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Belongingness and Self-efficacy in UK higher education STEM courses: The role of Gender Role Identity

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Research Article

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Abstract

The underrepresentation of women in STEM fields, especially in the UK where only 38.7% of researchers are female, remains a pressing concern. A cross-sectional study delves into the role of gender role identity, alongside other factors like perceptions of parental expectations and national identity, in influencing the decision to pursue STEM fields in higher education. Utilizing a dataset of 284 participants aged 18 to 50, this study comprises two primary sections: the first focuses on STEM choice using logistic regression, while the second examines self-belongingness and self-efficacy in STEM through hierarchical linear regression. Key findings reveal that traditional feminine identity correlates negatively with the choice of STEM. Additionally, several variables, including individual perceptions of parental expectations and national identity, significantly predict STEM choice. A unique interaction was observed amongst females in relation to gender role identity and choice of STEM. Meanwhile, in the context of self-belongingness and self-efficacy in STEM, females reported lower scores than males. The results emphasize the profound impact of self-stereotyping on these variables. The research underscores the importance of recognizing and mitigating the effects of gender roles and self-stereotyping in STEM educational choices and advocates for interventions to cultivate more inclusive environments. Future studies can further explore the development of self-stereotyping in the major choice of STEM and its impact on underrepresented groups within the field.

Introduction

Background of Gender Gaps in STEM Participation

The underrepresentation of girls and women in science, technology, engineering, and mathematics (STEM) fields is a worldwide phenomenon (Stoet & Geary, 2018). Only 30% of female students pursue STEM-related higher education studies across the world (Ismail, 2018). Females are still under-represented in the STEM of the UK. As of 2020, males accounted for 63.05% of STEM higher education students, while females made up only 41.4% of STEM undergraduate students (Mediaofficer, 2021; Verdugo-Castro et al., 2017). In the 2022/23 academic year, women and non-binary individuals comprised just 31% of core STEM students in higher education (*Women In STEM Statistics: Progress and Challenges - Stem Women*, 2023). Additionally, women represent only 38.7% of all researchers in the UK (Women in Science the Gender Gap in Science, 2019). Gender imbalances in STEM subjects arise as early as primary school age (McDool & Morris, 2020). In the fourth grade, girls recognize a gender gap in STEM and attribute academic outcomes to gender (Wieselmann et al., 2020). Although a greater number of 17-year-old females show interest in STEM compared to males, fewer choose STEM majors like computer science and engineering. This suggests that factors other than individual interest may influence their choices in STEM (Ro et al., 2021). According to Bronfenbrenner's (1979) ecological systems theory, individuals' choices and behaviours are influenced by different levels, such as gender role identity and parental expectations at the micro level, and cultural influence at the macro level, which influences individuals' choice of major at different stages of their development.

Gender role identity

Gender identity is a developing concept of an individual sense of self, such as being male, female or something else (Coleman et al., 2012; Cvencek et al., 2015). Gender role refers to shared beliefs about the characteristics of men and women that are learned by considering the role's context and the social surroundings in which it is played, such as different societal or cultural norms (Carter, 2014; Wood & Eagly, 2012). Gender role identity refers to the extent to which an individual identifies with the societal or cultural norms associated with their assigned or chosen gender——being masculine or feminine. Gender role identity can not only support typical gendered behaviours, but also lead to gender variations in behaviours, with the effect of social expectations and other social identities (Wood & Eagly, 2012). In

STEM, students often perform masculinity to align with the dominant culture and foster a sense of belonging within the discipline (Miller et al., 2021).

According to social cognitive career theory (SCCT), people learn and make decisions based on the interaction of personal factors, behaviours, and environmental influences (Lent et al., 1994). Firstly, gender role identity is developed through a combination of intrapersonal factors and environmental influence. Traditional gender roles often convey different expectations for men and women in terms of their activities, choices and behaviours. For example, women have been traditionally expected to take on caregiving roles, while men are perceived as assertive and achievement-oriented (Heilman & Wallen, 2010; Hill et al., 2010). Traditional feminine traits can predict females' participation in the life-science field, which is more stereotypically suited to them than STEM fields (Dicke et al., 2019). Secondly, conformity to traditional gender role norms is related to individuals' learning experiences with stereotypes, which further influence individual self-efficacy (belief in their capabilities) and outcome expectations (the outcomes they believe will occur as a result of their actions), both of which can influence the choice of a major (Y.-H. Liu et al., 2014; Tokar et al., 2007).

Individuals' perceptions of parental expectations and choice of STEM major

According to expectancy-value theory (Wigfield et al., 2009), individuals' choice of STEM majors can be influenced by expectancies and subjective task values, which are in turn influenced by individuals' perceptions of other people's attitudes and expectations for them, especially parents' influence. Expectancies are beliefs about one's performance in an activity, while subjective task values relate to the value placed on it, including its importance, intrinsic and utility value, and cost (Wigfield et al., 2009; Wigfield & Eccles, 2000). Parents critically shape their children's beliefs and values in early childhood through feedback on children's behaviours (Wigfield et al., 2009). A case study found that parents can influence children's initial choice of STEM through different levels, including the home environment, values and expectancies they endorse (Ardies et al., 2021). In the micro level of Bronfenbrenner's (1979) ecological systems, having supportive parents, parents' attitudes and values of STEM, and their gendered stereotyped thinking may influence children's choice of STEM and this influence can persist till adulthood (Chhin et al., 2009). Firstly, if parents perceive the high value of STEM, they are more likely to encourage their children to engage in STEM, which partly influences children's values in STEM (Šimunović et al., 2018; Šimunović & Babarović, 2020). Secondly, there is a gender difference in parental expectations in STEM. Parents are more likely to expect their sons, rather than their daughters, to work in STEM (*The ABC of Gender Equality in Education*, 2015). And it is found that girls are more likely to be influenced by parents' attitudes and beliefs than boys (Hildebrand et al., 2023).

National identity and choice of STEM major

In addition to parental influence on individuals' choice of STEM, national identity plays a critical role in individual expectancy beliefs and subjective task values, which is reflected in four aspects of this study, including individual perceptions of national scientific achievement, economic development, culture and sense of belonging (Chiu & So, 2022). The OECD report on gender differences in 15-year-olds' expectations for careers in engineering or computing reveals significant country variations. Chile, Colombia, Jordan, Mexico, Poland, Slovenia, and Thailand have relatively large proportions of students interested in this field, whereas Azerbaijan, Finland, Kyrgyzstan, Macao-China, Montenegro, and the Netherlands have notably smaller numbers (*The ABC of Gender Equality in Education*, 2015).

According to expectancy-value theory, individual values of STEM result from their interpretations of experiences with culture and social contexts, such as gender role stereotypes. (Festinger, 1957) states that individuals strive for

consistency in their beliefs, attitudes, and behaviours. When there is a dissonance between beliefs and behaviours, individuals try to eliminate it by changing their attitudes or behaviours, such as valuing the activities they want to engage in (Yahya et al., 2020).

According to the cultural dimension interaction model (Hofstede,2011), one of the most salient dimensions of culture is masculinity/femininity(M. J. Liu et al., 2022). Cultural differences in STEM values are influenced by economic development and gender equality across regions. A previous study found that individualistic cultures in WEIRD settings often lead to self-expressive academic choices in STEM to align with male stereotypes, while collectivistic cultures in less developed countries promote choices aimed at financial security (Soylu Yalcinkaya & Adams, 2020). Additionally, gender-equal cultures may lead to greater women's STEM participation and a narrower gender gap (Sørensen et al., 2016).

