Do STEM female undergraduates feel like impostors? The relationship between transformational leadership and the impostor phenomenon

Cristina Domínguez-Soto, Victoria Labajo and Jesús Labrador-Fernández
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Abstract

Transformational leadership has become increasingly relevant in volatile and complex work environments. However, the development of this leadership style could be threatened by the impostor phenomenon (IP). The IP was first observed in gifted women who felt like frauds, although they were outstanding achievers. Some women at STEM universities today will become leaders in the future. The purpose of this study is to establish the relationship between transformational leadership and the IP in STEM students, some of whom will occupy senior executive positions later in life.

In this study, 548 engineering students participated. We used structural equation modeling to test the regression model associating the different leadership styles with the IP. The results confirm that students experiencing impostorism tend toward transactional or passive leadership styles. Additionally, a lower degree of impostorism is related to a higher degree of transformational leadership behavior.

This study reveals gender differences concerning the IP, with female STEM students reporting greater impostor feelings. The IP is also significantly higher for first-year college students than for last-year college students. Implications for female leadership development and STEM students are discussed. We shed light on the female leadership perspective for future research.

Keywords: transformational leadership; impostor phenomenon; STEM; female leadership

1. Introduction

Leadership has been extensively studied from the male perspective. Now, with an increased presence of women in senior executive positions, female leadership needs further study. Many questions cannot yet be answered because there are still few positions of power occupied by women. However, we should start shedding light on these questions about the female leadership perspective. Currently, women at university are being called to hold more senior executive positions in the future. The understanding of how these women are developing their managerial skills during their education can help us anticipate the reality that awaits us in terms of future female leaders.

The number of women in leadership positions is still meager. We have identified a series of internal and external barriers that make it difficult for women to access senior management positions. Within these internal barriers, the impostor phenomenon is one barrier that slows down women's aspirations (Neureiter & Traut-Mattausch, 2016). This paper aims to explore the relationship between the IP and transformational leadership, a style that is very well adapted to female characteristics (Eagly, Johannesen-Schmidt, & van Engen, 2003).

1.1. The Impostor phenomenon

The impostor phenomenon (IP) has been researched for the last forty years (Bell, 1990; Clance & Imes, 1978; Mak, Kleitman, & Abbott, 2019). Impostor syndrome is the feeling of being a fake or a fraud in terms of professional career or academic success (Chromey, 2017). It is the situation in which one feels like a phony or dumb. People with impostorism feel that they are not intelligent

enough intellectually, despite all their outstanding achievements, which are due to luck, hard work, or favorable external factors. Impostorism is an unfair distortion about one's own competence or the illusion of not being competent enough (Clance & Imes, 1978). Impostors are more concerned about mistakes, which they overestimate (Thompson, Foreman, & Martin, 2000). People with this syndrome experience a fear of failure, feel guilty about their success and face issues internalizing the positive feedback they receive (Clance & OToole, 1987; Fried-Buchalter, 1997). When they have to work on a new challenging task, they approach it either by procrastinating or by overworking (Clance & Imes, 1978). When the job is completed, these individuals feel a short sense of relief just before focusing on the errors they made. Perfectionism is an essential element of impostorism (Chrisman, Pieper, Clance, Holland, & Glickauf-Hughes, 1995; Rohrmann, Bechtoldt, & Leonhardt, 2016; Thompson et al., 2000). Families with high standards of perfection and society with its gender roles are behind the origin of the impostor phenomenon (Clance, Dingman, Reviere, & Stober, 1995).

Studies regarding gender and the impostor phenomenon have shown different results. One study showed that this phenomenon occurs more frequently among women than among men (Clance & Imes, 1978). First, investigations on the IP found that it can be observed in high-achieving women (Bell, 1990). However, Topping and Kimmel (1985) discovered more men than women with significantly higher impostor ratings among university faculty members. Clance and O'Toole (1987) argued that a reason for this could be that women had to go through impostor experiences to become faculty members, so they had already labeled and overcome them. Since then, we have found many studies in which there are no significant gender differences in impostor tendencies (Bernard, Dollinger, & Ramaniah, 2002; Ferrari & Thompson, 2006; Fried-Buchalter,

1997; Lester & Moderski, 1995; Rohrmann et al., 2016; Vergauwe, Wille, Feys, De Fruyt, & Anseel, 2014; Wang, Sheveleva, & Permyakova, 2019). However, there are also many studies in which there is significant gender correlation with the IP, and among these, more studies demonstrate higher impostor ratings for females than for males (Cokley et al., 2018; Cozzarelli & Major, 1990; Ibrahim, Münscher, & Herzberg, 2020; Jöstl, Bergsmann, Lüftenegger, Schober, & Spiel, 2012; King & Cooley, 1995). In these cases, the samples consist of college students. Gender effects in impostor syndrome are still unresolved (Rohrmann et al., 2016).

