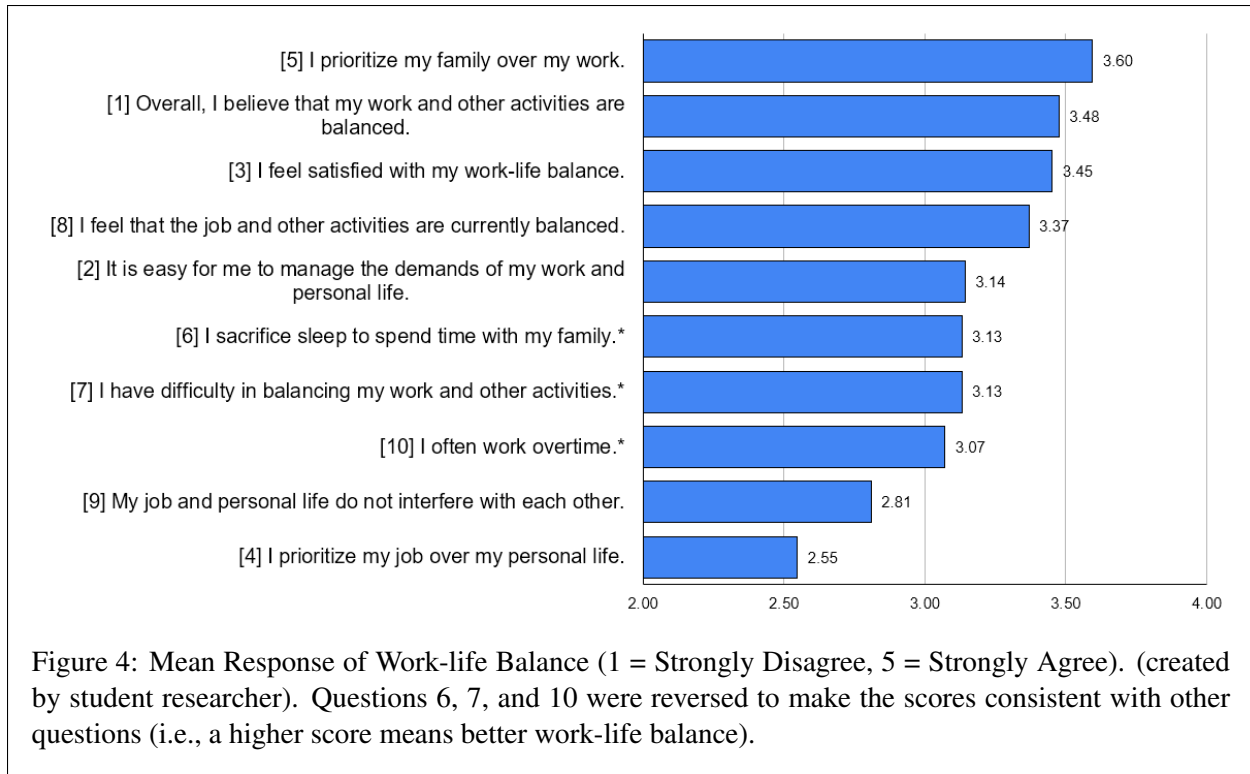
| Question | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|----------|-------------------|----------|---------|-------|----------------|
| Q3       | 13%               | 18%      | 15%     | 30%   | 24%            |
| Q4       | 13%               | 18%      | 17%     | 32%   | 20%            |

and strongly disagree as shown in Table 3. This suggests there is gender discrimination in the workplace.



### ***Results of Work-Life Balance at the workplace***

The overall average of work-life balance is 3.17 out of 5. Higher numbers indicate a higher level of balance between work and life (responses to Q6 (I sacrifice sleep to spend time with my family), Q7 (I have difficulty in balancing my work and other activities), Q10 (I often work overtime) were reversed so that higher scores mean good work-life balance.). The highest average was question 5, which is about prioritizing my family over my work. The average was 3.6 which is on the agreement side. This is consistent with the overall question since people thought their work and life were balanced.