Stereotype threat in STEM

Social cognition involves how we process information about others. Due to limited cognitive capacity, we are more likely to use representativeness heuristics to help us decide the way we think about others in a quick and relatively effortless manner, which may lead to inaccurate or biased assumptions (Baron & Branscombe, 2012). For example, we often determine if we belong to the group by a prototype of the group——the similarity between individuals and typical members of the group. The current STEM prototype is associated with gender-male, which leads females as a minority group to be stigmatised in academic contexts as they are perceived to be unfit for STEM prototypes (Kim et al., 2018). Previous studies have reported that STEM tends to be viewed as a male-gender-typed field among adolescents (Hildebrand et al., 2023; Master, 2021; Rogers et al., 2021). Some gender stereotypes can persist with age, such as masculine and feminine characteristics —— Boys and men should behave masculine and not feminine, while girls and women should behave feminine and not masculine (Sullivanid et al., 2022). Feminine identity is incongruent with STEM stereotypes and the devaluation of feminine traits in STEM puts women at a disadvantage in STEM (Pronin et al., 2004; Thébaud & Charles, 2018).

Gender stereotypes influence individuals' behaviours, activities, and performances, and in STEM, these stereotypes contribute to stereotype threat (Sullivanid et al., 2022; Verdugo-Castro et al., 2017). Individuals' susceptibility to stereotype threat is influenced by the significance of their various social identities, like gender, race, and age, which can be triggered by specific environmental cues (Inzlicht & Schmader, 2012; Turner & Oakes, 1986). When individuals internalize the STEM stereotype, their endorsement not only influences their ability beliefs and sense of belonging but also shapes their STEM motivations based on group identification and individual mindset (Master, 2021). A person who aligns more with the STEM prototype and believes that traditional gender roles are unchangeable is more likely to be affected by the STEM stereotype (Master, 2021). Furthermore, there is a gender difference in endorsement of STEM stereotypes. Women are more likely to self-stereotype by associating higher masculinity and gender-males with STEM majors as a result of cultural, parental, and situational influences (Makarova et al., 2019). Females in STEM, who are targeted by negative gender-related stereotypes, tend to feel uncertain about their belonging and tend to underestimate their abilities (Nosek et al., 2002).

Self-belongingness in STEM

According to social identity theory (Tajfel et al., 1979), social identity can be defined as the extent to which individuals see themselves in terms of their membership in a social group. Individuals belong to different social groups, such as gender, gender role and STEM groups. The STEM identity can be defined as the extent to which individuals see themselves as a member of a STEM group (Kim et al., 2018). Once individuals internalize their social group

memberships, such intragroup homogeneity effects can lead to in-group favouritism, out-group prejudice, and stereotyping (Barrett et al., 2004). People value their gender group membership and self-stereotyping by attributing traditional feminine or masculine characteristics to themselves and acting in accordance with their own gender identification in order to conform to others' gender-relevant expectations and gain social approval (Eagly & Wood, 2017). Conforming to masculine gender roles may contribute to a greater sense of self-belongingness in STEM groups that uphold masculine norms.

Considering the current masculine STEM stereotype is unfit with feminine gender role expectations, women in STEM who are highly identified with their gender group are more likely to feel that their gender group is devalued (Dasgupta & Stout, 2014; van Veelen et al., 2019). Furthermore, as stereotype threats to women's gender and gender role identity present in STEM, women may feel more pressure to conform to masculine norms in STEM, resulting in a disjunction between gender role identity and STEM identity (Blackburn, 2017). A recent study found that women with lower levels of self-identified masculinity tend to report higher gender stigma consciousness and a lower sense of belonging in physics courses (Li & Burkholder, 2024).

STEM Self-efficacy

Self-efficacy can be defined as a person's confidence in performing a task, so STEM efficacy is a student's confidence in their ability to succeed in STEM (Credé & Phillips, 2011; Jordan & Carden, 2017). Gender differences in academic self-efficacy are present in the early elementary school years (Rittmayer & Beier, 2008). Girls' academic self-efficacy in mathematics and computer science is lower than boys', and this difference increases significantly from elementary to secondary school (Huang, 2013).

According to Bandura's (1999) social cognitive theory, self-efficacy beliefs are acquired and modified via four primary sources of information: mastery experience, vicarious learning, social persuasion, and physiological and affective states. It is discovered that men's self-efficacy beliefs are primarily influenced by mastery experiences, while women's self-efficacy beliefs are more likely to be influenced by social persuasions and vicarious experiences, which may be reflected in culture and societal norms (M. J. Liu et al., 2022; Zeldin et al., 2008). In terms of mastery experience, successful experiences can raise self-efficacy, while failures lower it. Boys and girls are often encouraged to participate in gender-stereotyped activities, leading to the development of different skill sets and influencing their self-efficacy. A student is more likely to succeed in disciplines that correspond to their traditional gender role identity, such as boys and men being traditionally regarded as more masculine, which might strengthen their self-efficacy in male-dominated fields (Huffman et al., 2013; Wang et al., 2013). Women and girls who adhere to traditional feminine characteristics are more susceptible to the STEM stereotype, resulting in lower STEM self-efficacy (Ertl et al., 2017; Jordan & Carden, 2017). It is found that girls' self- efficacy in STEM is lower than that of social science majors (Yu & Jen, 2021). In Canada and US, females report lower self-efficacy in mathematics and computer science than their male peers(Cheryan et al., 2024). Additionally, previous research suggests that STEM stereotypes influence career interest indirectly by affecting self-efficacy and outcome expectations (Luo et al., 2021).

The present study

In summary, this study consists of two parts——the first part aims to explore the relationship between the choice of STEM and gender role identity, national identity, individual perceptions of parental expectations, timing of making decisions and self-stereotyping.

Hypothesis 1: The level of gender role identity is negatively related to the choice of STEM.

Hypothesis 2: The influence of gender role identity on the choice of STEM significantly differs among individuals based on their self-identified gender identities.

Hypothesis 3: National identity, individuals' perception of parental expectations, the timing of making major decisions and self-stereotyping can also influence the choice of major.

The second part is to compare the relationship between gender role identity and self-belongingness and the relationship between gender role identity and self-efficacy among males and females in STEM.

Hypothesis 4: In STEM, self-belongingness can be influenced by gender role identity, which differs between individuals who self-identify as female and those who self-identify as male.

Hypothesis 5: In STEM, self-efficacy can be influenced by gender role identity, which differs between individuals who self-identify as female and those who self-identify as male.

Hypothesis 6: In STEM, self-stereotyping may explain additional unique variance when predicting the effect of gender role identity on both STEM belongingness and STEM efficacy.

Method

Research Design

This study used a quantitative design through a survey (Appendix A) to address two sections with three outcome variables (the choice of STEM; self-belongingness and self-efficacy in STEM). The first section aims to assess how six predictor variables (gender, gender role identity, individual perception of parental expectations, national identity, the timing of the decision to major and self-stereotyping) individually or collectively contribute to students' decisions to pursue higher education STEM courses (see Figure 1).

The second section of the study focuses on two dependent variables (DVs): self-belongingness and self-efficacy in STEM fields. It investigates the effects of gender, gender role identity, and self-stereotyping on two DVs (see Figures 2 and 3).