The number of studies on impostorism is small, and they can be clustered into three types: the validity of the scales used to measure impostorism; its relationship with other constructs, mainly regarding personality factors; and its impact on different populations. Most researchers have used student samples (Mak et al., 2019). However, the IP has mostly been ignored in STEM research. There is limited evidence on how the IP influences recruitment, retention, and progress in STEM careers (French, Ullrich-French, & Follman, 2008; Lee, Anderson, Yates, Chang, & Chakraverty, 2020). Future research can shed light on this relationship and help obtain more female representation in STEM careers.

Women experience several internal barriers in professional career development, and impostorism is one of them. Those who feel like impostors do not progress to higher managerial positions and, instead, try to remain in their current roles (Kets de Vries, M F, 2005). Fried-Buchalter (1997) and Studdard (2002) believe that people who experience impostor syndrome have fewer career goals and lower aspirations than do those who do not. They cannot perform at their highest level, as fear and anxiety drain their energy to accomplish significant challenges. They do not enjoy success. Although both women and men experience this phenomenon, it

prevents more women than men from reaching their highest potential. Impostorism is an additional barrier facing women in progressing in their careers. In the case of men, society pushes them to go ahead, despite their feelings of impostorism (Clance & OToole, 1987).

1.2. Transformational and transactional leadership

Bass and Avolio (1994b) described the importance of managing organizations efficiently through transformational leadership theory, which refers to transforming the values and priorities of followers and motivating them to perform beyond expectations. Transformational leaders prioritize mutual goals. They encourage followers to transcend their self-interest for a higher collective purpose. Transformational leadership is sets higher standards than do the transactional and passive leadership styles.

The most traditional leadership style is the transactional style. The behaviors that define the transactional style are contingent rewards and active management by exception. Leaders clarify what followers need to do for a reward and establish rules when errors happen to avoid their reoccurrence. Transformational and transactional styles are opposite of the passive leadership style, which is represented by some senior managers who prefer to avoid responsibility. Laissez-faire leadership contrasts with the most effective working atmosphere, that of transformational leadership (Bass & Avolio, 1995).

Once we have explained the differences between leadership styles, we explore gender differences in light of transformational leadership theory. Eagly et al. (2003) concluded in a meta-analysis that women have better leadership skills than men as transformational leaders. Even as transactional leaders, women are also more balanced than men in delivering rewards to

followers. Women achieve high cohesion in teams because they change the power base; they go from “power over” to “power with” (Fondas, 1997). Transformational leadership development in female STEM students can foster their career growth, as women show better attributes than men for this leadership style (Vinkenburg, van Engen, Eagly, & Johannesen-Schmidt, 2011).

In addition to gender differences, the relationship of impostorism and the Big Five personality traits is another common subject in the research on impostor syndrome and transformational theory. Judge et al. (2000) revealed through a meta-analytic review that the “Big Five” personality traits (NEO-FFI)—neuroticism, extraversion, openness to experience, conscientiousness, and agreeableness—display a strong correlation with leadership, with extraversion having the strongest correlation. Bono and Judge (2004) completed a meta-analysis concluding that extraversion is positively correlated and neuroticism is negatively correlated with transformational leadership. Neuroticism has a specific negative correlation with charisma and intellectual stimulation, both of which are behaviors of transformational leadership. It is also reinforced through the literature that individuals who score high in neuroticism lack self-confidence and self-esteem (McCrae & Costa, 1991). Self-confidence is an essential characteristic of transformational leaders (Bass & Avolio, 1995). However, some studies present surprising results, as they do not suggest a significant association between transformational leadership and neuroticism (Zopiatis & Constanti, 2012) but rather a positive association between transformational leadership and extraversion, openness, and conscientiousness. To reinforce this positive correlation with conscientiousness, Bass (1985) hypothesized that achievement should be related to transformational leaders and that achievement and self-discipline are the main components of conscientiousness.

