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THE IMPACT OF FEMALE ROLE MODELS ON FEMALE STEM UNIVERSITY STUDENTS IN TAIWAN

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Abstract

This study examines the impact of female role models on the learning and development of female undergraduates in science, technology, engineering, and mathematics (STEM) disciplines during their university education in Taiwan. A qualitative approach of phenomenology was adopted, utilizing in-depth interviews for data collection. Fifteen female participants (aged 20 to 25) from diverse STEM programs across three universities were recruited. Data analysis revealed five core dimensions through which female STEM role models impacted female STEM students: (1) achieving professional success, (2) challenging gender stereotypes, (3) expressing empathy and sharing personal narratives, (4) fostering professional identity and competence, and (5) integrating professional and personal roles. Participants reported significant benefits from the presence, support, and guidance of female STEM role models. The study concludes with implications for educators, researchers, and policymakers, and offers recommendations for future inquiry.

Keywords

Female Role Model, Female University Student, STEM, Gender Stereotype

Despite comprising 49.38% of the undergraduate student population in Taiwan, women remain significantly underrepresented in STEM disciplines. Specifically, they account for only 13.67% in engineering, 32.40% in computer and communications sciences, 28.06% in natural sciences, and 32.62% in mathematics and statistics (Ministry of Education, 2025). This gender disparity reflects broader structural and cultural challenges within STEM education. One critical factor contributing to female attrition in STEM is the scarcity of female role models (FRMs) in these fields (Chan & Cheung, 2018; Hill et al., 2010; Milgram, 2011). Research suggests that role models play a pivotal role in enhancing women's representation at both entry and senior levels in STEM (Tal et al., 2024). In particular, FRMs are instrumental in expanding female participation and fostering inclusive learning environments (Bertrand & Duflo, 2017; Calvo-Iglesias et al., 2022; Rosenthal et al., 2013; Steffen & Hess, 2024). However, the influence of FRMs on female students in STEM remains underexplored in Taiwan. This study aims to address this gap by examining how FRMs shape the learning experiences and developmental trajectories of female undergraduates in STEM.

Gendered Experiences of Female STEM Students in Taiwan

STEM fields in Taiwan have historically been male-dominated, cultivating a culture characterized by masculine competition and hierarchical authority. Han (2009) investigated gender dynamics in science and engineering laboratories, revealing that these environments often reinforce gender distinctions and associate the process of becoming an engineer with masculine norms. Laboratory settings, in particular, serve as sites where mainstream masculine culture influences student identity formation.

Drawing on data from the Program for International Student Assessment (PISA) between 2006 and 2015, Huang and Wang (2019) examined gender differences in mathematical and scientific competencies among

Taiwanese students. While no significant disparities in performance were found, female students demonstrated markedly lower levels of interest, self-efficacy, participation in STEM-related activities, and enrollment in STEM majors. The authors attributed these patterns to the pervasive influence of gender stereotypes.

Liu (2001) explored career transitions among female STEM graduates and identified internalized barriers—such as diminished self-efficacy and gendered occupational stereotypes—as key constraints on women's professional development. Similarly, Hung (2014) analyzed the gendered experiences of 16 female STEM undergraduates, concluding that these students often reproduce class and gender disadvantages within academic settings. Tsai (2012) conducted a case study of a female scientist who actively advocated for gender equality in STEM. The study highlighted the challenges she faced and the strategies she employed to overcome learning and career obstacles. Li and Chen (2009) further emphasized the transformative potential of FRMs, noting their capacity to disrupt traditional gender frameworks and challenge entrenched stereotypes, thereby promoting gender equity in STEM.

Global Perspectives on Women in STEM

Internationally, women in STEM encounter persistent barriers that contribute to their attrition across educational and professional stages—a phenomenon often likened to a "leaky pipeline" (Goulden et al., 2011). Institutional climates and insufficient social support are among the factors that exacerbate female dropout rates in graduate STEM programs (Betz, 1994). For women who do not strongly identify with STEM, a sense of belonging emerges as a more reliable predictor of sustained interest than academic performance alone (Cheryan & Plaut, 2010).