Materials for Dependent measures: Choice of STEM (DV1)

The questionnaire contained 20 items. The detailed questions in order are described as followed. The whole properties for these subscales and participants' age can be seen in Table 1.

1. Gender

Gender was measured by the question "How do you describe yourself? (check one from: Male/Female/Prefer not to say/ Other (please specify)).

2. Age

Age was measured by the question "How old are you?".

3. Educational level

Educational level was measured by the question "What is your current level of study?" (Undergraduate/ Postgraduate/ Ph.D./ Other (please specify)).

4. Gender role identity

'Gender role identity' is measured by the TMF scale, which asks participants to rate themselves from 1 (very masculine) to 7 (very feminine) on six different personality items (Kachel et al., 2016).

5. Country of Upbringing

Participants were asked to answer, "In which country/countries did you grow up?" before the question of national identity.

6. National identity

National identity is assessed using a 5-point Likert scale from 1(Strongly Disagree) to 5(Strongly Agree) with four items concerning their nations' scientific achievements, economic development, culture, and belongingness, including the questions "I am proud of my country's scientific achievements", "I am proud of my country's economic development", "I am very interested in the culture of my country", "I have a sense of belonging to my country" (Chiu & So, 2022).

7. Individual perception of parental expectation

Individual perception of parental expectation is measured on a 5-point Likert-type scale from 1(Strongly Disagree) to 5(Strongly Agree) with 3 items ("My parents think that not attending university means failure'; 'My parents expect me to find a well-paid job in the future" and 'My parents prefer me to pursue a career in science rather than arts.') (Chen et al., 2022).

8. Timing of Major Decision

There are four periods when participants make their major decisions that relate to their current major (age 11-14; age 15-18; age 19-22; over age 22).

9. Choice of STEM (DV1)

DV1 in this section indicates whether the respondent is a STEM major, including 2 items ("Please write down the name of your current major" and "Do you consider it a STEM subject": "Yes" is coded as 1 and "No" as 0).

Materials for Dependent measures: females' self-belongingness (DV2) and self-efficacy in STEM (DV3)

Self-belongingness refers to the extent to which females feel they belong in STEM, which is measured by a 7-point Likert scale from 1(Strongly Disagree) to 7(Strongly Agree) with 5 items, including "There are times that I feel like I don't belong in the class of my major."; "I felt like an outsider in the class of my major."; "I don't know if I really belong in the field of my major."; "I am certain that I belong in my major."; "I am not sure I have the right background for my major." (Walton & Cohen, 2007).

Self-efficacy refers to their confidence in their ability to successfully perform tasks and achieve goals within this field, which is measured by a 7-point Likert scale from 1(Strongly Disagree) to 7(Strongly Agree) with 8 items, including "I believe I will receive an excellent grade in my major."; "I'm certain I can understand the most difficult material presented in the readings for courses of my major."; "I'm confident I can understand the basic concepts taught in courses of my major."; "I'm confident I can understand the most complex material presented by the instructor in courses of my major."; "I'm confident I can do an excellent job on the assignment and tests in courses of my major."; "I expect to do well in the

class of my major.”; “I’m certain I can master the skills being taught in the class of my major.”; “Considering the difficulty of this course, the teacher, and my skills, I think I will do well in courses of my major.”(Credé & Phillips, 2011).

Materials for measurement: self-stereotyping

Self-stereotyping in this study refers to the extent to which females believe their choice of majors is typically associated with their gender, which is measured by a 7-point Likert scale from 1(Strongly Disagree) to 7(Strongly Agree) with 6 items, including “I worry that my ability to perform well on tests is affected by my gender.”; “I feel confident in my ability to perform well on tests, regardless of my gender.”; “I worry that if I perform poorly on tests, others will attribute my poor performance to my gender.”; “I am proud of my performance on tests, and I know that my success is a result of my own efforts and abilities.”; “I worry that, because I know the negative stereotype about my gender and my major, my anxiety about confirming that stereotype will negatively influence how I perform on the tests.”; “I am motivated to do my best on tests, and I believe that my hard work and dedication will lead to success, regardless of any negative stereotypes that exist. (Marx, 2005). All subscales in this study have excellent reliability (Cronbach's α >0.7) and validity (see Appendix B - H). The whole properties for these subscales and participants’ age can be seen in Table 2.

Participants and Procedure

A total of 283 participants were recruited through Prolific, a widely used academic research platform for academic studies, and 23 participants were recruited from Facebook group (UK participants for thesis & dissertation), Prolific was chosen to ensure a diverse, high-quality participant pool while maintaining ethical standards. Participants received detailed study information and provided informed consent before participating.

Analytic strategy

To evaluate the hypotheses, binary logistic regression was an appropriate way to investigate the choice of STEM as a major; linear regression was used to predict self-belongingness and self-efficacy in STEM. Univariate ANOVA analysis was used to ascertain the effect of gender role identity on different DVs among different genders. A priori power analysis using G*Power 3.1.9.7 indicated that a minimum of 188 participants was required for logistic regression and 98 for hierarchical regression, assuming a medium effect size, α = 0.05, and power = 0.80 (Kang, 2021).

Data analytics and Final sample

There are 10 outliers based on age over 50 who are excluded after data collection. 2 persons chose "prefer not to say" in their gender, as well as 12 missing data points in question 9 (Do you consider it a STEM major?), 10 (When did you make your major selection that relates to your current major?) and four subscales (gender role identity, individuals’ perception of parental expectations, national identity and self-stereotyping scale). After excluding outliers and missing data, the final sample for data analysis in the first section consisted of 284 participants based on the above three criteria: gender, age and completion of the above subscales (The whole demographic information of all participants can be seen in Table 3). 155 of the participants were female (54.6 %), 121 of the participants were men (42.6%), 8 participants described them as non-binary (2.8%). 284 participants ranging from age 18 to 50 (mean age =25.71; SD=6.82. And there are 111 non-STEM participants (38.9%) and 173 STEM participants (61.1%). Furthermore, a t-test on age is performed between STEM majors and non-STEM majors, revealing that there is no significant difference in participants’ age (see Table 4).

After excluding 3 missing data points from the subscales of self-belongingness and self-efficacy and four non-binary persons from the STEM sample, the second section contains 166 participants: 91 of the participants were females (54.8 %), and 75 of the participants were males (45.2%).

Table 1

Properties for subscales and participants' age in dependent measures: choice of STEM

Scale	Full sample				STEM majors				Non-STEM majors			
	Mean	N	Range	SD	Mean	N	Range	SD	Mean	N	Range	SD
Age	25.71	284	18-50	6.82	25.38	173	18-50	6.47	26.24	111	18-48	7.35
TMF	23.62	284	6-42	10.15	22.43	173	6-40	9.93	25.48	111	6-42	10.25
PE	10.18	284	3-15	3.24	10.69	173	3-15	3.09	9.39	111	3-15	3.33
NI	13.93	284	4-20	3.31	13.63	173	4-20	3.47	14.40	111	6-20	2.99
Self-stereotyping	23.67	284	7-38	4.34	23.71	173	7-38	4.50	23.59	111	12-33	4.10

TMF: Gender Role Identity; NI- National Identity; PE – Individual Perception of Parental Expectation.

