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Social and Systemic Influences on International Students' Choice of a STEM Major

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ABSTRACT

Countless factors influence students' educational and career choices. We examined potential impacts on international students' choices to study STEM (science, technology, engineering, or math) through the lens of Social Cognitive Theory (Bussey & Bandura, 1999). Using partial least squares structural equation modeling (PLS-SEM), we analyzed the dataset with ten gender- and finance-related constructs as explanatory variables that impact the salience of various reasons for selecting a STEM major. Financial considerations and the availability of government-funded opportunities, women's lack of prominence in respondents' higher-education experiences and the availability of government-funded opportunities, and (a) job outlooks for women and the "chance to help others" and (b) women's lack of prominence in secondary education and the prospect of steady employment showed significant influence. These findings support the salience of financial concerns and gender-stereotyped, patriarchal culture influencing respondents to choose STEM majors for financial safety and/or egalitarianism.

Keywords: academic major, financial aid, foreign students, gender, higher education, international students, STEM

As the world continuously becomes more globalized, students are choosing to attend universities outside their home countries at increasing rates. Educational institutions in the United States have attracted a significant percentage of international students since the nation's founding (Hendricks & Skinner, 1977). This trend of students moving from their home country to pursue education in another (Koo et. al, 2021) has continued. Nationwide, there were 819,644 international students during the 2012-2013 academic year (Open Doors, 2023a).

The latest Open Doors report (2023b) revealed that in the 2022–2023 academic year, the total number of international students at U.S. colleges and universities increased to 1,057,188 students. This was an 11.5% increase from the previous year (Open Doors, 2023b) and a 28 % increase from a decade prior (Open Doors, 2023a). The top countries of origin included China (27.4%), India (25.4%), and South Korea (4.1%) (Open Doors, 2023b). This significant growth shows that the United States remains a popular destination for higher education, wherein more than half (55%) of its international students pursue STEM degrees (Open Doors, 2023b).

Internationally, the U.S. has fallen behind in awarding STEM degrees. Only 23.6% of bachelor's degrees awarded in the U.S. are in STEM, while Germany and Korea lead these statistics with 35.8% and 31.6% of bachelor's degrees being in STEM, respectively (Organization for Economic Cooperation and Development, 2022). Only about one in five domestic students in the U.S. earn bachelor's degrees in STEM (National Center for Education Statistics, 2023a-b), whereas international students seek the U.S. for their STEM education. Over 49% of international undergraduate students in the U.S. pursue STEM degrees (Granovskiy & Wilson, 2019). This is after they go through a year or more of extensive preparation, applications, and the stresses of social and cultural adjustment upon their arrival in a foreign country (Koo & Mathies, 2022).

Policies enacted by the Department of Homeland Security have impacted both universities and international students when it comes to the availability and attainment of STEM degrees. Beginning in 1990, the H-1B visa opened many doors for foreign-born individuals to work in the United States in a specialty field (American Immigration Council, 2023). Issuances of these visas were positively associated with international student enrollment in the United States (Shih, 2016). In 2016, the Department of Homeland Security amended student visas with the Optional Practical Training Extension for STEM Students (STEM OPT), extending international students' stays in the U.S. if employed in the STEM field (2016). This policy acted as an incentive for international students to enroll in STEM programs (Amuedo-Dorantes et al., 2019) and for colleges and universities to offer STEM programs of study (Kim, 2022).

As a historically male-dominated field, STEM environments have often excluded and even prevented women from growing their skills and knowledge and contributing to the field (Saxena et al., 2019), inhibiting innovative and economic benefits that could come from their inclusion. This exclusion may be a continuation of the lack of female representation in STEM education. In 2019, the National Science Foundation (NSF, 2022) found that 35.6% of bachelor's degrees awarded in the U.S. were in science and engineering, with women earning about an equal proportion of these degrees to men. A notable difference lies in the specific areas of study within science and engineering, however. Data on science and engineering degrees awarded to women skews strongly in favor of health and social science degrees, while less than a quarter of degrees in engineering and computer sciences were awarded to women (NSF, 2022). Historical gender stereotypes may affect the motives of students to study STEM or certain STEM subjects, and increasing non-male engagement in all STEM environments would be vital to the pursuit of social justice and the full engagement of human capital to increase American economic competitiveness (Porter, 1998; Stromquist, 1991).