1.3. The relationship between transformational and transactional leadership styles and the impostor phenomenon

Within the academic literature, no studies have explored the relationship between transformational leadership and the IP. Both constructs highlight the importance of understanding gender differences (Cozzarelli & Major, 1990; Eagly et al., 2003; Kark, Waismel-Manor, & Shamir, 2012; King & Cooley, 1995; Koenig, Eagly, Mitchell, & Ristikari, 2011; Rohrmann et al., 2016). Many studies on impostorism and transformational leadership also describe the interaction among the five personality traits, which can help determine the theoretical hypothesis regarding the associations between these two constructs. We will discuss whether there is a higher prevalence of impostorism among female students who adopt transformational leadership behavior or if it is more common among those who assume a more transactional or passive leadership role.

First, the IP may occur more frequently among female STEM students and with less intensity among male STEM students. Moreover, transformational leadership has been identified as a style that can help women become more efficient and successful leaders (Bass & Avolio, 1994a; Eagly et al., 2003; Vinkenburg et al., 2011). All efforts in education to reduce impostorism can diminish the attrition rate of female STEM students (Canning, LaCosse, Kroeper, & Murphy, 2019) and will improve the self-esteem that is a basic need for transformational leadership development (Judge, Bono, Ilies, & Gerhardt, 2002).

Second, through studies related to the Big Five personality traits, it is found that there is a higher prevalence of impostor syndrome among students who adopt passive or transactional

leadership styles. When studying impostorism and the Big Five personality dimensions, neuroticism is observed to be positively correlated with the impostor phenomenon, and conscientiousness is negatively associated (Bernard et al., 2002; Chae, Piedmont, Estadt, & Wicks, 1995; Ross, Stewart, Mugge, & Fultz, 2001). Ross et al. (2001) confirmed some previous findings, predicting the IP with a five-factor model, showing neuroticism as the best predictor. Depression and anxiety are neuroticism subscales with higher positive correlations with the IP (Bernard et al., 2002). Those who feel like impostors feel anxiety and expect not to perform well, exhibiting some depression traits (Chrisman et al., 1995). Regarding conscientiousness, self-discipline and perceived competence are the most consistent and strongest negative facets for impostors (Bernard et al., 2002). Moreover, as mentioned previously regarding the relationship between transformational leadership and the five-factor structure of personality, transformational style is negatively correlated with neuroticism (Bono & Judge, 2004) and positively correlated with conscientiousness (Zopiatis & Constanti, 2012). Through these two Big Five personality variables—neuroticism and conscientiousness—we hypothesize that the impostor phenomenon is negatively correlated with transformational leadership.

Finally, leadership in general and in IP relationships must be further explored through quantitative research. Rohrmann et al. (2016) studied the relationship between working styles among a sample of individuals in leadership positions who were experiencing impostorism. He found that the impostor phenomenon had a positive relationship with many constructs, such as neuroticism, depression, anxiety, narcissism, and procrastination, and negative correlations with conscientiousness and euthymia. The above study also suggested that impostorism is a barrier to the development of transformational leadership.

To confirm the abovementioned associations, we conducted quantitative research with STEM students. This study intends to answer the following questions:

- The impostor phenomenon occurs more frequently among female engineering students and less often in their male counterparts. Female STEM students can be more vulnerable to this syndrome than can male STEM students (hypothesis 1)
- As students experience achievements throughout university studies and overcome academic challenges, the impostor phenomenon may decrease over the years (hypothesis 2)
- The impostor phenomenon may be negatively associated with transformational leadership. There may be a higher prevalence of transactional leadership behavior among those students who feel like impostors (hypothesis 3)

2. Method

2.1. Participants and procedure

The sample consisted of 548 students (29% women) in bachelor's degree programs in the fields of engineering for industrial technologies and engineering for telecommunications technologies. A total of 308 participants (32% women) were first-year bachelor students, 111 (23% women) were fourth-year bachelor students, and 129 (25% women) were second-year master students. The purpose for selecting these courses were to understand the effect of age and to evaluate evolution through university studies. Transformational leadership theory assumes that transformational behavior skills can be learned (Avolio & Bass, 1998); therefore, leadership behavior can evolve over the years. Moreover, stronger impostor feelings among first-year

college students have been observed due to their higher perceived classroom competition (Canning et al., 2019). Examining students at the beginning and the end of their academic career will help avoid biases. All of the participants were aged between 18 and 26 years. There were 28 international students (5%) and 30 master's students who had pursued a bachelor of engineering degree at a different university.