Table 2

Properties for subscales and participants' age in Dependent measures: self-belongingness and self-efficacy

Scale	STEM majors□females vs. males□			
	Mean	N	Range	SD
Age	25.51	166	18-50	6.54
Self-belongingness	18.15	166	9-32	5.04
Self-efficacy	41.49	166	15-56	8.61
Self-stereotyping	23.69	166	7-38	4.45

Table 3

Demographic characteristics of participants

Demographic characteristics	Full sample		STEM majors		Non-STEM majors	
	N	%	N	%	N	%
Gender-Female	155	54.6	92	53.2	63	56.8
Gender -Male	121	42.6	77	44.5	44	39.6
Gender-non-binary	8	2.8	4	2.3	4	3.6
Educational level:						
Undergraduate	184	64.8	110	63.6	74	66.7
Postgraduate	74	26.1	45	26.0	29	26.1
Ph.D.	21	7.4	15	8.7	6	5.4
Other	5	1.8	3	1.7	2	1.8
Timing of making a major decision:						
Age 11-14	18	6.3	14	8.1	4	3.6
Age 15-18	134	47.2	89	51.4	45	40.5
Age 19-22	54	19.0	27	15.6	27	24.3
Age over 22	78	27.5	43	24.9	35	31.5
Countries in which they grow up involve:						
UK	188	66.2	100	57.8	87	78.4
growing up in more than one country.	32	11.3	20	11.6	14	12.6

Table 4

Results of t-test on ages between STEM and Non-STEM.

logistic parameter	STEM majors		Non-STEM majors		t (282)	p	Cohen's d
	M	SD	M	SD			
Age	25.38	6.47	26.24	7.35	-1.045	.297	-0.127

Results

DV1: Choice of STEM

In the first section of this study, regarding hypotheses 1-3, a hierarchical logistic regression was used to determine the effects of gender, gender role identity (TMF), national identity, the timing of making major decisions (age 11-14; age 15-18; age 19-22; over age 22), and individual perception of parental expectations on the choice of STEM (see Table 5). And Multicollinearity was assessed prior to logistic regression using tolerance, VIF, and collinearity diagnostics. The Variance Inflation Factor (VIF) values for all predictors were 1.000, and tolerance values were 1.000, indicating no multicollinearity concerns (Hair et al., 2010). Additionally, the condition indices were below 30, and no two predictors shared high variance proportions on the same dimension, further supporting the absence of multicollinearity.

Model 1 includes gender (male; non-binary; female) and TMF as IVs. The logistic regression model was statistically significant, $\chi2(3) = 12.891$, $p = .005$. The model explained 6% (Nagelkerke) of the variance in the choice of STEM and correctly classified 60.9% of cases. A high level of TMF was associated with a reduction in the likelihood of choice of STEM. Participants in STEM have a lower level of TMF than those who are not in STEM.

Model 2 includes gender, TMF, national identity, individual perception of parental expectations and timing of making major decisions (age 11-14; age 15-18; age 19-22; over age 22) as IVs. In terms of timing of making major decisions, the age 11-14 group was coded 1; age 15-18 was coded 2; age 19-22 was coded 3; and over age 22 group as reference group, was coded 4. This logistic regression model was also statistically significant, $\chi2(8) = 31.708$, $p < .001$. The model explained 14.3% (Nagelkerke) of the variance in the choice of STEM and correctly classified 66.2% of cases. Of the eight predictor variables, only three were statistically significant: gender, TMF and individuals' perception of parental expectations. The results suggested that increasing individuals' perception of parental expectations was associated with an increased likelihood of choice of STEM, while a high level of TMF was associated with a reduction in the likelihood of choice of STEM.

Model 3 includes self-stereotyping as an IV based on model 2. The logistic regression model was statistically significant, $\chi2(9) = 32.926$, $p < .001$. The model explained 14.8% (Nagelkerke) of the variance in the choice of STEM and correctly classified 65.1% of cases. In this model, national identity is statistically significant in addition to gender (female vs. male), TMF, and individuals' perceptions of parental expectations. Increasing individual perception of parental expectations was associated with an increased likelihood of choice of STEM, but a higher level of TMF and national identity was associated with a reduction in the likelihood of choice of STEM. Model 3 shows the most effective regression equation:

log(p/1-p) = 1.681 + 1.173*gender (female vs. male) - 0.070* TMF– 0.085*national identity + 0.122*individual perception of parental expectations.

Univariate ANOVA analysis found that TMF was significantly different between genders ($F(5,278) = 154.116$, $p < .001$, partial $\eta^2 = .735$) and between different choices of STEM ($F(1,282) = 6.22$, $p = .131$, partial $\eta^2 = .022$). Particularly, there is a significant interaction between gender-female and gender role identity ($F(1,278) = 10.30$, $p < .001$, partial $\eta^2 = .036$); In contrast, the differences in gender role identity for males ($F(1,278) = 3.56$, $p = .060$, partial $\eta^2 = .013$) and non-binary individuals ($F(1,278) = .544$, $p = .461$, partial $\eta^2 = .002$) were not statistically significant. Figure 1 illustrates gender role identity across genders (binary, male and female) and their choice of STEM.

In addition, there was a significant effect of timing of making major decisions on individuals' perception of parental expectation ($F(3, 280) = 8.408$, $p < .001$, partial $\eta^2 = .083$). Linear regression determined the timing of significant decisions as a predictor of individuals' perceptions of parental expectation, accounting for 8.3% variance, $F(3, 280) = 8.408$, $p < .001$. Furthermore, linear regression found that the variables of national identity and gender role identity explained a significant proportion of variance in self-stereotyping, = .042, $F(2,281) = 6.127$, $p = .002$, suggesting that a lower level of national identity and a higher level of TMF was related to an increased level of self-stereotyping.

Table 5

Hierarchical Logistic regression results for choice of STEM

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)			
							Lower	Upper		
Model 1									.060**	
Constant	1.687	0.392	18.506	1	<.001	5.403				
Gender- nonbinary vs. male	0.652	0.821	0.631	1	0.427	1.919	0.384	9.585		
Gender-female vs. male	1.232	0.492	6.260	1	0.012	3.428	1.306	8.998		
TMF	-0.081	0.024	11.266	1	<.001	0.922	0.880	0.967		
Model 2									.143***	.073***
Constant	1.213	0.823	2.171	1	0.141	3.363				
Gender- nonbinary vs. male	0.543	0.833	0.426	1	0.514	1.722	0.337	8.805		
Gender-female vs. male	1.116	0.510	4.786	1	0.029	3.053	1.123	8.296		
TMF	-0.069	0.025	7.510	1	0.006	0.933	0.888	0.980		
NI	-0.076	0.041	3.452	1	0.063	0.927	0.856	1.004		
PE	0.122	0.043	7.818	1	0.005	1.129	1.037	1.230		
TMM- age 11-14 vs. over 22	0.993	0.632	2.468	1	0.116	2.700	0.782	9.327		
TMM - age 15-18 vs. over 22	0.299	0.319	0.881	1	0.348	1.349	0.722	2.519		
TMM - age 19-22 vs. Over 22	-0.449	0.384	1.364	1	0.243	0.638	0.301	1.356		
Model 3									.148***	.005***
Constant	1.681	0.930	3.267	1	0.071	5.370				
Gender- nonbinary vs. male	0.560	0.835	0.450	1	0.503	1.750	0.341	8.989		
Gender-female vs. male	1.173	0.514	5.214	1	0.022	3.232	1.181	8.847		
TMF	-0.070	0.025	7.724	1	0.005	0.932	0.887	0.979		
NI	-0.085	0.042	4.087	1	0.043	0.919	0.847	0.997		
PE	0.122	0.043	7.826	1	0.005	1.129	1.037	1.230		
TMM- age 11-14 vs. over 22	0.987	0.631	2.448	1	0.118	2.682	0.779	9.231		
TMM- age 15-18 vs. over 22	0.308	0.319	0.933	1	0.334	1.361	0.728	2.542		

TMM - age 19-22 vs. Over 22	-0.423	0.385	1.209	1	0.272	0.655	0.308	1.392
Self-stereotyping	-0.025	0.023	1.214	1	0.271	0.975	0.933	1.020

**Significant at p <.05, **Significant at p <.01, ***Significant at p <.001*

TMF: Gender Role Identity; NI- National Identity; PE – Individual Perception of Parental Expectation; TMM – Time of Making Major Decision with age over 22 as the reference group.