Economic benefits that STEM degree holders bring could be amplified if international students choose to stay and pursue a STEM career in the U.S. During the 2022–2023 academic year, international students studying at U.S. colleges and universities contributed an estimated $40.1 billion to the U.S. economy and supported 368,333 jobs (NAFSA: Association of International Educators [NAFSA], n.d.-a). In Florida alone during the 2022–2023 academic year, 42,590 international students generated a financial impact of over $1.4 billion and supported 12,184 jobs (NAFSA, n.d.-b). Clearly, international students have become a powerful driver of innovation and economic activity in the U.S. (Hunt & Gauthier-Loiselle, 2010; Kerr & Lincoln, 2010; NAFSA, n.d.-a).

The University of Central Florida (UCF) is among the top five universities in Florida for foreign-student enrollment with 3,736 international students (Open Doors, 2023c). This study looks at the tangible and perceived factors that contributed to international students' choice of a STEM major at UCF, a diverse, urban, and renowned research university with over 60,000 students. Our specific constructs of interest included the potential for higher salaries, the chance to help others, the chance to be their own boss, the potential for steady employment, the interestingness of the work, the desire to please family and close friends, the desire to satisfy one's goals and intentions, and greater academic freedom than other fields. The research was guided by the following question: Which of our constructs of interest significantly influenced international students to choose to study STEM in the United States?

THEORETICAL FRAMEWORK

Social Cognitive Theory (Bussey & Bandura, 1999) guided this research on international students' selection of STEM studies. Bussey and Bandura state that humans are in the presence of and take in information from modeled behaviors from birth (1999). Like modern conclusions of the "nature and nurture" psychological development debate (Galton, 1874, p. 12), human development occurs through a combination of various internal and external influences (Bussey & Bandura, 1999). Modeled behavior in the home, interactions with peers, and media can all have significant impacts on one's growth and development (Bussey & Bandura, 1999). As applied in this study, our observation of interest was on how social and cognitive factors might have influenced international students' choice to study STEM in the United States.

Constructs of Interest

Social Cognitive Theory can be linked to the following questions related to our main constructs of interest:

Potential for Higher Salaries

How do modeled behaviors, particularly those related to success and financial stability in STEM fields, influence international students in their pursuit of higher salaries?

Chance to Help Others

In what ways do social factors, including observed behaviors and interactions, contribute to international students' perception of STEM studies as a pathway to making a positive impact and helping others?

Chance to Be My Own Boss

How does Social Cognitive Theory explain the influence of modeled behaviors, such as entrepreneurship and independence, on international students' inclination towards STEM fields as a means to be their own boss?

Potential for Steady Employment

To what extent do observations of stability and steady employment in STEM professions, as modeled by others, impact the decision-making process of international students?

Interestingness of the Work

How do social factors, including media portrayals and interactions with peers, shape the perception of the interestingness of work in STEM fields for international students?

Desire to Please Family and Close Friends

In what ways do modeled behaviors within the family and social circles influence international students to choose STEM studies to fulfill the expectations and desires of their family and close friends?

Desire to Satisfy One's Goals and Intentions

How does the Social Cognitive Theory explain the role of observed behaviors and influences in aligning international students' goals and intentions with the pursuit of STEM education?

Greater Academic Freedom Relevant to Other Fields

To what extent does the perception of greater academic freedom in STEM studies, influenced by social factors, contribute to the decision-making process of international students when compared to other fields?

By exploring these questions through the lens of the Social Cognitive Theory, one can gain insights into how observed behaviors and social influences shape the choices of international students in pursuing STEM studies.

LITERATURE REVIEW

On the surface, influences on international students' choice of a STEM major can be simply understood in terms of the "push" and "pull" model by McMahon (1992, p. 468-469). Variables in migrants' home countries can influence and "push" them abroad, and variables in destination countries can "pull" or attract migrants to travel there (McMahon, 1992, p. 468-469). The decision-making process is often both personal and analytical, with international students weighing the economic, academic, professional, and developmental costs and gains of traveling abroad for their education (Tokas et al., 2023).

Home Country Variables

Some of these pushing influences for international students have been difficult social pressures (Habu, 2000), a lack of research capacity, lower-quality educational programs, and a lack of employment opportunities (Park, 2009) in migrants' home countries. These influences are not always strictly negative. One study of Vietnamese international students found that familial and cultural perceptions of how to increase human capital had persuasive impacts on the students' decisions to study outside their home country (Pham, 2013).

Destination Country Variables

Variables of destination countries can attract international students. Higher quality education programs (Beine et al., 2014; Shanka et al., 2006), favorable university reputations (Lee, 2008; Wilkins et al., 2012), better employment opportunities (Binsardi & Ekwulugo, 2003), and better income opportunities (Perkins & Neumayer, 2014) have all been selling points for international students to study abroad. Relational ties that link institutions have also played a part (Yang et al., 2018). International students can also choose to study abroad if they share a common language with the country (Perkins & Neumayer, 2014) and if they desire the pursuit of self-betterment and fulfilling life experiences (Yang et al., 2018).

