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# FROM ENROLMENT TO DROPOUT: EXPLORING SEX-BASED DISPARITIES IN ENGINEERING EDUCATION TRAJECTORIES

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**Abstract**

Two primary factors contributing to disparities in engineering degrees are the low female enrolment and their high dropout rates. Understanding the reasons behind female students' choices related to engineering and the factors leading to their departure remains critical. This study presents empirical findings on the contrasting factors influencing career choices and dropout intentions among male and female engineering undergraduates. An analysis of data from 602 participants revealed significant differences in career motivations, with males being more self-oriented, whereas females demonstrated a more collectivist approach. Additionally, female students reported higher dropout intentions, correlated with more frequent experiences of discrimination and lower self-esteem. The study also identifies specific contexts within engineering campuses where female students experienced discrimination. By highlighting these differences and underscoring where discrimination occurs, this research enriches the comprehension of the challenges faced by female engineering students. These insights are vital for formulating strategies to boost female engagement and retention in engineering, targeting broader goals of diversity and equality in tertiary education.

***Keywords –*** Career choice motivations, Dropout intentions, Engineering education disparities, Perceived discrimination, Underrepresented females.

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## 1. Introduction

STEM (Science, Technology, Engineering, and Mathematics) careers play a crucial role in driving innovation and economic growth. Strengthening pathways into these fields and developing a competitive workforce must be a priority for educational institutions, industries, and governments (Tytler, 2020). Despite significant progress in education and labour force participation, female participation remains uneven, with a marked underrepresentation in certain scientific disciplines, especially engineering, where they make up just 24% of graduates (National Science Foundation, 2023). Despite efforts to increase female participation in STEM, enrolment patterns remain largely unchanged, and biases persist.

This study makes novel contributions to the understanding of sex disparities in engineering education by expanding the methodological and analytical scope of prior research. First, this investigation applies the FIT-Choice scale, a measure developed by Watt and Richardson (2007) to assess career motivations in education, to the field of engineering. This adaptation provides a new framework for analysing students' motivations for enrolling and persisting in engineering programs, offering a research tool for future studies on career choices in STEM degrees. Additionally, the study takes a comprehensive approach by examining both enrolment and dropout factors for male and female students, incorporating multiple variables to provide a dual-perspective analysis rather than focusing solely on female underrepresentation or a single stage of the educational pipeline. Specifically, it advances the conversation by identifying specific factors that motivate female students to pursue STEM careers, as well as pointing out the specific contexts in which discrimination occurs and the key actors involved. These findings are crucial in determining the unique drivers and barriers that shape female students' experiences in engineering, deepening the understanding of STEM-related disparities. Moreover, the study articulates practical recommendations for academia and policymakers to enhance female participation and retention in engineering programs.

### 1.1. Theoretical Framework

To understand why female students are underrepresented in engineering, it is essential to examine the specific reasons that diminish their interest and threaten their persistence. Previous research has identified two main causes for this underrepresentation: the low number of females enrolling in these programs and the dropout rate among those who do enrol. Studies by Kricorian, Seu, Lopez, Ureta and Equils (2020), Moote, Archer, DeWitt and MacLeod (2020), Seymour and Hunter (2019), and Tandrayen-Ragoobur and Gokulsing (2022) highlighted this concerning trend, emphasizing the urgent need to address both entry barriers and retention challenges to improve diversity in engineering.

Figure 1 illustrates the student learning journey, based on the phases identified by Hunt and Sankey (2013). By understanding the factors influencing female students to enrol or leave engineering programs, universities can develop targeted strategies to support their choices and improve their academic experience. These efforts can boost application rates, improve completion and graduation rates, and ultimately increase the number of female engineers in the workforce.

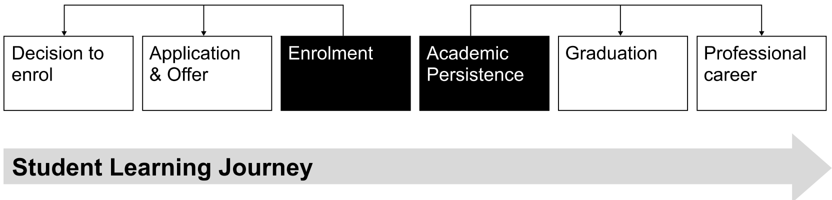


Figure 1. Overview of Fundamental Phases in the Student Learning Journey

Despite initiatives to boost female enrolment in STEM, significant disparities remain in engineering (Eurostat, 2023; National Science Foundation, 2023). Academic research, including a recent study by Tandrayen-Ragoobur and Gokulsing (2022), has revealed that women enrol in STEM-related degree programs at a considerably lower rate than men.

These disparities have often been attributed to stereotypes that dictate the appropriateness of professions based on social roles (Chan, 2022; Gottfredson, 2002; Moote et al., 2020; Parnell, Whiteford & Wilding, 2019). Careers misaligned with the stereotypes often fail to be seen as viable options, diminishing the likelihood of atypical vocational aspirations, such as females pursuing engineering (Baltà-Salvador, Peña, Renta-Davids & Olmedo-Torre, 2024; Makarova, Aeschlimann & Herzog, 2019; Moote et al., 2020). Therefore, achieving gender parity in STEM enrolment rates requires a detailed analysis of career selection processes and the influences shaping them, including sex differences.