DV2: Self-belongingness in STEM

Hierarchical linear regression predicting self-belongingness was performed to address hypotheses 4 and 6 (Table 6). From model 1, gender (female vs. male) explained 4.8% of the variance in self-belongingness, F (1, 164) = 8.314, p = .004. With the inclusion of TMF and its interaction with gender, TMF didn't significantly predict self-belongingness, p = .212. A subsequent model, considering gender, TMF, self-stereotyping, and their interactions, accounted for 29.2% variance, F (5, 160) = 13.196, p < .001, highlighting that for each unit increase in self-stereotyping, females' self-belongingness decreases by 0.395 units. The linear regression equation of self-belongingness is:

Self-belongingness= 31.902 –0.395*(self-stereotyping).

A one-way ANOVA revealed a significant difference in self-belongingness between females (M = 22.21, SD = 7.22) and males (M = 25.31, SD = 6.47), F (1, 164) = 8.31, p = .004, partial η^2 = .048. Levene's test for equality of variances was not significant, p = .227, suggesting that the assumption of homogeneity of variances was met. Significant differences were observed between gender and TMF, F (1,164) = 453.95, p < .001, Levene's test for equality of variances was not significant, p = .740, suggesting that the assumption of homogeneity of variances was met. Additionally, gender had a significant effect on self-stereotyping, F (1, 164) = 16.63, p < .001, and Levene's test again showed equal variances across groups (p = .986). However, the Shapiro–Wilk tests revealed significant deviations from normality in the residuals for models including gender: self-belongingness, W (166) = .976, p = .005; TMF, W (166) = .983, p = .041; and self-stereotyping, W (166) = .964, p < .001. These results indicate that the normality assumption was violated for the models that included gender.

When 'gender' was excluded in the hierarchical regression model, TMF significantly predicted self-belongingness, = .038, F (1, 164) = 6.492, p = .012 (see table 7). And All VIF values were below 1.10, indicating no concerns of multicollinearity among the predictors (Hair et al., 2010). Prior assumption checks indicated that the residuals were independent (Durbin–Watson = 2.10), evenly distributed (based on the residual scatter plot), and normally distributed, as both the Kolmogorov–Smirnov (p = .200) and Shapiro–Wilk (p = .066) tests were non-significant; moreover, all VIF values were below 1.10, indicating no multicollinearity concerns. These findings suggest gender's potential moderating role in the TMF-self-belongingness relationship. Moreover, TMF significantly influenced self-stereotyping, explaining 6.4% of its variance, F (1, 162) = 11.166, p < .001.

Given TMF's differing distributions between genders, separate analyses were conducted to specifically examine the impact of TMF and self-stereotyping within same-gender identity. Results showed TMF solely cannot predict self-belongingness among females and males in STEM, only self-stereotyping reduced females' self-belongingness by .578 SD, = .337, F (2, 88) = 22.339, p <.001, and males' by .334 SD, = .134, F (2, 72) = 5.563, p = .006 (refer to Tables 8 and 9).

Table 6

Hierarchical Linear Regression for variables predicting self-belongingness (gender included).

	B	SE B	β	95% C.I.for B		
				LL	UL	
Model 1						0.048**
Constant	25.307***	0.795		23.736	26.877	
Gender-female vs. male	-3.098**	1.074	-.220**	-3.019	0.003	
Model 2						0.062
Constant	27.835**	2.170		23.549	32.120	
Gender-female vs. male	-9.384	4.799	-.655	-18.861	0.092	
TMF	-0.196	0.156	-.276	-0.505	0.113	
Gender* TMF	0.321	0.210	.704	-0.094	0.737	
Model 3						0.292***
Constant	31.902***	2.315		27.330	36.475	
Gender-female vs. male	0.794	4.912	.056	-8.906	10.495	
TMF	-0.145	0.138	-.204	-0.417	-0.127	
Gender* TMF	0.172	0.185	0.377	-0.194	0.538	
Self-stereotyping	-0.395**	0.129	-.329**	-0.650	-0.141	
Gender *self-stereotyping	-0.333	0.170	-.417	-0.669	0.004	

**Significant at p <.05, **Significant at p <.01, ***Significant at p <.001*

TMF: Gender Role Identity

Table 7

Hierarchical Linear Regression for variables predicting self-belongingness (gender excluded).

	B	SE B	β	95% C.I.for B		
				LL	UL	
Model 1						0.038*
Constant	26.686***	1.322		24.075	29.296	
TMF	-.138*	0.054	-.195*	-0.245	-0.031	
Model 2						0.271***
Constant	33.028***	1.450		30.164	35.891	
TMF	-0.049	0.049	-.069	-0.146	0.048	
Self-stereotyping	0.599***	0.083	-.499***	-0.762	-0.435	

**Significant at p <.05, **Significant at p <.01, ***Significant at p <.001*

TMF: Gender Role Identity

Table 8

Hierarchical Linear Regression for variables predicting self-belongingness (females only)

	B	SE B	β	95% C.I.for B		
				LL	UL	
Model 1						0.008
Constant	18.450***	4.497		9.515	27.385	
TMF	0.125	0.148	.090	-0.168	0.419	
Model 2						0.337***
Constant	32.697***	4.281		24.189	41.204	
TMF	0.027	0.123	.019	-0.216	0.271	
Self-stereotyping	-0.728***	0.110	-.578***	-0.947	-0.509	

**Significant at p <.05, **Significant at p <.01, ***Significant at p <.001*

TMF: Gender Role Identity

Table 9

Hierarchical Linear Regression for variables predicting self-belongingness (males only)

	B	SE B	β	95% C.I.for B		
				LL	UL	
Model 1						0.024
Constant	27.835***	2.028		23.792	31.877	
TMF	-0.196	0.146	-.155	-0.487	0.096	
Model 2						0.134***
Constant	31.902***	2.348		27.222	36.583	
TMF	0.145	0.140	-.115	-0.423	0.134	
Self-stereotyping	-0.395**	0.131	-.334**	-0.656	-0.135	

**Significant at p <.05, **Significant at p <.01, ***Significant at p <.001*

TMF: Gender Role Identity

DV3: Self-efficacy in STEM

Hierarchical linear regression analysis was performed to address hypotheses 5 and 6 (see Table 10). From Model 1, gender alone explained 3.2% of the self-efficacy variance, = .032, F (1, 164) = 5.433, p = .021. Incorporating TMF and its interaction with gender (Model 2) increased explained variance to 6.7%, = .067, F (3, 162) = 3.900, p = .010, suggesting an interaction between gender role identity and self-efficacy among both genders. Model 3 containing gender (female vs. male), TMF, self-stereotyping and the interaction term (gender* TMF; gender*self-stereotyping) as IVs explained a significant proportion of variance in self-efficacy, = .243, F (5, 160) = 10.283, p < .001. The relationships suggest that as TMF drops a unit, women's self-efficacy goes up by 0.351 units more than men's, and each unit rise in self-stereotyping results in a 0.690 unit decrease in self-efficacy. This relationship is summarized as:

Self-efficacy = 55.970 - 0.351*(TMF) - 0.690*(self-stereotyping).

