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Interpersonal and academic self-efficacy and its relationship with employment of food industry engineering students: A gender perspective

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An analysis of self-efficacy and its effect on employment was performed with data obtained from Food Industry Engineering Students (FIES), with strong food engineering, food manufacturing and innovation-related competencies, from 2019 to 2021. The aim was to determine if there is a relationship between self-efficacy and employment in FIES to define potential actions for educational institutions looking to reduce the gender disparity in professional life. Results showed differences in self-assessment categories regarding gender, with men having a better self-perception, especially in economic analysis and clarity in professional objectives. Women rate higher only in food development, traditionally associated with women from household to the food industry. Except for the entrepreneur positions favoring men, these differences were not observed in the employment data 1 year after graduation. This might be due to the national context where entrepreneurship is associated with masculine traits. Tasks commonly associated with specific genders seem to influence student self-efficacy, but this is not reflected in the employment rate of FIES at least within the evaluated period. Food Industry Engineering is considered atypical within STEM disciplines because more women graduate than men depicting gender roles similar to those in the national environment. These results are important for employers, government, and higher education institutions to create strategies to improve self-efficacy among students to reach their full potential as employees and as entrepreneurs to create a better environment for national economic development.

KEYWORDS

food industry engineering, entrepreneurship, gender-gap, employment, self-efficacy

Introduction

Science, technology, engineering, and mathematics (STEM) disciplines have been given much attention due to their merging capacity and ability to help solve challenges currently faced by the world population. Traditionally STEM has had persistent underrepresentation of women leading to biases in services and products, increasing the gender pay gap and hindering women's economic security (AAUW, 2020). Within the society, the reduction of this gender gap is majorly influenced by higher education institutions, which are one of the main drivers of society changes through their academic programs and, according García-Holgado and García-Peñalvo (2022), should focus on the guidance of women in STEM to improve their self-efficacy. This concept refers to the beliefs about the ability to "organize and execute the courses of action required to produce given attainments" (Bandura, 1997), which concerns to what people believe they can do with their skills and abilities under certain conditions. Therefore, this concept plays a crucial role in areas such as self-regulation, psychological wellbeing and adjustment, education, and occupation choice and performance (Maddux and Gosselin, 2012).

The occupation of a person and their performance can be predicted by their self-efficacy beliefs. As reported by Zhang et al. (2021), a high self-efficacy may promote a more accessible acquisition of generic skills and professional competence to students. A higher occupational self-efficacy has been linked to predict higher salary, higher ranking job positions, and greater job satisfaction years later (Abele and Spurk, 2009). Additionally, academic self-efficacy during adolescence leads to greater job satisfaction and lower unemployment probability by age 21 (Pinquart and Sörensen, 2003). It is important to note that self-efficacy and employability of students were linked to be strong contributors to subjective wellbeing in Taiwanese and Chinese students (Xu et al., 2021). Therefore, high self-efficacy is an important ability when searching for job and employment.

Within STEM disciplines, Food Science, Food Technology, or Food Industry Engineering are multidisciplinary programs involving chemistry, biochemistry, nutrition, microbiology, and engineering, aiming to solve problems associated with the food system. These programs are considered atypical in STEM disciplines since countries including the USA, Bolivia, South Africa and Mexico report having more women graduates than male graduates (Bezies-Cruz et al., 2016; Cruz-De-Urioste, 2016; Metcalfe, 2019; National Center for Education Statistics, 2019a), although those with a limited number of admitted students had more male graduates (Universidad Nacional Autónoma de México, 2020).

Despite the high female participation, disciplines such as Food Science still report gender bias. In addition, lower confidence in women has been reported, reflected due to their lower classroom participation rates and lower self-efficacy (Ainscough et al., 2016; Eddy and Brownell, 2016).

Considering the importance of self-efficacy, the current gender gaps, and the gender bias in female dominated disciplines, it is crucial to analyze the relationship between employment and self-efficacy. Nonetheless, there is to date no study where the employment of graduates is reported in association to self-efficacy as Food Engineering students. Therefore, this study aims to determine if there is a relationship between self-efficacy and employment in Food Industry Engineering students to define potential actions for educational institutions looking to reduce the gender disparity in professional life. Furthermore, the proposed hypothesis is that if female students have a lower interpersonal and academic self-efficacy than male students, then their employment rates and job levels will be lower.

Literature review

Science, technology, engineering, and mathematics

STEM is an acronym for the fields of science, technology, engineering, and mathematics, which are disciplines considered to constitute fundamental aspects of human lives. As the term was first coined by the US National Science Foundation in the early 2000s, the main motivation for this initiative was the low math and science performance of US students in comparison to other countries (Kumtepe and Genc-Kumtepe, 2015). Throughout the years, the percentage of jobs in STEM has grown and according to Zilberman and Ice (2021) this trend will continue in the years to come, as it is expected to grow by 8% by 2029, compared with 3.7% for all occupations. Despite this fact, the percentage of students in STEM is still low, including female students.

During 2015 in the United States, overall bachelor's degrees awarded to women were higher than to males (58 vs. 42%), but in STEM areas, the percentage was reported to be lower (36 vs. 64%) (National Center for Education Statistics, 2019b). More recently, Mexico has closed 75.7% of its overall gender gap, but the participation of Mexican women in STEM disciplines is only 14.5%, in comparison to 37.6% of men graduates (World Economic Forum, 2021).

There are number of factors influencing career selection in STEM such as family support, influence of teachers and scholar environment, gender stereotypes, and career self-efficacy. All these factors are increasingly important in low-income students or students raised under vulnerable backgrounds, where all these barriers are increased and derived in reduced and lower career expectations (Toglia, 2013).

Employment is an important part of a person's life, as it allows them to make their own choices and decide how they want to live. Work allows the population not only to feel productive and valued, but also to develop new skills.

Nevertheless, for women around the world finding a job is harder than it is for men, and one of the objectives in this document is to explore the role of a single trait, self-efficacy, in the employment of Food Industry Engineering students, as a STEM program with interesting differences compared with other similar career paths.

Self-efficacy and employment

Self-efficacy is described as the confidence a person has in their ability to achieve something desired, and it has been widely studied throughout the years at different education levels (elementary, secondary, and high school) and different situations.

It has been reported that increasing levels of perceived self-efficacy gave rise to higher performance accomplishments (Bandura, 1982). A math skill performance study made by Flanagan and Einarson (2017) concluded that more confident students outperformed less confident students, and those with more determination for achieving long-term goals performed better overall in the course. In general, researchers stated that math confidence was significantly related to quantitative skills assessments' performance.

According to a study performed in the UK by Dacre Pool and Qualter (2013), emotional self-efficacy (ESE) was found to be an important predictor of graduate employability. While working graduates with higher ESE perceived themselves as highly employable, ESE had no direct effect on career satisfaction. Similarly, Petruzziello et al. (2020) determined that general self-efficacy has a positive and indirect effect on job search success, as job search self-efficacy influences it. Both studies concur that self-efficacy is a crucial personal resource that can help new entrants in their job search attempts.

As research overall suggests that any interventions designed to increase the employability of graduates should look to increase both skills and confidence, soft skills must also be taken into consideration. Soft skills such as positive attitude, self-motivation and self-direction are important to employers, and can even help land a job when technical skills are limited (Majid et al., 2019). Additionally, extroversion can have a moderating effect on the job search self-efficacy-job search success relationship (Petruzziello et al., 2020). Therefore, an integrated approach for teaching soft skills to students may be beneficial for improving these skills.

Higher education institutions and educators play a major role in the academic and professional development of their students. Pedagogy for employability has been positively linked to students' absorptive capacity and employability; educators should encourage the students' confidence and incorporate the competency required in their courses for the development their future employment (Li K. et al., 2020; Peng et al., 2021). Self-efficacy, deep approach to learning, and great awareness of teachers' transformational leadership and greater skill in problem-based learning are positively related with students' employability (Wang et al., 2020; Zhao et al., 2021).

