Characterization of Stress, Sense of Belonging, and Engineering Identity in First-Year Engineering Students

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Introduction

The National Academies of Science, Engineering, and Medicine are private, non-governmental institutions consisting of three entities: the National Academy of Sciences, the National Academy of Engineering, and the National Academy of Medicine. These agencies are working collectively to guide the nation on science and technology, integrate the practice of engineering into national advisory efforts, and provide advice on medical and health-related issues. The report entitled 'Barriers and Opportunities for 2-year and 4-year STEM Degrees: Systematic Change to Support Students' Diverse Pathways,' from the National Academies of Sciences, Engineering, and Medicine [1] focuses on furnishing a comprehensive overview of the current challenges faced by students aspiring to attain an engineering degree or certificate. As such they explore the available opportunities and strategies needed to surmount these barriers associated with the culture of engineering education, defined as the shared patterns of norms, behaviors, and values within engineering disciplines that significantly impact teaching methods, and the overall classroom experience.

Over the past ten years, there has been a theoretical shift in education research that recognizes all learning is a cultural process [2]. They define 'culture' in engineering education as the explicit and implicit customs, behaviors, norms, and values considered standard or typical in engineering and propose an ecological framework that draws mainly from cognitive and sociocultural theories for learning in "places and pursuits" [2].

A proposed theoretical framework or cultural map for the way of "knowing ourselves" and "how we do things around here" at the departmental, disciplinary, or institutional level is built on the premise that culture remains the source of value, meaning, and ways of understanding for people who live within it [3]. The study [3] emphasizes that culture is not static but rather open to shifting values and cultural norms, and any snapshot of a culture is set within a specific place and time. Thus, these reports [1, 2, 3] collectively emphasize the importance of understanding differences of view in the culture of engineering education before any effective culture changes in engineering education could be introduced.

Since the 1990s, there have been enormous studies calling for a cultural change in the environment of higher education and focusing directly on the culture of engineering education. Several research studies [4, 5, 6, 7] acknowledge that the social, psychological, and structural aspects of STEM education in colleges and universities play an important role in shaping how students align their identities with their academic domains in such a way that this alignment termed their academic identities has a certain impact on their efforts and achievements. The study [8] reveals that the college experience for individual students is influenced by their perceptions of interpersonal interactions and norms, which a reflective of the college culture and thus play a pivotal role in shaping student performance, engagement, and persistence, surpassing predictions solely based on socioeconomic status or academic preparedness indicators.

The fundamental concept of Engineering Stress Culture (ESC) originates from the unique demands and challenges inherent in the culture of engineering education which equates learning with suffering and shared hardship identity, as emphasized in one of the six pillars of cultural dimension by [3]. The heightened intensity and exclusivity within engineering programs give rise to what is termed a 'meritocracy of difficulty' [9]. In another work [10] characterizes ESC as a phenomenon where students perceive high stress and poor mental health as the norm, which identifies as a specific and distinguishable subset within the broader culture of engineering education. Thus, ESC is intricately connected to the shared patterns of norms, behaviors, and values within engineering disciplines during this study period.

Within engineering education, much research work has independently explored the impact of a strong sense of belonging [11, 12, 13] and engineering identity [10, 14, 15, 16, 17] on students' overall mental health well-being (MHW) and academic success [18, 19]. However, the clarification of a connection between all three factors within the context of engineering stress culture (ESC) in first-year engineering courses remains unclear. This paper presents a study aimed at examining the influence of the sense of belonging and engineering identity in the Engineering Stress Culture (ESC) within first-year engineering courses and how these constructs vary across student demographics. The analysis is based on survey data collected at the end of the fall semester of 2023.

Methods

Survey Design

After approval from IRB, an online Qualtrics survey was completed by the study participants at the end of the Fall of 2023 at a higher education institution in the Midwest. The study participants were 18 years or above and in their first year of engineering education. In addition to participant demographics, the survey collected data about participants' sense of belonging, engineering identity, and perceived stress.

The survey incorporated a measure of a sense of belonging [11] that assessed two constructs: three items each on general belonging in the engineering major and belonging in the engineering classroom.

