Female participation in UGB's WISE Women in STEM Entrepreneurship program

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Abstract

Entrepreneurship in science, technology, engineering, and mathematics (STEM) is a key driver of innovation and economic growth; however, women's participation in this field remains limited due to structural, educational, and cultural barriers. To address this, the WISE Women in STEM Entrepreneurship program was implemented for the first time in El Salvador by Gerardo Barrios University (UGB) in 2024, as part of a regional initiative led by IDB Lab. This study analyzes participants' experiences to assess the effectiveness of the program's three components: specialized training in STEM entrepreneurship, personalized mentoring, and a final business competition. A parallel-convergent mixed-methods design was applied, integrating quantitative data from surveys and qualitative insights from a focus group. The results show high satisfaction levels (76%–96%) across four key dimensions: business training, access to technological tools, leadership development, and networking opportunities. Thematic analysis using Atlas.ti identified five central themes: personal empowerment, mentoring as catalytic scaffolding, access to STEM opportunities, support networks, and technology as both a facilitator and a challenge. The triangulated findings suggest that the program effectively promotes women's inclusion in STEM entrepreneurship by combining technical instruction, gender-responsive support, and collaborative learning. These insights offer valuable guidance for designing inclusive entrepreneurship programs in Latin America, where persistent inequalities continue to limit women's full participation in innovation-driven environments.

Keywords

STEM, entrepreneurship, gender, experiences

1. Introduction

Entrepreneurship in science, technology, engineering, and mathematics (STEM) represents a fundamental pathway for innovation and economic development. However, there is a significant gender gap in this field, due to a double masculinization of both the STEM area and the entrepreneurial ecosystem [1]. This limited female representation reduces both women's access to profitable sectors and the innovative potential and exploitable talent in these strategic areas.

In this context, several training initiatives have emerged specifically aimed at developing entrepreneurial skills in women in scientific-technological careers. Programs such as Women in the enterprise of Science & Technology (WEST); Women's Startup Lab [2]; WE-TECH (Women Entrepreneurship in Technology) [3]; the Female Founder Initiative of Founder Institute [4]; and the IDB Lab's Women in STEM Entrepreneurship (WISE) program implemented in several Latin American countries [5], have demonstrated the importance of specific interventions that address the particular barriers faced by women entrepreneurs in these fields. Along these lines, the WISE Women in STEM Entrepreneurship program implemented by the Universidad Gerardo Barrios (UGB) in El Salvador [6] represents a strategic initiative that seeks not only to train women entrepreneurs but also to transform the regional technological entrepreneurial ecosystem. STEM entrepreneurship training for women represents an educational field with distinctive characteristics that differ from general entrepreneurship education. This approach can be

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understood from the perspective of Zimmerman's empowerment theory [7], which highlights psychological empowerment as a foundation for active participation and agency of individuals and aligns with Wenger's [8] concept of Communities of Practice, where collaborative learning and professional networks enhance innovation in technological environments.

Training programs for women entrepreneurs should include elements such as gender mainstreaming, gender-sensitive training approaches, and the adoption of technology and innovation appropriate for women entrepreneurs [9], recognizing technology and its dual role as both enabler and disruptor in marginalized contexts, as conceptualized by Nambisan [10]. recognizing technology and its dual role as both enabler and disruptor in marginalized contexts, as conceptualized by Nambisan [11], incorporating leadership and professional network-building components that enhance participants' ability to navigate adverse environments, especially where cultural norms do not favor female entrepreneurship [12]. Complementarily, the studies of [13] reveal the importance of considering the different stages of professional life of women entrepreneurs (Early, Middle and Advanced Career Phase), since each group has specific training needs and different levels of human capital, which suggests that educational programs should be flexible and adaptable to meet both young women seeking training in technology and marketing, as well as older women who prioritize legal and financial aspects.

For entrepreneurship training programs in STEM, relevant and pertinent content is essential [14], as up-to-date material drives innovative entrepreneurial thinking. Teaching strategies for entrepreneurship [15] favor experiential methods as superior to traditional ones. In terms of resources and support, the accompaniment of instructors [16] favor experiential methods as superior to traditional ones. In terms of resources and support, the accompaniment of instructors [17] is important in entrepreneurial learning. Accessibility to complementary resources is a determining factor in the development of entrepreneurial skills [18]. Professional growth through communication skills [19] and group collaboration [16] is directly related to entrepreneurial success. Another important aspect in the entrepreneurial trajectory is the leadership role [20] and bonding experiences as a practical application [21]. Finally, much of the success of entrepreneurial activities is based on the creation of collaborative networks and trust [22], so it is important that programs also have spaces to generate and strengthen these collaborative dynamics.