According to Perez-Felkner (2018), it was observed that student's beliefs in individual and collective ability could shape their longer-term STEM outcomes. In 2010, STEM degree-holding women comprised 37% of all STEM workers in the USA and earned about one-third less in non-STEM related works and 19% less in STEM occupations than their male counterparts, although salary differences have been reported being narrower among recent graduates.

Sex-based stereotypes have been reported to impair women. For example, an arithmetic task where both genders perform equally well was used as an aid in the hiring of candidates. The results indicated that both female and male subjects were more likely to hire men, primarily due to their performance boasting, in contrast to the women's underestimation (Reuben et al., 2014). Additionally, female students are less likely to self-report mastering the goals of a course than their male counterparts, independently of their general point average (GPA) (Lang et al., 2020). Also, male and female students have been found to have different routes to the development of employability, which suggests more gender-specific approaches should be taken into consideration by higher education institutions (Peng, 2019).

In general, an individual's employability could increase if the gap between their perception of reality and objective reality is closed (Tseng, 1972). Therefore, an accurate self-perception of one's abilities is necessary to excel in the academic and work environment.

Culture and career development

Cultural expectations can greatly impact the career development of a person, as culture influences the way decisions are made. In a recent LinkedIn report, the analysis showed that women tend to apply to 20% fewer jobs than men and are 16% less likely to apply to a job after viewing it. Additionally, recruiters are 13% less likely to view a female profile (Tockey and Ignatova, 2019). Nevertheless, despite the lower application rates, women are more likely to be hired when applying for the same positions as men by 16% for same-level jobs and 18% for senior roles. No data indicate the main reason for this, but it is stipulated to be because females tend to be more selective when applying for a job, which leads them to be overqualified and having a bigger gap between the perceived and objective reality (Hacohen and Nicks, 2019; Tockey and Ignatova, 2019).

Furthermore, women were more likely to be out of the labor force by 6%, particularly between the ages 30–65, with a 12% difference. For most women, in comparison to men, the main factors were family-related reasons (48 vs. 9%) and no need to work (41 vs. 26%) (US National Science Foundation, 2014).

At the University of Cartagena, a student dropout analysis for the Food Science program was conducted, in which the financial situation resulted as the main reason for their studies interruption. Nevertheless, women were 5.6% less likely than men to dropout for this reason (Acevedo et al., 2015). Therefore, cultural expectations are portrayed as males are more likely to be seen as financial providers, concurring with a lower financial related decision-making for women.

According to Marshall (1995) and Ragins et al. (1998), it is suggested that male dominated organizational cultures represent a barrier to women's advancement because men generally accumulate more power and resources than women, depicting the importance of the context in career development. According to Lobel (1999), organizational culture is among the central factors in promoting a supportive work environment, due the fact that organizations are based on norms, beliefs, attitudes, and assumptions, which in turn influence organizational practices (van Vianen and Fischer, 2002). Bajdo and Dickson (2001) described that organizations maintaining a culture promoting gender equity are more likely to have a higher number of women in management positions.

Besides the organizational culture, the national habits influences the choice of studies and professional career, being Latin-American countries traditional in terms of career choices and family structures that limit women's choices and alternatives when professional careers are determined.

Currently, the global labor force participation rate for women is 47%, whereas for men it is 72%. Although it varies according to the region, reducing the employment gender gap is crucial. From a social standpoint, closing the gender gap is integral to human welfare, as females have the freedom to work safely, fairly, and with dignity. From an economic perspective, more balanced participation could substantially boost global GDP (International Labour Organization, 2022).

The investment in women's employment is key to unlocking growth in emerging and developing countries. For example, higher levels of gender diversity can drive up productivity and innovation, enhance the company's relations with the local community, and provide greater insights into consumer preferences (International Finance Corporation, 2013). As seen in surveyed companies with investment programs in emerging and developing markets, at least one third had measured improved profits and a further 38% expected returns (McKinsey, 2010). Therefore, balancing cultural expectations and reducing the employment gender gap brings many benefits.

Gender perspective

The gender perspective assesses the impact of gender on opportunities, social roles, and interactions of people, as it influences every aspect of the economic, social, daily, and private lives of individuals in societies. Although gender issues originate in biological characteristics, gender differences are social constructs inculcated in cultural perceptions of tendencies and capabilities of men and women that affect employment, poverty family life, health, education, environment, public life, and decision making (FAO, 1999).

Historically, women have been excluded from research studies, and therefore most are conducted on middle-aged men. This lack of evidence about the effectiveness of medical interventions in women can result in the exposure of patients to treatments that are harmful or in the withholding of beneficial treatment (Marino et al., 2011).

Women are responsible for most of the world's food production, yet their social and economic impacts are commonly disregarded (USAID, 2010). In Africa, women receive less than 10% of small farm credit and 1% of total credit to the agricultural sector. They are also responsible for nutrition in most homes but have limited education and control over resources. Nevertheless, studies show that women, when given the opportunity, are more likely than men to spend on their family's nutritional needs, healthcare, and school fees for children. Hence, the empowerment of women is key to lifting rural communities out of poverty and to attaining food security in the developing world.

Some strategies that seek to empower women in vulnerable environments have been developed. For example, Ruiz-Cantisani et al. (2021) developed a mentoring program and workshops in STEM and gender equity with public high school female students, who showed high interest in topics of STEM careers. Despite the limitations faced, the authors state that these actions can make a cultural and social change that the community demands and needs, by becoming aware of the reality in issues of gender equity and personal development.

Altogether, the inclusion of a gender perspective results in a more critical understanding of the current situation, which further allows a better development of the social, economic, and health contexts of society.

Materials and methods

Student's self-evaluation and standardized tests

Participants

During five semesters between January 2019 until June 2021, all senior students (100%) of the Food Industry Engineering program from Tecnologico de Monterrey in the city of Monterrey enrolled in the Bioengineering Design Project (BT3014) participated in the analysis. A total of 107 students, consisting of 80 women and 27 men (74.8 and 25.2%, respectively), responded to a self-evaluation survey described in the following subsection.

Tecnologico de Monterrey is a non-profit, independent, private education institution with 78 years of trajectory, and a member of various associations such as Universitas 21, Worldwide Universities Network and The Pacific Alliance. In the city of Monterrey, more than 15,000 students are currently enrolled completing their undergraduate studies. The Food Industry Engineering Program, one of the 18 programs pertaining to the School of Engineering and Sciences, can be found on several campus but the majority of the FIES population is in Monterrey and Queretaro. These characteristics and alliances highlight the representation Tecnologico de Monterrey has both on a national and international scale.

While the study actively avoided biases, the distribution of the data itself presents a disadvantage as the women-to-men ratio is imbalanced. Nonetheless, since the population of food science-related fields commonly presents this distribution, analyses were performed with all data collected to avoid discarding potentially useful information.

Self-evaluation survey design

An online survey was designed for the senior students to self-evaluate their interpersonal and academic abilities required to develop the project performed during the semester on a 1–10 scale, where 10 was used as the highest grade and 1 the lowest. Interpersonal abilities inquired were capacity of the student for: (1) identifying of a problem (IDPROB), (2) solving a problem (SOLPROB), (3) work as a team (TEAMWORK), and (4) their clarity in professional objectives (OBJS); whereas the academic abilities auto assessed were: (1) food development (FOODDEV), (2) food process design (FOODPRODES), (3) food-biotechnology equipment design (EQDES), (4) use of unit operation for food and biotechnology process (UNITOP), (5) economic analysis for a project (ECAN), and (6) design of food safety systems (HACCP). Missing data from the results was not taken into consideration for the analysis because the missing rate was low (1%).