The belief that women are inherently less capable in STEM remains widespread (Reuben et al., 2014), fostering environments of threat and alienation that undermine women's career development. Stereotypes about female mathematical ability are often transmitted through familial and educational channels, shaping girls' attitudes and diminishing their performance and interest in STEM disciplines (Gunderson et al., 2011). These cultural narratives contribute to the internalization of doubt and the erosion of science identity among women.

Gender stereotyping also influences women's perceptions of the communal utility of science, thereby weakening their identification with STEM fields (Smith et al., 2015). The underrepresentation of women and exclusionary messages from STEM gatekeepers—such as professors and male peers—signal to female students that they are not valued as scientists. These experiences compromise the development of science identity and self-efficacy, as women are frequently subjected to scrutiny and skepticism regarding their competence and legitimacy in STEM (London et al., 2011; Rosenthal et al., 2013).

Female Role Models in STEM

Role models are individuals who exemplify behaviors, achievements, or values that others aspire to emulate. Kearney and Levine (2020) define a role model as someone who sets an example for another individual to follow, while Gladstone and Cimpian (2021) emphasize their capacity to positively influence motivation by serving as successful exemplars. As Warrell (2020) succinctly puts it, "seeing is believing"—the visibility of role models can inspire action, strengthen aspirations, and foster a mental framework for success.

In the context of higher education, FRMs in STEM remain scarce. Steffen and Hess (2024), through an online survey of girls aged 14–20 in Germany, found that FRMs were most commonly identified within the family domain, while male role models predominated among teachers, entrepreneurs, and peers. Notably, female scientists and entrepreneurs—potential FRMs in STEM—were significantly underrepresented.

Milgram (2011) argues that women need to see FRMs in professional environments who resemble them. Exposure to successful FRMs has been shown to predict greater engagement and investment in STEM fields, particularly among women (Rosenthal et al., 2013). The presence of FRMs enhances female students' sense of belonging and reinforces the belief that effort leads to success in STEM (Shin et al., 2016). FRMs also contribute to improved performance, retention, and preference for STEM studies (Drury et al., 2011; González-Pérez et al., 2020).

Qualitative research by Lindner and Makarova (2024), based on 20 group interviews with female students in Switzerland, revealed that female scientists were largely unknown to participants, reinforcing the perception of physics as a male-dominated domain. These findings underscore the importance of FRMs in fostering interest, motivation, and self-esteem among female adolescents in STEM. Tal et al. (2024), using a mixed-methods approach, identified seven key characteristics of STEM role models: ambition, charisma, empathy and encouragement, inspiration, knowledge, talent, and professionalism. Female participants most frequently cited empathy and encouragement as defining traits. The study concluded that role modeling—an environmental factor—plays a critical role in cultivating intrinsic motivation, especially among women in STEM.

Bowman et al. (2022) found that higher female representation in STEM courses predicted improved academic outcomes for all students, with more pronounced benefits for female students. Similarly, Marx and Roman (2002) reported that women who strongly identified with mathematics outperformed their male peers on math assessments when supported by a FRM. Williams and Ceci (2012) further emphasized that exposure to positive FRMs is a key driver of female success in STEM. Murphy (2022) noted that female instructors in STEM

courses consistently benefit female students more than male students, helping to dismantle stereotypes and foster engagement.

Sociocultural stereotypes about scientists and scientific careers continue to undermine women's interest in STEM (Shin et al., 2016). FRMs can buffer against these effects by protecting women's self-concept and science identity (Stout et al., 2011; Dasgupta, 2011). Exposure to successful FRMs helps girls recognize that individuals "like them" can thrive in STEM (Hill et al., 2010). Young et al. (2013) demonstrated that meaningful contact with FRMs—such as female science professors—can reduce implicit gender stereotypes and strengthen identification with STEM.