The assessment of engineering identity in the survey included a professional identity scale [14] that is based on social cognitive theory focusing on self-efficacy beliefs and outcome expectations, as proposed by [20]. This scale comprised three constructs, each with three items related to recognition by others and interest, and five items on competence/performance.

Additionally, the survey integrated a perceived stress scale [21] that was developed for use with higher education students. The Perceived Stress Scale (PSS) derived its score from 10 questions inquiring about the student's feelings and thoughts over the last month.

The dataset addresses five outcomes (SBM, SBC, EIR, EIT, EIC, and PS), each corresponding to specific constructs as detailed in Table 1. Two outcomes (SBM and SBC) are related to the sense of belonging—one to the engineering major and the other to the engineering classroom.

Additionally, three outcomes (EIR, EIT, and EIC) are associated with the three engineering identity constructs: EIR focuses on Recognition by Others, and EIT and EIC address Interest and Competence / Performance respectively. Lastly, PS represents a single outcome on the Perceived Stress Scale (PSS), derived from 10 questions assessing the student's feelings and thoughts over the previous month.

Table 1. Description of Constructs in First-Year Engineering Undergraduate Experience.

Outcome no.	Constructs	*Descriptions*
SBM	Sense of Belonging: Engineering Major	*How do comfort, belonging, and enjoyment in engineering among first-year undergraduate students relate to the overall satisfaction in their major?*
SBC	Sense of Belonging: Engineering Classroom	*Do perceived levels of support, sense of belonging, and enjoyment in learning engineering contribute to the sense of belonging in the engineering classroom for first-year engineering undergraduate students?*
EIR	Engineering Identity: Recognition by Others	*Do the perceptions of being recognized as an engineer by parents, instructors, and peers influence the engineering identity of first-year engineering undergraduate students?*
EIT	Engineering Identity: Interest	*How do individuals' interest, enjoyment, and fulfilment in engineering activities relate to their overall engineering identity?*
EIC	Engineering Identity: Competence/Performance	*How do individuals' confidence in understanding engineering concepts, perceived competence in exams, and being sought after for help in the subject relate to their overall sense of competence within their engineering identity?*
PS	Perceived Stress	*How do first-year engineering undergraduate students reflect on their feelings and thoughts about perceived stress in the last month?*

Therefore, the statistical significance test of the hypotheses concerning these outcomes aims to determine if there are differences in mean across all constructs among gender groups (Female vs. Male) and ethnicity/race groups (African American vs. White) respectively. Additionally, we examine whether there is a difference in the correlation between outcome constructs by gender groups (Female vs. Male) and by race (African American vs. White).

Both the sense of belonging and engineering identity assessments utilized a 7-point Likert scale, which is a specific type of anchored numeric scale. Responses ranged from 0 (Strongly Disagree) to 6 (Strongly Agree). Similarly, the Perceived Stress Scale (PSS) was evaluated on a 5-point Likert scale, with response options ranging from 0 (Never) to 4 (Very Often). The Likert scales align with the concept of self-rated measures mentioned by [21]. Both the statistical and descriptive analyses were performed using Statistical Packages RStudio (version 2023.12.1), Excel, and online tools [22].

Participants and Data Collection

The database comprises 705 entries, facilitating a comprehensive demographic analysis as detailed in Table 2. Regarding gender distribution, Female represent 25.3% of the entries, while the majority (73%) identify as Male. A small percentage (1.7%) identified as another gender or opted not to disclose, thereby limiting our ability to analyze participant trends within these

groups separately due to small sample sizes. Therefore, we have excluded those who identified as another gender or opted not to disclose from the gender analysis.

Table 2. Demographic Breakdown by Gender and Ethnicity/Race (n = 705) for the Fall 2023 First-Year Engineering Undergraduate Experience Survey.