Gender-Based Influences

Historically modeled stereotypes from parents, teachers, peers, and media have shaped students' attitudes and expected norms of gendered behavior (Bussey & Bandura, 1999). Educational environments have often influenced many female students to believe they belong in service, caretaking, teaching, or administrative careers, and male students to believe they belong in STEM fields or should do physical labor (Bussey & Bandura, 1999). Teachers have often consciously or unconsciously practiced gender bias in their classrooms: For academic performance, males often receive praise while females receive criticism. For behavior, males often receive criticism while females receive praise (Bussey & Bandura, 1999). Becker and Nilsson have discovered further gender inequity in science classrooms through gender-biased pictures in chemistry textbooks (2021).

Bohrmann and Akerson (2001) describe a longstanding pattern of sexism and gender disparities in science classes against female students. Educators' attitudes toward students have viewed males as more competent, and thus worthy of more attention and opportunities. They've tended to call on male students more often and select male students for leadership roles, like lab assistants (Bohrmann & Akerson, 2001). School counselors have shown to be less likely to recommend math majors for female students looking into higher education (Welsch & Winden, 2019). Even if educators don't practice such gender biases, male students will likely still be centered in STEM classrooms if teachers don't actively and intentionally make their classrooms gender-equitable environments (Bussey & Bandura, 1999).

Students' perceptions of themselves and the nature of STEM environments have also critically influenced whether they pursue STEM courses and careers. A study of high school students by Ito and McPherson (2018) showed that a sense of belonging in STEM courses was positively correlated with students' pursuit of those courses, and females taking STEM courses generally had a lower sense of belonging than their male classmates. Further, many high school students believed success in the STEM field required them to be inherently intelligent, and this belief was negatively correlated with female students' pursuit of STEM courses (Ito & McPherson, 2018). Such circumstances are likely contributing factors to why female students are less likely to even enroll in STEM courses (Bussey & Bandura, 1999). As early as middle school, students' postsecondary educational and occupational expectations for themselves, like those previously mentioned, can begin to take shape and influence decisions about their future (Bandura et al., 2001).

Among STEM workplaces, activities and social engagements are most often male-dominated and exclude female employees (De Welde & Laursen, 2011). This has led to less belonging and social support for female employees (Clancy et al., 2017). Oftentimes, female employees will not attend these events at all due to the environments feeling hostile and unsafe (Clancy et al., 2017). Outright hostility and attempts to undermine female co-workers by male STEM employees occur as well, often because male employees fear that their central position in STEM workplaces is threatened by female employees (Danbold & Huo, 2017).

Postsecondary students majoring in STEM face environments where there are not only more men than women, but where women face systemic disadvantages (Kinzie, 2007). Historically, there have been significantly fewer females in STEM classes and career fields than men (Reinking & Martin, 2018) and significantly fewer female leaders than male leaders in STEM (Ito & McPherson, 2018). The National Center for Science and Engineering Statistics (NCSES) reported that even though the overall workforce in the U.S. is 52% male and 48% female, the STEM field is composed of 65% males and 35% females (2023).

Research on female international postsecondary students is scarce. Stromquist's (1991) study, *Daring to Be Different: The Choice of Nonconventional Fields of Study by International Women Students*, is a notable exception. Stromquist compared hundreds of international undergraduate and graduate male and female students in conventional and unconventional majors, where the latter was basically defined as a woman studying STEM. Stromquist found that students' and parents' proficiency in math and science and encouragement from fathers both had positive relationships with women's selection of nonconventional majors (i.e., STEM). Seeing the value in this methodology, we adapted portions of Stromquist's (1991) questionnaire for this study.

Continuing this work is relevant because the Stromquist data is over 25 years old and does not reflect changes in demographics, economies, and social values. For instance, most respondents expected their then or future spouse's career to take precedence over their own, a now markedly dated value for many people.

Social influences, such as gender and culture, and educational and vocational disparities and opportunities have influenced domestic and international students alike in their choices to pursue STEM courses and careers. On top of political hurdles, international students' intentions to seek out STEM fields are impacted by these same factors in both their home countries and their destinations of choice. Gaining more information about why international students choose to study STEM amidst numerous social and logistical barriers could prove beneficial to future studies on the pursuit of STEM by women and non-binary individuals. Furthermore, this could aid in countering discriminatory and patriarchal belief systems (Kinzie, 2007) and be critical to equitizing and amplifying success for all humans.