Standardized tests and general point average

An exit and standardized test (EGEL, Examen General de Egreso or General graduation Exam by the National Centre of Evaluation), also known as CENEVAL, evaluates knowledge and academic skills of recent graduates from different bachelor's degrees on a national scale. Results for this test and the student's cumulative GPA were recollected. Availability of the results varies with each semester. During Spring 2020 and Winter 2020, the EGEL test was not applied due to the COVID-19 health contingency, while during the latter, an institutional integrative exam designed by the Food Industry Engineering professors was applied. Therefore, a total of 77 EGEL test results were considered for analysis. The reported GPAs for the students were collected as the ones reported while presenting the standardized test. For the Food Industry Engineering Program, the EGEL test is divided into four sections: Food Product Development (IDEPROALI); Unit Operations for the Conservation or Transformation of Food (IOPEUNICT); Design and Operation of Food Processes (IDIORPROA); Food Quality Management (IGESCAALI).

For analysis purposes, four self-assessment categories were linked to the four EGEL sections: food development (FOODDEV), use of unit operation for food and biotechnology process (UNITOP), food process design (FOODPRODES), and food safety systems (HACCP), respectively. Additionally, all academic abilities were linked to the general EGEL test result. For registers with no EGEL results, the self-evaluation data was not considered for the analysis.

Statistical analysis

Each of the variables analyzed for the statistical study was evaluated using Anderson-Darling and Kolmogorov-Smirnov normality tests using statistical analysis tool RStudio, considering a confidence level of 95%. A T-Student analysis was completed for results with normal distribution; for results without a normal distribution, a non-parametric Mann-Whitney-Wilcoxon test was performed. Additionally, for each item of the self-evaluation, a Levene homogeneity of variance test was done to evaluate if there was a difference by gender.

Employment data of food industry engineering graduates

The Tecnologico de Monterrey provided the employment information collected. This institution collects for every graduate generation information regarding their employment after 3 and 12 months of graduating for research purposes. In the employment survey, information collected about their work status included five categories: (1) employee, (2) entrepreneur, (3) not seeking employment, (4) unemployed and seeking, or (5) without answer. In addition, respondents must choose if their employee positions are executive-level, medium-level, entry-level, or not specified.

Analyzed data corresponds to 10 semesters during August 2015 and June 2020, where a total of 385 graduates answered this employment survey. Respondent's distribution comprises 300 women and 85 men (77.9 and 22.1%, respectively). Unfortunately, information available for Winter 2019 after 12 months of graduating is incomplete since it was provided while its application was still undergoing, while for Spring 2020, the employment survey had not been applied altogether.

Statistical analysis

The proportion of the graduate's work status was analyzed using the two-proportions *Z*-Test RStudio analysis tool, which allows to compare two observed proportions. For each comparison, it was determined whether males or females

had a higher proportion, and the alternative was accordingly adjusted to greater for men and less for women. The alternative assignment was done automatically in alphabetical order. The confidence level used was 90%.

Results and discussion

Student's self-evaluation and standardized tests

Student's overview

Demographics of the students who responded to the self-evaluation survey are shown in **Figure 1**. Throughout analyzed semesters, female students outnumber male students. Semesters in which more men had a greater representation were the first semester of the period analyzed (Spring 2019) and the fourth (Winter 2020) with 33.3%, while the third semester (Spring 2020) had the least male representativeness with only 6.67%. Men-women proportion differences may be due to a reinforcement of gender norms. A study suggests that cultural norms regarding femininity contribute to gender segregation in academic fields of study (Beutel et al., 2018). Hence, despite Food Industry Engineering being a STEM major, more women and fewer men might decide on food science as a field of study because of its feminine association. Analyses were still performed with all data collected to avoid discarding potentially useful information.

Students' self-assessment

The mean values of each evaluated ability along with its standard deviation, are shown in **Figure 2** (**Supplementary Table 1**). Taking females and males into account, on average, undergraduates self-evaluate best in *teamwork*, while the worst self-perceived is *food-biotechnology equipment design*. Most values ranged between 7 and 9, except for the two already mentioned.

It is suggested that undergraduates do not feel well-prepared for the equipment design's theoretical learning throughout their careers. On the other hand, teamwork is a frequently practiced skill with which they feel more comfortable. This is consistent with the literature, where it was found that those skills with the highest frequency of practice resulted in a better self-perception by undergraduate students (Cruz et al., 2012).

Mean values of each evaluated ability along its standard deviation were then graphed according to gender (**Figure 3** and **Supplementary Table 2**). Again, male students have a higher mean auto-assessment value in 8 of the 10 categories, with *teamwork* and *food development* as the only areas in which female students reported a higher self-efficacy. A statistical difference among the different categories by gender was observed. A normality test indicated that the data does not follow a normal distribution and a Levene test showed that only the variance for *food development* self-assessment was different between men and women (**Supplementary Table 3**). Non-parametric Mann-Whitney-Wilcoxon test with a 95% confidence level and two tails was performed, using a null hypothesis that the male's self-evaluation means value (μM) and the female (μW) were equal by category (H0: $\mu M = \mu W$/category) (**Table 1**). This analysis resulted in three categories being statistically different: (1) *food development*, (2) *economic analysis for a project*, and (3) *clarity in professional objectives*.

In *food development*, the *p*-value calculated was 0.0102, and it indicated that women self-perceived up to one unit better and have a more homogenous self-assessment than men. On the other hand, in *economic analysis for a project*, with a *p*-value of 0.0386, men self-evaluated up to one unit better than women, while in *clarity of professional objectives*, it was up to 2 units (*p*-value 0.0183). These results suggest that men tend to have a better self-efficacy of more considered empirical abilities.

Self-evaluation results for all categories by semester and gender show that a minority of men's evaluations range from low values (**Figure 4**). During Spring 2020, the semester with the lowest male participation, the lowest self-evaluation from male students was a 7, whereas most were 10. In the first, second and fifth semesters, most male self-evaluations tend to stay over the value 6. The fourth semester has the lowest values reported among men. Female participation seems consistent throughout the semesters, with few low values and a fair amount among the 7–9 values.

The statistical difference among self-evaluation of male and female students was performed using a non-parametric Mann-Whitney-Wilcoxon hypothesis test (90% confidence level with right tail), obtaining a *p*-value of 0.09299, indicating that men self-perceived better than women in the categories considered. The results are best appreciated in **Figure 5**. Self-evaluation results distribution by gender shows that males tend to have a better self-perception, despite the lower representation in the Food Industry Engineering program.

These self-evaluation results concur with what is found in the literature, where women generally have lower self-efficacy. For example, it has been reported that in a self-perception scale, when women outperform men, they do not estimate having superior abilities, whereas when men outperform women, they do (Echavarri et al., 2007). Additionally, women sometimes have a lower self-efficacy even when they have a higher GPA (Whitcomb et al., 2020). On the other hand, a similar study investigating self-efficacy in men and women in STEM majors in a small private university found no relationship between gender and self-efficacy, but it is suggested that the sample was too small to obtain significant results (Jordan and Carden, 2017). The sample size in this study might explain why only 3 out of the 10 ability categories show the statistical difference, and a bigger study considering more academic semesters would be needed to evaluate any gender gap correctly.