2.2. Measures

2.2.1. Transformational leadership

We propose measuring the type of leadership among engineering students through the Multifactor Leadership Questionnaire scale (Bass & Avolio, 1995). The MLQ is a 5-point Likert scale of 45 questions. The MLQ includes the concepts of transformational, transactional, and passive/avoidant leadership. The MLQ self-rating form was administered as an online survey via a non-Mind Garden survey system, with a license to conduct the instrument. In the current study, the Cronbach's alpha of the MLQ scores was 0.76.

2.2.2. Impostor phenomenon

Since the impostor phenomenon was defined, four different instruments have been utilized to assess it: the Clance Impostor Phenomenon Scale (CIPS; Clance, 1985), Harvey Impostor Scale, Perceived Fraudulence Scale, and Leary Impostor Scale (Mak et al., 2019). The CIPS is the preferred scale for the general population due to its reliability and sensitivity (Holmes, Kertay, Adamson, Holland, & Clance, 1993; Mak et al., 2019). The CIPS is a 5-point Likert scale of 20 questions. According to Holmes et al. (1993), a total score of 62 or higher assumes that an individual suffers from impostor syndrome. In the current study, the Cronbach's alpha of the CIPS

was 0.826.

2.2.3. Demographic Variables

The selected demographic variables are gender (coded as 0 = male and 1 = female), age, and university course (coded as 0 = first-year degree, 1 =fourth-year degree, 2 = second-year master's degree).

2.3. Data analysis

Some analyses were carried out using JASP (version 0.11) to evaluate the constructs. The impostor phenomenon was originally defined with three subscales (Clance, 1985). Moreover, many studies have applied the following three factors: fake, discount, and luck (Brauer & Wolf, 2016; Chrisman et al., 1995; Holmes et al., 1993; McElwee & Yurak, 2010). However, other studies have found it more appropriate to conduct CFA with one or two factors (French et al., 2008; Jöstl et al., 2012; Rohrmann et al., 2016; Simon & Choi, 2018). Mak, Kleitman, and Abbott (2019) suggested that the further clarification of the construct's dimensionality is needed. The best model for this study proposes two factors (see Fig. 1), with a reliability of 0.845. The two observed factors and their loadings are fake, with 29%, and luck, with 12%. French et al. (2008) also combined the original factors—fake and discount—into one factor, defining two elements, fake

and luck (see Table 1). The total CIPS score is used in our study, as the literature shows inconsistency regarding the number of factors.

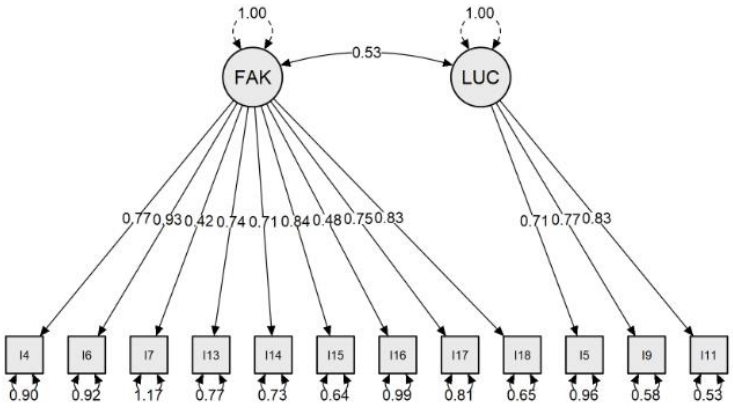


Fig. 1
Impostor phenomenon factor loadings. I#: Selected items. The correlation between factors is 0.53.

