Developing a Conceptual Framework: Women STEM Faculty's Participation in Entrepreneurship Education Programs

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Abstract

Motivated by the high socio-economic impact of innovations in science and technology, entrepreneurship in STEM disciplines is gaining increasing attention. As a result, entrepreneurship education programs (EEPs) have been introduced and designed to train STEM faculty and expose them to entrepreneurial practice. This study examines factors influencing women STEM faculty's perspectives on their participation in EEPs within the broader socio-cultural context of academia. The study addresses the under-researched and under-theorized area of women academics in STEM entrepreneurship by drawing on adult participation literature and key theoretical works in entrepreneurship education to formulate the conceptual grounding. Using qualitative methods, including in-depth interviews with 32 women STEM faculty, the findings identify internal and external influences and unpacks their complex interactions across the programmatic and systemic dimensions. Internal factors include perceptions of entrepreneurship, STEM academic identity, entrepreneurial identity, and self-efficacy, while external factors included professional mentors, personal role models, socioemotional support, and financial resources. The study conceptually synthesizes these factors and elucidates a nuanced understanding of women STEM faculty's perspectives on their participation in EEPs, offering insights for future research and program development to enhance diversity, equity, and inclusivity in STEM entrepreneurship education.

Keywords Entrepreneurship education · Women faculty · Conceptual model · STEM · Gender

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Introduction

The participation of women in entrepreneurship has garnered increasing attention from scholars exploring the barriers and motivators influencing women's entrepreneurial activity. Cardella et al. (2020) noted a growing scholarly interest in women's entrepreneurship over the past two decades, with recent research delving into personal traits, experiences, and perceptions to better understand women's underrepresentation in the field. The gendered nature of entrepreneurship, influenced by societal gender roles and cultural norms, creates challenges for women entrepreneurs (Cardella et al., 2020). While comprehensive reports on the distribution of men versus women academic entrepreneurs are scarce, recent data shows that female-led ventures are 63 percentage points less likely than male-led ventures to secure external funding, largely due to differences in startup orientation and investor biases (Guzman & Kacperczyk, 2019). Women, particularly those in science, technology, engineering and mathematics (STEM) fields, face structural, individual, and cultural barriers that impact their perceptions of entrepreneurship and their likelihood to pursue entrepreneurial endeavors (Adikaram & Razik, 2022; Schnittker & Ettl, 2021). Individuals pursue entrepreneurship due to a variety of reasons such as the desire for personal development achieved through engaging in meaningful work and learning from the business creation process; ability to control work life and/ or combine work and personal life; gaining financial and social status; continuing family tradition; dissatisfaction with prior work; and the desire to contribute to the community (Stephan et al., 2015).

This study aims to contribute to the existing literature by focusing on an under-studied population—academic women in STEM. Despite the critical role that STEM fields play in driving innovation and economic growth, women in these fields remain significantly underrepresented, both in academia and in entrepreneurial ventures (Chowdhury & Endres, 2005; Elliott et al., 2020; Vidadievna, 2024). The unique position of women STEM faculty, who are often at the forefront of cutting-edge research and technological advancements, makes their potential contributions to entrepreneurship particularly valuable. However, their participation in entrepreneurship education programs (EEPs) and subsequent entrepreneurial activities is not well understood compared to their male counterparts (Elliott et al., 2020). Furthermore, a majority of entrepreneurship research literature employ a 'deficit' framing in which the lack of entrepreneurship-related attributes in women when compared to men is used to explain underrepresentation (Marlow et al., 2019). Building on recent calls for asset-based, gender-sensitive approaches (Brush et al., 2009), the presented work focusses on identifying systemic and programmatic factors that may hinder women STEM faculty's engagement in entrepreneurship programming. Specifically, instead of contrasting with men and highlighting the deficits, we examine women STEM faculty's perspectives as an independent entity, and place the onus on the system to change and create inclusive environments that mitigate underrepresentation. Therefore, we ask the following research question: What factors describe women STEM faculty's perspectives on participation/non-participation in EEPs? Through an exploration of factors influencing their participation or non-participation in entrepreneurship education programs, this research seeks to uncover motivations and barriers unique to this demographic, with the goal of informing interventions (i.e., entrepreneurship education programs) that can increase STEM women's entrepreneurial activity and fostering further theoretical and empirical research in this relatively underexamined area of STEM education.

Background

Entrepreneurship education programs are increasingly being implemented to provide STEM faculty with pathways to learn about, and engage in commercialization around the globe (Archana et al., 2022). In the United States, recent initiatives have focused on fostering entrepreneurship in STEM fields, such as the National Science Foundation's Epicenter Program: National Center for Engineering Pathways to Innovation and I-Corps Program. These programs provide academic researchers with platforms to engage in entrepreneurship training to leverage their technical and scientific innovations (Nnakwe et al., 2018). The rapid growth and popularity of the I-Corps program, which has trained over 3000 researchers, underscores the increasing traction of entrepreneurship in STEM fields. The I-Corps program provides an immersive, experiential learning environment to STEM faculty where they work towards developing and evaluation the viability of commercializing their STEM-based research inventions. The STEM faculty work in teams comprising of graduate students from their research labs, and a business mentor provisioned through the program. Similarly, higher education institutions have also developed entrepreneurship education programs on their campuses in the form of technology transfer programs startup incubators which provide local support on learning about. and pursuing commercialization (O'Shea and Lee, 2022). Additionally, a systemic literature review that compared academic entrepreneurs to non-academic entrepreneurs indicated that the challenges in academic entrepreneurship are heavily influenced by institutional contexts rather than just individual traits (Miller et al., 2018). Institutional policies and the focus on formal channels like patents and IP management can limit academic entrepreneurship to structured, legally-bound activities. However, many valuable informal activities, such as consultancy and public lectures, are often overlooked and under-supported. This institutional emphasis can stifle the broader spectrum of entrepreneurial engagement that thrives on less formal interactions, demonstrating that effective academic entrepreneurship requires supportive institutional frameworks that recognize and facilitate a wide range of knowledge transfer activities. While the benefits of these programs are that they provide an avenue housed within the academic setting to pursue entrepreneurial pathways, the anticipated challenges are likely to stem from misalignment between academic roles and responsibilities, and individual motivations for faculty (Shekhar et al., 2018; Shekhar & Huang-Saad, 2021; Shekhar et al., 2024). Lastly, to cultivate entrepreneurial skills among STEM graduates (Gilmartin et al., 2016). For example, at Brown University, a two-semester course sequence exposes engineering undergraduates to entrepreneurial training using projects developed through industry collaborations and lectures conducted by faculty and industry participants (Creed et al., 2002).