Previous psychological research has highlighted several relevant factors influencing career choice, such as vocational interest (Hansen & Wiernik, 2018; Holland, 1997; Kim & Beier, 2020; Nye, Su, Rounds & Drasgow, 2012; Stoll & Trautwein, 2017), outcome expectations (Ertl, Luttenberger & Paechter, 2017; Leaper & Starr, 2019; Moote et al., 2020), confidence in relevant skills (Banchefsky & Park, 2018; Ertl et al., 2017; McGuire, Mulvey, Goff, Irvin, Winterbottom, Fields et al., 2020; Tandrayen-Ragoobur & Gokulsing, 2022), support from teachers, parents, and peers (George-Mwangi, Johnson & Malaney-Brown, 2021; Pitt, Brockman & Zhu, 2020; Tandrayen-Ragoobur & Gokulsing, 2022; Wallis, Locke, Ryall & Harden, 2023), as well as the appeal of high-status and well-paid careers (Hall, Dickerson, Batts, Kauffmann & Bosse, 2011).

Nevertheless, it is essential to explore how career choice factors vary between male and female students. Only with this comparison will it be possible to determine whether current recruitment strategies are valid for students of both sexes, and whether targeting female students in a specific way may be necessary. Prior research indicated that male students often focus on personal and professional ambitions, such as high salaries and prestigious positions, while female students tend to value altruistic goals and a deeper sense of societal contribution (Alfirević, Arslanagić-Kalajdžić & Lep, 2023; Brañas-Garza, Capraro & Rascón Ramírez, 2018; Diekman, Brown, Johnston & Clark, 2010; Fernández, Castro, Otero, Foltz & Lorenzo, 2006; Garibay, 2015; Yang & Barth, 2015). In addition, the study by Prieto-Rodriguez, Sincock, Berretta, Todd, Johnson, Blackmore et al. (2022) identified interest as the most influential factor for female STEM professionals, outweighing financial incentives, work flexibility, and status.

Despite extensive research on the low enrolment of female students in STEM degrees, significant gaps still exist in understanding the factors that motivate individuals, especially females, to pursue engineering careers. Previous studies have primarily focused on factors that deter girls from engaging in STEM fields during their early education (Bian, Leslie & Cimpian, 2017; Riegle-Crumb & Peng, 2021). However, this leaves a concerning void in understanding the positive motivations of female students who choose to major in engineering. Given the evidence that career choice factors vary between male and female students (Diekman et al., 2010; Fernández et al., 2006; Garibay, 2015; Prieto-Rodriguez et al., 2022; Yang & Barth, 2015), assessing career choice factors from a sex-based perspective is essential, especially in engineering where female underrepresentation remains significant. In addition, existing research has broadly categorized all STEM fields together (Mann, Legewie & DiPrete, 2015; Ozis, Pektaş, Akça & DeVoss, 2018), overlooking the nuanced differences between STEM subdisciplines. Grouping engineering with other STEM fields, such as the natural sciences, where female enrolment is higher, makes it hard to determine if career choice factors apply universally across STEM or differ significantly between subdisciplines. Moreover, some studies have only focused on single factors in career choice, leaving a gap in understanding which factors are most influential. Ultimately, there is a need to validate measurement instruments for assessing career choices in engineering. The Factors Influencing Instructional Choice (FIT-Choice) scale, developed by Watt and Richardson (2007), has been widely used to explore factors influencing the choice of a teaching career (Kristmansson & Fjellström, 2022; Martínez-Moreno & Petko, 2023; Wang, Liu, Qiu, Tang, Wang & Zou, 2024). It draws on expectancy-value and social cognitive career theories to examine the motivations and factors driving individuals to pursue teaching careers. Although it has been adapted to fields like healthcare (Almutary & Al-Moteri, 2020), its application in engineering remains largely unexplored.

The underrepresentation of female students in STEM, particularly in engineering, goes beyond initial enrolment and is further impacted by lower retention and graduation rates (Beasley & Fischer, 2012; Ortiz-Martínez, Vázquez-Villegas, Ruiz-Cantisani, Delgado-Fabián, Conejo-Márquez & Membrillo-Hernández, 2023). Female students not only enrol in engineering programs at lower rates but are also more likely to drop out, resulting in fewer female graduates than initial enrolment numbers would suggest (Luttenberger, Paechter & Ertl, 2019). Academic literature has identified significant factors affecting student retention, including academic satisfaction, self-esteem, and perceived discrimination.

Academic satisfaction refers to the degree of contentment, fulfilment, or happiness students experience in their academic life. Numerous studies have demonstrated a strong link between student satisfaction and the likelihood of continuing their studies (Lent, Miller, Smith, Watford, Lim & Hui, 2016; Navarro, Flores, Lee & Gonzalez, 2014; Pedler, Willis & Nieuwoudt, 2022; Roberts & Styron, 2010). Recent research across various disciplines, including business, nursing, and health sciences, has supported that satisfaction with educational environments is crucial for student commitment to their studies (Collard, Scammell & Tee, 2020; Holland, Westwood & Hanif, 2020; Naeem, Aparicio-Ting & Dyjur, 2020). In addition, Rigg, Coller, Reynolds, Levin and McCord (2015) found that women in STEM fields reported lower academic satisfaction than their male counterparts.