A one-way ANOVA revealed significant gender differences in self-efficacy levels within STEM, with females (M = 40.10, SD = 8.27) scoring lower than males (M = 43.19, SD = 8.75), F (1, 164) = 5.43, p = .021. Levene's test for equality of variances was not significant (p = .210), indicating that the assumption of homogeneity of variances was met. However, the Shapiro–Wilk test revealed a significant deviation from normality in the residuals for the model including gender, W (166) = .972, p = .002. These results indicate that the assumption of normality was violated in the model that included gender. Additionally, self-efficacy and self-stereotyping were moderately negatively correlated, r = −.470, p < .001.

Given TMF's differing distributions between genders, separate analyses were performed to explicitly explore the effect of TMF and self-stereotyping within same-gender identity. For females, only self-stereotyping predicted their reduction in self-efficacy by 0.428 SD. For males, self-stereotyping and TMF together accounted for the variation in self-efficacy, with reductions by .431 and .205 SD respectively, = .249, F (2, 72) = 11.920, p < .001 (refer to Tables 11 and 12).

Table 10

Hierarchical Linear Regression for variables predicting self-efficacy.

	B	SE B	β	95% C.I.for B		
				LL	UL	
Model 1						0.032*
Constant	43.187***	0.981		41.250	25.123	
Gender-female vs. male	-3.088*	1.325	-.179*	-5.704	-0.472	
Model 2						0.067*
Constant	48.869***	2.646		43.645	54.094	
Gender-female vs. male	-13.378*	5.851	-.776*	-24.932	-1.825	
TMF	-0.440*	0.191	-.508*	-0.817	0.064	
Gender* TMF	0.594*	0.257	1.065*	0.087	1.101	
Model 3						0.243***
Constant	55.970***	2.927		50.190	61.750	
Gender-female vs. male	-8.368	6.209	.485	-20.630	3.895	
TMF	-0.351*	0.174	-.405*	-0.695	-0.007	
Gender* TMF	0.421	0.234	0.756	-0.041	0.884	
Self-stereotyping	-0.690***	0.163	-.470***	-1.012	-0.368	
Gender *self-stereotyping	-0.071	0.216	.073	-0.355	0.497	

**Significant at p <.05, **Significant at p <.01, ***Significant at p <.001*

TMF: Gender Role Identity

Table 11

Hierarchical Linear Regression for variables predicting self-efficacy (females only)

	B	SE B	β	95% C.I.for B		
				LL	UL	
Model 1						0.009
Constant	35.491***	5.152***		25.255	45.728	
TMF	0.154	0.169	.090	-0.183	0.490	
Model 2						0.190***
Constant	47.602***	5.424***		24.189	41.204	
TMF	0.070	0.155	.044	-0.238	0.379	
Self-stereotyping	-0.619***	0.140	-.428***	-0.896	-0.341	

**Significant at p <.05, **Significant at p <.01, ***Significant at p <.001*

TMF: Gender Role Identity

Table 12

Hierarchical Linear Regression for variables predicting self-efficacy (males only)

	B	SE B	β	95% C.I.for B		
				LL	UL	
Model 1						0.066*
Constant	48.869***	2.686		43.516	54.223	
TMF	-.440*	0.194	.257*	-0.826	-0.054	
Model 2						0.228***
Constant	55.970***	2.961		50.068	61.872	
TMF	-0.351*	0.176	-.205*	-0.702	0.000	
Self-stereotyping	-0.690***	0.165	-.431***	-1.019	-0.361	

**Significant at p <.05, **Significant at p <.01, ***Significant at p <.001*

TMF: Gender Role Identity

Discussion

The first section of this study is to investigate the potential factors influencing STEM choice based on different social identities and parental and cultural expectations, as well as their influence on self-stereotyping. Specifically, this section predicted that the level of gender role identity that was measured by TMF which ranges from low masculinity to high femininity in a continuum is negatively related to the choice of STEM (H1). Additionally, it was predicted that the influence of gender role identity on the choice of STEM fields significantly differs among individuals based on their self-identified gender identities (H2). Furthermore, this section explored whether national identity, individuals' perception of parental expectations, the timing of making major decisions and self-stereotyping can also influence the choice of major (H3). The details of these findings will be discussed in the following sections.

Hypothesis 1:

The first hypothesis, predicting that low masculinity and high femininity are negatively related to the choice of STEM, was supported. This follows previous literature which found that individuals with gender role identity are more likely to engage in typical gendered behaviours and choose typical gendered domains (Dicke et al., 2019).

Hypothesis 2:

The second hypothesis predicted that the influence of gender role identity on the choice of STEM fields may differ in gender. The results supported this hypothesis that there is only a significant interaction between female and gender role identity. In addition, the finding that increasing gender role identity was associated with an increased probability of self-stereotyping adds support to the association between gender role identity and STEM stereotype, which is in accordance with the previous literature that women are more likely to self-stereotype by associating higher masculinity and gender-males with STEM majors (Makarova et al., 2019).

Hypothesis 3:

The results partially confirm this hypothesis: lower levels of national identity and higher levels of masculinity and individuals' perceptions of parental expectations can predict an increased likelihood of choice of STEM. According to social identity theory, people can be influenced by stereotype threat and form self-stereotypical ideas, which are dependent on the value of multiple social identities, as demonstrated by the finding that national identity and gender role identity can significantly influence their self-stereotyping.

Contrary to the hypothesis, the timing of making major decisions and self-stereotyping did not play a significant influence on STEM choice. One explanation is sample and methodological design: In this study, there are more participants in STEM (60.9%) than those who are not in STEM (39.1%). And, in different groups of the timing of making major decisions, STEM participants outnumber or equal non-STEM participants. In the hierarchical logistic regression, the timing of making major decisions (age group 15-18 vs. over 22 and age group 19-21 vs. over 22) significantly predicted individual perceptions of parental expectations, which explains the possibility of multicollinearity between these two IVs (the timing of making major decisions and individual perceptions of parental expectations). Similarly, national identity and gender role identity significantly predicted self-stereotyping, which to some extent indicates that the non-significance of self-stereotyping could be a result of the multicollinearity rather than indicating that self-stereotyping is unimportant in predicting the choice of STEM. Prior research has shown that individuals' endorsement of STEM-related stereotypes can influence their motivation to pursue STEM, depending on the extent of their group identification and personal mindset. For example, individuals who perceive themselves as fitting the STEM prototype and who hold a fixed belief in traditional gender roles are more likely to be influenced by STEM stereotypes (Master, 2021).