Despite the expansion of EEPs, gender disparities persist across all academic levels in STEM from undergraduate students to faculty members (Shekhar et al., 2018; Piva & Rovelli, 2022). These disparities are exacerbated by structural obstacles like inequitable venture capital funding and biased evaluations in pitch competitions (Brooks et al., 2014; Brush et al., 2022). These barriers reflect broader gender biases and affect women's opportunities in entrepreneurship. Moreover, women encounter additional challenges, including perceived financial support deficits, unfavorable economic conditions, and academic gender stratification, which restrict their access to commercialization opportunities (Murray & Graham, 2007; Verheul et al., 2012). At the individual level, obstacles like fear of failure, lack of support, and competency concerns further hinder women's entrepreneurial pursuits (Shinnar et al., 2012). Despite these barriers, some women are driven by motivations such

as family business backgrounds and a desire for autonomy. Unlike men, who often enter entrepreneurship earlier and with more confidence, women tend to prefer accessible, cost-effective, and informal EEPs over formal programs, highlighting the need for gender-specific support and training (Cho et al., 2019).

While men also face barriers such as concerns about competency and experience different societal pressures that shape their entrepreneurial journey differently (Shekhar, 2022), the landscape of women in STEM entrepreneurship is a less explored area (Treanor, 2022), with literature reviews underscoring the lack of research on academic women in STEM entrepreneurship (Poggesi et al., 2015). Gendered norms within STEM and entrepreneurship perpetuate barriers, requiring women to navigate a male-dominated culture (Kuschel et al., 2020). However, women in STEM bring innovation to entrepreneurship, even though they face disparities in patenting and industry-funded research opportunities (Blume-Kohout, 2014; Nager et al., 2016). Research that examines women as an independent demographic group is scare. Majority of research uses a comparative approach that identifies the 'lack of' several factors (e.g., entrepreneurial intent (Díaz-García & Jiménez-Moreno, 2010), entrepreneurial attitude (Sánchez & Fuentes, 2010), entrepreneurial self-efficacy (Mozahem, 2021) in contrast with men, as explanations for lower representation. Thus, understanding the unique challenges and opportunities faced by women STEM faculty in entrepreneurship is crucial for several reasons. First, their participation can lead to the commercialization of academic research, which can have significant societal and economic benefits. Second, promoting entrepreneurship among women STEM faculty can contribute to greater gender diversity in the entrepreneurial ecosystem, leading to a broader range of innovations and perspectives. Third, insights from this research can inform the design of more effective EEPs that support women in overcoming barriers and leveraging their strengths in entrepreneurial ventures. Finally, addressing the underrepresentation of women in STEM entrepreneurship can serve as a catalyst for broader cultural and institutional changes, promoting a more inclusive and equitable environment in both academia and the entrepreneurial sector.

Methodology

To address our research question, we design our study using qualitative research methods (Miles et al., 2019). Acknowledging the notion that meaning does not exist independent of the human interpretive process (Hatch, 2023; Hesse-Biber & Leavy, 2006; Miles et al., 2019), a qualitative approach was chosen to comprehend the factors influencing women STEM faculty's perspectives regarding EEP participation. Additionally, by engaging in qualitative research, we seek to understand the meaning that people ascribe to their world (Hesse-Biber & Leavy, 2010). Particularly, this study "…aim[ed] to look at a 'process' or 'meanings' individuals attribute to their given social situation" (Hesse-Biber & Leavy, 2010, p. 45) pertinent to EEP participation/non-participation. Qualitative data provides richness and holism, supporting the development of thick description around phenomena of interest (Miles et al., 2019). This study explores the proposed research question by studying a small group of focal participants to illuminate their experiences/perspectives in and around entrepreneurship programming. To do so, we used in-depth interviews as the primary data source from each focal participant, i.e., self-identified women STEM faculty actively engaged in research.

Theoretical Framework

The research draws upon disparate fields and utilizes commonly used theoretical works from the entrepreneurship education literature, including the theory of planned behavior (TPB) (Lortie & Castogiovanni, 2015), social cognitive career theory (SCCT) (Lent et al., 1994), and Shapero's entrepreneurial event theory (SEE) (Licht & Siegel, 2005), identified through a systematic review of literature (Huang-Saad et al., 2018), in conjunction with adult participation theories (Cross, 1981). Our approach is informed by recent scholarship highlighting the limited use of theory in discipline-based research (Beddoes, 2022). Particularly, we concur with Beddoes (2022) in noting that reliance on a single theory such as self-efficacy theory limits what can be observed, understood, and ultimately changed within the field. To avoid oversimplification of a complex phenomenon (i.e., women STEM faculty perspectives on EEPs), we draw on the insights from multiple theoretical works by utilizing key constructs identified in these theories to inform our qualitative data collection and synthesis. The details of the systematic review and identification of key theoretical constructs noted in entrepreneurship literature is presented in our prior work (Shekhar et al., 2018). It is to note that the theoretical constructs take different names and forms across theories, however, as summarized in Table 1, there is often partial or full overlap in the conceptualizations. Furthermore, this summary only includes 'input' constructs and not 'output' constructs such as intention and behavior, since the focus of our study was an input factors informing participation/ non-participation in EEPs (output factor).