Self-esteem is an individual's internal evaluation of their own worth or value, incorporating beliefs like "I am competent" or "I am worthy". Rosenberg's foundational study demonstrated that low self-esteem, often due to prejudice, can negatively impact performance (Rosenberg, 1965). Subsequent studies, like Kwek, Huong, Rynne and So-Bbus (2013), found that self-esteem and resilience significantly influenced academic success in hospitality and tourism undergraduates. Recent investigations across diverse demographics and education levels have reinforced this relationship. Studies in Nigeria (Okoye & Onokpaunu, 2020) and Romania (Lupu, 2023) reported positive connections between self-esteem and academic achievement. Similar results emerged from studies on high school students in Iran (Ahmadi, 2020), Mexican students in grades 5 to 11 (Zheng, Atherton, Trzesniewski & Robins, 2020), and primary school students in Spain (Moyano, Quílez-Robres & Pascual, 2020). Yu, Qian, Abbey, Wang, Rozelle, Stoffel et al. (2022) also found self-esteem to be a significant predictor of academic performance among rural students in China using the Rosenberg Self-Esteem Scale.

Research on the retention of underrepresented students must take perceived discrimination into account (Baltà-Salvador, Olmedo-Torre & Peña, 2022; Prieto-Rodriguez et al., 2022). Academic discrimination, defined as unfair treatment in educational settings based on race, sex, gender, and other personal attributes, significantly harms students' academic experiences and long-term professional prospects. Researchers frequently highlighted perceived discrimination as a barrier to retaining female students in male-dominated fields like engineering (Diele-Viegas, Cordeiro, Emmerich, Hipólito, Queiroz-Souza, Sousa et al., 2021; Hill, Corbett & Andresse, 2010; Ortiz-Martínez et al., 2023; Starr & Leaper, 2019). Stereotypes can foster a hostile environment, hindering the success of students who diverge from social norms and amplifying barriers for females in STEM degrees (Husbands-Fealing & Myers, 2012; Jebsen, Nicoll-Baines, Oliver & Jayasinghe, 2022; Leaper & Starr, 2019; McKinnon & O'Connell, 2020). Prior research has indicated that discrimination in university settings can diminish student engagement and persistence, reducing female students' graduation rates (Beasley & Fischer, 2012; Casad, Petzel & Ingalls, 2019). Additionally, discrimination can correlate with lower self-esteem, particularly among minority students (Casad et al., 2019; Sladek, Umaña-Taylor, Oh, Spang, Tirado, Vega et al., 2020).

While research has advanced in understanding academic persistence, gaps remain, particularly for female engineering students. Additional studies are needed to fully understand sex differences influencing undergraduates' commitment to engineering programs. Furthermore, the connection between academic persistence and self-esteem remains unclear. Previous studies on the underrepresentation of female students in STEM have used other constructs, like self-efficacy or self-concept (Liberatore & Wagner, 2020; Zander, Höhne, Harms, Pfost & Hornsey, 2020). Nevertheless, some studies have indicated that females' lower math confidence is no longer a central factor in explaining their underrepresentation in

STEM fields (Sax, Kanny, Riggers-Piehl, Whang & Paulson, 2015). Therefore, further research should expand and identify other factors that may affect female students' achievement, such as self-esteem, which has a broader scope and can affect females beyond their confidence in math. Finally, while previous literature acknowledged discrimination faced by female engineering students, threatening their academic persistence, it lacks clarity on the timing and nature of these incidents. Some studies have identified discrimination and sexual harassment from peers, professors, and academic staff (Leaper & Starr, 2019; Ong, Smith & Ko, 2018), occurring in classrooms and group work activities (Beigpourian & Ohland, 2023; Leaper & Starr, 2019; Tormey, Fong, Aeby, Vukmirovic & Isaac, 2019). However, these factors are often studied separately, hindering direct comparisons to pinpoint the most relevant situations for discrimination against female engineering students.

The present study aims to expand the current knowledge regarding the disparities in engineering majors by analysing the factors influencing female students' enrolment and dropout rates in these programs while addressing the identified gaps in the literature. This knowledge will help to understand how sex shapes students' educational trajectories in engineering studies and identify critical elements and situations that should be prioritized to develop effective support plans to reduce disparities. Understanding why females are underrepresented in engineering majors and how the gaps can be reduced is crucial for several reasons. Since engineering professions rank among the highest in salaries and job growth (NACE, 2023), the low representation of female students in this field exacerbates disparities in earnings and opportunities. Additionally, increasing the presence of women in engineering can enhance the availability of role models for younger generations, inspiring future participation. Research has shown that individuals are more likely to develop interest and engage in fields where they can identify with role models (Isaacson, Friedlander, Meged, Havivi, Cohen-Zada, Ronay et al., 2020; Kricorian et al., 2020). Furthermore, studying in a diverse environment is crucial to all students' academic growth, fostering critical thinking, innovation, and effective problem-solving (Antonio, Chang, Hakuta, Kenny & Milem, 2004; Bakay, 2023). When female students are not involved in the design of solutions for society's problems, the unique needs and desires of females may be overlooked, and the solutions raised are only analysed from a male perspective that is not representative of the general population. With a more diverse workforce, science and technology products, services, and solutions will be better designed and adequately represent the diversity of society (Hill et al., 2010).