The MLQ scale is well consolidated. The reliability ranges of the nine factors analyzed for Europe are from 0.61 to 0.78 (Bass & Avolio, 1995). In our sample, the reliability of the nine factors (α) ranges from 0.47 to 0.71. To obtain acceptable reliability, our model can be simplified to three factors, as suggested by Avolio and Bass (1995), transformational (TRANSF), transactional (TRANS), and passive (PASS) leadership. In the present sample, the internal consistencies of these three factors amount to α (TRANSF) = .851, α (TRANS) = .630 and α (PASS) = .723.

To investigate the relationship between transformational leadership and the impostor phenomenon, data were also analyzed with structural equation modeling (SEM) using AMOS version 26.

3. Results

3.1. Descriptive analysis

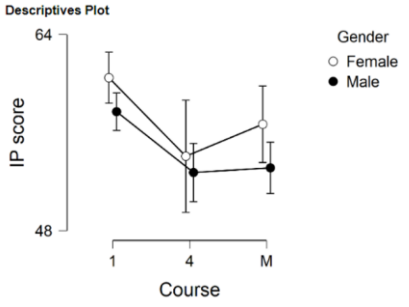
The first set of analyses examined the impact of impostorism on STEM students. A preliminary analysis showed that 32% of our sample can be considered impostors, showing a total score of 62 or higher (Holmes et al., 1993). A simple statistical analysis was used to demonstrate gender differences in this sample. Female STEM students suffer from a greater impostor phenomenon than do their male counterparts, but the effect is small (t (546) = 3,089, p = 0.002; Cohen's d = 0.3). In the sample, 39% of women suffered from the impostor phenomenon, compared to 29% of men.

The course in question also significantly affected the IP, with it being higher in first-year students (40%) than in fourth-year students (21%) and second-year master's students (21%) (t = 4,101, p <0.001 and t = 3,282, p = 0.003). Two-way ANOVA was used to examine the effect of gender and course on the impostor phenomenon. Main effects were found for both gender (F (1,542) = 4,691, p = 0.031, w ^ 2 = 0.006) and course (F (2,542) = 11,193, p <0.001, w ^ 2 = 0.036). There was no statistically significant interaction between the effects of gender and course together on the IP (p = 0.79). Tukey's post hoc correction showed that the IP was significantly higher in first-year students than in fourth-year and second-year master's students (t = 4.101, p <0.001 and t = 3.282, p = 0.003). There were no significant differences in courses between fourth-year students and second-year master's students (p = 0.634). Table 1 provides the mean and standard deviation of the IP, considering gender and course effects. A descriptive plot also displays the IP values in a figure to better illustrate the differences. The simple main effects related to gender showed that

the IP was significantly higher among women than among men and first-year students (F (1) = 4.485, p = 0.035). However, there was no gender difference in terms of course between fourth-year and second-year master's students (p = 0.588 and p = 0.105, respectively).

Table 1
Descriptive statistics for the effects of gender and course differences on the impostor phenomenon

Gender	Course	Mean	SD	N
Female	1	60.48	10.48	100
	4	54.08	11.06	25
	M	56.69	8.64	32
Male	1	57.71	11.13	208
	4	52.76	11.07	86
	M	53.13	10.39	97



The means, standard deviations, and correlations among study variables are presented in Table 2. For both women and men, impostorism was positively related to transactional and passive leadership and negatively associated with transformational leadership, as expected. Regarding the size of the effect concerning impostorism, passive leadership experienced a moderate effect (0.3 <r <0.5) for both genders; however, for the rest of the variables, there was a small effect (0.1 <r <0.3).

Table 2
Descriptive statistics and correlations among study variables for men and women

Variable	Course	TRANSF	TRANS	PASS	IP	MEAN	SD
Course	—	0.09	0.04	-0.22***	-0.19***	0.67	0.83
Transformational leadership (TRANSF)	0.13	—	0.56***	-0.35***	-0.25***	2.60	0.49
Transactional leadership (TRANS)	-0.17*	0.47***	—	-0.15**	0.14**	2.42	0.50
Passive leadership (PASS)	-0.23**	-0.56***	-0.29***	—	0.46***	1.19	0.62
Impostor phenomenon (IP)	-0.18*	-0.24**	0.20*	0.33***	—	56.40	11.06

* $p < .05$, ** $p < .01$, *** $p < .001$
N_{male} = 391 and N_{female} = 157
Note: Values above the diagonal represent correlations for men, and those below the diagonal represent correlations for women.