Rosenthal et al. (2013) reaffirm that exposure to STEM role models enhances engagement and investment, particularly among women. Lockwood and Kunda (1997) found that female students' self-belief increases when they observe relatable FRMs succeeding in STEM. Zawistowska (2017), through narrative analysis of women in technology and engineering, revealed that choosing male-dominated majors often coincided with the presence of a significant role model who provided support, challenged stereotypes, and influenced university preferences. Chan and Cheung (2018) reported that female high school students were more likely to pursue STEM careers when they perceived female professionals as embodying a humanistic image of STEM.

Role-model interventions have been shown to foster belonging and identity among female STEM students, strengthening their connection to the STEM community (Casad et al., 2018; Van Camp et al., 2019). Merritt et al. (2021) conducted a field experiment in which girls participated in workshops led by FRMs. Post-intervention, participants exhibited strong identification with their role models and enhanced science identity. González-Pérez et al. (2020) found that such interventions positively influenced girls' enjoyment of mathematics, perceived importance of the subject, expectations of success, and STEM aspirations. Notably, the more counter-stereotypical the role-model content, the stronger the link between success expectations and STEM career choices.

Rationale of the Study

This study adopts the framework of observational learning—specifically vicarious experience—as a theoretical lens. Observing individuals in gender-congruent roles fosters traditional aspirations, while exposure to those in nontraditional domains (e.g., women in STEM) introduces counter-stereotypical possibilities (Olsson & Martiny, 2018). Repeated exposure to gender-incongruent role models can reduce gender stereotyping and promote nontraditional career behaviors. In this study, FRMs are conceptualized as agents of change who model both gender-congruent behaviors (e.g., care, support, and relational intimacy) and gender-incongruent competencies (e.g., technical expertise and leadership). By integrating personal and professional roles harmoniously, FRMs help female students navigate stress, overcome barriers, and cultivate resilience in STEM environments. Ultimately, FRMs serve as catalysts for reducing stereotype threat and enhancing the learning, coping, and developmental outcomes of women in STEM.

Method

This study employed a phenomenological qualitative research design to explore the lived experiences of female STEM undergraduates in Taiwan, specifically focusing on the influence of female role models (FRMs) within their academic environments. Phenomenology seeks to uncover and articulate the subjective meanings individuals assign to their experiences, offering rich, descriptive insights into the life-world—the realm of everyday consciousness (Schwandt, 1997). By foregrounding participants' own narratives, this approach aligns with the study's objective to understand how FRMs shape female students' learning and development in STEM disciplines.

Participants

Fifteen female undergraduate students from three universities in Taiwan participated in this study. Their ages ranged from 20 to 25 years, with a mean age of 21.75 years. Eligibility criteria included current enrollment in a STEM program and the presence of at least one FRM within their department or academic network. All participants voluntarily agreed to share their experiences and perspectives regarding the impact of FRMs on their academic trajectories.

Interviewer

Data collection was conducted by a trained research assistant (RA) who held a master's degree in counseling. Prior to the study, the RA completed formal coursework in interviewing techniques, counseling theory, qualitative research methods, and general research methodology. She also participated in pilot interviews to refine her approach. Throughout the study, the RA prioritized building rapport with participants, maintaining a respectful, open, and nonjudgmental stance to foster trust and encourage candid dialogue.

Data Collection

Each participant engaged in a one-on-one, in-depth interview lasting between 90 and 120 minutes. These interviews constituted the primary data source for the study. Participants were recruited through snowball sampling, beginning with initial contacts and expanding through referrals. The RA introduced the study's purpose and procedures to prospective participants and obtained informed consent prior to each interview. Interview questions were designed to elicit detailed reflections on participants' experiences with FRMs. Core questions included: "Please describe your female role models from STEM programs or departments." "How have these FRMs influenced your learning and development in STEM?" All interviews were audio-recorded and transcribed verbatim to ensure accuracy and preserve the integrity of participants' narratives. These transcripts formed the basis for subsequent data analysis.