## 2. Present Study

This research examined sex disparities in engineering education, focusing on why female students chose to enrol in engineering degrees and the factors that influenced their intentions to leave before graduation. To this end, the study explored female students' specific motivations for pursuing engineering and the factors that contributed to their dropout, such as perceived discrimination, self-esteem, and academic satisfaction. In addition, it examined the contexts in which female students felt discriminated against in STEM academic environments. The study addressed research gaps in engineering education by applying the FIT-Choice scale to assess career-choice factors in engineering and differentiating results between male and female students. By identifying key enrolment and attrition factors, this research provided empirical evidence to inform strategies for academic institutions and policymakers, supporting efforts to enhance diversity and equality in STEM fields.

With this aim, this research seeks to answer the following questions:

1. What are the main differences between male and female students in their motivations for choosing engineering careers? It was expected that the factors influencing female students' decisions to pursue engineering would differ from those influencing male students (Fernández et al., 2006; Garibay, 2015; Gottfredson, 2002; Moote et al., 2020; Yang & Barth, 2015).

2. How do sex differences manifest in students' perceptions of discrimination, self-esteem, academic satisfaction, and dropout intentions within engineering degree programs? Compared to male students, female students were expected to report lower academic satisfaction and self-

esteem, as well as higher perceptions of discrimination and greater intentions to drop out from engineering programs (Beasley & Fischer, 2012; Casad et al., 2019; Dresden, Dresden, Ridge & Yamawaki, 2018; Leaper & Starr, 2019; Morris & Lent, 2019).

3. Is there a relationship between dropout intentions, perceived discrimination, self-esteem, and academic satisfaction among male and female engineering students? Correlations were anticipated to emerge between dropout intentions and the variables under examination, particularly among female students.

4. What actors and situations contribute to female students' experiences of discrimination in engineering environments, and how do these compare with males' experiences? This study explored which actors and situations caused female students to feel discriminated against on engineering campuses. Comparing the experiences of female and male students provided a deeper understanding of the factors and situations that might be particularly detrimental to female students (Leaper & Starr, 2019; Ong et al., 2018).

## 3. Methodology

### 3.1. Participants

The study was carried out at the Universitat Politècnica de Catalunya · BarcelonaTech (UPC), a public university in Spain specializing in science, technology, engineering, and architecture. A total of 602 engineering students participated in the study by completing a questionnaire. Participation was voluntary, and no incentives were provided. All necessary measures were implemented to protect personal data, and participants provided informed consent to receive communications. Participants' anonymity and the confidentiality of their responses were strictly maintained. Of the 602 participants, 74.8% were male and 25.2% female, a distribution reflecting the sex proportions typically observed in engineering programs (National Science Foundation, 2023).

### 3.2. Measures

A questionnaire was specifically designed for this study, incorporating measures from existing literature and adapting them to align with the engineering context.

To assess the factors motivating the choice of STEM as a career, the study adapted the FIT-Choice scale (Watt & Richardson, 2007), a widely recognized tool for evaluating career choice factors in education, to fit the engineering field. The adapted scale presented students with eleven motivational factors in a multiple-choice question (e.g., "Achieve a high salary").

Students rated their academic satisfaction with their studies on a four-level scale, from "Not satisfied" to "Very satisfied", based on Ramsden's (1991) study.

Following Bunker, Brown, Bohmann, Hein, Onder and Rebb (2013) study, participants were asked how frequently they considered leaving or changing their studies to assess their dropout intentions. Responses were recorded on a four-level scale from "Never" to "Very often".

To evaluate self-esteem, the study used four items from the Rosenberg Self-Esteem Scale (RSES) (Rosenberg, 1965). Students rated their agreement with statements like "I wish I could have more respect for myself" using a four-level Likert scale where higher scores indicated stronger agreement. The self-esteem scale demonstrated good reliability, with a Cronbach's alpha of 0.80.

Finally, participants were asked how frequently they experienced six discriminatory experiences (e.g., "Treated badly or unfairly by a teacher") derived from Pachter, Bernstein, Szalacha and Coll (2010), on a four-level scale from "Never" to "Very often". The scale showed an acceptable reliability, with a Cronbach's alpha of 0.68. Additionally, participants were asked to indicate whether they had ever felt discriminated against on a four-level scale from "Never" to "Very often" and responded to two customdesigned questions exploring the situations in which they had experienced discrimination (e.g., "In administrative procedures") and who was responsible (e.g., "Teachers").

### 3.3. Procedure

The study used an anonymous questionnaire created with Google Forms©. Before distribution, the questionnaire underwent a validation process to ensure it was comprehensive, the questions were clearly formulated, and there were no design flaws or ambiguities. The research team and faculty members recruited participants via email, with a motivational letter explaining the study's purpose. Completing the questionnaire took approximately fifteen minutes, and participants were given a one-week deadline.