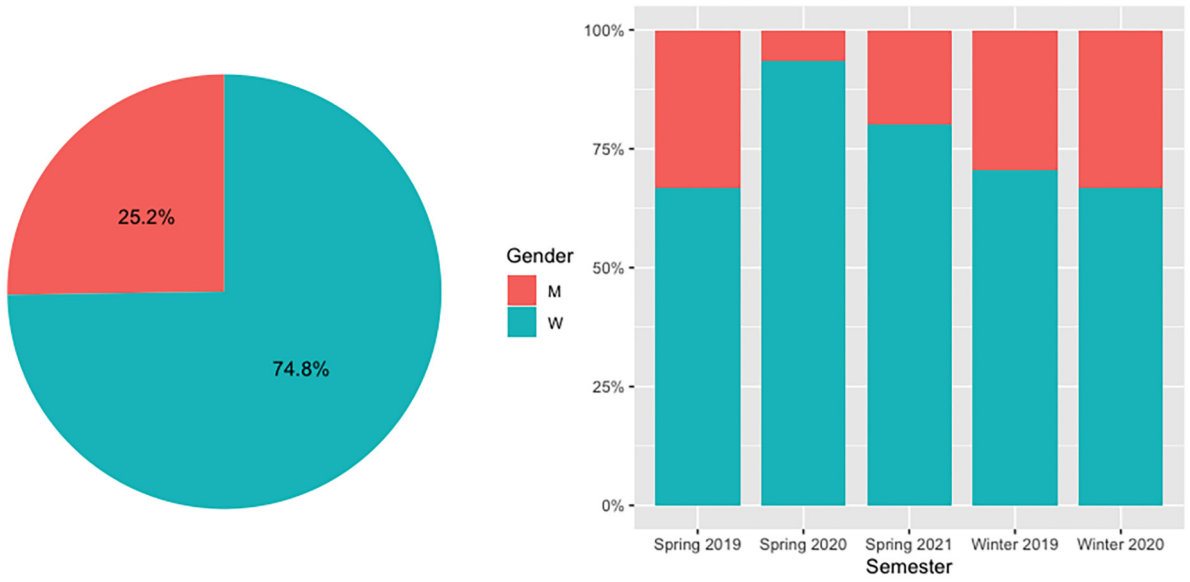

FIGURE 1
Percentage distribution of the Senior Food Industry Engineering students by gender **(Left)**. The total proportion of the male and female students by gender during the five academic semesters evaluated **(Right)** (M, Men; W, Women).

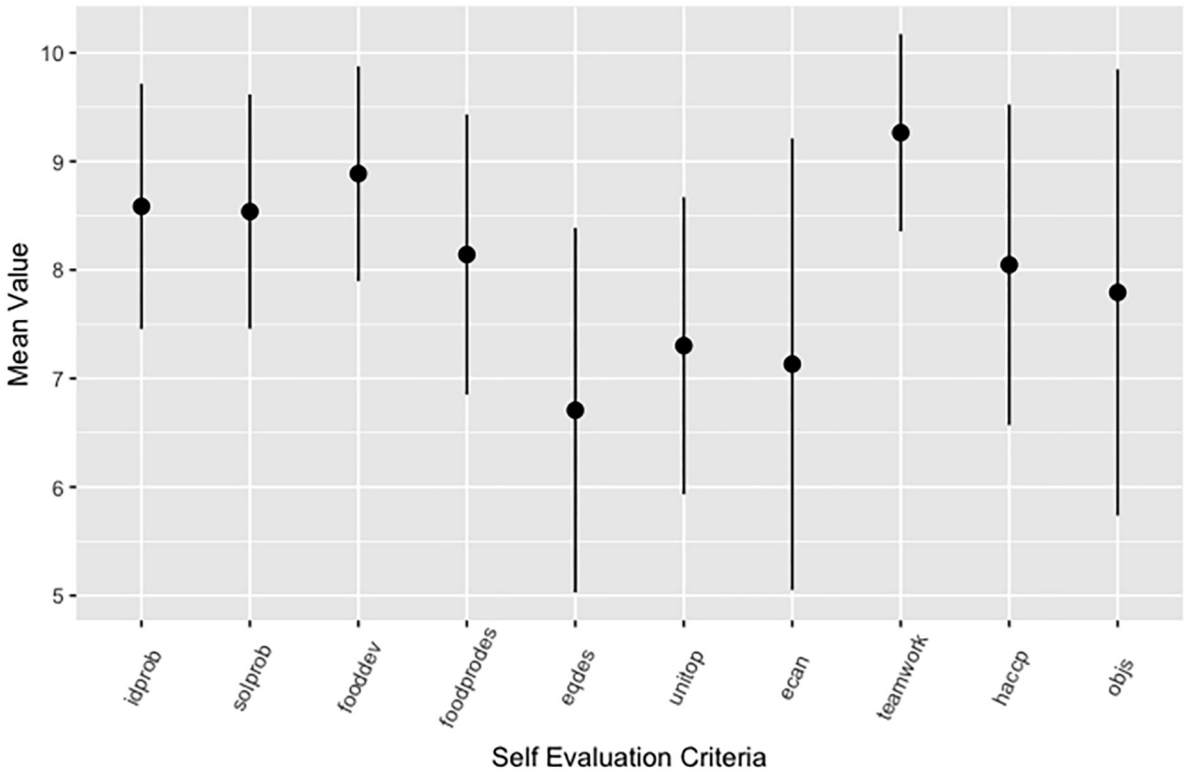

FIGURE 2
Self-evaluation means values by category or criteria with standard deviation for all students. The self-assessment used 10 as the highest grade and 1 as the lowest.

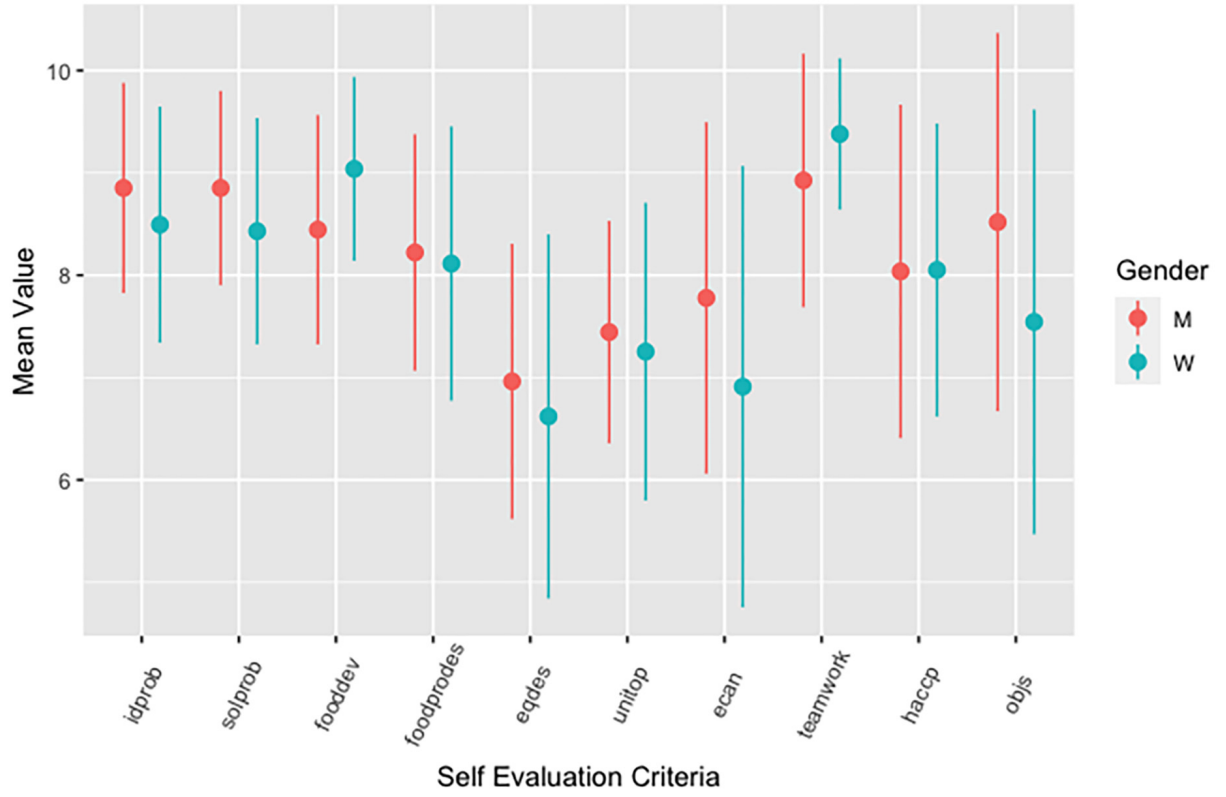

FIGURE 3
Self-evaluation means values for all students classified by gender and category or criteria with standard deviation. The self-assessment used 10 as the highest grade and 1 as the lowest (M, Men; W, Women).