Table 1 Summary of Theoretical Constructs

Theory of Planned Behavior (TPB)	Social Cognitive Career Theory (SCCT)	Shapero's Entrepreneurial Event Theory (SEE)	Description
Perceived Behavioral Control	Self-Efficacy	Perceived Feasibility	Self-efficacy (derived from SCCT) or the confidence in one's ability to perform a task with success is similar to perceived behavioral and perceived feasibility, as conceptualized in TPB and SEE, respectively
Attitude Subjective Norm	Outcome Expectations and Goals	Perceived Desirability	Perceived Desirability (derived from SEE) overlaps with an individual's attitude towards participation and subjective approval from others (derived from TPB), and an individual's expectation that the participation outcomes will meet their desired goals (derived from SCCT)

Sampling and Participants

The study used a combination of purposive and snowball sampling approach to recruit participants. Our participants, STEM women faculty, include tenure-track and non-tenure-track faculty employed by STEM departments. Purposive sampling involved selecting participants based on specific criteria, such as women-identifying faculty in science or engineering schools, with varying tenured status and EEP participation statuses. Snowball sampling was then utilized, where initial participants recommended colleagues fitting the criteria. Participants were offered $100 incentive for their engagement. The sample encompassed 32 self-identified women faculty, including 13 EEP participants and 19 EEP non-participants. The participants in the EEP included those who had engaged with various types of programs, such as the national-level EEP for faculty (I-Corps), university-level EEPs, and non-university EEPs. The majority of these participants had prior experience with the national I-Corps program. Conversely, non-participants shared their views and perceptions on their exposure to EEPs and entrepreneurship. Our study featured individuals from twenty different U.S. universities, predominantly from research-intensive institutions. To ensure diversity in our sample, we purposively selected participants with varied racial and ethnic backgrounds. We achieved comparable representation among Black, Latina, Asian, and White participants. In addition to racial and ethnic diversity, we sought maximum variation across STEM disciplines by including participants from diverse STEM fields such as colleges of engineering, natural sciences, and mathematics. To ensure privacy of the participants, university names are not revealed. However, to provide context, additional demographic details of the participants are provided in Table 2.

Table 2 Participant Demographics

	EEP Participants	Non-EEP Participants
Race/Ethnicity		
White	4	6
Black	3	3
Latina	3	2
Asian	2	3
South Asian	1	1
Middle Eastern	1	1
Mixed	1	1
Position/Rank		
Assistant Professor	3	9
Associate Professor	5	5
Professor	7	3
University Type		
R1	12	13
Non-R1 (R2 or UG)	3	4

Data Collection

The study primarily relied on in-depth, semi-structured interviews conducted virtually by one member of the research team, with an additional team member attending some interviews to ensure research quality and consistency. These hour-long interviews, recorded and transcribed, aimed "to understand the lived experiences" (Hesse-Biber & Leavy, 2006, p. 118) of women STEM faculty regarding their participation or non-participation in EEPs. Overall, the interview protocol was grounded in the key theoretical perspectives reported in the sections above. Additionally, two versions of the interview protocol were developed based on participants' EEP engagement status, exploring perceptions and experiences systematically. Sample interview questions are detailed in Table 3.

Data Analysis

To analyze the data and identify the factors pertinent to women STEM faculty's participation in EEPs, we engaged in several rounds of qualitative coding. We first used in vivo coding (Saldaña, 2013) to provide a sense of what women STEM faculty were saying about their experience in academia and around entrepreneurship. Two researchers coded 30% of the data separately for intercoder reliability and compared the coded transcripts on a line-by-line basis (O'Connor & Joffe, 2020). The researchers reached 100% consensus on in vivo coding through multiple discussions. The code book was flexible and adapted to all interviews. To ensure quality, the two researchers maintained an analytical memo throughout first-round coding, capturing their initial thoughts about the data. This memo served as a way to audit progress in subsequent rounds of coding, and maintain trustworthiness in qualitative research (Miles et al., 2019; Saldaña, 2013).

In the second round of coding, our research team first sorted the first-round codes into larger categories, working in a collaborative manner to group and name subsequent categories of codes. The research team compared code occurrences to internally audit the categorization to ensure that it was representative of majority of the participants' experiences. Henceforth, we are addressing these categories as 'factors' in alignment with the research questions. After the factor level codebook was developed, two researchers coded 15% of the data separately and compared it to establish intercoder reliability (ICR). In this round, we established ICR two ways. First, an Intraclass Correlation Coefficient 0.94 indicated 94% similar code occurrence between the researchers. Second, similar to first-round coding, we engaged in discussive consensus toward achieving 100% consensus on codes. After ICR, the two researchers divided the remaining interviews and a priori coded using

Table 3 Sample Interview Questions

All Participants	What did you know about entrepreneurship before your current career?
	Do you consider yourself an entrepreneur?
	What does it mean to be an entrepreneur in your field?
EEP Participant	What were your prior experiences that motivated your interest in EEP?
	What skills do you think you need to perform well in EEP that you were enrolled in?
	How did your confidence in these skills inform your decision to enroll in EEP?
Non-EEP Participant	Why haven't you participated in EEPs in your current position?
	Is there a context/situation where you would participate in an EEP? If so, what?
	What are the most challenging parts of EEP that you can anticipate?

the factor-level code book. Similar to the first-round, the two researchers contributed to an analytical memo that captured how they saw factors being related in the data. This memo served as an audit process as the qualitative analysis progressed from coding to explanation building. After developing the final codebook, the codes were visually organized to illustrate their interrelationships by one researcher and reformed through discussions with another researcher. Specifically, the factors were synthesized into four quadrants, distinguishing between internal and external influences as well as systemic and programmatic dimensions as emergent in the participants responses. Further details on this organization are provided in the findings.