After data collection, responses were checked to identify outliers and missing values. Descriptive and frequency analyses were used to summarize the sample characteristics. Differences in career motivation factors and experiences of discrimination between males and females were analysed using the Chi-Square test for independence. The Mann–Whitney U test was applied to examine differences in students' academic experiences based on sex. Relationships between variables were assessed through Spearman's correlation analysis, with statistical significance set at $p < 0.05$.

## 4. Results

The original dataset, which included 602 participants, was carefully analysed to identify irregularities or extreme cases. Four significant outliers were excluded, leaving 598 valid entries. Due to the mandatory nature of the questions, all fields were fully completed and no data gaps were present.

Chi-square tests revealed significant differences between male and female students in the factors that influenced their decision to enrol in engineering studies (Figure 2). Female students were significantly less likely than males to choose engineering based on personal vocation ($N = 598$, $X^2 = 7.33$, $p = .007$) and perceived skills proficiency ($N = 598$, $X^2 = 4.03$, $p = .045$). Female students were also less likely to be influenced by their friends when making this decision ($N = 598$, $X^2 = 7.48$, $p = .006$). In contrast, the influence of family and teachers did not differ significantly between males and females. Notably, females were more likely to be motivated by a desire to positively impact society ($N = 598$, $X^2 = 4.77$, $p = .029$). In contrast, males were more likely to consider job availability ($N = 598$, $X^2 = 8.21$, $p = .004$) and high salary potential ($N = 598$, $X^2 = 21.92$, $p = .000$) as key factors in their decision.

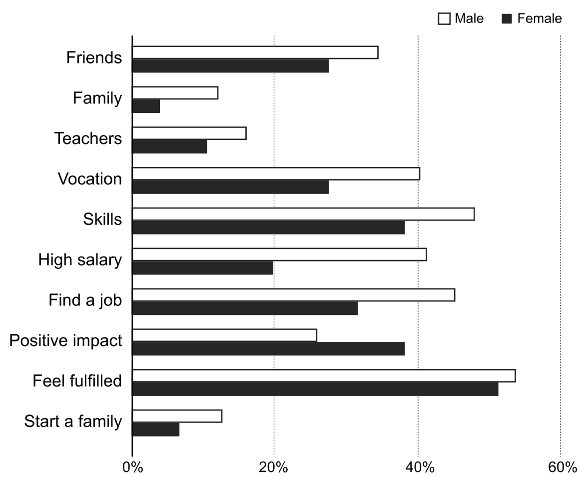


Figure 2. Career Choice Factors by Sex

Table 1 highlights significant differences in self-esteem, perceived discrimination, and dropout intentions between male and female engineering students. Female participants reported lower self-esteem, more frequent experiences of discrimination, and higher dropout intentions than male students in engineering studies. These findings are not only statistically significant but also reveal serious and troubling disparities that require urgent attention. While academic satisfaction did not differ significantly between male and female students, the significant disparities in self-esteem and perceived discrimination are profound and warrant urgent action.

Table 2 shows how self-esteem, discrimination, and academic satisfaction relate to dropout intentions among male and female students. Across both groups, students with lower self-esteem, lower academic satisfaction, and higher experiences of discrimination were more likely to consider dropping out. Among female students, self-esteem had the strongest correlation with dropout intentions. Unexpectedly, while female students reported experiencing more discrimination than males, this was not directly linked to their self-esteem or academic satisfaction.

| **Variable**[a] | **Male**[b] | | **Female**[c] | | ***U*** | ***Z*** | ***p*** |
|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | | | |
| Academic satisfaction | 2.76 | 0.61 | 2.76 | 0.61 | 33488 | -0.26 | .795 |
| Self-esteem | 3.10 | 0.57 | 2.84 | 0.57 | 24713 | -5.05 | .000*** |
| Perceived discrimination | 1.35 | 0.41 | 1.42 | 0.42 | 29670 | -2.37 | .018* |
| Dropout intentions | 1.97 | 0.86 | 2.20 | 0.99 | 30084 | -2.23 | .026* |

*Note.* $N = 598$. [a]Range = 1-4. [b]$n = 446$. [c]$n = 152$. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 1. Students' Differences in Descriptive Statistics and Mann-Whitney U Test by Sex

| **Variable** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| 1. Academic satisfaction | - | .289*** | -.262*** | -.380*** |
| 2. Self-esteem | .171* | - | -.149* | -.306*** |
| 3. Perceived discrimination | -.123 | -.152 | - | .244*** |
| 4. Dropout intentions | -.261** | -.602*** | .234** | - |

*Note.* Male students' results ($n = 446$) above the diagonal; female students' results ($n = 152$) below. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 2. Sex-Based Correlations Among Study Variables

Figure 3 illustrates the disparity in perceived discrimination on engineering campuses based on students' responses to whether they had ever felt discriminated against at university. As the figure shows, a higher percentage of male students reported "never" experiencing discrimination, while a higher proportion of female students reported feeling discriminated against "occasionally" "often" or "very often". Statistical analysis confirmed that females were significantly more likely to perceive discrimination based on their sex ($N = 598$, $X^2 = 24.07$, $p = .000$). These findings underscore the urgency of addressing academic discrimination within engineering studies, as it remains prevalent in university settings.