METHOD

This study used partial least squares structural equation modeling (PLS-SEM) to explore the relationships among international students' choice of STEM major and influential factors, assessed via questionnaire. A PLS-SEM model has the advantage of controlling for measurement errors in assessing the relationships among the factors. Determining the appropriate sample size is crucial for the evaluation of PLS-SEM results, especially when considering the 10:1 rule suggested by Garson (2016), as described by Hair et al. (2017). According to this rule, a minimum sample size should be at least 10 times the largest number of formative indicators used to measure a single construct. Alternatively, it should be at least 10 times the largest number of structural paths directed at a particular construct in the structural model. Applying these criteria, the minimum sample size for any of the discussed models can range between 30 and 160 based on a given construct. For example, the paper's eight constructs would necessitate a minimum sample size of 80. It's essential to consider the relative size of the sample, taking into account the effect size, statistical power (set at .80), and the size of the population, as recommended by Hair et al. (2017). Chin's (2010) guidelines suggest a minimum sample size between 100 to 150, cautioning against exceeding 500 to 1,000. Furthermore, G*Power analysis (version 3.1) indicates that the minimum sample required ranges from n=106 (with .10 alpha, .80 power, and .15 effect) to n=127 (with .05 alpha, .80 power, and .15 effect) (Faul et al., 2009). However, to mitigate PLS bias and address concerns associated with small samples (Yıldız, 2023), a final sample size of 208 is sought. This comprehensive approach ensures that the chosen sample size aligns with various guidelines, statistical considerations, and the specific needs of the study.

Instrument

We created a structured questionnaire (see Appendix) titled *Survey of Factors Influencing International Students' Choice of STEM*. Questions were partly adapted from Stromquist's (1991) validated instrument, *Daring to Be Different*. We added new questions based on the survey constructs, which were also informed by Social Cognitive Theory. We employed seven-point Likert scales to assess experiences in both K-12 and higher education. Additionally, a probability scale ranging from 0 to 100 percent was utilized for two specific questions related to male and female participants in their respective countries. For the selection of their major field of study, we also used a scale ranging from 0 to 100 percent. The final questionnaire had 35 questions. Herein, selected questions informed eight constructs: gender in higher education experience ($\alpha = .802$, $n = 3$), gender in secondary education experience ($\alpha = .813$, $n = 3$), gender in elementary education experience ($\alpha = .837$, $n = 3$), gender equity, gender roles, female gender and perceived probability of STEM-related employment ("occupational conditions"), policy support, and finance.

Participants

We distributed the questionnaire by mass email solicitation to all international students at UCF—approximately 1000 students. In total, 208 students submitted the questionnaire during the availability period whose genders included female (n = 102; 52%) and male (n = 93; 48%). No participants selected transgender, non-binary, or other as a response to the gender item. Although 11 students submitted incomplete questionnaires, we included their responses using mean replacement for unanswered questions. Most participants were enrolled in STEM-related degree programs, and all participants could speak English as that was an admission requirement for international students at the university. The majority (81%) were undergraduates. Among the 191 respondents who shared their country of origin, 65 countries were represented.

Respondents primarily studied STEM-related degrees at many different colleges at University of Central Florida, with the largest representations coming from the College of Engineering and Computer Science (*n* = 47; 23%), the College of Sciences (*n* = 33; 16%), the College of Optics and Photonics (*n* = 10; 5%), the School of Biomedical Sciences (*n* = 10; 5%), and the College of Education and Human Performance (e.g., science education; *n* = 9; 4%). Before data collection, UCF's Institutional Review Board reviewed and approved the study as safe for human subjects. All international students at UCF were solicited via an email with a hyperlink to complete the questionnaire on the Qualtrics survey platform, which included an informed consent letter. Non-completers received three email reminders in subsequent weeks.

Hypotheses

We were interested in the eight identified constructs that influenced respondents' choices of STEM-related academic majors and the magnitude of each construct's contribution. We identified 10 potential reasons for choosing a STEM major, which we assessed by asking respondents the question, "How important were the following values in your selection of your major field of study?" For each reason, respondents could drag a slider with values from 0–100, yielding 101 potential choices, ranging from "not at all important" to "extremely important." These reasons and our associated research hypotheses were as follows:

H_1: Our constructs of interest influence international students to choose STEM majors due to professional opportunities.

H_2: Our constructs … due to potential for higher salaries.

H_3: Our constructs … due to the chance to help others.

H_4: Our constructs … due to the chance to "be my own boss."