### Inferential Analysis

The previous section described mean scores from survey questions under the four constructs. In this section, the relationship between these scores and both demographic and engineering choices were explored.

### ANOVA Results

To answer the proposed RQs, ANOVA analysis of the main effects of age, education, work duration, type of workplace (private vs. public), gender of colleague, gender of collaborator on all four survey constructs (Engineering Interest, Campus Experience, Gender Discrimination at the workplace, Work-Life Balance) and engineering choices were conducted. If ANOVA analysis indicated means from different groups were different, then Post Hoc Tukey tests were applied to determine which groups caused the differences.

- *Results of the Main Effects of Age*

ANOVA analyses of the main effects of age on all survey construct measures and engineering choices showed significance only on the measure of Gender Discrimination at the workplace ( $F(2, 81) = 3.57, p < 0.05$ ). The Post Hoc Tukey Test showed that only the age group 18-29 (mean = 2.44, std dev = 0.86) was significantly lower than that of above 40 (mean = 3.16, std dev = 1.01) ( $p < 0.05$ ). Younger

people perceived lower gender discrimination in the workplace compared to older people.

- *Results of the Main Effects of Education*

The main effects of education on all survey construct measures and engineering choices showed significance only on Engineering Future Choice (whether they would continue working in engineering in the future) ( $F(2, 82) = 3.304, p < 0.05$ ). The Post Hoc Tukey Test showed that only the undergraduate degree group (mean = 2.13, std dev = .39) was significantly higher than the Ph.D group (mean = 2.00, std dev = 0.44) ( $p < 0.05$ ). People with an undergraduate degree tend to continue working in engineering more than those with a Ph.D degree.

- *Results of the Main Effects of Work Duration*

The main effects of work duration on all survey construct measures and engineering choices showed significance on the measure of Gender Discrimination at the workplace ( $F(3, 78) = 4.004, p < 0.05$ ) and Work-Life Balance ( $F(3, 78) = 3.970, p < 0.05$ ).

The Post Hoc Tukey Test on Gender Discrimination in the workplace showed that people who worked less than one year in their current workplace (mean = 2.30, std dev = 1.07) perceived significantly lower gender discrimination than the groups that worked 5-10 years (mean = 3.26, std dev = 0.93) ( $p < 0.05$ ) or over 10 years (mean = 3.17, std dev = 0.96) ( $p < 0.05$ ) in the current workplace (both  $p < 0.05$ ). People who worked less than one year perceived less gender discrimination than people who worked 5 or more years.

The Post Hoc Tukey Test on Work-Life Balance showed that people who worked less than one year in their current workplace (mean = 3.64, std dev = .62) perceived significantly higher work-life balance than all other three groups (1-4 years: mean = 3.11, std dev = 0.60; 5-10 years mean = 3.02, std dev = .71; above 10 years: mean = 2.97, std dev = 0.73) (all three  $p < 0.05$ ). People in their first year of their current workplace perceived Work-Life Balance better than people with a longer work duration in their current workplace.

- *Results of Main Effects of Type of Workplace (Private vs. Public)*

The main effects of type of workplace on all survey construct measures and engineering choices showed no significance ( $p > 0.05$ ). The Type of Workplace does not have any difference in participant perception of gender discrimination at the workplace and work-life balance.

- *Results of Main Effects of Gender of Colleagues*

The main effects of gender of colleagues on all survey construct measures and engineering choices

showed significance only on the measure of Gender Discrimination at the workplace ( $F(2, 79) = 3.38$ ,  $p < 0.05$ ). The Post Hoc Tukey Test on Gender Discrimination at the workplace showed that people whose colleagues were mostly men (mean = 2.86, std dev = .98) perceived higher gender discrimination than people whose colleagues were equally men and women (mean = 2.00, std dev = 1.11) ( $p = 0.06$ ).

- *Results of Main Effects of Gender of Collaborators*

The main effects of the gender of collaborators on all survey construct measures and engineering choices showed no significance ( $p < 0.05$ ). The gender of collaborators does not have any difference in participant perception of gender discrimination at the workplace and work-life balance.