Ethnicity/Race	Gender			Total
	Female n (%)	Male n (%)	Other n (%)	
Asian	25 (3.6%)	48 (6.8%)	1 (0.2%)	74 (10.6%)
Black or African American	9 (1.3%)	21(3%)	-	30 (4.3%)
More than one race	7 (1%)	21 (3%)	3 (0.4%)	31 (4.4%)
Native American or Alaska Native	-	1 (0.1%)	-	1 (0.1%)
Native Hawaiian or Pacific Islanders	-	1 (0.1%)	-	1 (0.1%)
Other ethnicity/race	2 (0.3%)	8 (1.1%)	-	10 (1.4%)
White	135 (19.1%)	415 (58.9%)	8 (1%)	558 (79.1%)
Total	178 (25.3%)	515 (73%)	12 (1.7%)	705 (100%)

Regarding the demographic data, the survey reveals a predominantly Male respondent base, with White individuals constituting the majority. Specifically, 59% of the respondents identify as White and Male. These findings are consistent with several studies [23, 24], underscoring the prevalence of White students, particularly Male, in engineering.

Results and Discussion

Sense of Belonging

Table 3 presents the total score and standard deviation of self-rated sense of belonging (Belonging, SBM, and SBC) for the first-year engineering undergraduate experience survey at the end of the Fall of 2023, categorized by gender and ethnicity.

Table 3. The Total Score, Standard Deviation, and Correlation of Sense of Belonging by Gender and Ethnicity for the Fall 2023 First-Year Engineering Undergraduate Experience Survey.

Group		Counts (n)	Belonging	Major (SBM)	Classroom (SBC)	Pearson's product-moment correlation (r)
			Total Score (Standard Deviation)			$r_{(SBM, SBC)}$
Gender	Female	178	25.66 (7.36)	12.70 (3.99)	12.96 (3.78)	0.791
	Male	515	26.78 (6.94)	13.44 (3.71)	13.34 (3.51)	0.849
	p-value *($p < 0.05$)	-	0.076	0.03*	0.243	0.021*
Ethnicity	African American	30	24.70 (8.64)	12.27 (4.49)	12.43 (4.26)	0.949
	White	558	26.59 (6.96)	13.30 (3.79)	13.29 (3.50)	0.820
	p-value *($p < 0.05$)	-	0.248	0.266	0.288	0.0001*

Overall, Female scored lower on average across Belonging, SBM, and SBC compared to Male. However, this difference was not statistically significant, except within SBM, Major. This significant difference suggests that Female's belief in comfort, belonging, and enjoy being in the engineering major appears to be weaker than that of Male.

Additionally, there is a strong positive correlation between the engineering major and the engineering classroom for both Female ($r = 0.791$) and Male ($r = 0.849$), with a significant difference between the two correlations at $p < 0.05$. This suggests that among both genders, there is a substantial association between being in an engineering classroom and pursuing an engineering major. Notably, success or satisfaction within the engineering classroom may somewhat more predictively influence positive feelings toward the engineering major for Male compared to Female.

A strong positive correlation exists between the sense of belonging in SBM and SBC for ethnic groups. African Americans demonstrate a stronger correlation coefficient of 0.949 compared to Whites ($r = 0.820$), indicating a significant difference between the two correlations at $p < 0.05$. This suggests that for African American and White students, feeling a sense of belonging in the engineering classroom is highly correlated with feeling a sense of belonging in the engineering major. Notably, this association is significantly stronger for African American students compared to White students. The pronounced connection observed may imply that fostering an inclusive and supportive environment within the engineering classroom could directly enhance the major experience, particularly for African American male students.

The strong positive correlation observed between the sense of belonging in the engineering classroom and the engineering major, across both gender and ethnicity groups, supports prior research [11], which highlighted a significant correlation effect between belonging in the

engineering classroom and the major. Furthermore, [1] suggests that when students establish a sense of belonging to an academic setting, it can enhance their academic engagement and students' identification with their major. These findings support that when students feel a sense of belonging in their engineering classroom, they will likely experience a similar sense of belonging in the engineering major.

Therefore, creating an inclusive and supportive environment within the engineering classroom will possibly enhance the sense of belonging in the engineering major for all students, with a particular emphasis on benefiting both Male students and African American students, especially African American Male, who constitute 3% of the participants in this study.