Data Analysis

The first author was the analyst. She analyzed data by following the procedures proposed by Moustakas (1994): (1) Reading through the written transcripts several times to obtain an overall feeling for them; (2) Identifying significant phrases or sentences that pertained directly to the experience; (3) Formulating meanings and clustering them into themes common to all of the participants' transcripts; (4) Integrating the results into an in-depth, exhaustive description of the phenomena; and (5) Validating the findings with the participants, and including participants' remarks in the final description.

The analyst employed strategies proposed by Gibbs (2007). She (1) checked the transcripts against the original recordings, (2) constantly compared the data with the codes and wrote memos about the codes and their definitions, and (3) cross-checked codes and compared results that were independently derived. In addition, strategies proposed by Creswell and Miller (2000) were adopted. The analyst (1) triangulated different data sources of information, (2) used member checking to determine the accuracy of the findings through taking the final report or specific descriptions or themes back to participants, (3) used rich description to convey the findings and provide detailed descriptions of the setting and multiple perspectives about a theme, (4) clarified the bias through self-reflection which created a narrative that resonated well with readers, (5) presented negative or discrepant information that ran counter to the themes, and (6) spent prolonged time in the field to develop an in-depth understanding of the phenomenon and to convey details about the site and the people that lead credibility to the narrative account. The other authors served as peer de-briefers to review and ask questions to assist the analyst to reveal a more objective description.

Results

Five key themes emerged from the data analysis, as outlined below. Each theme is supported by quotations from selected participants to enhance illustration and contextual depth.

Female Role Models Achieving Professional Success in STEM

Participants identified a diverse range of FRMs, including professors, upper-level students, peers, scientists, professionals, and family members. Several participants cited female relatives—particularly mothers and extended family members with expertise in mathematics and science—as early inspirations for pursuing STEM disciplines. Across interviews, FRMs were consistently described as pivotal figures in shaping participants' academic motivation and development.

Female professors and teachers in STEM were frequently mentioned as influential FRMs. These educators were recognized for their subject mastery, particularly in mathematics and science, and for their ability to foster student engagement. One participant remarked, "A few female teachers taught natural sciences and mathematics. They are good teachers and good role models!" Participants admired these professors' reasoning and problem-solving abilities, rational thinking, and resilience, noting that such traits helped them navigate academic challenges. FRMs were described as instrumental in cultivating students' patience, persistence, and tolerance for frustration. As one student reflected, "(A female) calculus professor had a profound influence on me... not only with respect to knowledge on calculus but also in terms of the cultivation of my mental toughness, such as patience, persistence, stress immunization, and frustration tolerance, in the face of numerous learning barriers in STEM."

Peer role models also played a significant role. Participants were inspired by the diligence and academic success of female classmates, particularly in mathematics and science. These female peers demonstrated that women could excel in STEM through hard work and determination. One participant shared, "These young women in our class are diligent learners... They showed me that young women can learn science and math subjects well through unwavering determination and steadfast perseverance in learning."

Parental encouragement further reinforced the impact of FRMs. Several participants noted that their parents emphasized the importance of mathematics and science and introduced them to the biographies of renowned female scientists. From an early age, participants were exposed to biographies and media coverage of female scientists, which inspired in them a sense of aspirational agency—an internalized belief that "those who strive can achieve likewise." This motivation led to their determined commitment to pursuing careers in STEM.

One student stated, "(I) admire some female scientists like... (female) Nobel Prize winners and (female) technology leaders." These narratives of female achievement demonstrated a high level of ambition and strong professional competence, and served as motivational tools, encouraging participants to pursue STEM studies with dedication.

Female Role Models Challenging Gender Stereotypes

FRMs were also recognized for their role in challenging societal stereotypes that portray women as less capable in STEM. Female professors, through their excellence in teaching and research, directly confronted prejudices suggesting that women lack proficiency in mathematics and science. Similarly, high-achieving female peers revealed that women could succeed in traditionally male-dominated fields.

Participants reported encountering accomplished female scientists through academic conferences, workshops, and laboratory visits. These FRMs exhibited qualities such as calmness, rationality, creativity, and logical reasoning—traits that countered prevailing gender stereotypes. Their presence affirmed that women possess the intellectual and emotional capacities required for STEM success.