H_5: Our constructs … due to the potential for steady employment.

H_6: Our constructs … due to the interestingness of the work.

H_7: Our constructs … due to the desire to please family and close friends.

H_8: Our constructs … due to the desire to satisfy one's goals and intentions.

H_9: Our constructs … due to greater academic freedom relevant to other fields.

H_{10}: Our constructs of interest influence international students to choose STEM majors due to the availability of government-funded opportunities.

While early analyses attempted to group these reasons together, we observed via trial and error that it was inappropriate to consolidate many of the reasons. While, unfortunately, this gives a non-parsimonious model with 80 interactions and 80 potential research hypotheses, we view this as more of an exploratory study from which we can locate potential areas of interest based on reliability, validity, statistical significance, and effect sizes of the results.

EMPIRICAL ANALYSIS

We empirically tested our hypotheses using survey data that we analyzed in a partial least squares structural equation model (PLS-SEM) using the SmartPLS 3.0 software package (Ringle et al., 2015) to test both the structural model and hypotheses. Our independent variables were (a) gender in higher education experience, (b) gender in secondary education experience, (c) gender in elementary education experience, (d) gender equity, (e) gender roles, (f) female gender and perceived probability of STEM-related employment ("occupational conditions"), (g) policy support, and (h) finance. Our dependent variables of interest were ten potential reasons to choose a STEM major. After running the PLS-SEM algorithm, we obtained estimates for the constructs in the model (e.g., goodness of measure and path coefficients).

Structural Model

Table 1 shows that our reflective constructs, dealing with respondents' retrospective perceptions of patriarchal gender discrimination in kindergarten to postsecondary education, had outer loadings values of 0.777–0.925, average variances extracted (AVEs) of 0.717–0.769, and composite reliability values of 0.870–0.902, all of which exceed recommendations for reliability and convergent validity (Hair et al., 2017).

Table 1: Assessment of Measurement Model

Constructs and items	Outer loadings	Outer weights	VIF	*p* value	AVE	CR	Rho_A	Cronbach's alpha
Higher education					0.717	0.884	0.807	0.802
Q8_1	0.846							
Q8_2	0.872							
Q8_3	0.821							
Secondary education					0.769	0.870	0.703	0.701
Q7_2	0.867							
Q7_3	0.887							
Elementary education					0.754	0.902	0.915	0.841
Q6_1	0.896							
Q6_2	0.925							
Q6_3	0.777							
Policy support[a]								
Q3_1		0.069	1.270	0.436				
Q3_2		0.961	1.694	0.074				
Q3_3		0.064	1.453	0.438				

Q3_4	–0.253	1.385	0.266
Q3_5	–0.520	1.294	0.155
Finance[a]			
Q12_1	–0.410	1.177	0.131
Q12_2	0.246	1.358	0.178
Q12_3	0.752	1.447	0.039*
Q12_4	0.117	1.395	0.363
Q12_5	0.049	1.333	0.422

ote. VIF = variance inflation factor; AVE = average variance extracted; CR = composite reliability. Constructs with only one item (gender quity, traditional gender, and occupational condition) are not included in the table.
Formative construct.
$p < 0.05$.

To assess the discriminant validity of our reflective constructs, we used the Fornell–Larcker criterion (Table 2) and the more conservative heterotrait–monotrait ratio (HTMT; Table 3). Our squared AVEs for each construct exceeded correlations with other constructs in the model, providing evidence in support of discriminant validity (Hair et al., 2017). However, our HTMT value for gender in secondary as compared to elementary education is 0.901, which implies that by this measure, we failed to establish discriminant validity for these constructs, as the typical cut-off is 0.9 or lower (Henseler et al., 2015). Nevertheless, our result may be acceptable because HTMT is a conservative estimate, 0.901 is only slightly higher than 0.9, and our Fornell–Larcker criterion indicates discriminant validity.

Table 2: Discriminant Validity - Fornell–Larcker Criterion

Construct	Higher education	Secondary education	Elementary education	AVE
Higher education	0.847[a]			0.717
Secondary education	0.623	0.877[a]		0.769
Elementary education	0.620	0.672	0.868[a]	0.754

Note. Omitted Fornell–Larcker criterion for other constructs were all < .30.
[a] Square roots of AVE.

Table 3: Discriminant Validity - Heterotrait–Monotrait Ratio (HTMT)

Construct	Higher education	Secondary education	Elementary education
Higher education			
Secondary education	0.835		
Elementary education	0.761	0.901[a]	

[a] Violation of discriminant validity. Only reflective constructs with multiple items are included here.