Sense of Belonging and Perceived Stress

Table 4 presents the correlation between self-rated perceived stress (PS) and the sense of belonging (Belonging, SBM, and SBC) for the first-year engineering undergraduate experience survey at the end of the Fall of 2023, categorized by gender and ethnicity.

Table 4. Correlation of Perceive Stress and Sense of Belonging by Gender and Ethnicity for the Fall 2023 First-Year Engineering Undergraduate Experience Survey.

Group		Counts (n)	Perceived Stress (PS)	Pearson's product-moment correlation (r) (SBM = Eng. Major, SBC = Eng. Classroom, PS = Perceived Stress)			
			Total Score (Standard Deviation)	r (PS, Belonging)	A r (PS, SBM)	B r (PS, SBC)	A > B p-value *(p<0.05)
Gender	Female	178	22.69 (6.69)	-0.382	-0.357	-0.365	0.429
	Male	515	18.53 (6.92)	-0.323	-0.304	-0.318	0.271
	p-value *($p < 0.05$)	-	0.0001*	0.441	0.248	0.276	-
Ethnicity	African American	30	22.67 (7.92)	-0.395	-0.398	-0.381	0.382
	White	558	19.12 (7.11)	-0.346	-0.336	-0.324	0.308
	p-value *($p < 0.05$)	-	0.002*	0.387	0.358	0.371	-

The self-rated PS score for Female is 22.69 (95% CI: 21.71 to 23.67), indicating that they perceive stress as "Sometimes" according to the Likert scale. In contrast, Male have a lower PS score of 18.53 (95% CI: 17.93 to 19.13), suggesting that they perceive stress as "Almost Never" according to the Likert scale. This difference in PS scores between Female and Male is statistically significant.

African Americans recorded a total PS score of 22.67 (95% CI: 19.84 to 25.50), indicating a range of stress perceptions from "Almost Never" to "Sometimes" based on Likert scale. In contrast, Whites scored lower at 19.12 (95% CI: 18.53 to 19.71), predominantly indicating stress

levels as "Almost Never" from the Likert scale perspective. This disparity in PS scores between African Americans and Whites remains statistically significant even after bootstrapping, which adjusts for the differing sample sizes between the two groups.

These findings suggest that Female and African Americans tend to perceive higher levels of stress compared to Male and White, respectively. This result aligns with previous studies [10, 25, 26], which reported elevated stress levels among female students.

Table 4 reveals a moderate negative correlation between PS and the sense of belonging constructs across gender and ethnicity groups, indicating that higher perceived stress levels are associated with lower levels of belonging, regardless of gender or ethnicity. In other research [12], a one-unit increase in the sense of belonging was associated with a 0.23-unit decrease in the frequency of student-reported mental health problems during the academic year. The study also highlighted that the sense of belonging explained only 8.6% of the variance in the mental health indicators, emphasizing the complex and multifaced nature of mental well-being factors.

Despite slight variations among the correlation values, Female show a slightly stronger negative correlation (range: -0.357 to -0.382) compared to Male (range: -0.318 to -0.323), and similarly, African Americans demonstrate a slightly higher negative correlation range (range: -0.381 to -0.395) compared to Whites (range: -0.324 to -0.346). All groups exhibit a consistent medium effect size regarding the correlation between perceived stress and a sense of belonging. Consequently, lower levels of perceived stress among Male and Whites within their respective gender and ethnic groups may not significantly affect feelings of belonging within the engineering context, as compared to Female and African Americans, respectively.

In general, Female tend to exhibit a heightened awareness of the relationship between perceived stress and sense of belonging, as indicated by their higher PS scores and a stronger negative correlation between perceived stress and sense of belonging, compared to males within the gender context. Similarly, African American may demonstrate a greater ability to predict the connection between perceived stress and the sense of belonging compared to White within the ethnic context. As reported by [13], African American students experience greater sensitivity about their belonging in the education setting than nonminority, and their social belonging intervention has improved African Americans' self-reported health and well-being.

Engineering Identity

Table 5 presents the total score and standard deviation of self-reported engineering identity at the end of Fall 2023 from the first-year engineering undergraduate experience survey among participant groups, categorized by gender and ethnicity.