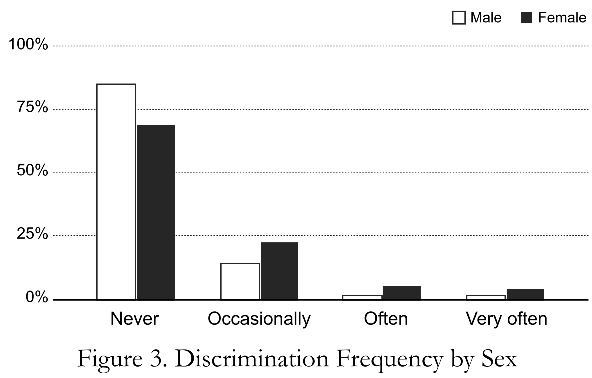


Figure 3. Discrimination Frequency by Sex

Figure 4 shows where students most frequently reported experiencing discrimination and who was responsible for it. Female students reported the greatest levels of discrimination in classes, followed by group work and leisure activities. The chi-square test revealed that female students significantly experienced more discrimination in classes ($N$ = 598, $X^2$ = 11.66, $p$ = .001), group work ($N$ = 598, $X^2$ = 7.60, $p$ = .006), administrative procedures ($N$ = 598, $X^2$ = 13.62, $p$ = .000), and leisure time ($N$ = 598, $X^2$ = 6.29, $p$ = .012) compared to their male counterparts. When asked about the sources of discrimination, female students identified their peers and teachers as the primary sources of discrimination, with administrative staff also playing a significant role in their experiences of discrimination. Statistical analysis confirmed that females were significantly more likely to report discrimination from peers ($N$ = 598, $X^2$ = 16.02, p = .000), teachers ($N$ = 598, $X^2$ = 23.69, $p$ = .000), and administrative staff ($N$ = 598, $X^2$ = 5.99, $p$ = .014) than males, indicating that discrimination in university settings disproportionately affects female students, both in academic and social contexts.

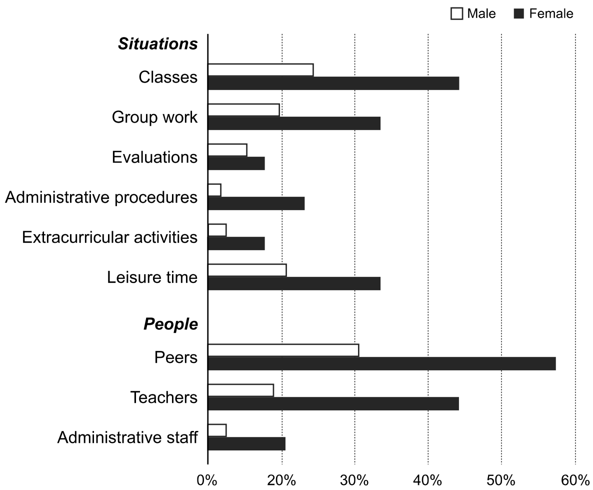


Figure 4. Discrimination Factors by Sex

## 5. Discussion

Boosting female participation in STEM careers remains a major challenge in higher education (National Science Foundation, 2023; World Economic Forum, 2023). This study examines the academic experiences of male and female engineering students, focusing on career choice and dropout intentions. The findings provide an updated view on female participation in engineering, highlighting whether enrolment and retention challenges have evolved or remain unchanged.

Regarding sex differences in the factors influencing students' decisions to pursue engineering, male students were more likely than female students to choose STEM studies because of their skills and vocational interests, reflecting prevalent stereotypes in engineering careers (Banchefsky & Park, 2018; Bian et al., 2017; Chan, 2022; Froehlich, Tsukamoto, Morinaga, Sakata, Uchida, Keller et al., 2022; Hill et al., 2010; Kong, Wang & Zhang, 2023). According to a recent study by Camarero-Figuerola, Renta-Davids, Tierno-García and Gilabert-Medina (2022), students who choose a career based on vocation tend to adopt deeper and more strategic learning approaches, which enhance their academic results. Therefore, the lower likelihood of females choosing engineering careers based on vocation may ultimately affect their performance and completion rates.

Notably, female students were more motivated to study engineering to positively impact society than their male counterparts. In contrast, male students were more likely to choose engineering for the potential of a high salary and the ease of job acquisition. These findings are consistent with previous psychological research on career goals, which suggests that females tend to exhibit stronger collectivistic interests and place higher value on communal goals, such as helping others (Alfirević et al., 2023; Brañas-Garza et al., 2018; Fernández et al., 2006; Vilar, Liu & Gouveia, 2020; Zeffane, 2017).