Measurement Model

We considered interactions between constructs that were formative, reflective, and unifactorial on ten potential reasons why students chose their fields of study. Although some inner loadings were obscured, we saw that overall, several of the ten reasons account for statistically significant variance in responses. Our constructs of gender equity, traditional gender roles, and occupational conditions were unifactorial with the input questions asking respondents to give a percentage estimate of males in their country who are in STEM majors, males in their country who are in STEM professions, and the percent chance that a woman graduating with a STEM degree in their country would get a job in the same field, respectively. For these questions, respondents were given a horizontal slider to select the level of individual percentage points.

Our constructs regarding three levels of education were reflective, while policy support and finance/economics were formative in nature.

In addition to two gender constructs with only one item each, our three education constructs were all reflective and all involved patriarchy in the classroom, with questions on seven-point Likert scales. For the secondary education construct, we asked the extent to which respondents agreed that in their experience with secondary school in their country, examples mostly involved males (Q7_2), and that "teachers seemed to perceive males as smarter than females in some areas, and females as smarter than males in other areas" (Q7_3). Although we also asked about whether teachers valued male opinions over female opinions (Q7_1), we dropped this item from the model because its item loading was too low. We retained the six items from the questionnaire about elementary and higher education, which, although different, were thematically similar to the secondary school questions.

RESULTS

We obtained path coefficients from SmartPLS output and tested the statistical significance of the path coefficients (Table 4) by 5,000 iterations of bootstrapping, as recommended by Hair et al. (2017). Four of our 80 hypotheses were statistically significant, while another seven were nearly significant, with bias-corrected confidence intervals that did not include zero, yet *t*-values that were below the critical value of 1.96 for a two-tailed *t*-test. Our effect sizes (F^2) were small, ranging from 1.0 to 6.0% of variance explained, with the strongest effect size implying that the formative construct of financial contributions to one's living expenses explained 6.0% of the variance in whether the availability of government-funded opportunities influenced one's selection of a STEM major ($p < .05$). Consequently, we might conclude that individuals who receive funding for living expenses from a variety of sources give greater consideration to the availability of scholarships, stipends, and financial aid when selecting a STEM major. It should be noted that the finance questions were reverse-coded, with one corresponding with receiving "a great deal" of funding and five corresponding with receiving "none at all" from each of five sources, which is the reason for the negative path coefficient and confidence interval. Our formative constructs, policy support and finance, utilized items that all had variance inflation factors (VIFs) below five (Table 4), indicating that multicollinearity was not an issue. There were no significant response differences to report between female and male participants.

able 4: Hypothesis Testing for 11 of 80 Hypotheses That Were Supported or Nearly Supported

Hypothesis	Variables	Path coefficient	*t* value	95% CI	F^2	Supported?
H1f	Occupational conditions → Professional opportunities	0.125	1.822	[0.017, 0.244]	0.014	No
H2f	Occupational conditions → Higher salaries	0.134	1.912	[0.016, 0.249]	0.016	No
H3c	Elementary education → Chance to help others	0.192	1.802	[0.045, 0.393]	0.018	No
H3f	Occupational conditions → Chance to help others	0.163	2.123*	[0.038, 0.288]	0.024	Yes
H4b	Secondary education → Be my own boss	–0.164	1.625	[–0.341, –0.017]	0.013	No
H5c	Elementary education → Steady employment	0.227	2.161*	[0.072, 0.410]	0.024	Yes
H7c	Elementary education → Please family and friends	0.172	1.789	[0.028, 0.338]	0.015	No
H7e	Traditional gender role → Please family and friends	–0.106	1.685	[–0.208, –0.002]	0.010	No
H9c	Elementary education → Greater academic freedom	0.191	1.740	[0.021, 0.387]	0.017	No
H10a	Higher education → Government-funded opportunities	0.257	3.229**	[0.117, 0.382]	0.041	Yes
H10h	Finance → Government-funded opportunities	–0.243	2.124*	[–0.406, –0.089]	0.060	Yes

ote. All confidence intervals were bias-corrected. While 11 CIs excluded zero, only four were significant at the .05 level.
1.96 ($p < 0.05$).
* 2.58 ($p < 0.01$).

Our analysis resulted in three main findings. First, financial considerations and the availability of government-funded opportunities explained 6.0% of the variance in the choice of a STEM major ($p < .05$). Second, women's lack of prominence in respondents' lived experiences in higher education and the availability of government-funded opportunities explained 4.1% of the variance ($p < .01$). Finally, (a) job outlooks for women and the "chance to help others" and (b) women's lack of prominence in secondary education and the prospect for steady employment each explained 2.4% of the variance ($p < .05$). Overall, these findings support the salience of both financial concerns and gender-stereotyped, patriarchal culture influencing respondents to choose STEM majors for financial safety and/or egalitarianism, supporting Social Cognitive Theory (Bussey & Bandura, 1999).