Table 5. The Total Score and Standard Deviation of Engineering Identity by Gender and Ethnicity for the Fall 2023 First-Year Engineering Undergraduate Experience Survey.

Group		Counts (n)	Engineering Identity	Recognition by Others (EIR)	Interest (EIT)	Competence (EIC)
			Total Score (Standard Deviation)			
Gender	Female	178	48.54 (11.01)	13.11 (3.28)	14.40 (3.25)	21.02 (6.10)
	Male	515	50.39 (10.63)	13.42 (3.21)	14.46 (3.20)	22.51 (5.44)
	p-value *($p < 0.05$)	-	0.052	0.286	0.833	0.004*
Ethnicity	African American	30	42.90 (11.19)	12.70 (3.39)	14.77 (2.88)	15.43 (6.95)
	White	558	50.13 (10.67)	13.36 (3.21)	14.51 (3.20)	22.26 (5.56)
	p-value *($p < 0.05$)	-	0.002*	0.305	0.641	0.0001*

Referring to Table 5, Male exhibits a higher mean score over the Female on all three constructs of the Engineering Identity. The difference in the mean scores of these engineering identity constructs between Male and Female is not statistically significant, except for EIC, Competence. This suggests that while both genders generally share positive beliefs about engineering identity, Female exhibit weaker confidence in understanding engineering concepts, perceived competence in exams, and being sought after for help in the subject of engineering competence, compared to Male.

In terms of ethnicity, Whites scored significantly higher in Engineering Identity compared to African Americans at $p < 0.05$, and this result remains statistically significant even after bootstrapping. A statistically significant difference ($p < 0.05$) was observed in the EIC score, indicating that White exhibited greater confidence in understanding engineering concepts and their abilities within the field compared to African Americans, who displayed a more neutral sentiment. This suggests that African American students may not only lack a strong identification with engineering but significantly perceive themselves as less competent in the field compared to their White counterparts.

The broader insight from previous research [15] highlights that "Performance/competence" positively predicts both "Interest" and "Recognition by Others". Table 6 presents the correlation of engineering identity constructs (specifically, EIR = Recognition by Others, EIT = Interest, and EIC = Competence) from the first-year engineering undergraduate experience survey at the end of Fall 2023. The engineering identity correlations represent the intersection of three measurable dimensions: students' belief in their competence/performance, the recognition they receive from others, and their interest in engineering [14]. The intersection of constructs is built on the premise of symbolic interactionism for the understanding of the engineering role of identity [14], as someone would self-rate themselves differently in each of these dimensions and envision various configurations of engineering identity. As shown in Table 6, all correlations among these constructs show a positive and moderate to strong relationship across gender and ethnic groups.

Table 6. Correlation of Engineering Identity Constructs by Gender and Ethnicity for the Fall 2023 First-Year Engineering Undergraduate Experience Survey.

Group		Counts (n)	Pearson's product-moment correlation (r) (EIR= Recognition by Others, EIT = Interest, EIC = Competence)					
			A $r_{(EIR, EIC)}$	B $r_{(EIR, EIT)}$	C $r_{(EIC, EIT)}$	A > B *p*-value *(*p*<0.05)	C > A *p*-value *(*p*<0.05)	C > B *p*-value *(*p*<0.05)
Gender	Female	178	0.621	0.527	0.670	0.025	0.169	0.002*
	Male	515	0.675	0.664	0.734	0.313	0.013*	0.001*
	p-value *(*p* < 0.05)	-	0.143	0.007*	0.074	-	-	-
Ethnicity	African	30	0.670	0.388	0.447	0.036*	0.083	0.336
	White	558	0.665	0.644	0.717	0.179	0.014*	0.001*
	p-value *(*p* < 0.05)	-	0.482	0.036*	0.016*	-	-	-

Across the gender groups, there's a significant disparity in correlation coefficients between Females and Males concerning the relationship between EIR and EIT. Male students demonstrate a stronger association between recognition by others and interest in the field, with a correlation coefficient of 0.664 compared to 0.527 among female students. Consequently, this suggests that concerning the relationship between recognition by others and interest, male students perceived a stronger relationship between recognition by others and interest in shaping their identity in engineering compared to female students.