### ***Exploratory Factor Analysis***

Among all the survey questions, Engineering Interest, Campus Experience, Gender Discrimination at the Workplace, and Work-Life Balance questions can be thought of as independent variables or factors, and Engineering Choice can be thought of as dependent variables or factors. To examine the relationship between them, factor reduction is necessary since there are too many independent variables (35 of them). Exploratory Factor Analysis (EFA) is commonly used to find underlying factors and to reduce the observed number of factors. The model can be written as  $X = M + L \times F + E$ , where  $X$  are observed variables,  $M$  are observation mean,  $L$  are factor loadings,  $F$  are underlying factors and  $E$  are error terms. Because the survey questions can be grouped into 4 categories, 4 factors are also assumed in the EFA analysis. Table 4 shows factors that have loadings higher than 0.7. As expected the survey questions indeed clustered into the 4 categories of III) to VI) in section Survey Design.

### ***Confirmatory Factor Analysis***

To further confirm that it is reasonable to group the 35 questions into 4 constructs, which correspond to 4 underlying or latent factors, Confirmatory Factor Analysis (CFA) was applied to the survey results. Based on the questions selected from Table 4, and limiting at most 5 questions from each question category, the four latent factors can be constructed as follows:

1. Engineering Interest (EI). It relates to College Interest questions 3, 5, 6, 9 and 10.
2. Campus Experience (CE). It relates to Campus Experience questions 6 and 7.
3. Gender Discrimination at the Workplace (WD). It relates to workplace Gender Discrimination questions 1, 3, and 4.

Table 4: Factor loading from EFA. Only show those greater than 0.70. As expected, the factors are aligned with the question categories (created by student researcher).

|               | Factor |   |       |   |                 | Factor |       |   |       |
|---------------|--------|---|-------|---|-----------------|--------|-------|---|-------|
|               | 1      | 2 | 3     | 4 |                 | 1      | 2     | 3 | 4     |
| Interest1     |        |   |       |   | Discrimination1 |        |       |   | 0.731 |
| Interest2     | 0.719  |   |       |   | Discrimination2 |        |       |   |       |
| Interest3     | 0.769  |   |       |   | Discrimination3 |        |       |   | 0.813 |
| Interest4     |        |   |       |   | Discrimination4 |        |       |   | 0.824 |
| Interest5     | 0.774  |   |       |   | Discrimination5 |        |       |   |       |
| Interest6     | 0.772  |   |       |   | Balance1        |        | 0.844 |   |       |
| Interest7     | 0.753  |   |       |   | Balance2        |        | 0.800 |   |       |
| Interest8     | 0.758  |   |       |   | Balance3        |        | 0.868 |   |       |
| Interest9     | 0.821  |   |       |   | Balance4        |        |       |   |       |
| Interest10    | 0.785  |   |       |   | Balance5        |        |       |   |       |
| College1      |        |   |       |   | Balance6_rev    |        |       |   |       |
| College2_rev  |        |   |       |   | Balance7_rev    |        | 0.819 |   |       |
| College3_rev  |        |   |       |   | Balance8        |        | 0.823 |   |       |
| College4      |        |   |       |   | Balance9        |        |       |   |       |
| College5      |        |   |       |   | Balance10_rev   |        |       |   |       |
| College6      |        |   | 0.864 |   |                 |        |       |   |       |
| College7      |        |   | 0.776 |   |                 |        |       |   |       |
| College8      |        |   |       |   |                 |        |       |   |       |
| College9      |        |   |       |   |                 |        |       |   |       |
| College10_rev |        |   |       |   |                 |        |       |   |       |

4. Work-Life Balance (BA). It relates to Work-Life balance questions 1, 3, 8, and 7.

Table 5 shows the Average Variance Extracted (AVE) and Composite Reliability coefficients (CR) from the CFA analysis. The results show that all constructs have AVE and CR higher than the desired thresholds.