One participant articulated the impact of Taiwan broader societal context on women: "Because (Taiwan) society tells girls that girls are less logical, weaker in mathematics, and worse in natural sciences. People tend to believe that girls are more suitable for studying humanities and social studies. We (female students) need FRMs who break gender stereotypes. If there are none (FRMs), female students tend to fall into the trap (of believing that women are unsuitable for learning and working in STEM)." This sentiment underscores the critical role of FRMs in reshaping perceptions and empowering female students to resist internalized limitations and external gender stereotypes in socioculture of Taiwan.

Female Role Models Expressing Empathy and Sharing Personal Narratives in STEM

Participants described how FRMs in STEM—particularly professors, senior students, and professionals—demonstrated empathy and shared personal experiences that resonated with the gender-specific challenges faced by women in STEM environments. These narratives underscored the importance of relational support and gender-informed mentorship in fostering resilience and belonging among female STEM students.

Several participants noted that women in STEM encounter unique physiological and environmental challenges, particularly in laboratory settings. These included exposure to pollutants, heavy machinery, and extended experimental hours, which may adversely affect reproductive health and menstrual regularity. One participant recalled, "She (a female teacher) told me that it would be difficult for female students to do this (an experimental project), day and night are often reversed (in conducting experiments). Also, a machine may be too heavy to carry (for female students)." Such disclosures from FRMs helped normalize these challenges and offered practical insights into navigating them.

Participants emphasized that female professors were more attuned to the emotional and psychosocial experiences of female students than their male counterparts. They, being part of a gender minority in STEM programs, described FRMs as understanding their confusion, anxiety, and self-doubt that often accompany over the university career. Drawing from their own lived experiences, FRMs possess a deep understanding of the challenges faced by female STEM students—including academic pressure, career uncertainty, self-doubt, and a lack of confidence in their abilities. They are also attuned to the broader difficulties women encounter in STEM learning environments, such as systemic bias, social prejudice, and the emotional toll of navigating gendered expectations. One student shared, "I feel that a male professor may not understand the stress and frustration that I experience in STEM. Instead, my female professors, peers, and seniors can understand (my situation in STEM)." Another added, "(A female professor) shares her stories about learning in STEM, so I feel close to her and I am willing to rely on her. When I encounter difficulties or doubts, I seek her help with confidence!"

Although the number of female professors in STEM departments was reported to be limited, their influence was described as substantial. Participants advocated for increasing the representation of female faculty, noting that these professors fostered inclusive and supportive classroom environments. One student remarked, "A female professor shares her personal stories (in the classes). I feel happy in her class, which has a warm, caring, open and positive atmosphere. I find that students are more willing to ask questions when the teacher is female."

FRMs were consistently portrayed as embodying both professional competence and relational warmth. They integrated technical expertise with traditionally feminine attributes such as empathy, compassion, and care. As one participant noted, "Female teachers are concerned about (students') lives... They show more empathy, support, encouragement, and care when interacting with their students (relative to male teachers)." These qualities enabled FRMs to address gender-specific challenges and provide emotional scaffolding for female students navigating uncertainty and self-doubt in STEM learning.

In addition to faculty, senior female students and peers also served as FRMs, offering mentorship and guidance based on shared experiences. These peer mentors helped participants address academic, experimental, and career-related challenges. One student reflected, "Senior female students shared their experiences, which could be similar to mine. As FRMs, they understood my needs and problems in STEM and suggested effective strategies, skills, and ideas because they had encountered similar problems in STEM." Participants also valued interactions

with female industry professionals who were invited to speak on campus, sharing career trajectories and offering practical advice that enriched students' academic and professional aspirations.

Female Role Models Fostering Professional Identity and Competence

Participants consistently expressed admiration for female professors who demonstrated excellence in teaching, research, and academic leadership. These professors were perceived as embodying strong professional identities and competencies equivalent to those of their male counterparts. Participants highlighted that female professors who actively engage in classroom instruction, mentoring, laboratory management, and scholarly inquiry serve as powerful FRMs. Their identity and ability to overcome challenges and pursue professional growth was particularly inspiring.