Engineering is among the professions offering the highest salaries and professional recognition (NACE, 2023), so these factors are often highlighted to promote engineering careers. In addition, stereotypical masculine attributes like individuality and competitiveness are often subconsciously promoted on STEM campuses and considered crucial for success (Guiffrida, 2006; Johnson, 2007; Riegle-Crumb, Peng & Buontempo, 2019). However, the findings of this study suggest these values are more closely aligned with the career aspirations of male students than those of female students, potentially reducing female interest in these fields. This highlights the need for recruitment strategies to challenge these stereotypes and encourage more diverse motivations, ensuring that engineering is presented as an inclusive field that values collaboration, social impact, and a wide range of skills. To achieve this, recruitment campaigns can empathise aspects of engineering that align with motivations commonly reported by female students, such as contributing to societal challenges like climate change, healthcare, and social infrastructure. Shifting the values emphasized in engineering toward a more socially and collectively oriented perspective can enhance female participation and improve access for other minority groups, including ethnic minorities (Guiffrida, 2006; Johnson, 2007). This transformation would benefit the entire engineering community by fostering a more diverse educational and professional environment.

Previous research highlights how the scarcity of female role models in the engineering sector can diminish female's interest in these fields (Drury, Siy & Cheryan, 2011; González-Pérez, Mateos de Cabo & Sáinz, 2020; Olsson & Martiny, 2018). The results of this study show that male students place greater emphasis on friends as a motivating factor in choosing engineering. The underrepresentation of women in STEM can limit female students' opportunities to have same-gender peers who inspire and support their aspirations, further reinforcing the perception that these fields are not meant for them. Mentorship programs, networking opportunities, and targeted outreach efforts could help bridge the gap by providing female students with access to inspiring figures who demonstrate that engineering is a viable and rewarding career path for them.

Despite engineering being a well-paying profession, female students were less inclined to choose an engineering career based on salary. This is a very relevant and worrisome finding that can be attributed to the persisting wage gap in engineering roles (World Economic Forum, 2023), which limits the visibility of females in high-earning and decision-making positions within the field. As a result, female students might expect lower salaries than their male peers, even when pursuing the same degree. These findings suggest that addressing gender pay disparities and increasing female representation in high-level positions could have a broad impact. Not only could this diversify the engineering workforce, but it could also enhance female interest in pursuing engineering degrees (González-Pérez et al., 2020; Riegle-Crumb & Morton, 2017).

Regarding students' intentions to drop out, it is particularly alarming that female students have shown significantly higher intentions to abandon their studies than their male counterparts. This concerning trend is linked to lower self-esteem and more frequent experiences of discrimination. As Abril and Castellsagué (2024) suggest, lowering the dropout rate among women in engineering also requires examining universities' social and political commitment to fostering gender equality, inclusion, and diversity.

Furthermore, correlation analysis revealed that female students' dropout intentions were associated with their academic satisfaction, self-esteem, and perceived discrimination. These findings align with prior research (Beasley & Fischer, 2012; Casad et al., 2019; Leaper & Starr, 2019; Luttenberger et al., 2019) and highlight the need to focus not only on increasing female enrolment in engineering but also on improving campus environments and academic experiences to support their success. Without tackling these issues, female representation in engineering may increase at the enrolment stage but remain low at graduation.

A notable and unexpected discovery was that female students' perception of discrimination was not linked to their academic satisfaction. In contrast, male students showed a significant connection between these factors. Additionally, despite facing higher levels of discrimination and lower self-esteem, female students reported similar academic satisfaction levels to male students. This phenomenon may be explained through disidentification theories (Himma, 2001; Steele, 1997; Verkuyten & Thijs, 2004), which suggest that individuals facing discrimination and negative stereotypes in certain domains may detach their self-esteem from their academic achievements. According to these theories, if discrimination or stereotyping adversely affects a student's academic experience and performance, potentially leading to poorer outcomes, the student may choose not to let this impact their self-esteem.

However, the findings indicate that academic disidentification among female engineering students may follow other patterns, and despite experiencing more discrimination and having lower self-esteem than their male counterparts, they do not let these factors diminish their academic success and satisfaction. This assumption is supported by data on credits approved by the students of the faculty of this study, which shows that female students have a higher rate of academic credit approval (80%) than male students (75%). Additionally, recent studies from elementary school to university consistently show that girls perform as well as or better than boys in mathematics (O'Dea, Lagisz, Jennions & Nakagawa, 2018; Rodríguez, Regueiro, Piñeiro, Estévez & Valle, 2020; Zander et al., 2020). Therefore, the findings of this study challenge earlier disidentification theories, which indicate that female students mentally distance themselves from their academic struggles to protect their self-esteem. Instead, the results suggest that in engineering, female students separate their performance from stereotypes, ensuring their academic success remains intact even in the face of discrimination. While this resilience among female students is encouraging, it should not overshadow the need for institutional change.

This insight offers a fresh perspective on disidentification theories and encourages further research into the personal and academic effects of stereotypes on female engineering students. It also highlights the crucial role of self-esteem in research involving groups susceptible to negative stereotypes or discrimination. Moreover, the findings indicate that simply tracking the academic progress of female engineering students is insufficient to identify those at risk of dropping out (Ortiz-Martínez et al., 2023). For instance, although this study found that female students reported more intentions to drop out than their male counterparts, they had a higher rate of credit approval.