Table 5: Results of Confirmatory Factor Analysis. Average Variance Extracted (AVE) and Composite Reliability (CR) for constructed latent variables are shown (created by student researcher).

| Construct | AVE > 0.5 | CR > 0.7 | Convergent Validity |
|-----------|-----------|----------|---------------------|
| EI        | 0.59      | 0.87     | Established         |
| CE        | 0.74      | 0.85     | Established         |
| WD        | 0.72      | 0.88     | Established         |
| BA        | 0.71      | 0.91     | Established         |

### ***Structural Equation Modeling***

In the Structural Equation Model (SEM), the four choices were regressed on the four latent variables constructed in the previous section. Model fit indices are shown in Table 6, with four of them at their rec-

ommended levels. This indicates that the hypothesized model can explain relationships among the observed variables. Regression coefficients are shown in Table 7 and a graphic representation is shown in Figure 5.

Table 6: SEM fit indices. Four of them meet the recommended level.

| Fit Ind.          | X2  | df  | p-value | X2/df | GFI   | AGFI  | NFI   | CFI   | RMSEA |
|-------------------|-----|-----|---------|-------|-------|-------|-------|-------|-------|
| Recommended Level |     |     | > 0.05  | < 3.0 | > .80 | > .80 | > .80 | > .90 | < .05 |
| Value             | 147 | 111 | 0.01    | 1.32  | 0.86  | 0.78  | 0.82  | 0.95  | 0.06  |

Table 7: SEM regression coefficients (created by student researcher).