The second section of this study predicted that students' self-belongingness and self-efficacy are influenced by gender role identity and self-stereotyping is reflected in such relationships (H4, H5, H6). Detailed findings are discussed in subsequent sections.

Hypothesis 4:

The fourth hypothesis predicted that in STEM, self-belongingness can be influenced by gender role identity, which differs between individuals who self-identify as female and those who self-identify as male. The results didn't confirm

this hypothesis: There was a significant difference in self-belongingness between males and females in STEM. When controlling the effect of gender, gender role identity didn't significantly predict self-belongingness. When IV (gender) was excluded in the hierarchical linear regression, gender role identity significantly predicted self-belongingness. In addition, within both male and female groups in STEM, gender role identity didn't significantly predict 'self-belongingness'. Further research should examine the factors influencing the relationship between gender and self-belongingness, considering not only personal gender roles but also demographics and broader socio-cultural influences within male and female groups, such as the intersections of race, gender, family income, and academic majors (Ovink et al., 2024). Additionally, it is important to explore various dimensions of self-belongingness in STEM, including the academic performance, mindset, and leadership (Corson & González-Morales, 2024).

Hypothesis 5:

The results supported this hypothesis that the effect of gender role identity on self-efficacy is different for males and females. Females with higher levels of femininity have lower levels of self-efficacy compared with males. In the female group, gender role identity does not exert a significant influence on self-efficacy. In contrast, among males, gender role identity significantly affects self-efficacy levels. Females' self-efficacy is more likely to be influenced by social persuasions and vicarious experiences, which may be reflected in other cultural and societal factors. Further study can investigate how gender norms and expectations differentially impact males and females in a comparative context. Male may be more likely to be influenced by the traditional gender morns to choose gender-atypical occupations in Switzerland .

Hypothesis 6:

The last hypothesis, predicting that, in STEM, self-stereotyping may explain additional unique variance when predicting the effect of gender role identity on both STEM belongingness and STEM efficacy. The results follow the theoretical evidence. Females are more likely to develop self-stereotypical ideas that impact their sense of belonging in STEM, consistent with previous studies, which may result from a disjunction between females' gender role identity and STEM identity (Master & Meltzoff, 2020). In terms of self-efficacy, individuals who endorse more gender stereotypes in STEM have lower self-efficacy. It is consistent with the social cognitive theory that self-efficacy beliefs can be influenced by stereotypical experiences in various ways: mastery experience, vicarious learning, social persuasion, and physiological and affective states. Furthermore, cultural and gender norms can exacerbate gender disparities in STEM engagement by influencing self-efficacy beliefs (Chan, 2022).

Strengths, Limitations and Future Directions

A key strength of this study is to explore the relationship between gender role identity and the choice of STEM from the individual perspective. Especially, gender role identity was measured by the TMF scale with masculinity and femininity in a continuum, which was used in the second section to investigate females' sense of belonging and self-efficacy in STEM. Given that the choice of STEM is multifaceted and impacted by a variety of personal and external factors, this study included individuals' views of parental expectations and national identity to explore parental and cultural influences on STEM choice from a social psychological standpoint.

However, there are also some limitations in this study. Firstly, individual cognitive processes are ignored in this study. People act on their gender identities through a self-regulatory process that is also mediated by biological factors such as hormones, and testosterone, which can also impact gender differences in behaviours that facilitate masculine or

feminine behaviours in a certain social setting (Wood & Eagly, 2012). In addition, future studies should include sexual and racial minorities to better understand the complexity of STEM stereotypes, rather than focusing solely on gender-female (Forsythe et al., 2024). Notably, women of colour reported the lowest sense of belonging in STEM fields—except in biological science (Howson & Kingsbury, 2024). Secondly, the sample cannot provide evidence of the developmental process of gender role identity. Gender stereotypes emerge in childhood and interact with other social and cultural factors such as the country's economic development, education system, gender equality policies, and historical trends. Individual experiences, such as gender discrimination, also play a critical role in their choice of STEM and females' belongingness in STEM by reinforcing their gender stereotypes in STEM (Rogers et al., 2021). Further studies can consider the effect of gender stereotypes in STEM across countries. Furthermore, around 11% of participants grew up in more than one country, and 40% of participants did not grow up in the UK, which may influence their national identity (Esses et al., 2001). Thirdly, it is difficult to ascertain the actual parental influence on participants and if it corresponds to participants' perceptions of parental influence in this study. And masculine norms vary in different STEM majors, further research can focus on STEM majors with a higher level of masculine culture, such as computer science, engineering, and physics (Cheryan et al., 2017).

Implications

This study emphasizes the importance of understanding gender roles in the context of educational choices. It could encourage further research into how gender identities shape career decisions to promote gender balance in STEM.

Self-stereotyping may play a crucial role in both the choice of STEM and self-belongingness, which supports the notion that societal stereotypes not only influence educational choices but also affect individuals' self-efficacy. Bussey and Bandura (1999) stated that people can acquire a model's behaviours through observation. An individual is more likely to identify a person as a role model based on a high degree of demographic similarities, such as gender, race (Lee et al., 2023). It is more challenging for females in STEM to establish STEM self-efficacy since few female role models in STEM contradict the STEM stereotype. Strategies to counter self-stereotyping and foster inclusivity in STEM, like role-model interventions featuring female figures challenging STEM stereotypes, can bolster women's self-efficacy (González-Pérez et al., 2020; Porter et al., 2020). On the other hand, despite being in the minority, women may have high self-efficacy independent of their gender role identity. Thus, the effect of gender role identity on self-efficacy should be considered with individual experiences and other social factors.

Conclusion

This research concludes that individuals' choice of STEM can be influenced by gender role identity, individuals' perceptions of parental expectations, national identity and self-stereotyping. Moreover, the significant interaction between female and gender role identity emphasizes the complex influence of self-stereotyping on women's self-belongingness and self-efficacy within STEM fields. However, no significant influence of gender role identity was found for females' STEM self-belongingness when controlling the effect of gender. Nevertheless, this study provides a strong foundation for future research into other mediator elements between gender role identity and self-belongingness, such as bias and discrimination.

Overall, this study sheds light on the intricate interplay of gender role identity and other factors in STEM experiences. It calls attention to the importance of recognizing and addressing these dynamics in educational settings to promote greater equity and inclusion in STEM.

Declarations

Not applicable.

Ethical considerations

The Faculty of Humanities and Social Sciences Research Ethics Review Committee at [University Name] approved our survey (Approval No: M2223-124) on [Month 05, 2023]. Respondents provided written informed consent before beginning the survey.

Recruitment was conducted exclusively through Prolific (https://www.prolific.com), a widely used research platform that adheres to ethical research standards. All ethical principles were strictly followed, including informed consent, voluntary participation, and anonymity.

Consent to participate

The study was approved by the Research Ethics Review Committee at on Month 05, 2024. All participants provided written informed consent prior to participating.

Consent for publication

Not applicable.

Declaration of conflicting interest

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Author Contribution

Author Yuanyi Zhu led the manuscript writing and data analysis.