Standardized tests

Standardized tests and general point average

The EGEL standardized test results depicted a non-normal distribution. The *p*-value obtained from the Mann-Whitney-Wilcoxon hypothesis test (95% confidence level, two tails) was 0.1384, indicating no difference among the standardized test results between males and females. For Spring 2019, Winter 2019, and Spring 2021, the EGEL results and student's GPA depicted a correlation coefficient of 0.21, a low value indicating little correlation between the GPA and the EGEL score of the students, which shows that the higher the GPA, the better the EGEL results. To better analyze the information, a differentiation was made by gender (Figure 6).

The results show a positive tendency for both females and males, indicating that the better the GPA, the higher the EGEL score (Figure 6). However, although both genders show a positive tendency, the rate of change and its correlation coefficient (0.34) is higher for women than for men. This shows that the EGEL score for women is related to their GPA, and the strength of the relationship between these variables is stronger. These differences might be due to a male's preference for empirical rather than academic skills.

The analysis of the GPA normal distribution was done, depicting data distribution was not normal. The Mann-Whitney-Wilcoxon test (95% confidence level, two tails) indicated that women have a higher GPA than men ($P = 0.01983$).

EGEL results and self-assessment

The EGEL standardized test results and the mean values of the academic self-assessment were correlated, obtaining a coefficient as low as −0.082. To better analyze the information, a distinction by gender was made (Figure 7). The correlation coefficient for women was −0.12, which suggests that the EGEL score is lightly and negatively correlated to self-assessment; even though the correlation is not high, it indicates that the higher they self-evaluate, the lower their EGEL score. With a correlation coefficient of 0.015, men have no significant correlation between their self-evaluation and their EGEL score.

Despite finding no significant performance difference in standardized tests, a slight difference between women and men in their self-assessment was found. Women were found to have a lower self-assessment as they had a higher general EGEL score; men were found not to correlate their self-evaluations and standardized test results. Even though there is

TABLE 1 Non-parametric Mann-Whitney-Wilcoxon hypothesis test of mean difference by self-evaluation category and gender a 95% confidence level and two tails[a].

Self-evaluated category	*P*-value obtained in the Mann-Whitney-Wilcoxon Test with two tails	Confidence interval (95%)	
		Lower limit	Upper limit
Identifying a problem (IDPROB)	0.1848	-6.8249×10^{-05}	9.9999×10^{-01}
Solving a problem (SOLPROB)	0.1031	-4.0120×10^{-05}	9.9995×10^{-01}
Food development (FOODDEV)	**0.0102**	−1.0000	-2.9501×10^{-05}
Food process design (FOODPRODES)	0.7914	-7.8045×10^{-06}	9.9999×10^{-01}
Food-biotechnology equipment design (EQDES)	0.4021	-3.8665×10^{-06}	9.9995×10^{-01}
Use of unit operation for food and biotechnology process (UNITOP)	0.8618	−1.0000	0.9999
Economic analysis for a project (ECAN)	**0.0386**	2.6073×10^{-05}	1.0001
Teamwork (TEAMWORK)	0.1134	$-9.9995 \times 10^{-0.1}$	2.0889×10^{-06}
Design of food safety systems (HACCP)	0.7540	−1.0000	1.0000
Clarity in professional objectives (OBJS)	**0.0183**	1.1636×10^{-05}	2.0000

[a]It is understood that a negative range in the confidence interval limits favors women, while a positive range favors men. Values in bold indicate a category is statistically different.

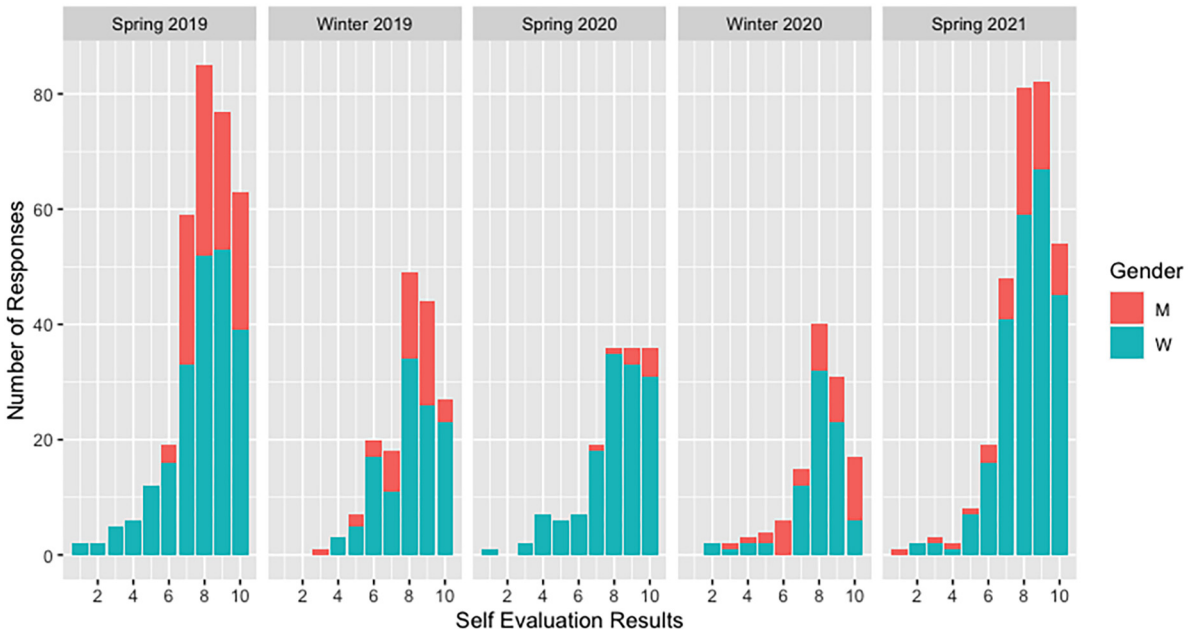

FIGURE 4
Self-evaluation results distribution by semester and gender (M, Men; W, Women). The self-assessment used 10 as the highest grade and 1 as the lowest.

no significant difference in the results of this study, they align in general with the literature, as women in self-assessments tend to underestimate their abilities and performance, while men overestimate them (Beyer, 1990; Dunning et al., 2003).

The EGEL results analyzed by section and compared with the self-assessment in the same topic were graphed in **Figure 8**. With correlation coefficients close to zero, there is little to no significant correlation between the self-assessment per area and the result obtained. To better analyze the information, the genders were analyzed separately.

Women's results and self-assessment show a correlation coefficient close to 0, which suggests no association (**Figure 9**). On the contrary, men's results and self-assessment show an $R = -0.27$ for Food Development, which indicates that the higher their self-evaluation, the lower their EGEL result in the similar exam area (IDEPROALI, **Figure 9**). Additionally,