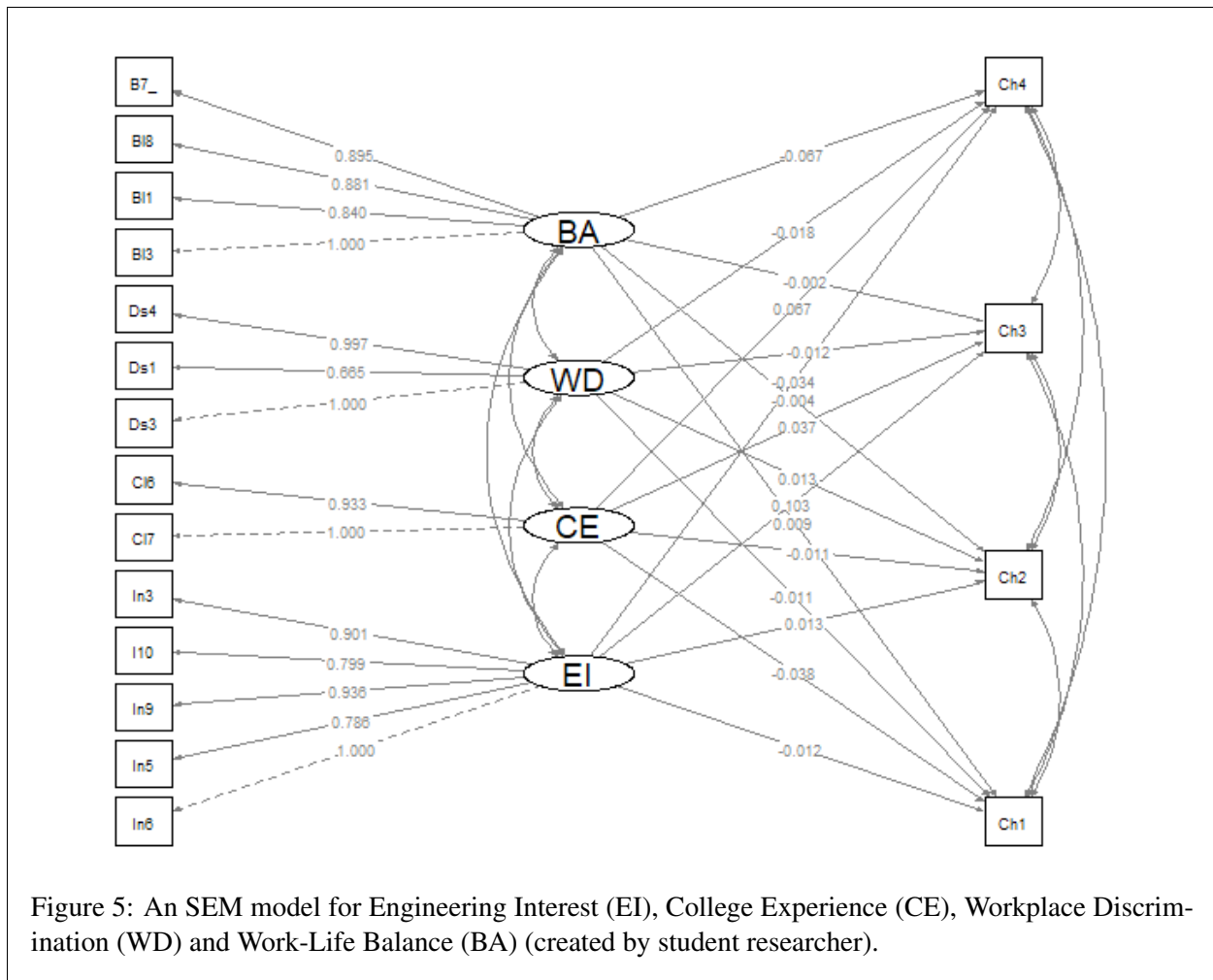
| Engineering Choice | Factor | Coefficient | Standard Error | z     | pvalue |
|--------------------|--------|-------------|----------------|-------|--------|
| Choice1            | EI     | -0.02       | 0.03           | -0.62 | 0.53   |
| Choice1            | CE     | -0.04       | 0.02           | -1.50 | 0.13   |
| Choice1            | WD     | -0.01       | 0.02           | -0.63 | 0.53   |
| Choice1            | BA     | 0.01        | 0.02           | 0.28  | 0.78   |
| Choice2            | EI     | 0.01        | 0.02           | 0.73  | 0.46   |
| Choice2            | CE     | -0.01       | 0.01           | -0.81 | 0.42   |
| Choice2            | WD     | 0.01        | 0.01           | 1.13  | 0.26   |
| Choice2            | BA     | 0.00        | 0.01           | -0.30 | 0.77   |
| Choice3            | EI     | 0.09        | 0.04           | 2.20  | 0.03   |
| Choice3            | CE     | 0.04        | 0.03           | 1.05  | 0.29   |
| Choice3            | WD     | -0.01       | 0.03           | -0.46 | 0.64   |
| Choice3            | BA     | 0.00        | 0.03           | -0.06 | 0.95   |
| Choice4            | EI     | -0.06       | 0.05           | -1.13 | 0.26   |
| Choice4            | CE     | 0.06        | 0.04           | 1.46  | 0.14   |
| Choice4            | WD     | -0.02       | 0.03           | -0.48 | 0.63   |
| Choice4            | BA     | -0.06       | 0.04           | -1.43 | 0.15   |

## Discussion

In this section, possible explanations for each finding was explored and suggestions for both academic and industry were discussed.

### Discussion for RQ1

*RQ1: How do contextual factors influence women's perception of gender discrimination in engineering education?*



Overall, the study found there was little to no gender discrimination on campus. This is likely due to many universities working to create an inclusive environment for women. For example, as of 2023, 6 out of 8 Ivy League universities have women presidents and this reflects the commitment for universities to have gender equality (Gotian, 2023). It can serve as a role model for other universities and eventually the workforce in general.

## Discussion for RQ2

*RQ2: How do demographic factors influence women's perception of gender discrimination and work-life balance at the workplace?*

The data show that younger people perceived lower gender discrimination at the workplace compared to older people. Older employees might have more experience and might recognize gender discrimination that younger employees might fail to recognize. They could have experienced or observed the struggles of rising

to executive positions so they may perceive higher gender discrimination. According to Harvard Business Review, as you move up every corporate level, the proportion of women drops slightly (Chilazi, Bohnet, & Hauser, 2021), which shows that there are probably potential barriers to advancing in position, whether due to gender discrimination or other factors. This agrees with our findings that older women perceived higher gender discrimination.