3.2. The relationship between leadership styles and the impostor phenomenon

To examine the relationship between the IP and different leadership styles, structural equation modeling (SEM) was employed using the maximum likelihood method via AMOS. Although the causal paths of the IP and leadership styles are not entirely clear, it is assumed that the IP influences leadership styles. We conducted three analyses with these leadership styles as outcome variables. We used a two-step method by checking the measurement and structural models (Anderson & Gerbing, 1988). We also explored the potential common method variance through Harman´s single factor test (Harman, 1976), demonstrating reasonable evidence that common method variance should not pose a serious threat in this investigation.

3.2.1. Measurement models

Before testing our measurement models, a series of confirmatory factor analyses (CFAs) were conducted to determine the distinctiveness of the constructs—IP, TRANS, TRANSF and PASS. The best CFA for the IP is presented in the data analysis section in Fig. 1. Regarding leadership styles, we trimmed some individual items with factor loadings below 0.5 to refine the instrument (Podsakoff & Organ, 1986). The composite of transformational leadership was measured with scores consisting of 14 items (α = .84). Transactional leadership was measured through the original eight items with a reliability (α) of 0.63, which was acceptable in previous studies (Bass & Avolio, 1995). Passive leadership was reduced to 6 items (α = .739), a procedure that is consistent with empirical work (Aga, Noorderhaven, & Vallejo, 2016; Vinger & Cilliers, 2006).

The three measurement models for the IP with leadership styles produced a good fit. The standardized regression weights (SRWs) for the three models were all significant (p<0.000) and generally above 0.4, showing convergent validity. Discriminant validity was also demonstrated by using Fornell and Larcker's (1981) suggestion. According to this criterion, the square root of the average variance extracted (AVE) of each construct is larger than the correlation with the other construct in each of the three analyzed models (see Table 3).

Table 3
Measurement models for the IP with leadership styles

Models	χ2	df	χ2/df	GFI	CFI	RMSEA	SWR range	√AVE IP	√AVE leadership style	Correlation IP-leadership style
IP - TRANSF	635.45	287	2.21	0.92	0.91	0.05	0.25-0.73	0.57	0.52	-0.17
IP - TRANS	391.29	162	2.42	0.93	0.91	0.05	0.25-0.74	0.57	0.44	0.19

IP - PASS	325.01	129	2.52	0.94	0.93	0.05	0.26-0.74	0.57	0.57	0.52

Note: TRANSF = transformational leadership style; TRANS = transactional leadership style; PASS = passive leadership style.

3.2.2. Structural models

We ran the three models, adding two control variables—gender and course. The first structural model, representing the relationship between the IP and transformational leadership, displayed acceptable goodness of fit (χ2 = 725,429; df =335; χ2/df = 2,165; GFI = .912; IFI= .904; TLI = .891; CFI=.903; RMSEA=.046) and explained 17% of the transformational leadership variance. The second structural model, showing the association between the IP and transactional leadership, presented a good fit (χ2 = 464,032; df =197; χ2/df = 2,355; GFI = .928; IFI= .898; TLI = .879; CFI=.897; RMSEA=.050) but explained only 4% of the transactional leadership variance. The third structural model, exhibiting the relationship between the IP and passive leadership, also showed acceptable fit (χ2 = 397,362; df =161; χ2/df = 2,468; GFI = .931; IFI= .918; TLI = .903; CFI=.918; RMSEA=.052) and explained 30% of the passive leadership variance. The results of our analysis are described in Fig. 2, where the standardized estimates for all the paths are shown. All the relationships between the IP and leadership styles are significant. Higher degrees of impostor syndrome are associated with a higher preference for transactional or passive leadership styles, while lower degrees of impostorism result in a higher preference for the transformational leadership style.

Regarding control variables, gender has a remarkably significant impact on the relationships between the IP and the transformational and passive leadership styles, and the control variable—course—only has a considerable effect on the passive leadership model. We investigated the potential moderation effect, where the control variables exhibit a significant impact, following

Holmbeck's guidelines (Holmbeck, 1997). No evidence of either gender or course moderation in the relationships between the IP and leadership styles was found.