Finances are a statistically significant factor in international students' choice of a STEM major. We found that policies and educational conditions in their home countries were negatively impacted by their choice of study. Gender inequality in their home countries restricts female international students from equitable opportunities in STEM-related fields. In this study, policies in respondents' home countries that they perceived as promoting gender inequality were negatively correlated with choosing to study within STEM fields. This implies that policies are not aligned with supporting gender equality in STEM educational environments.

DISCUSSION

According to Wang and Degol (2013), gender stereotypes can influence students' prospective choices that do not fit prescribed gender roles in society. Stromquist's (1991) finding that gender negatively influences students' choice of a STEM major was not supported by the current study in which gender failed to be a significant variable. It is noteworthy that despite the absence of significance, the direction of the effect was similar to Stromquist's. The difference may be explained by sample size, sample composition, universities included, or the fact that the studies were separated by over 25 years.

In this study, students' choice of STEM major was impacted by occupational conditions, financial concerns, and perception of gender bias in elementary and higher education in their countries of origin. Statistically significant relationships between the constructs are limited to the following:

1. Occupational gender conditions are associated with choosing a STEM major for the chance to help others.
2. Perception of gender bias in elementary education is associated with choosing a STEM major because it would provide steady employment.
3. Perception of gender bias in higher education is associated with choosing a STEM major because of the availability of government-funded opportunities.

4. Receiving financial contributions toward living expenses that were large and/or from a greater number of sources is associated with choosing a STEM major because of the availability of government-funded opportunities.

Limitations and Further Research

A potential limitation of this study was volunteer bias because we solicited responses via an email broadcast and only analyzed those who engaged with and completed the questionnaire. Therefore, it is possible that completers were different from non-completers. Additionally, there were only one or two respondents from most countries of origin, three of our eight constructs had only one item, and our PLS-SEM model may have been more useful if simplified.

Further research should focus on comparing STEM and non-STEM females from other countries with large sample sizes more representative of international students in general. Future studies of this nature could also be strengthened by increasing the number of countries represented by respondents. Since findings from this study point to cultural and gender-related influences, aligning with our frame of Social Cognitive Theory (Bussey & Bandura, 1999), future studies would benefit from being framed by more specific cultural or feminist theories.

CONCLUSION

This study focused on international students' perceptions to determine factors that would influence their choice to study STEM in higher education. The results provide a model for increasing the number of international female students in STEM programs and informing educators, researchers, and administrators to better understand international female students' challenges in STEM programs at universities in the United States. International students bring significant knowledge and skills that have proven to be beneficial to the U.S. economy (NAFSA: Association of International Educators, 2023). While removing existing social and logistical obstacles for these students would prove to be economically beneficial, the decreased experiences of discrimination and bias could very likely improve international students' experiences at work and school, elevating their academic and professional performance and, ultimately, their longevity in the STEM field.

This study also provides guidance for policymakers to create more opportunities for women and non-binary individuals in STEM-related fields in their home countries. Since we know that numerous social and cognitive factors impact students' growth and development (Bussey & Bandura, 1999), and therefore, their decision-making (Bandura et al., 2001), it's vital that existing gender inequities be addressed. Intentionally identifying and pursuing controllable factors that might decrease obstacles female and non-binary students face in education, and in STEM environments specifically, could lead to improved STEM experiences for everyone in the places they call home.

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APPENDIX

Survey of Factors Influencing International Students' Choice of STEM

Q1. You are being asked to participate in a research study on "Factors influencing international students' choice of field." The study is being conducted by faculty who are professors in College of Education and Human Performance Department at the University of Central Florida. The survey has 19 questions and it should be completed in one setting taking approximately 3-5 minutes. Should you have questions about the study or to report a problem please contact Dr. Jahani at shiva.jahani@ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

Your participation in voluntary and your responses are confidential. If you consent to voluntarily participate, please click the "Next" button to continue with the survey.

Q2. Which of the following percentages best describes the percentage of males in STEM (Science, Technology, Engineering and Mathematics) majors in your country?

0 10 20 30 40 50 60 70 80 90 100

Male

Q3. To what extent do you agree or disagree with the following statements about women in STEM globally?