To better understand the specific contexts in which female students experience discrimination on engineering campuses, this study identifies particularly concerning situations that should be addressed when developing action plans to counteract discrimination. The findings reveal a troubling reality within engineering campuses, wherein female students predominantly face discrimination during classes, team projects, and leisure activities, much more than their male peers. In many cases, this mistreatment came from their classmates and instructors, with female students reporting a higher likelihood of experiencing negative behaviours from both peers and faculty. These findings underscore the entrenched issues of sex-based disparities and discrimination within STEM academic environments, emphasizing the urgent need for immediate interventions to foster a more inclusive and equitable educational experience for every learner. Key actions include implementing clear reporting mechanisms for discrimination, conducting regular climate surveys to assess inclusivity, and making necessary adjustments based on student feedback (Hartman, Forin, Sukumaran, Farrell, Bhavsar, Jahan et al., 2019). Moreover, higher education institutions should develop structured support systems, including mental health and peer support networks specifically designed for female students in STEM (Wilkins-Yel, Arnold, Bekki, Natarajan, Bernstein & Randall, 2022).

Building upon previous research, the findings of this study reinforce that discrimination is often observed in classroom settings (Leaper & Starr, 2019). This reaffirms the critical need to adopt gender-sensitive teaching methodologies and carefully monitor group dynamics. Given the importance of these findings, it is imperative that teachers are provided with the essential training in inclusive teaching practices to create engaging learning activities and cultivate a welcoming, supportive environment (Diele-Viegas et al., 2021; Ertl et al., 2017; Ortiz-Martínez et al., 2023). It is especially important to monitor group work dynamics, establishing mechanisms for actively monitoring classroom interactions and promptly intervening when discrimination or bias is observed. Beyond the activities, course materials should include diverse perspectives and contributions from underrepresented groups in STEM fields, and instructors should use inclusive language in classroom discourse and in instructional materials. Additionally, universities must pay closer attention to social activities, which often lack supervision and can make female students more vulnerable to discrimination. By implementing these measures, educational institutions can proactively support female students' retention and success in STEM disciplines (Diele-Viegas et al., 2021).

The fact that female students felt discriminated against by their teachers may be linked to the predominance of male faculty members in engineering departments, which worsens the issue by limiting female students' opportunities to build supportive relationships with their instructors (Baird, 2018; Diele-Viegas et al., 2021; Ortiz-Martínez et al., 2023). Consequently, engineering universities should not only train current professors in gender-inclusive practices but also actively recruit and retain more female faculty members in engineering departments to create a more inclusive environment for female students. Moreover, raising awareness about discrimination among faculty members and students on university campuses is essential. Universities should adopt a zero-tolerance policy towards such behaviour and foster a collective commitment to eradicate it from classrooms and the campus (Diele-Viegas et al., 2021; Hussain & Jones, 2019). Strengthening this approach by setting up a network of equality advisors and mentors can provide support to female students in these situations, offering a safe space for them to report incidents (Diele-Viegas et al., 2021; Hill et al., 2010).

In summary, this study provides novel insights into sex differences in career choice motivations. Among the differences identified, a particularly relevant one is that while male students prioritize salary and job security, female students are more driven by societal impact, underscoring the need for recruitment strategies that address these distinct motivations. Additionally, this study challenges traditional views on female deidentification, showing that female students may maintain academic satisfaction despite experiencing higher levels of discrimination and lower self-esteem. However, these factors strongly correlate with their dropout intentions, which are higher than those of male students. The research also highlights that female students experience discrimination in multiple areas, including classrooms, group work, and leisure time, with peers and professors identified as the main sources of this discrimination. By implementing strategic interventions such as role model engagement, institutional policy reforms, inclusive teaching practices, and targeted support systems, universities can create more equitable pathways for female students in engineering, fostering long-term success and increasing their representation in the field.

### 5.1. Limitations and Future Research

The findings of this study should be considered alongside certain limitations, which also point to directions for future research.

First, this study focuses on male and female students, excluding the experiences of nonbinary and gender-nonconforming individuals. This highlights the need for future research to include a broader range of gender identities and explore how gender intersects with other social identities. Additionally, future studies could adopt an interdisciplinary approach to examine whether the findings hold across STEM disciplines beyond engineering.

This study relies on self-reported survey responses, which may not always reflect actual dropout rates. Future research should consider using enrolment data or longitudinal studies to track students over time and determine whether their reported intentions to drop out correspond to actual dropout behaviour.

Finally, future research can explore additional factors, such as the influence of role models, coping mechanisms, experiences of sexual harassment, or subtle forms of discrimination, to gain a more comprehensive understanding of female students' retention in engineering.

## 6. Conclusion

This study contributes significantly to the ongoing dialogue regarding disparities in STEM fields between male and female students, particularly within engineering disciplines. By examining the factors that influence the decision to pursue and remain in engineering programs, the research sheds light on the persistent underrepresentation of female students. The study underscores significant differences in motivations for enrolling in engineering degrees, with male students drawn by personal vocation, perceived skill proficiency, and job stability with a good salary, whereas female students are more motivated by the desire to make a positive societal impact. Remarkably, female students reported lower self-esteem, higher perceptions of discrimination, and greater intentions to drop out, highlighting the need for targeted support and interventions to improve their academic and personal experiences in engineering programs. Furthermore, an exploration into the concept of disidentification suggests that while female students may not allow discrimination to dampen their academic satisfaction, it does affect their self-esteem and dropout intentions, pointing towards a complex interplay between personal resilience and systemic barriers.


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