Across the ethnic groups, a significant difference in correlation exists between African American and White students concerning the relationships between EIR and EIT, as well as between EIC and EIT. In both cases, White students display stronger correlations. This suggests that White demonstrate a stronger relationship between recognition by others and interest, as well as between competence and interest, in shaping their identity in engineering compared to African American students.

Among females, there's a statistically significant difference at $p < 0.05$ between the correlations of "competence and interest" and "recognition by others and interest". This suggests that the correlation between "competence and interest" is stronger than "recognition by others and interest" (i.e., C > B). This finding implies that the relationship between competence and interest in engineering plays a stronger role in shaping females' identity in the engineering field. Therefore, it's possible to enhance females' confidence in their engineering competence and interest to foster their identity and engagement.

From Table 6, it is evident that both the Male and White groups display a stronger correlation between "competence and interest" compared to the correlation between "recognition by others

and competence" (i.e., C > A) or "recognition by others and interest" (i.e., C > B), and this difference is statistically significant at $p < 0.05$. This suggests that for both groups, Male and White, the balance between self-recognition of competence and interest in engineering may strongly influence their identity in the field, particularly among White males, who comprise 59% of the participants in this study.

For African Americans, the correlation between 'recognition by others and competence' is stronger than the correlation between 'recognition by others and interest' (i.e., A > B), and this difference is statistically significant at $p < 0.05$. Thus, the impact of the relationship between feelings of recognition by others and competence in engineering may strongly influence African Americans' identity in the field. This result suggests that a balance between recognition by others and self-recognition of competence is significant for fostering a positive engineering identity among African Americans.

Table 7 presents the Likert scale score and standard deviation of engineering identity from the first-year engineering undergraduate experience survey at the end of Fall 2023 among participant groups, categorized by gender and ethnicity. Within each group (Female, Male, and White), there is a significant difference in the satisfaction Likert scale score between two specific comparisons: EIR versus EIT and EIT versus EIC. Notably, higher satisfaction scores are observed for interest than recognition by others and competence, respectively. This implies that within these groups of students (Female, Male, and White), there is strong evidence that students exhibit high interest in the engineering field. Additionally, while competence and recognition by others also play a role in shaping their identity, they may be perceived to be relatively less significant compared to interest.

Table 7. The Likert Scale Score and Standard Deviation of Engineering Identity by Gender and Ethnicity for the Fall 2023 First-Year Engineering Undergraduate Experience Survey.

Group		Counts (n)	Recognition by Others (EIR)	Interest (EIT)	Competence (EIC)	Turkey's adjusted *p*-value *($p < 0.05$)		
			Likert Score (Standard Deviation)			EIR vs. EIT	EIR vs. EIC	EIT vs. EIC
Gender	Female	178	4.37 (1.09)	4.80 (1.08)	4.20 (1.22)	0.01*	0.35	0.0001*
	Male	515	4.47 (1.07)	4.82 (1.07)	4.50 (1.09)	0.001*	0.896	0.001*
	p-value *($p < 0.05$)	-	0.286	0.833	0.004*	-	-	-
Ethnicity	African	30	4.23 (1.13)	4.92 (0.96)	3.09 (1.39)	0.065	0.001*	0.0001*
	White	558	4.45 (1.07)	4.84 (1.07)	4.45 (1.12)	0.0001*	1.00	0.0001*
	p-value *($p < 0.05$)	558	0.305	0.641	0.0001*	-	-	-

Table 7 reveals a significant difference in the satisfaction Likert scale score among African Americans between EIR versus EIC and EIT versus EIC with lower satisfaction scores on

perceived competence versus recognition by others and interest. This suggests that African American students may hold different beliefs about their engineering identity, potentially lacking competence while expressing relatively high interest and perceived high recognition by others in the engineering field.

Perceived Stress and Engineering Identity

Table 8 illustrates the correlation between perceived stress and engineering identity by gender and ethnicity for the Fall 2023 First-Year Engineering Undergraduate Experience Survey, indicating an overall negative weak to negative moderate correlation across gender and ethnic groups.