Limitations

Despite the strengths of our qualitative approach, several limitations should be acknowledged. The study's sample size of 32 participants, while providing rich qualitative data, limits the generalizability of the findings. While the purposive and snowball sampling methods allowed us to gather diverse and in-depth perspectives across different academic ranks, disciplines, and institutions, this approach may have introduced selection bias, as participants might share perspectives not representative of all women STEM faculty. In spite of these limitations, these findings are transferable and can offer valuable insights into the experiences of women STEM faculty in similar contexts and geographical regions. While the study draws on multiple theoretical frameworks to avoid the limitations of relying on a single theory, this approach adds a layer of complexity in the synthesis and analysis of the data. However, we have taken quality measures through peer debriefing and practices of reflexivity to ensure the trustworthiness of the findings.

Findings

Overall, our findings show that STEM faculty participation in EEPs was shaped by a complex interplay of *internal* and *external* influences which were further intertwined with the *systemic* and *programmatic* dimensions pertinent to entrepreneurship and entrepreneurship programming. In particular, internal influences included factors affecting individual members, such as faculty members' perceptions of the relevance of entrepreneurship education to their field and their identity as a faculty in STEM and higher education. Similarly, *external* influences involved factors outside of the individual, such as their personal role models and professional mentors, and the support for entrepreneurial initiatives. The *programmatic* dimension centered on the specific content, structure, resources, and communication, directly linked to the program's design and implementation. On the other hand, the *systemic* dimension encompassed the broader STEM academic and entrepreneurship context that shaped entrepreneurial engagement within academia. To synthesize the findings, we visually presented the internal and external influences along the horizontal axis, and the systemic and programmatic factors on the vertical axis (as illustrated in Fig. 1). This multi-dimensional conceptualization provides a nuanced understanding of the women STEM faculty's perspectives on participation in EEPs. In the following sections, we explicate these factors by thematically focusing on each quadrant of the emergent conceptualization with quotes from our EEP-participants and non-EEP participants (denoted as P and NP, respectively). The key words from each quote have been provided to indicate the identifiers for each quadrant.
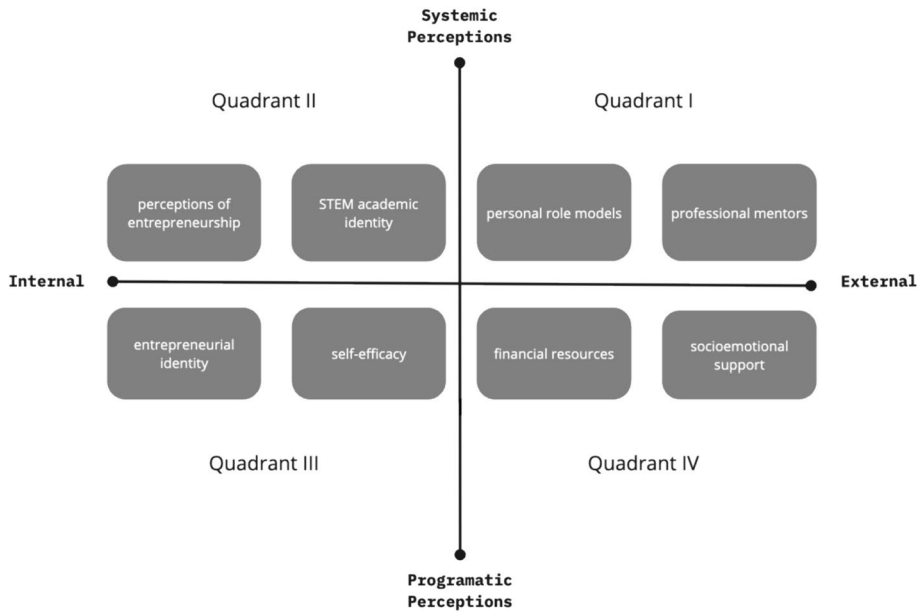
Fig. 1 Conceptual Framework Depicting Factors for EEP Participation

Internal and Systemic

The emergent findings indicated that two factors—perceptions of entrepreneurship and STEM academic identity were situated with the internal influences and systemic dimensions. First, it was recurrent in the findings that participants' perceptions of entrepreneurship were an interplay between their internal reflections and systemic influences. For example, faculty's perceptions of entrepreneurship noted uncertainties and contemplations in regard with entrepreneurship. Expressing a sense of unfamiliarity with the aspect of entrepreneurial process, faculty participants expressed resistance based on their perceptions of time and effort which conflicted with their roles and responsibilities as a member of the STEM academic system they are situated in, as evident in the following comment,

> But then how to translate that to an actual technology, or product, how to make that transition, I feel that I suddenly don't know. And so I would be from the get go, I would just assume that it would take me a lot of time, **that I would have to commit a lot of time to learn it. Right? (NP)**

Second, faculty's discussion to engage in EEPs reflected a negotiation of the individual's STEM academic identity with the systemic reward structures that are placed in academia, as echoed in the comment,

> So if you are spending time going down an entrepreneurship path, and that means you're submitting to less grants, are you making your next steps harder? Because that would be a consideration for me right now. It would take a big encouragement in order to try something new, just because I'm close to going up for tenure, and I just need to be able to stay focused to hit the points that are already in the reward structure. (NP)

The internal and systemic dimensions of faculty engagement EEPs revealed a complex interplay between personal perceptions of entrepreneurship and the overarching systemic influences within the academic landscape. The participants' understanding of entrepreneurship was a negotiation between their internal reflections and broader systemic structures in which they operate as STEM academics. Within the STEM academic domain, individuals grappled with the concept of entrepreneurship, perceiving it as a potential commitment with inherent risks. Their view was often shaped by the experiences of colleagues and professionals in the academic sphere, where entrepreneurship was linked to ventures such as clinical translation and the development of diagnostic tools. However, faculty members expressed uncertainties and contemplations about the entrepreneurial process, particularly in transitioning ideas to products, highlighting a perceived unfamiliarity and resistance due to the anticipated time and effort investment. Importantly, this perceived commitment clashed with the established roles and responsibilities of STEM academics, prompting a negotiation of individual roles within the broader academic and disciplinary landscape, also known as STEM academic identity (Leigh et al., 2022). As articulated by participants, this negotiation involved weighing the pursuit of entrepreneurship against traditional academic pursuits, such as grant submissions, considering the potential impact on future career advancements, especially with regards to tenure. This dual perspective illustrated how faculty members' perceptions of entrepreneurship and their academic identity intersected and negotiated with systemic reward structures within academia, providing a nuanced understanding of how the internal influences operate with the systemic dimension in informing their participant (or not) in entrepreneurship and EEPs.