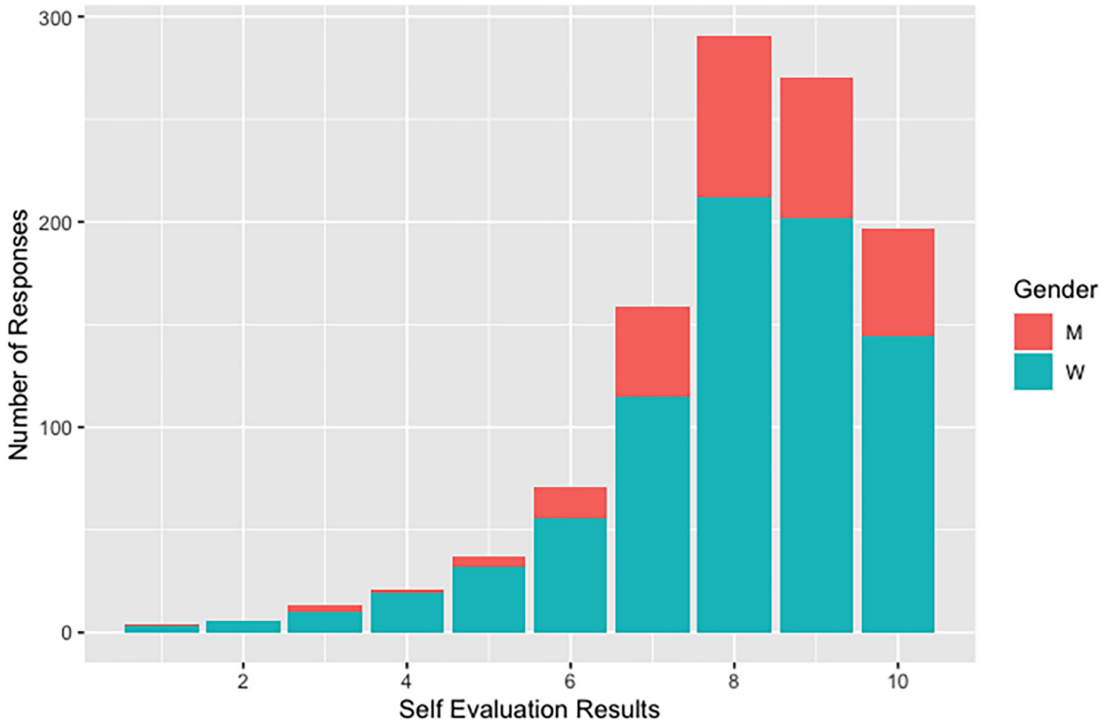

FIGURE 5
Self-evaluation results distribution by gender for all categories assessed and for all students (M, Men; W, Women).

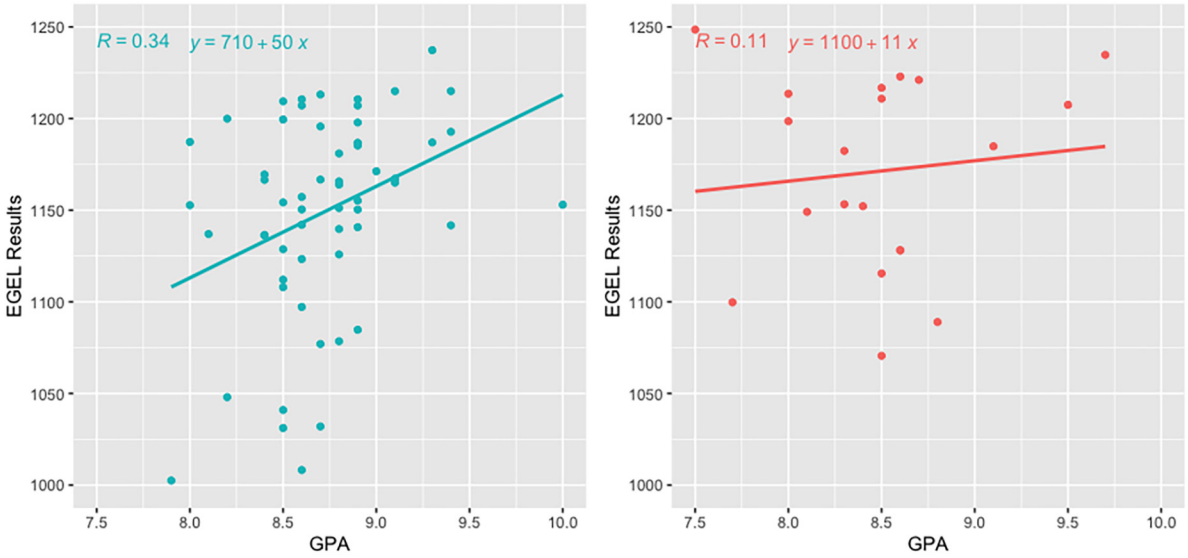

FIGURE 6
EGEL (General graduation Exam by the National Centre of Evaluation) results and GPA comparison by gender. The correlation coefficients for women and men are 0.34 and 0.11, respectively (Blue–Women; Red–Men).

for Food Process Design with an R = 0.26, the higher their self-evaluation, the higher their IDIORPROA EGEL result.

Nevertheless, self-efficacies by the EGEL section slightly differ from general results since there seems to be no correlation in the female's self-evaluation and their section score, in contrast to the male's. Considering women have a higher self-efficacy in Food Development, it is unsurprising that a higher Food Product Development (IDEPROALI) score in men is linked

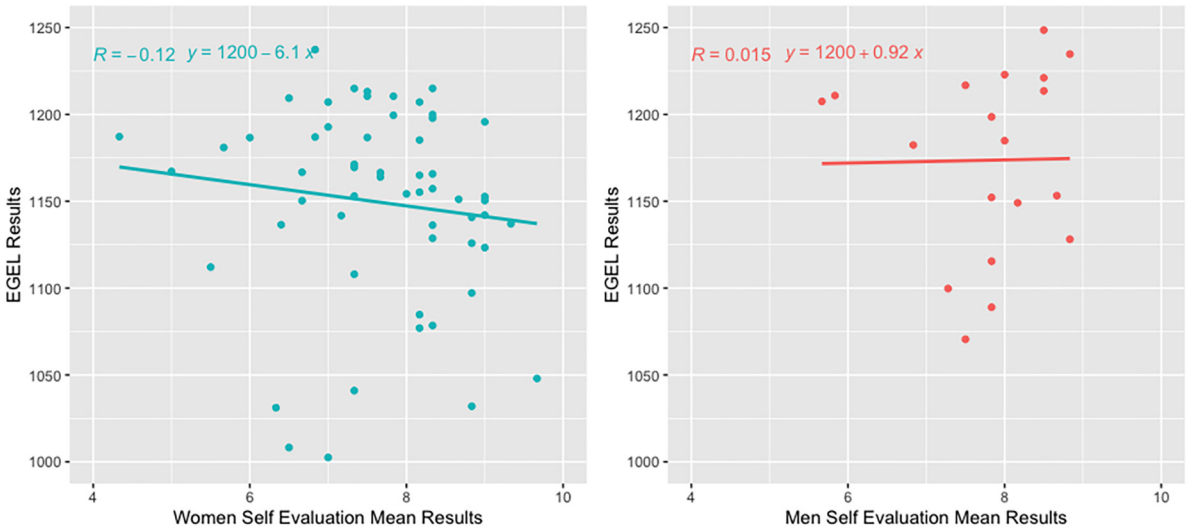

FIGURE 7
EGEL (General graduation Exam by the National Centre of Evaluation) results and self-evaluation of academic categories mean results comparison by gender. The correlation coefficients for women and men were −0.12 and 0.015, respectively.