The worldview in scientific theory and methodology is predominantly masculine. (1)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

The way science is taught favors male students. (2)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor	Somewhat agree (5)	Agree (6)	Strongly agree (7)

			disagree (4)			
☐	☐	☐	☐	☐	☐	☐

Science curricula do not include relevant examples for females. (3)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

There are very few female scientists/engineers to act as role models. (4)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

Culture influences females not to seek a STEM-related career. (5)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

Q4. Which of the following percentages most closely describes the percentage of males in STEM (Science, Technology, Engineering and Mathematics) professions in your country?

0 10 20 30 40 50 60 70 80 90 100

Male

Q5. What is the probability of a woman who graduates with a STEM degree in your country getting a job in her field of preparation?

0 10 20 30 40 50 60 70 80 90 100

Probability of female employment in STEM

Q6. Thinking back to your experiences in elementary or primary education in your country, to what extent do you agree or disagree with the following descriptions?

In school, males had privileges that females did not. (1)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

It seemed like my teacher preferred to interact with males rather than females. (2)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

The instructional examples used in class frequently reinforced gender stereotypes (e.g., males as leaders, females taking care of children) (3)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

Q7. Thinking back to your experience in secondary education in your country, to what extent do you agree or disagree with the following descriptions?

In class, teachers seemed to value males' opinions more than females' opinions. (1)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

In class, most of the examples involved males. (2)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

In class, teachers seemed to perceive males as smarter than females in some areas, and females as smarter than males in other areas. (3)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

Q8. Thinking back to your experience in higher education in your country, to what extent do you agree or disagree with the following descriptions?

In my university, there were things that males could do that females could not. (1)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

Some university subjects were primarily reserved for males, while others were reserved for females. (2)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

While the student body was mixed, most of the decision makers were male. (3)

Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
☐	☐	☐	☐	☐	☐	☐

Q9. How important were the following values in your selection of your major field of study?

Not at all important — Extremely important

0 10 20 30 40 50 60 70 80 90 100

Professional Opportunities

Higher salaries

Chance to help others

Chance to be my own boss

Steady employment

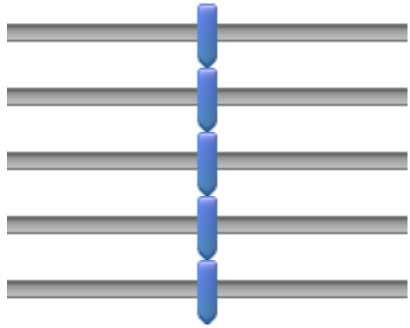
Interesting work

To please my family and close friends

To satisfy my goals and intentions

Greater academic freedom

Government-funded opportunity



Q10. Is your field of study available in the universities of your home country?

- ☐ Definitely yes (1)
- ☐ Probably yes (2)
- ☐ Might or might not (3)
- ☐ Probably not (4)
- ☐ Definitely not (5)

Q11. When did you develop an interest in your current field of study?

- ☐ Before coming to this country (1)
- ☐ After coming to this country (2)

Q12. To what extent did each of the following groups financially contribute to your living expenses while earning your current education?

	A great deal (1)	A lot (2)	A moderate amount (3)	A little (4)	None at all (5)
Family (1)	☐	☐	☐	☐	☐
This university (2)	☐	☐	☐	☐	☐
Home government (3)	☐	☐	☐	☐	☐
U.S. government (4)	☐	☐	☐	☐	☐
Self (5)	☐	☐	☐	☐	☐
Other (6)	☐	☐	☐	☐	☐

Q13. Could you please write your current comprehensive GPA score here?

Q14. Could you please write your GRE score here?

____

Q15. Please identify your college.

- ☐ Burnett School of Biomedical Sciences (1)
- ☐ College of Education and Human Performance (i.e., Science Education) (2)
- ☐ College of Engineering and Computer Science (3)
- ☐ College of Optics and Photonics (4)
- ☐ College of Science (5)
- ☐ Other (6)

Q16. Please identify your current academic level.

- ☐ Graduate (1)
- ☐ Undergraduate (2)

Skip to: Q17 if Q16 = Undergraduate

Q17 What year are you?

- ☐ Freshman (class of 2021) (1)
- ☐ Sophomore (class of 2020) (2)
- ☐ Junior (class of 2019) (3)
- ☐ Senior (class of 2018) (4)
- ☐ College of Science (5)
- ☐ Other (6)

Q18. Please select your country of origin.

Click to write Choice 1 (1)

▼ Afghanistan (0) ... Zimbabwe (196)

Q19. What is your gender?

- ☐ Male (1)
- ☐ Female (2)
- ☐ Transgendered (3)
- ☐ Non-binary (4)
- ☐ Click to write Choice 5 (5)