External and Systemic

Participants' responses demonstrated that external influences encompassing influences originating from beyond an individual (e.g., peers and family members, and professional mentors), were intricately woven into larger systemic dimensions (e.g., academic and societal environment). Notably, personal interactions with friends, family, and professional mentors emerged as a salient external factor that played a pivotal role in shaping individuals' notions about entrepreneurship at a broader systemic level, which emerged during the discussion around the participants' engagement in entrepreneurship programs. For instance, one of the participants, Dr. Cu, shared a nuanced experience within her family, where both academic and entrepreneurial paths were valued. While her father who was medical doctor instilled the value of entrepreneurial independence, her grandfather who are also into academia underscored the value of academic career pursuits, as noted in the following quote:

> My dad was an entrepreneur, in a sense that he was a doctor and he had a medical office, and he did really well for a while. He always told me, when I was young, it's good to be your own boss. I always have that in the back [of the mind]... It's funny, my grandfather was the academic. He inspired. […] My parents had the dream of winning the Nobel prizes someday doing research to do Nobel prizes. But my dad always said, you should have your own business at the same time. (P)

Overall, this upbringing exemplifies how the broader familial system contributed to shaping the reasons to engage in entrepreneurship at a broader systemic-level. For several participants, these external interactions positively shaped their perceptions of entrepreneurship, making engagement in it an appealing and natural choice. However, such

interactions did not always result in shaping the systemic level perceptions of entrepreneurship that these individuals held. Specifically, for several study participants, in spite of witnessing positive experiences among peers and family, entrepreneurship represented uncertainty, and was thus actively avoided. For example, while Dr. Ka had self-employed parents and a grandparent who was an entrepreneur, Dr. Ka had a contrasting viewpoint, as echoed in this comment,

> *My parents are self-employed so I probably come at this from a totally different viewpoint, as well. […] I watched my parents … my grandpa was entrepreneurial, too. They all excelled at it, so it's not like I'm fearful of it but I have come this far in my life and I have stability. I have health insurance that I know. I have retirement contributions that I know. It doesn't fluctuate. I love the stability of a faculty career. Why would I trade that? We have one of the most stable positions that you could possibly ever have. Why would I trade that for uncertainty? I mean, you could become wildly successful but the odds are really against you of doing that. I can't do it. It's impossible. (NP)*

For Dr. Ka, the stability and predictability offered by a tenured faculty position outweighed the allure of entrepreneurship's potential success that she observed in her family. In her case, the broader systems of academia and entrepreneurship were associated with stability (e.g., existing tenure structure) and uncertainty (e.g., perceived risks associated with venturing), respectively. These associations were not positively transformed regardless of the presence of affirming external influences.

In addition, the impact of external influences on systemic perceptions also manifested through professional mentors in which participants' responses offered insights into the influence of mentors in influencing their participation. For example, one such participant, Dr. Wh, who considers herself as an entrepreneur credited their graduate advisor for her exposure to entrepreneurship. Emphasizing that the advisor's involvement in patenting and navigating entrepreneurial processes, Dr. Wh's responses reported how their graduate school advisor contributed to her awareness of entrepreneurship in an academic setting.

> *I guess I should give [my grad school advisor] some credit because that did kind of… that was part of my experience with learning about entrepreneurship. […] He did patent and go through the process, so I guess that sort of led to me becoming aware of entrepreneurship. (NP)*

Along similar lines, other participants referenced their doctoral and postdoc supervisors and other professional colleagues as sources for gaining awareness and enablers for positively shaping their systemic-level ideas and notions of entrepreneurship. Overall, these findings highlighted the influence mentors and professional networks can have on shaping individuals' inclination towards entrepreneurship in academic settings.

The external influences on faculty engagement EEPs extended beyond individual considerations. These influences included interactions with peers, family members, and professional mentors within larger societal and academic systems. Personal interactions within familial contexts, as illustrated by Dr. Cu, showcased how the external system of family dynamics contributed to perceptions of entrepreneurship. While many participants drew positive perceptions from such interactions, not all experiences result in shaping systemic-level perceptions uniformly. Overall, this quadrant illustrates the nature of external influences, encompassing familial influences, personal experiences, and mentorship, in shaping systemic perceptions of faculty engagement in entrepreneurial education.

Internal and Programmatic

The first factor that related with the internal influence and the programmatic dimension was influences that emerged from the interview responses is participants' self-efficacy—their confidence in their own abilities to engage in entrepreneurship. The degree of self-efficacy varied among participants, with some expressing confidence in their capacity to be entrepreneurs, while others holding strong reservations. For example, one of the participants, Dr. An, shared her perspective that shed light on the perceived self-efficacy that STEM academics may associate with entrepreneurship. According to Dr. An, the skills and attitudes required for successful entrepreneurship, particularly in regard with 'selling' aspects of entrepreneurship, can seemingly run counter to the qualities that define a good scientist, as elaborated in the comment below,

> *I guess conviction that works and being able to convince someone else to part with a lot of money on an idea, and if you're not able to convey that confidence, and you don't have that skill, that personality, I think it's very difficult, and it's, to me, almost counterintuitive to being a really good scientist because scientists, you're always questioning, but when you're selling an idea you have to put that aside. (NP)*

Dr. An's insights highlight the perceived tension where faculty needed to transform their approach from inherent 'questioning' nature of their scientific training, to the 'selling' aspect of entrepreneurship programs. Furthermore, it provides a nuanced perspective on how the self-efficacy that faculty have garnered in their scientific domain, may not translate into self-efficacy related to the 'selling' aspect of entrepreneurial process, which is typically a core programmatic focus of EEPs.