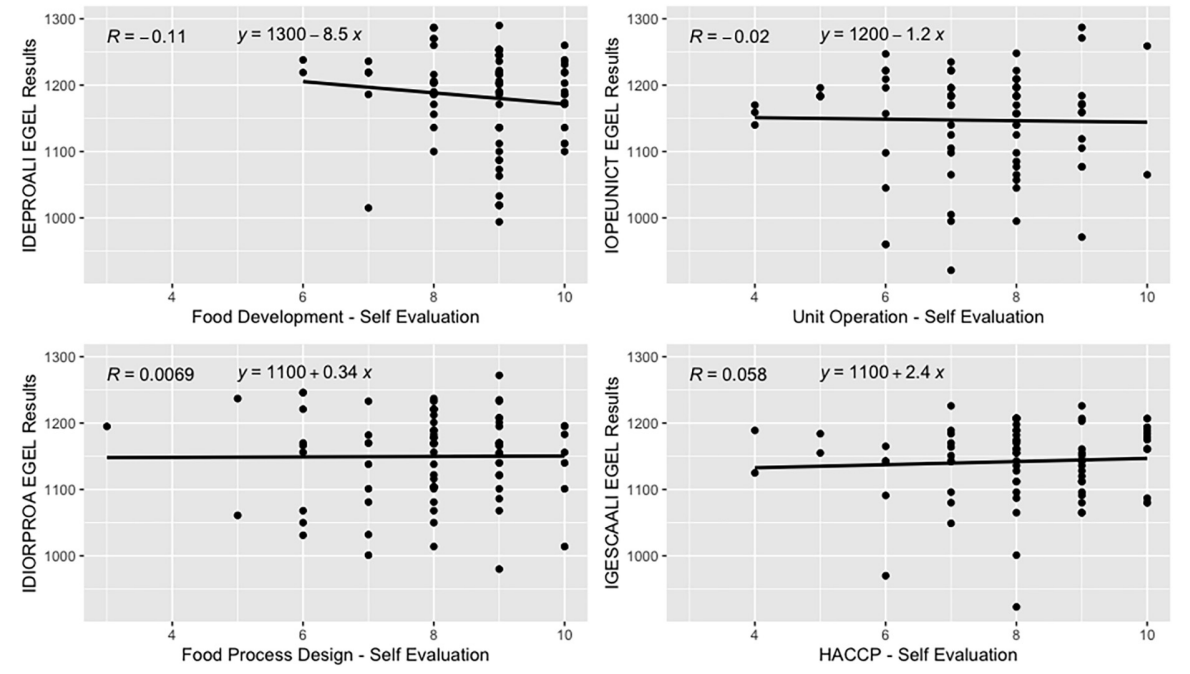

FIGURE 8
EGEL (General graduation Exam by the National Centre of Evaluation) results and self-evaluation of academic categories mean results by EGEL section. IDEPROALI = Food Product Development (R = −0.11); IOPEUNICT = Unit Operations for the Conservation or Transformation of Food (R = −0.02); IDIORPROA = Design and Operation of Food Processes (R = 0.0069); and IGESCAALI = Food Quality Management (R = 0.058).

to a lower food development self-assessment. Regarding food process design and its possible association with a *masculine* engineering skill, a higher Design and Operation of Food Processes (IDIORPROA) score was seen with a higher food process design self-evaluation, which aligns with the literature found as men show a higher self-efficacy in a computer related experiment than women (Sieverding and Koch, 2009). Males perceive themselves as equally efficacious in both traditionally female and male vocations, whereas females as inefficacious in vocations dominated by men (Bandura, 1982).

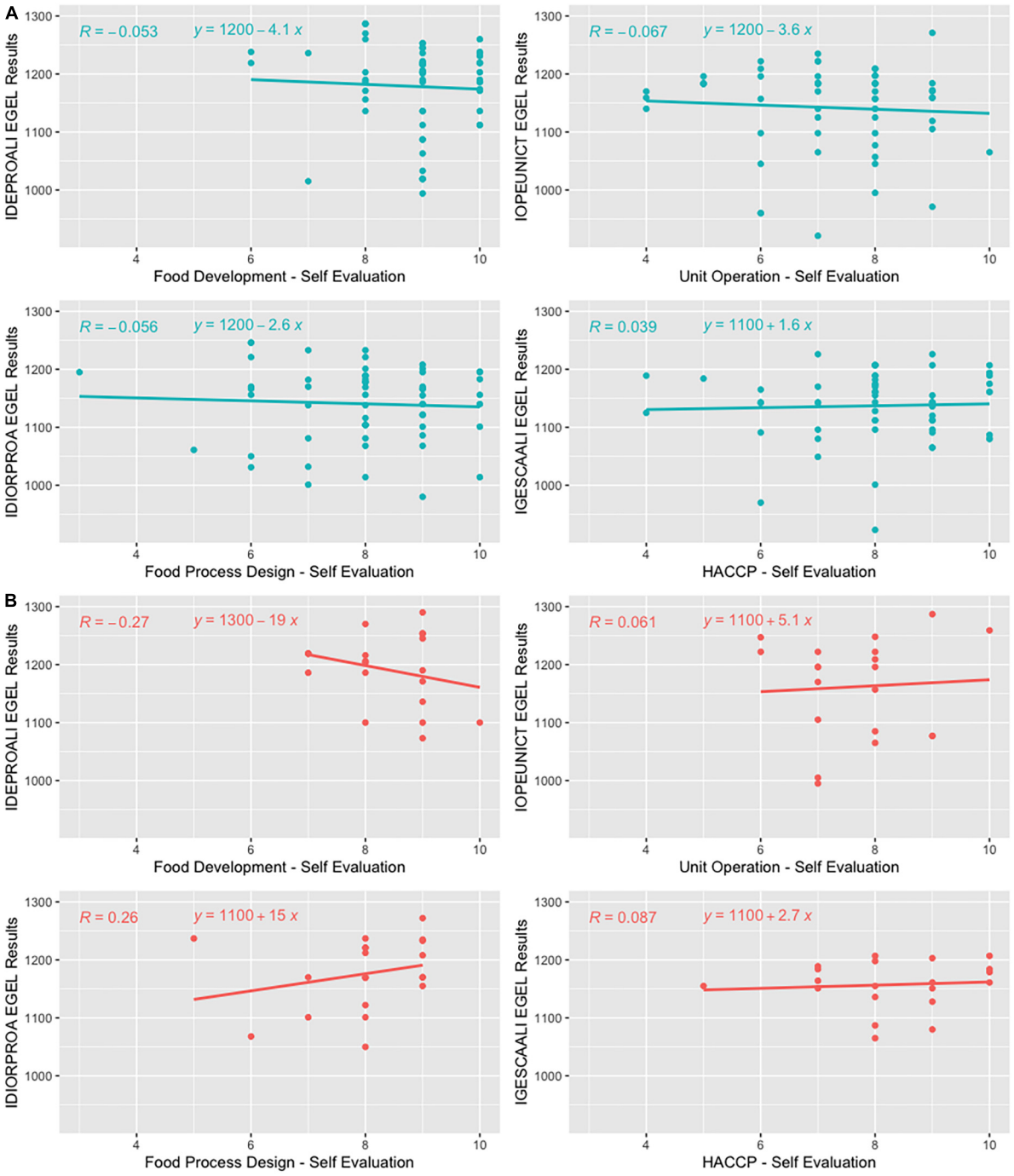

FIGURE 9
EGEL (General graduation Exam by the National Centre of Evaluation) results and self-evaluation of academic categories mean results by EGEL section for **(A)** women and **(B)** men. IDEPROALI, Food Product Development; IOPEUNICT, Unit Operations for the Conservation or Transformation of Food; IDIORPROA, Design and Operation of Food Processes; IGESCAALI, Food Quality Management. The correlation coefficients for women by category were −0.053, −0.067, −0.056, and 0.039, respectively; for men −0.27, 0.061, 0.26, and 0.087, respectively.

The self-efficacy disparity could be due to an impostor syndrome. It has been reported that a moderate to strong impostor phenomenon negatively impacts research self-efficacy (Jöstl et al., 2012). Although this phenomenon is present in both genders, it has been mostly linked to females (Bravata et al., 2020). Women seem to experience the impostor phenomenon at higher rates because of the roles expected to be fulfilled in society, especially due to Latin American family

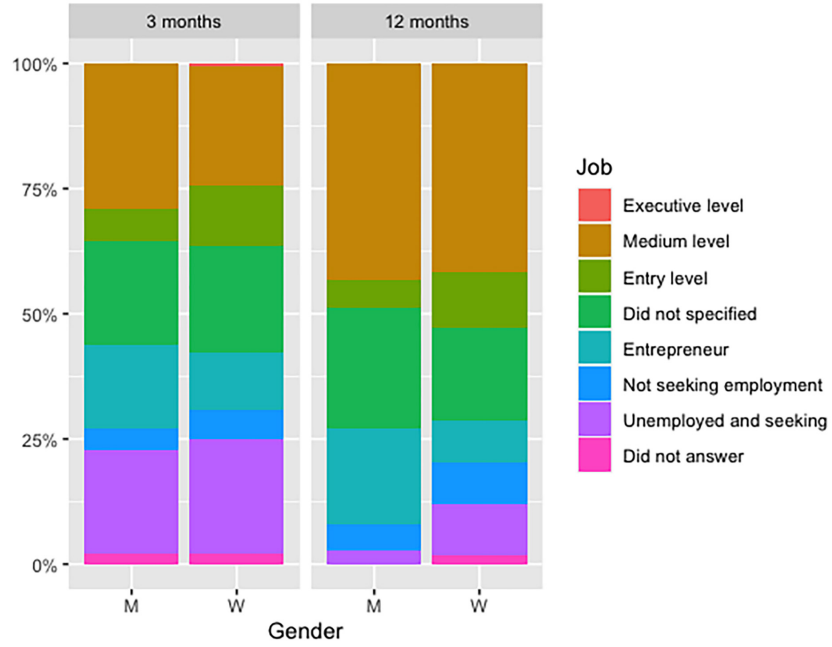

FIGURE 10
Employment distribution after 3 and 12 months of graduation for all participants (M, Men; W, Women).