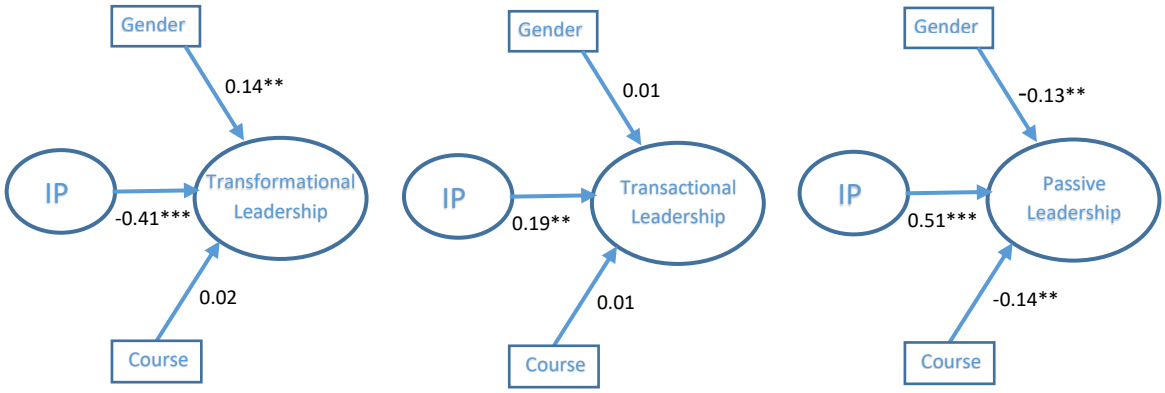


Fig. 2. Standardized SEM maximum likelihood estimates from testing the effect of imposter syndrome on transformational, transactional, and passive leadership styles. Note: ** p< .005, and *** p<.001.

4. Discussion

As predicted, we found that impostorism is greater in female STEM students than in their male counterparts. Female engineering students, especially in their first years at university, recognize themselves as being less legitimate than their peers in STEM campus life. Thus, Hypothesis 1 is confirmed. This research is one of the few studies focused on impostorism among STEM students (Canning et al., 2019; French et al., 2008; Tao & Gloria, 2019). Women in STEM careers are still a concern, as gender disparities persist. The 20th century has been characterized by the dismantling, if not the breakdown, of the administrative, social, economic, and political barriers that had previously prevented women from occupying managerial positions (Campbell & Campbell-Whatley, 2019; Gram, Morrison, & Skordis-Worrall, 2019). There are also internal barriers that are more subtle and challenging to make visible. This research addresses one internal

obstacle—impostorism (Clance & OToole, 1987). We need to further study the IP in STEM students, as it can help lead to increased female representation in leadership roles.

Another important finding is that female STEM students in their first year are more vulnerable to suffering from impostor feelings. However, as students progress in university, impostor syndrome decreases significantly, as described in Hypothesis 2. These results corroborate the importance of helping students during their first years at university gain a sense of belonging to the institution and academia to overcome the IP (Chapman, 2017). One unanticipated finding is that at the end of participants' careers, there are no significant gender differences. In our sample, we found that 49% of first-year female undergraduates suffered from impostor feelings compared with 36% of their male counterparts. However, in recent years, impostor feelings have decreased to 21%, both in women and in men and, surprisingly, at the same level. A possible explanation for this may be that women who progress in engineering develop self-confidence to cope with the challenges they face. This finding is similar that of Rohrmann et al. (2016), who explained the absence of gender differences related to impostorism at higher leadership levels. Although the IP is generally more frequently found in women than in men, women who advance in their professional careers overcome impostorism using more active coping methods than those used by men (Hutchins & Rainbolt, 2017).

In reviewing the literature, no data were found for the association between the IP and transformational leadership. We tested a structural model to explain the impact of the IP on different leadership styles. The findings reported here suggest that impostorism may be negatively associated with transformational leadership, confirming Hypothesis 3. Students with a

higher perception of impostorism adopt transactional or passive leadership behaviors. These results confirm the theoretical explanation mentioned in the introduction.