It is important to note that while low self-efficacy was a deterrent to participation, several participants indicated that participation in EEPs played a pivotal role in developing and enhancing participants' self-efficacy for entrepreneurship. For example, Dr. Na's experience underscores the profound impact of participating in EEPs on her confidence in describing herself with marketing or business skills. Prior to engaging in an EEP, she expressed having zero confidence in these areas, highlighting a transformative journey facilitated by the program.

> *I had zero [confidence]. Zero. [EEP] helped me tremendously. It was the first step. Zero, literally. So, [EEP]... I was at zero. [EEP] gave me DC level, and then I went into other programs starting from [EEP] from that DC level. Yes, [EEP]does give you a DC level [of confidence]. (P)*

Dr. Na's testimony exemplifies how an EEP has the potential to mitigate challenges associated with factors internal to the participants (self-efficacy), by elevating it from a low level to where they feel empowered and equipped for entrepreneurial endeavors.

The second internal and programmatic factor was entrepreneurial identity. Entrepreneurial identity can be seen either as a set of fixed traits or as an evolving story of how entrepreneurs define themselves through their experiences and actions (Radu-Lefebvre et al., 2021). Responses from participants who have participated in EEPs underscored that in contrast with self-efficacy, the formation entrepreneurial identity was not straightforward yes or no, rather it evolved as they engaged with different element of the programmatic context. For example, Dr. Ol stated the following:

I don't consider myself an entrepreneur. I'm learning a lot. I'm seeing the benefit of being in this [EEP] space and maybe two years from now, maybe I might consider myself an entrepreneur, but as of this moment, the answer is no. (P)

Dr. Ol's remarks resonated with several other participants who shared a similar outlook, expressing that their involvement in the program set them on a trajectory toward forming an entrepreneurial identity. For example, Dr. Sa articulated, "*I think I'm still in training, or the still gaining experience doing. But there are some things I maybe haven't done at least more than once yet, to feel super comfortable*" (P).

The narratives of the participants underscored the transformative influence of EEPs on participants' self-perception and their journey toward embracing an entrepreneurial identity. The acknowledgment of being in a learning phase, coupled with the recognition of gaining valuable experiences (i.e., gaining self-efficacy), emphasizes the program's role in shaping not only the participants' skills but also their evolving sense of self within the entrepreneurial landscape. Within the internal programmatic quadrant, we observed that EEPs act as catalysts for shifts in internal influences, fostering the emergence of an entrepreneurial identity and growth of self-efficacy among STEM faculty participants.

External and Programmatic

External and programmatic quadrant included external influences such as financial resources and socioemotional support that the faculty availed through the entrepreneurship education programs (EEPs). Particularly, women STEM faculty noted that in addition to financial compensation received for their time, EEPs provided equally important socioemotional support in the form of encouragement and collaborative environment, as pointed out by Dr. Wi:

"There's this [EEP] that's a new programme that right now is more of like a support group. So, different women within the community get together […] And so I would say the last two have actually been super helpful in terms of helping me understand and leverage different resources within my institution that I didn't really know existed." (NP)

Dr. Wi's perspective echoed other faculty in emphasizing the importance of programmatic features that provide collaborative and emotionally-supportive spaces in fostering participation in entrepreneurship programming. In addition, several faculty members concurred that forming a network and community of like-minded faculty with diverse backgrounds provided a sense of safety and support to grow as entrepreneurs. For example, Dr. He's perspective underscores the EEP's intentional programmatic efforts to bring together individuals from diverse institutional backgrounds. This program feature contributed to the program's inclusivity, wherein coaches actively created a safe space for participants to share both positive and negative experiences:

"I will say that this particular program, I want to say that they do a really good job. They try to bring a lot of people from many different universities from many different backgrounds.[…] The coaches regardless that they do a really good job trying to sometimes forcing people to talk, forcing people to share. […] They do a really good job making it a comfortable space, safe space so everyone can share. […] because sometimes for me, it's, okay, I want to hear the good stuff, but I want to hear the bad

stuff because that's the only way that I have to improve. These particular groups are really good on that, really good on that." (P)

In addition to socioemotional support, participants discussed how the programmatic feature of financial resources in the form of grants, was a factor that led to their EEP engagement. For example, Dr. An's experience elucidated the active support of the university's tech transfer office, which not only introduced Dr. An to the EEP but also provided essential guidance and encouragement. Program features such as workshops and assistance with grants and fellowships, provided a conducive environment that enabled her to apply and engage in an EEP, as explained in the comment below,

So basically I learned about [EEP] from [the university] tech transfer office. So they were very supportive. I applied to some internal grants. I did some workshops. […]. There was a lot of internal stuff and then they felt that I've learned enough working here at the university that I could actually apply to national [EEP]. So we applied, we put together a small document and we were awarded this [EEP] grant or whatever it's called. (NP)

Several other faculty reported similar support such as Dr. He and Dr. Za, as elucidated in the comments below:

They invited me, when was it, at the beginning of the year to apply as a fellowship with them. So I applied with a project. I get some money, so it was fun. Yeah, they have a lot of support, are very well structured for supporting people. (P)

Participants' experiences underscored how institutional affiliations, combined with grant opportunities, served as a bridge connecting faculty members to the entrepreneurship programs.

Discussion

The qualitative examination of women STEM faculty participation in EEPs illuminated a multifaceted landscape, revealing a unique interplay of internal and external influences along the systemic and programmatic dimensions. In this section, we discuss the implications of key findings and their significance in shaping effective strategies for fostering EEP participation among women faculty in STEM fields. For the purpose of synthesis, we organize the discussion thematically focusing on each quadrant of the emergent conceptualization, offering suggestions for practice and directions for future research.