One participant reflected, "She (a female professor) is simply enjoying her own (teaching and research) work… (She) has professional knowledge and can expand and deepen her professional competence… I wish to be like her, someone who can enjoy and perform well in a (STEM) profession." This sentiment illustrates how FRMs not only model professional expertise but also convey a sense of fulfillment and purpose in their academic careers.

Beyond faculty, participants also recognized the professional competence of female peers and scientists. Female classmates who demonstrated diligence and academic growth were viewed as role models, as were female scientists whose passion and commitment to their work exemplified professional excellence. These FRMs were seen as individuals who honored their professional identities, committed to their work, and performed diligently to develop themselves as experts within their communities in STEM.

Female Role Models Integrating Professional and Personal Roles

Participants observed that FRMs skillfully balanced their professional responsibilities with personal roles, such as those associated with family and caregiving. These FRMs were described as integrating communal and nurturing roles—such as being daughters, mothers, spouses and friends—with their professional identities as educators, researchers, and scholars. FRMs emphasize the importance of maintaining physical and mental health, practicing effective time management, and optimizing productivity during limited free time within the highly competitive STEM learning and professional environments. Most critically, they advocate for the establishment of robust support and resource systems, which enable women to efficiently navigate and fulfill both professional responsibilities and personal life tasks. Through adaptive strategies and flexible coping mechanisms, FRMs maintained harmony between their personal and professional lives, contributing to a rich and fulfilling existence.

One participant remarked, "Male (STEM) teachers are less concerned about familial issues or not concerned at all and concentrate solely on their (STEM) careers. They don't need to take care of their children or do housework because their wives handle all of these matters. By contrast, female (STEM) teachers must apply various strategies and skills to take care of their children, housework, and professional careers (in STEM). Wow, they (female teachers) are really amazing in keeping both personal and professional roles stable and balanced."

This observation underscores the dual expectations placed on women in STEM and the resilience required to navigate them. FRMs were admired not only for their academic and/or professional achievements but also for their ability to manage complex life roles with grace and effectiveness. The example provided participants with a realistic and empowering model of what it means to play personal and professional roles appropriately and thrive in both personal and professional domains.

Discussion

The findings of this study underscore the pivotal role of female role models (FRMs) in supporting the learning and development of female STEM undergraduates in Taiwan, despite their limited representation in higher education. Participants identified four key contributions of FRMs: (1) affirming the presence of women in STEM, (2) challenging gender stereotypes and modeling professional competence, (3) offering empathy, support, and personal narratives, and (4) integrating professional and personal roles. These themes are discussed below.

Affirming the Presence of Women in STEM

In male-dominated STEM environments, the visibility of female teachers, peers, and professionals serves as a powerful affirmation that women can belong and succeed in these fields. This supports the notion that "seeing is believing" (Warrell, 2020), and echoes prior research indicating that same-gender role models are particularly effective in attracting young women to STEM (Cheryan et al., 2011; Stout et al., 2011). Even a small number of FRMs can significantly influence female students' motivation, persistence, and sense of belonging.

Participants described FRMs as highly relevant figures—teachers, seniors, and professionals within their own programs or departments—whose success in STEM felt attainable and inspiring. This aligns with Lockwood and Kunda's (1997) assertion that relatable role models enhance students' belief in their own potential. Exposure to FRMs predicted greater engagement and investment in STEM (Rosenthal et al., 2013), positively influencing enrollment and retention (Chan & Cheung, 2018). As Milgram (2011) emphasizes, women need to see role models

who resemble them in relevant positions. These findings also resonate with Lindner and Makarova (2024), who highlight the importance of FRMs in fostering interest, motivation, and self-esteem among female adolescents in STEM.