4.1. Limitations and future research

The current research has several limitations. First, our measures are based on self-reports, so we cannot rule out common method bias (Podsakoff, MacKenzie, & Podsakoff, 2012). However, response biases can be assumed to be small, as the study is designed as an online survey with anonymous participation and assured confidentiality. Response bias is also balanced by the large sample size. Second, a cross-sectional study design does not allow for causal conclusions to be drawn about observed relationships. Third, the generalizability of the findings is limited, as the sample comes from only one university in Spain. Future investigations can test the proposed relationship in a different population, considering other countries and universities in the same STEM context. Finally, the samples of women in fourth-year and second-year master's courses were relatively small (N = 25 and N = 32, respectively). Therefore, some results should be interpreted with caution.

Another possible area for further studies is the investigation of whether instances of women reaching top leadership positions have escalated due to their overcoming of internal barriers. The more difficulties and challenges they face, the more resilient they become in breaking the glass ceiling. In addition to the organizational obstacles to achieving high-level positions, some women

face unblocked cultural prejudices and gender discrimination in addition to other internal barriers as the IP.

4.2. Practical implications

Women in STEM careers could become highly successful executives in the future. By studying them, we can shed light on the female leadership perspective. Women have better leadership skills than do men as transformational leaders (Eagly et al., 2003). We suggest that developing transformational leadership behaviors in female STEM students will also help them overcome impostorism. A broader range of leadership styles will contribute to decreasing the negative impact of the IP. Teachers may empower career striving and encourage career planning. Impostors may handicap themselves, as the IP is an inner obstacle to career development (Neureiter & Traut-Mattausch, 2016). The IP is associated with more impoverished leadership styles—transactional and passive leadership. Reducing the IP effect on female students can allow them to further develop their transformational leadership style.

5. Conclusions

This paper is the first attempt at examining the relationship between the IP and transformational leadership. This study aims to gain a better understanding of these two constructs to shed light on female leadership development. Imposter syndrome is related to poorer leadership styles, such as passive leadership or transactional leadership styles. However, it is negatively associated with the transformational leadership style. The second major finding among Spanish STEM students is that impostor feelings are more intense among women than

men in the first year. Then, impostorism decreases throughout their careers. In their final courses, no gender differences were found.

Feeling like an impostor is a destructive behavior in progressing as an efficient leader. The sooner it is detected, the better for career development among future female leaders. Impostorism is one hazard in the first steps of the leadership journey (George & McLean, 2007). Kets de Vries (2005) described how perfectionist overachievers, through anxiety and fear of failure, tend toward micromanagement and are incapable of delegating. In other sectors, like health care, impostor syndrome has been identified among female undergraduates, preventing them from achieving their highest potential (Haney, Birkholz, & Rutledge, 2018). For female STEM students, the IP is stronger than that for their male counterparts, especially in the first year, where they can feel that they look out of place and uncomfortable.

The stereotypes that lead to women facing more difficulties in becoming leaders and Christian culture's emphasis on humility discounting credit may increase the feeling of impostorism (Dahlvig, 2013; Haney et al., 2018). However, references support that transformational leadership is a style closer to female characteristics and very effective for this VUCA environment (Bass & Avolio, 1994; Eagly et al., 2003; Fondas, 1997). An increase in the number of female leaders can produce a more androgynous concept of leadership and therefore reduce bias toward current and potential female leaders (Koenig et al., 2011). Reinforcing transformational leadership can help women decrease their impostor feelings.

There is limited evidence on how the impostor phenomenon influences recruitment, retention, and achievement in STEM (French et al., 2008). Tao and Gloria (2019) suggested that the IP could explain some gender gap in STEM, as they demonstrated that the impostor phenomenon

damages the persistence attitudes of female Ph.D. STEM students. In our study, there is no evidence that the IP is related to career dropouts for only female students. The percentage of women in their fourth year was similar to the percentage of women enrolled four years previous (25% versus 28%, respectively). Although our study suggests that the IP in the first year is significantly higher in women than in men, in final years, instances of impostorism decrease to similar levels in women and in men, without a decrease in the percentage of female students. A longitudinal study can demonstrate whether impostor syndrome influences withdrawal from university.

Data Availability Statement

The datasets generated and/or analyzed during the current study are not publicly available due to the MLQ instrument copyright holder but are available from the corresponding author on reasonable request and with permission of Mind Garden, Inc.

Consent

Informed consent was obtained from all participants included in the study.

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