People who worked less than one year perceived less gender discrimination than people who worked 5 or more years. This may be due to new employees not having enough time to recognize gender discrimination and are focused on learning and getting familiar with their work environment. They also could be excited to join a new workforce and not worry about gender discrimination or be aware of it yet. People who have worked in an organization for 5 or more years may have experienced many instances of gender discrimination. This can be explained by the honeymoon-hangover effect which talks about how when a worker changes jobs, they feel a sudden increase in job satisfaction at the new job but this is followed by a slower decline in job satisfaction (Boswell, Boudreau, & Tichy, 2005). This means that new hires should go through programs that educate them on how to recognize gender discrimination.

Women who had colleagues who were majority men perceived higher gender discrimination than people whose colleagues were equally men and women. In male-dominated workplaces, women may feel left out. If an organization is gender balanced, the organization may already support equal opportunities for men and women, showing less discrimination for women. Also with equal men and women, there is more opportunity for women to provide support to other women. Increasing the number of women in the workplace can provide many benefits like support networks, but it does not guarantee a decrease in gender discrimination. This may also lead to feelings of tokenism where women may feel that they were only hired or promoted because of the need to fulfill a diversity requirement.

People in their first year of their current workplace perceived work-life balance better than people with a longer work duration in their current workplace. New employees might be given more flexibility because they are new to the company and have to adjust. By being flexible, workers are able to work longer hours before their workload negatively impacts their work (Hill, Hawkins, Ferris, & Weitzman, 2001). As time goes on, they will be assigned more responsibilities and tasks to do and this can negatively impact their work-life balance. Also, work-life balance is a relatively new concept. As workers join a new organization now, policies like maternity and paternity leave already exist. Over the years, there has been an increase in paid weeks of leave (DiNapoli, 2023). Long-working employees might remember times when such policies didn't exist, therefore perceiving their work-life balance as worse. Newer employees might have joined their current workplace when these policies existed. Organizations should have regular check-ins with their

employees to ensure that their work-life balance is maintained. Poor work-life balance may lead to burnout which will lower productivity.

### **Discussion for RQ3**

*RQ3: How do demographic factors influence women to choose engineering in college and career?*

People with an undergraduate degree tend to continue working in engineering more than those with a Ph.D degree. Someone with an undergraduate degree may be excited to start working in their field of major while a Ph.D. student might be more focused on academic research and can also work in other fields, not just engineering due to their broader skill set. Ph.D. training equips them with transferable skills that can help them work in a variety of different fields (Sinché et al., 2017). This is important because companies and organizations should focus on this group for long-term retention. Also, universities should better prepare Ph.D. students for work and let them see that engineering is a rewarding career so that they will be more likely to stay in this field in the future.

### **Discussion for RQ4**

*RQ4: How do individual and contextual factors influence women to choose engineering in college and career?*

The SEM analysis showed women were more likely to stay in the engineering field if they had a high interest in the field. This will drive their intrinsic motivation. They will more likely find the field or subject enjoyable and will more likely stay, even if their field is male-dominated. Engineering is a tough field and without the initial interest, it will be really hard to stay in the field. Professors should make their curriculum more interesting and engaging for women to spark their interests and make them more likely to stay in the engineering field.

## **Conclusion**

Women have been underrepresented in STEM fields, especially in engineering. To tackle the issue, it is important to determine the underlying causes. To this end, a survey was designed and conducted, and then the results were analyzed. It was found that there were significant differences in the perception of gender discrimination, work-life balance, and engineering choice among different demographic groups. The results also showed gender discrimination was much less severe on campus than in the workplace. Additionally, the results indicated interest in engineering was a significant factor in women's decisions to stay in the field. The

findings of this research are mostly consistent with those from previous studies. However, a key difference is that this study identified less gender discrimination on campus compared to earlier findings.