dynamics (Zepeda and Barahona, 2020). In general, gender and race/ethnicity identity shape the experiences of the impostor syndrome in STEM (Chakraverty, 2019). Therefore, the self-efficacy gender gap found among the results of this study might be due to gender norms, although future research on this topic is encouraged. Other studies have found that trust between men and women varies depending on age. Although, for example, women tend to have less confidence than men between the ages of 20 to 40, although their ability does not differ, at age 40, women's confidence levels match their male peers (Mullen, 2019; Zenger and Folkman, 2019). Based on the above, it is suggested to research self-assessment questions to groups of different ages to analyze if there is a difference in self-perception as the students go from adolescence to adulthood.

Self-efficacy has been related to performance, and it could be an effective predictor of career exploitation and progression (Blustein, 1989; Sadri and Robertson, 1993; di Tullio, 2019). Furthermore, a gender gap in self-assessments might contribute to gender gaps in educational and labor market environments, as women systematically self-evaluate less favorably than equally performing men (Exley and Kessler, 2019).

Employment of food industry engineering graduates

Food Industry Engineering graduates have some differences in employment depending on their gender. After 3 and 12 months of graduating, men appear to have more medium-level jobs and fewer entry-level jobs than women. Additionally, a higher percentage of male entrepreneurship is reported at both periods (**Figure 10**). The statistical analysis was performed using the ratio test for comparison among genders (**Table 2**). Although there was no difference between males and females with a 90% confidence in medium-level and entry-level jobs, a difference was found in entrepreneurship with a *p*-value of 0.0708 favoring men.

TABLE 2 Two-proportion *Z*-test between gender by evaluation period and work status[a].

		Two-proportion *Z*-test with 90% confidence level (*P*-value)	
		3 months	**12 months**
Employee	Executive level	0.5000	NA
	Medium level	0.2881	0.5000
	Entry level	0.1887	0.2446
	Did not specified	0.5000	0.3002
Entrepreneur		0.2321	**0.0708**
Not seeking employment		0.4716	0.4126
Unemployed and seeking		0.4539	0.1401
Did not answer		0.5000	0.4933

[a]Gray shaded cells indicate a higher proportion for men, while white cells indicate a higher proportion for women. Therefore, the analysis was adjusted to greater (men) or less (women) in the statistical analysis. Values in bold indicate a category is statistically different.

Despite our results not showing a statistical difference between men's and women's employment, the gender gap in the labor market has been documented. Different professional situations were documented for the same STEM majors in Poland. Women tend to experience more difficulty finding a job, receive fewer job offers and are less likely to find a job consistent with their education (Jasko et al., 2020). Starting in middle school, girls avoid judgment by avoiding science and math fields altogether, saying they are not interested in reducing negative stereotypes (Hill et al., 2010). In addition, the risk of failure is a critical factor since 22% of women decide not to apply to jobs due to this reason (Mohr, 2014). Thus, some of the differences in employment ratios found in the results might be attributed to a risk of failure and judgment. However, while women studying higher education in STEM were more confident than men in STEM and women in non-STEM, their career transition and advancement are more difficult and less likely to occur (Bennett et al., 2021).

Entrepreneurship after 12 months of graduating resulted in a gender gap. The number of women entrepreneurs in OECD countries is less than men, and they usually have average lower profits. The main reasons for these differences are the time and resource constraints women have the complicated and expensive business formalization costs, and the difficulty securing equity capital. The major gap is attributed to start-up orientation, with external investors seeing women's projects with less growth potential (Organisation for Economic Cooperation and Development, 2012; Guzman and Kacperczyk, 2019). Additionally, it has been argued that women STEM entrepreneurs face a masculinized context from both the STEM fields and entrepreneurship, which usually leads them to imitate some masculine traits (Li C. et al., 2020; Poggesi et al., 2020). Hence, women's entrepreneurship 12 months after graduation might be limited by the masculine context and lack of investment support.

Food Industry Engineering, being an atypical program in the STEM majors regarding their male to female graduate ratio, might result in lower gender gaps in the labor market. Still, tasks commonly associated with a specific gender seem to influence the self-efficacy of the students. This is consistent with the literature, as females performing *masculine* tasks only believed they could succeed if encouraged (Lirgg et al., 2019). In general, an improvement of self-efficacy is required since regardless of gender, the level of self-efficacy is positively correlated with the range of career options seriously considered and the degree of interest shown in them by the professionals (Bandura, 1982).

Finally, potential actions to reduce gender disparity in professional life should be focused on boosting career transition, supporting work advancement, and especially achieving an accurate self-efficacy of academic and interpersonal abilities. Some of the recommendations for self-efficacy improvement in school, organizations and institutions, include the establishment of challenging yet achievable short-term goals (Schunk and Pajares, 2002); comparison of student or employee's performance to themselves rather than to their classmates (Bandura et al., 2008); provision of positive feedback on strategy steps when solving problems (Zimmerman and Kitsantas, 2002); highlighting the relevance of context by making connections between study and professional work (Papastergiou, 2010; Bartimote-Aufflick et al., 2016).

Future research on this topic should include more academic semesters to achieve a bigger sample and better evaluate any gender gap for a more accurate analysis. Moreover, variables such as age and social status should also be considered for intersectionality purposes, and the effect gender norms might have on undergraduate students and how their self-efficacy is shaped. Finally, a longer period than 12 months after graduation is needed to gain a deeper understanding of the employment trends of Food Industry Engineering graduates.

Conclusion

Food-related science fields are considered atypical programs in STEM disciplines since more women than men graduates are reported. Nonetheless, these disciplines still report gender bias, which can affect the performance of the students and professionals. Considering self-efficacy as the belief to perform certain actions given certain skills and abilities, it has been reported to greatly influence areas such as education and occupation choice and performance. To find elements that can be improved for the guidance of students, this study had the objective of determining the relationship between self-efficacy and employment in Food Industry Engineering students.

Our results showed that men self-evaluate better than women, which concurs with literature stating that women tend to have a lower self-efficacy. Differences in both self-assessments and GPA suggest men are more interested in empirical rather than academic skills.

One important conclusion of this work is that the employment of Food Industry Engineering graduates by gender only showed statistical differences in entrepreneurship, which might be attributed to a lack of investment support and the double masculinized context from STEM fields and entrepreneurship. The findings of this work concede for the identification of the current social and economic contexts of the Mexican society, specifically regarding the Food Industry Engineering students. As a result of this recognition, the planning and the development of necessary measures for the support of gender equity becomes more attainable. Therefore, some of the potential actions recommended include boosting career transition and supporting work advancement.

In conclusion, the differences found in interpersonal and academic self-efficacy among the male and female students did not result in an employment difference among recent graduates, except for entrepreneurship. It is important to state that a longer

analysis period might be required to determine any trends better. Furthermore, it is recommended that a similar study be conducted in a different cultural and social context to assess differences in regional traditions.

Data availability statement

The original contributions presented in this study are included in the article/**Supplementary material**, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

AR-G analyzed the data, interpreted the results, and drafted the manuscript. LV-S and AR-P guided in the conception of the work and critically revised the manuscript. CC-H designed the survey, collected its results, gathered the standardized test results, and edited the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.860430/full#supplementary-material

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