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Figures

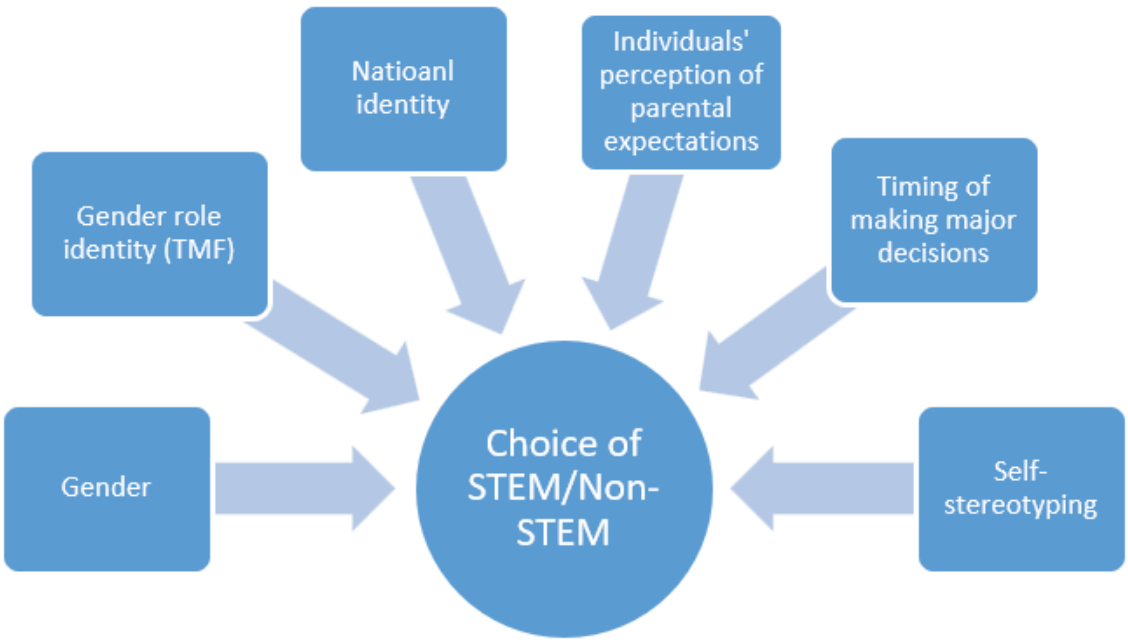


Figure 1

Thematic map showing the influence of six variables on STEM/non-STEM choice (DV1).

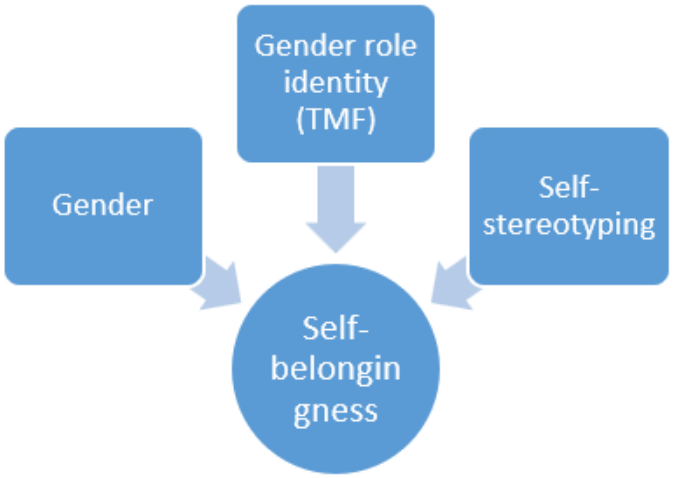


Figure 2

Thematic map showing the influence of three variables on self-belongingness in STEM (DV2).

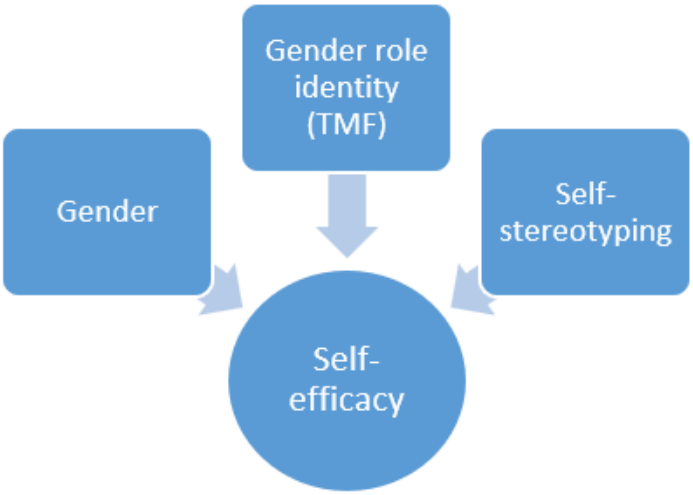


Figure 3

Thematic map showing the influence of three variables on self-efficacy in STEM (DV3).

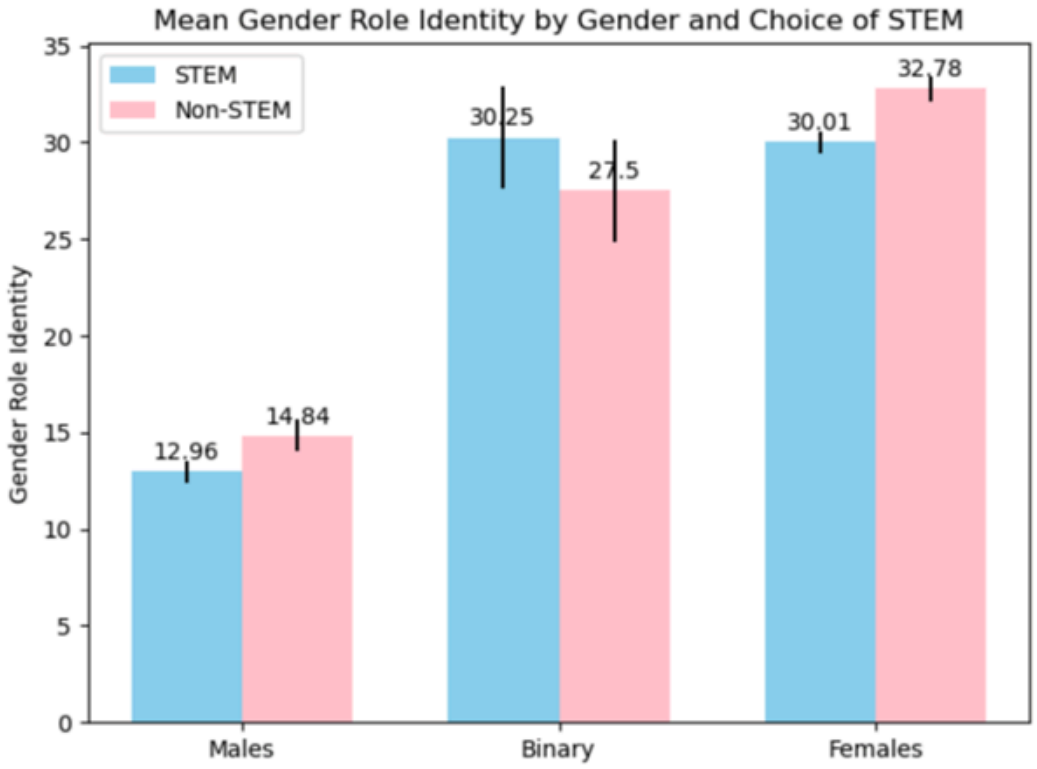


Figure 4

Figure 1 Gender Role Identity by Gender and Choice of STEM

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