Table 8. Correlation of Perceive Stress and Engineering Identity by Gender and Ethnicity for the Fall 2023 First-Year Engineering Undergraduate Experience Survey.

Group		Counts (n)	Pearson's product-moment correlation (r) (EIR = Recognition by Others, EIT = Interest, EIC = Competence, PS = Perceive Stress)						
			r (PS, Identity)	A r (PS, EIR)	B r (PS, EIT)	C r (PS, EIC)	A > C p-value *(p<0.05)	B > C *p*-value *(*p*<0.05)	B > A *p*-value *(*p*<0.05)
Gender	Female	178	- 0.211	- 0.207	- 0.026	- 0.257	0.216	0.00006*	0.006*
	Male	515	- 0.296	- 0.273	- 0.191	- 0.305	0.172	0.0001*	0.009*
	p-value *($p < 0.05$)	-	0.150	0.212	0.028*	0.276	-	-	-
Ethnicity	African	30	-0.440	-0.399	-0.047	- 0.494	0.696	0.008*	0.039*
	White	558	- 0.271	- 0.243	- 0.155	- 0.290	0.0787	0.00001*	0.006*
	p-value *($p < 0.05$)	-	0.162	0.188	0.290	0.109	-	-	-

Within the genders (Female, Male) and the ethnicities (African American, White) group, there is a significant difference in correlation concerning the relationships between "PS and EIT" and "PS and EIC", as well as between "PS and EIT" and "PS and EIR", indicating that correlation between "perceived stress and interest" consistently exceeds the correlations between "perceived stress and competence" and "perceived stress and recognition by others" respectively.

This suggests that the relationship between perceived stress and interest is less strongly associated with the relationship between perceived stress and competence and perceived stress and recognition by others within the field, across diverse demographic groups. The observed correlation relationship suggests a slight tendency for higher levels of perceived stress to be associated with slightly lower interest in the field. However, further research is needed to determine causality and identify any underlying factors influencing this relationship.

Additionally, there is a statistically significant difference in correlation between Female and Male students concerning the relationships between PS and EIT. This finding suggests that the impact of perceived stress on interest in engineering may be more pronounced among males

compared to females. For females, the very weak negative correlation between perceived stress and interest in engineering compared with their male counterparts suggests that even if interest is not strong, the risk of higher levels of perceived stress is low.

Conclusion

In summary, the end of Fall 2023 first-year engineering undergraduate experience survey reveals a predominant demographic of White Male respondents. Both Male and White groups demonstrate a positive perception and relatively higher mean scores of a sense of belonging and engineering identity within their respective gender and ethnicity groups. There is a strong positive correlation between the engineering classroom and the engineering major experience across gender and ethnic groups, highlighting the importance of fostering inclusivity and support within the engineering classroom that could directly enhance their major experience, particularly for African American male students. Female and African American students demonstrate relatively higher perceived stress levels compared to Males and White, respectively. Notably, Female and African Americans demonstrate a greater ability to predict the connection between perceived stress and a sense of belonging. Within the Female, Male, and White groups, the relationship between perceived competence and interest in the engineering field may play a stronger role in shaping their engineering identity. Conversely, for African American students, the impact of the relationship between recognition by others and competence in engineering may strongly influence their identity in this field. Across the gender group, Male students perceived a stronger relationship between recognition by others and interest in shaping their engineering identity compared to Female students. Additionally, across the ethnic group, White students indicate the relationship between recognition by others and interest, as well as perceived competence and interest exert a stronger influence on their engineering identity compared to African American students.

Perceived stress shows a weaker association with individuals' interest in engineering compared to their relationship with competence or recognition by others, suggesting a lower risk of stress even when interest is not strong, particularly for female students. Further research is essential to establish causality and uncover underlying factors influencing the relationship between a sense of belonging, mental health and well-being (MHW), and engineering identity within the context of Engineering Stress Culture (ESC). This work may also explore how these factors evolve as first-year students progress through subsequent semesters to gain a deeper understanding of how the sense of belonging, engineering identity, ESC, and students' MHW interplay over time, enriching our comprehension of these dynamic relationships.

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