Challenging Gender Stereotypes and Modeling Professional Competence

Observational learning involving FRMs emerged as a key mechanism for attracting and retaining female students in STEM. The presence of FRMs signals that women are well-suited to STEM careers and helps buffer against the harmful effects of gender stereotypes (Stout et al., 2011; Zawistowska, 2017). Gender-counter-stereotypical role models reduce stereotyping and promote nontraditional aspirations (Olsson & Martiny, 2018). Exposure to successful FRMs enables female students to challenge internalized beliefs about gender and STEM, fostering motivation and enjoyment in science learning (Bertrand & Duflo, 2017; Chan & Cheung, 2018; Hill et al., 2010; Shin et al., 2016).

Participants admired FRMs who demonstrated professional competence in teaching, research, and academic leadership. These FRMs exhibited ambition, charisma, and deep subject knowledge—traits identified by Tal et al. (2024) as central to effective role modeling. Responding to the study results, empathy and encouragement were frequently cited characteristics by female students (Tal et al.). FRMs helped students set aspirational goals and reconcile their gender identity with their STEM identity, reducing perceived incompatibility (London et al., 2011) and weakening implicit stereotypes that associate science with masculinity (Young et al., 2013). By modeling excellence and resilience, FRMs disproved stereotypes suggesting women are less intellectually capable or less suited for STEM careers (Hung, 2014; Dasgupta, 2011; Li & Chen, 2009).

Offering Empathy, Support, and Personal Narratives

Participants emphasized the emotional and relational support provided by FRMs, which helped them navigate the challenges of STEM education. FRMs were described as warm, caring, and approachable—qualities that distinguished them from male faculty and peers. Their ability to understand female students' psychosocial and emotional experiences, particularly in male-dominated environments, fostered trust and psychological safety among participants.

FRMs shared personal stories of difficulties, struggles, perseverance and success in STEM, offering students a sense of connection and validation. These narratives helped students feel empowered and supported, especially during moments of self-doubt, confusion, uncertainty or stress. The results of this study echoes Merritt et al. (2021), who found that role model identification strengthens science identity. Participants reported feeling more confident and motivated after hearing FRMs' personal experiences, which motivated them to follow FRMs' career path and reinforced their commitment to STEM programs.

The nurturing qualities of FRMs—empathy, support, and mentorship—were instrumental in enhancing students' emotional well-being and academic persistence. These findings align with Chan and Cheung (2018), who noted that female students often prefer careers perceived as meaningful and caring. FRMs' showing care and empathy and sharing personal narratives promoted a humanistic image of STEM. FRMs affirm that academic/technical expertise and humanity/empathy can coexist in STEM, thereby attracting and retaining female students in STEM programs and careers.

Integrating Professional and Personal Roles

Participants admired FRMs who successfully balanced professional responsibilities with personal roles such as caregiving and family life. FRMs demonstrated adaptive strategies for managing dual roles, offering a realistic and empowering vision of life in STEM. Their ability to integrate personal and professional identities contributed to a holistic model of success, reinforcing the idea that women can thrive in both domains.

FRMs were seen as embodying traditional feminine roles—caring for children and/or other family members, managing household responsibilities—while simultaneously achieving professional success in STEM. This duality resonated deeply with participants, who felt more aligned with STEM after witnessing FRMs navigate these complexities. The study supports findings by Casad et al. (2018) and Van Camp et al. (2019), which show that role-model interventions enhance students' sense of belonging and identity in STEM.

Participants expressed confidence in their ability to become STEM professionals who integrate warmth, empathy, and technical expertise. The presence of FRMs demonstrated that success in STEM does not require sacrificing personal life, echoing Williams and Ceci (2012). These integrated role models helped female students envision futures where they could contribute meaningfully to STEM while maintaining personal fulfillment.

Summary

The findings of this study both affirm and extend existing literature on the role of FRMs in STEM. Consistent with prior research, participants confirmed that FRMs enhance female students' motivation, self-efficacy, and sense of belonging (Chan & Cheung, 2018; Rosenthal et al., 2013; Tal et al., 2024). The scarcity of FRMs and their

importance in countering stereotypes (Steffen & Hess, 2024; Milgram, 2011) as themes echoed strongly in the present results.