Systemic and Internal

First, in regard with the systemic dimension, our study underscores that faculty members' perceptions of their self in the context of academic entrepreneurial engagement interacted with the broader systemic structures within the STEM academic landscape. Particularly, the negotiation of STEM academic identity with the aspects innate to entrepreneurship programming showcased the nuanced decision-making process these faculty members undergo. Overall, this finding underscores the importance of academic identity and contributes to the growing body of literature on this topic (Kogan, 2000). Specifically, the findings echo recent literature that notes the tensions between faculty's perceived identity

and the continuously evolving roles/responsibilities of being an academic (Billot, 2010; Flecknoe et al., 2017). Furthermore, recent work by Hayter et al. (2022) found that faculty members often negotiate their academic identities when considering engagement in entrepreneurship programs, highlighting the complexity of decision-making in STEM fields. This was seen in our findings where the faculty grappled with the gap between the inherent questioning nature of their STEM academic identity and the 'selling' aspect emphasized in EEPs. This tension prompts a reevaluation of the how EEPs are implemented and advertised for greater participation among women STEM faculty (Martin, 2012). Thus, targeted interventions within EEPs are necessary to address the perceived tension between scientific questioning and the 'selling' aspect of entrepreneurship. However, we argue that choosing 'questioning' over 'selling' is not only pathway to resolve this tension, rather an integration of the two may yield optimal results that preserves the purpose of EEPs while mitigating significant misalignment with STEM academic identity. For instance, the 'questioning' and 'selling' aspects can be equally emphasized in the programs in which the faculty engage in 'questioning' the value of their product/service to potential end-users, rather than solely focusing on—how it can be sold? Although the two approaches may seem similar, the former brings the process of scientific inquiry to the forefront without completely delineating the end-user from the process. Such reframing and revisions to current practices may assist in better aligning EEPs with women faculty's internal perceptions of themselves.

Systemic and External

While one may assume that familial experiences and role models can positively shape the broader system-level perceptions of entrepreneurship, our findings note that positive impact may not be universally applicable and the presence of an entrepreneur in the family may yield varying results. Particularly, women STEM faculty may have the preference for the stability offered in a faculty career, despite a familial background in entrepreneurship. In contrast, based on our findings, mentorship may be more a pivotal in shaping perceptions of and engagement towards EEPs. One plausible explanation is that mentors such as graduate advisors and colleagues operate within the STEM academic contexts in which the women faculty are situated in and can thus be instrumental in negotiating academic identities when making a decision towards participation in EEPs. Research extensively notes the impact of mentors in the formation of academic identities at different academic levels (Devos, 2005; Hall & Burns, 2009; Palmer et al., 2015) Thus, recognizing the key role academic mentors and colleagues can play, we emphasize the need for approaches within entrepreneurship programs that create a community of practice tailored to faculty STEM academic and/or disciplinary contexts in which women STEM faculty situate themselves. While research as examined some aspects of community of practices in the realm of academic entrepreneurship (Giudice et al., 2013; Jones et al., 2021; Rossano-Rivero & Wakkee, 2018), we call for further research that examines women faculty in STEM fields.

Programmatic and Internal

In regard with the programmatic dimension, our findings demonstrate the transformative programmatic potential of EEPs in enhancing self-efficacy (internal influence), as evidenced by participants' reported journeys from minimal self-efficacy to substantial growth during their engagement in the EEPs. Moreover, the development of an entrepreneurial identity indicates the dynamic nature of faculty members' self-perception,

evolving as they engage with different elements of the programmatic context. This evolution suggests that EEPs act not only as educational initiatives but also as catalysts for shifts in internal influences, fostering the development of a distinct entrepreneurial identity among STEM faculty. Entrepreneurial self-efficacy and entrepreneurial identity are widely noted as critical components informing one's affinity towards demonstrating entrepreneurial behaviors in theoretical and empirical literature (Brändle et al., 2018) While supporting the benefits of developing EEPs in forming these traits among women STEM faculty, our findings suggest further inquiry to unpack how these traits may serve as barriers to entry due to the prevalence of gender stereotypes in STEM entrepreneurship (Barnir, 2021; Kuschel et al., 2020; Sweida & Reichard, 2013) and academic spaces (Casad et al., 2021).

Programmatic and External

Furthermore, as emergent in our findings, external influences, such as socioemotional support and financial resources, need to be thoughtfully incorporated as critical components within the programmatic structure of EEPs. This is in line with extant literature that notes that EEPs that address gender-specific challenges, may enhance women in STEM's entrepreneurial self-efficacy and intent (Elliott et al., 2020). A study by Sinell et al. (2018) which compared the gender-specific challenges and constraints on entrepreneurship in academia also reported that "females perceive the lack of resources […] and knowledge more often and as greater challenges" than their male colleagues (p.22). As supported by our findings, socioemotional support emerges as an important factor, particularly for women faculty navigating traditionally male-dominated STEM fields. The creation of collaborative and emotionally supportive spaces within EEPs fosters a sense of community, providing a platform for shared experiences and mutual encouragement. Networking and community-building efforts contribute not only to a supportive environment but also to a unique learning opportunity. Learning experiences that provide exposure and building competencies are noted as crucial for women's STEM entrepreneurship (Schneider, 2021).