In the future, it would be helpful to track the race and the geographic location of the participants. This is because different racial groups may face different challenges and have different expectations. Different geographic locations may have different industry practices and policies in their workplace. Finally, an increase in sample size will help get more accurate and consistent results. Doing this study again in the future can offer an understanding of how perceptions have changed about women's campus and workplace experience because of changing standards and practices.

## Appendix: Survey Questions

### I) Three Screening questions:

1. What is your gender?
2. What is your age?
3. Did you complete a major in engineering in college?

### II) Five Demographic questions, which are related to RQ2 and RQ3:

1. What is your highest education degree?
2. What is your duration of work in your current organization?
3. Do you work for a public or a private employer?
4. Among your colleagues are there mostly women or men?
5. In your work do you cooperate/collaborate (for example with co-partners, clients, students, etc) more with men or women?

### III) Ten Engineering Interest (EI) questions (Toker & Gültaş, 2019), which are related to RQ4,

1. I enjoy comparing and contrasting two perspectives on a topic related to engineering
2. I enjoy reasoning about different perspectives in an engineering area-related technical debate
3. I get satisfaction out of working on integrating ideas from the different areas of engineering
4. I like thinking about the implications and future applications of findings in engineering-related areas
5. I like thinking about what the real-world applications of engineering concepts could be
6. I like to integrate findings to make inferences on an engineering-related technical topic
7. I enjoy spending my time thinking to come up with a number of ideas about a topic related to engineering
8. I enjoy using my accumulated knowledge and ideas in engineering to further the advancements of the engineering fields
9. I find it exciting to develop creative ways to solve engineering-related problems
10. I like to critically analyze the strengths and weaknesses of technical propositions in engineering fields

### IV) Ten Campus Experience (CE) questions (Bahnson, Hope, Satterfield, Wyer, & Kirn, 2022), which are related to RQ1 and RQ4:

1. In class, faculty members answered my questions with respect.
2. I heard comments that degraded women often within academic settings (classrooms, labs).
3. I heard sexist comments every semester within academic settings (classrooms, labs).
4. In my experience, MY ADVISOR treated students of different genders the same.
5. In my experience, FACULTY members treated students of different genders the same.
6. I was treated fairly by my advisor in college.
7. I was comfortable discussing ENGINEERING OR TECHNICAL topics with my advisor.

8. I was comfortable discussing PERSONAL topics with my advisor.
9. In the classroom/lab, my advisor never talks down to students.
10. It is common for a female graduate student to present an idea and get no response, and then for a male student to present the same idea and be acknowledged.

After IV), a screening question was asked: Have you ever worked in the engineering field? Those who answered NO were instructed to skip sections V) and VI) and go directly to section VII).

V) Five Gender Discrimination at Workplace (WD) questions, which are related to RQ2 and RQ3:

1. Receiving less pay for the same jobs as men
2. Experiencing threats to my personal safety on a day-to-day basis
3. Having to work harder than men to get the same recognition
4. Not receiving the same career opportunities as men
5. Being victims of sexual harassment

VI) Then Work-Life Balance (BA) questions, which are related to RQ2 and RQ3:

1. Overall, I believe that my work and other activities are balanced.
2. It is easy for me to manage the demands of my work and personal life.
3. I feel satisfied with my work-life balance.
4. I prioritize my job over my personal life.
5. I prioritize my family over my work.
6. I sacrifice sleep to spend time with my family.
7. I have difficulty balancing my work and other activities.
8. I feel that the job and other activities are currently balanced.
9. My job and personal life do not interfere with each other.
10. I often work overtime.

VII) Four Engineering Choice questions, which are related to RQ3 and RQ4:

1. Did you choose engineering as your major to pursue it as a career after college? (Y/N)
2. Are you currently working in an engineering-related field? (Y/N)
3. I intend to continue working as an Engineer. (Y/N/Not Sure)
4. Have you ever left a career in the engineering field to pursue another field? (Y/N)

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