However, this study adds depth by highlighting the emotional, relational and integrative dimensions of FRMs in STEM, which are less emphasized in prior literature. While existing studies focus on professional competence and stereotype disruption, the present findings reveal that FRMs' warmth, empathy, caring, and personal storytelling are equally influential. Participants valued FRMs not only for their STEM achievements but also for their humanistic qualities—supporting the idea that women's STEM success can coexist with traditional feminine attributes (e.g., warmth, empathy, caring, compassion) in sociocultural context.

Another divergence lies in the emphasis on role integration. While literature often treats professional success as distinct from personal life, participants in this study admired FRMs who balanced both domains. This suggests a nuanced understanding of STEM identity for women in Taiwan, where relational harmony and caregiving are deeply valued. The study also expands the concept of female role modeling to include senior peer and familial influences, not just institutional or famous scientist figures. The contributions of this study deepen our understanding of how FRMs shape female students' academic and professional trajectories and facilitate their learning and development, particularly in sociocultural contexts where gender disparities persist in Taiwan.

Implications and Conclusions

This study highlights the impact of FRMs on the academic engagement, emotional resilience, and professional identity formation of female STEM undergraduates in Taiwan. Despite their limited representation, FRMs serve as powerful agents of change—affirming the presence of women in STEM, challenging entrenched gender stereotypes, offering empathetic support, and modeling the integration of personal and professional roles. These findings carry significant implications for educational policy, institutional practice, and future research.

First, the study reinforces that exposure to FRMs enhances female students' confidence, persistence, and sense of belonging in STEM. Therefore, leaders and policymakers should prioritize the recruitment, retention, and visibility of female faculty, professionals, and students in STEM disciplines. Institutional efforts should include targeted hiring practices, mentorship initiatives, and inclusive representation across academic and industry platforms.

Second, counseling and education professionals should design and implement intervention programs that facilitate meaningful interactions between FRMs and female students. These programs should emphasize both gender-congruent and gender-counter-stereotypical behaviors—such as empathy, care, rationality, and resilience—to help students internalize a broader, more inclusive image of STEM identity. Observational learning through FRMs enables female students to emulate diverse professional attributes, thereby strengthening their academic performance and career aspirations.

Third, the study underscores the importance of relational and emotional support in STEM education. FRMs who share personal narratives and demonstrate caring and empathy to help female students navigate stress, uncertainty, and self-doubt. These gender-congruent behaviors—rooted in warmth, care, empathy, and communal values—are not peripheral but central to the development of professional identity of women in STEM. Institutions should cultivate environments where such relational mentoring is recognized, supported, and integrated into pedagogical practice.

Fourth, the integration of personal and professional roles modeled by FRMs offers a compelling framework for holistic success in STEM. Female students benefit from seeing FRMs who balance caregiving responsibilities with academic excellence, challenging the notion that professional achievement must come at the expense of personal fulfillment. This dual-role modeling is particularly salient in Taiwan sociocultural contexts where familial and communal values are deeply embedded. Educational systems should support work-life balance policies, flexible learning and career pathways, and recognition of diverse forms of professional and/or academic performance.

Finally, future research should explore the nuanced processes through which FRMs influence female students' identity formation, competence development, career trajectories and integration of personal and professional roles. Longitudinal studies could examine how sustained exposure to FRMs shapes professional alignment and development over time. Additionally, comparative research across sociocultural contexts could illuminate how FRMs negotiate gender norms, program rules, and institutional constraints differently, offering insights into globally responsive strategies for gender equity in STEM.

This study validates core findings from the literature while offering new insights into the relational, emotional, and integrative dimensions of FRMs in STEM. In conclusion, FRMs are not merely symbolic figures—they are relational, pedagogical, and sociocultural catalysts who help female students envision and enact their place in STEM. By affirming presence, modeling excellence, offering care, and balancing roles, FRMs contribute to a more inclusive and humanistic STEM landscape. Institutions that invest in FRM-centered strategies are not only supporting individual students—they are reshaping the future of STEM itself.

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