Moreover, our findings indicate that the convergence of institutional initiatives and external grants plays a pivotal role, acting as a bridge for seamless integration of entrepreneurial engagement into academic pursuits. This compliments the findings by Sinell et al. (2018) and Cardella et al. (2020) which identified lack of financial incentives a challenge for academic entrepreneurship. Also, research notes that academics engage in entrepreneurship through "symbiotic relationships with other academics" wherein a faculty initiates an entrepreneurial opportunity and others get involved in the endeavors (De Silva, 2016, p. 2169). Thus, institutional resources may need to go beyond providing financial support and offer access to mentorship and networking opportunities, with thoughtfully ensuring the inclusivity for women STEM faculty instead of generic approaches. Such initiatives that focus on supporting women in STEM entrepreneurship are likely to serve as a catalyst for research innovation and entrepreneurial activities among women academics. By leveraging these resources, EEPs can enhance their effectiveness in promoting women's participation by bridging the gap between academic entrepreneurship and traditional academic roles (De Silva, 2016), and consequently foster their success in both academic and entrepreneurial endeavors.

Theoretical and Methodological Implications

In addition to these research and practical implications, the study's findings provide implications for advancing theoretical grounding to explain women STEM faculty's perspectives on participation in EEPs. The study investigates the research questions by drawing on adult participation literature and key theoretical works from entrepreneurship education literature. While leveraging factors identified in adult participation theories (Cross, 1981) and theoretical frameworks from entrepreneurship education literature (Shekhar et al., 2018) improves the theoretical grounding with the of the with pertinent literature, situating the research within the broader socio-cultural context of STEM academia ensures a holistic examination that captures the lived experiences of women STEM faculty within the systemic norms of STEM fields. Also, our approach is in line with recent shifts in the entrepreneurship education literature that have moved from the sole dependance on traditionally used theories (e.g., theory of planned behavior and entrepreneurial event theory Joshi et al., 2020; Lortie & Castogiovanni, 2015), to utilizing other theoretical perspectives in conjunction (Kruse et al., 2019).

As Beddoes (2022) highlights, the use of theory in discipline-based research tends to oversimplify and underexplore theoretical nuances when examining a complex phenomenon. Beddoes distinguishes between 'big-T' theory, which refers to established, widely recognized theories rooted in positivist traditions and 'little-t' theory, which encompasses a broader array of theoretical perspectives that may be more flexible and interpretive in nature. While big-T theory are often applied in a more rigid and structured manner, with a focus on empirical validation and hypothesis testing, little-t theory allows for a deeper exploration of complexity, diversity, and context in understanding the phenomena (Beddoes, 2022). Methodologically, our study addresses the limitations of big-T theory in discipline-based research by using the 'little-t' approach and contributes towards building a nuanced understanding of the complex phenomena surrounding women STEM faculty members' engagement in entrepreneurship programming.

Recommendations for Practitioners

Based on our study, we recommend specific actions for that various stakeholders may implement. First, universities and STEM departments could develop and promote EEPs inclusive to the unique needs of women STEM faculty, providing robust support through tech transfer offices and fostering an inclusive environment with workshops and safe spaces for sharing experiences. Second, program developers and administrators could design EEPs that include socioemotional support, networking opportunities, and financial support such as grants and fellowships, while also addressing self-efficacy and entrepreneurial identity development to help participants build confidence. Third, policymakers and funding bodies could allocate funding to support the development and expansion of EEPs by targeting STEM women and incentivizing institutions to maintain programs that support entrepreneurial pursuits among women faculty. These actions are likely to create a supportive environment that encourages women STEM faculty to engage in academic entrepreneurial activities, ultimately leading to increased participation and success in entrepreneurship.

Conclusion and Future Work

Our study contributes to an understanding of the factors influencing women STEM faculty's participation/non-participation in EEPs. Findings from this study offer critical insights for the design and implementation of EEPs inclusive and supportive to women STEM faculty. The findings highlight that women STEM faculty face internal barriers such as perceptions of entrepreneurship and self-efficacy, as well as systemic challenges related to academic identity and reward structures. External factors, including family background, professional mentors, and socioemotional support, also significantly influence their engagement with EEPs. Programmatic elements such as the structure, resources, and financial support provided by EEPs play a pivotal role in facilitating participation. Addressing the internal tensions and negotiating STEM academic identity within the context of entrepreneurship is imperative for programmatic success. Designing and implementing interventions to be inclusive towards diverse external influences and providing mentorship opportunities are crucial for creating a supportive entrepreneurial ecosystem. Additionally, the transformative impact of EEPs on self-efficacy and the development of entrepreneurial identity emphasizes the need for targeted strategies within programmatic dimensions. By recognizing the complexity of these influences and dimensions, we can pave the way for the development of more effective and inclusive entrepreneurship education initiatives that resonate with the diverse experiences of women in STEM. Lastly, by synthesizing insights generated through our diverse sample, and grounding our work in theories from disparate fields, the study provides an example on the use of little-t theory and offers a comprehensive conceptual framing for understanding the dynamics influencing women STEM faculty's perspectives on EEPs. This approach not only advances theoretical and empirical research in this domain but also highlights actionable steps for stakeholders to enhance participation and success in entrepreneurship among women STEM faculty.

Extending this study could involve a detailed comparative analysis of entrepreneurial motivations and challenges faced by men versus women in STEM fields. For example, future research could explore an in-depth analysis on how male entrepreneurs encounter barriers such as fear of failure, perceived lack of support, and competency concerns, and assess how these factors compare to those experienced by women. Also, we encourage researchers focusing on comparative analysis to go beyond examining the differences in the types of barriers and challenges faced by men and women in academic EEPs, and critically evaluate how prevalent structures in the academic entrepreneurship programs may differentially affect men and women in overcoming the challenges. It is anticipated that such findings may lead to more asset-based suggestions for improving diversity, equity, and inclusion in academic EEPs. Additionally, broadening the scope to compare entrepreneurial intentions and obstacles across academic and non-academic contexts would provide deeper insights. This could include evaluating challenges and benefits specific to academic women in STEM, such as those in tenure-track and non-tenure-track positions, PhD holders, staff, administrators, and university leaders, across various STEM disciplines. By comparing the perspectives of both men and women, and academic versus non-academic contexts, this research could offer targeted strategies for creating supportive and equitable entrepreneurial ecosystems in STEM.

Declarations

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