Despite the advances in programs for STEM entrepreneurs, it is important to understand their real impact and the most effective elements to overcome gender barriers. This research contributes through the analysis of the experiences of the participants of the WISE program at Gerardo Barrios University in El Salvador, being especially relevant in the Latin American context where gender inequalities and gaps in STEM education converge. The findings will not only improve the WISE-UGB program, but will also guide similar initiatives in other institutions, contributing to more inclusive and equitable entrepreneurial ecosystems in the region.

2. WISE Women in Stem Entrepreneurship Latin America

WISE Latin America [5], represents a natural extension of the STEM education ecosystem. As part of a regional initiative led by IDB Lab and IAE Business School, the program operates in ten Latin American countries, focusing on strengthening female technological entrepreneurship. It was carried out for the first time in El Salvador in 2024, being the Gerardo Barrios University the pioneer institution in implementing it.

The program is structured into three main components. The first is the “Entrepreneurship in STEM” training course, which comprises seven seminars: it begins with an introduction to the concept of entrepreneurship and the skills needed to face technological challenges, followed by the identification of opportunities and the definition of viable business models, continuing with STEM innovation processes focused on customer needs; it also includes financial aspects such as the analysis of investments and funding sources, marketing and sales strategies specific to STEM ventures, essential technological, legal and accounting tools, and ends with crucial elements such as team building, leadership, social capital development, and managing work-life balance.

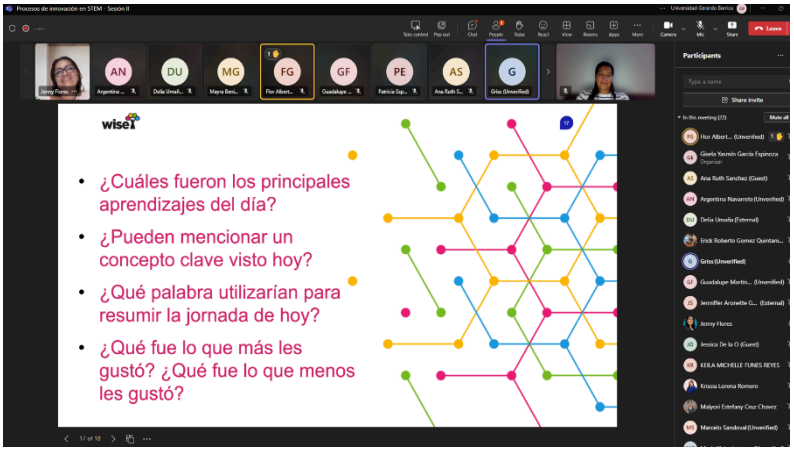

Figure 1: Seminar session "Innovation processes in STEM" of the training course "Entrepreneurship in STEM". Retrieved from: WISE-UGB El Salvador Program Results Report.

The second component, the mentoring system, has ten mentors specialized in various areas such as mathematics, administration, marketing, information technology and entrepreneurial development, and ten ventures selected through an evaluation with the program's coordination at the institution. The matching process between mentors and entrepreneurs is carefully carried out, ensuring that the mentor's experience and specialization is aligned with the specific needs of each project.

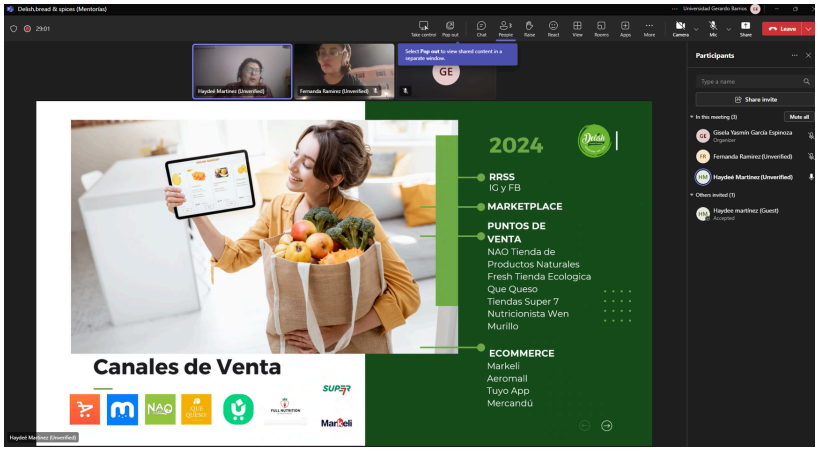

Figure 2: Personalized mentoring session for the venture "Delish, bread & spices". Retrieved from: WISE-UGB El Salvador Program Results Report.

The third component consists of a final competition where the projects of the program participants are evaluated according to specific criteria. These criteria include the size of the opportunity, the value proposition, the business model, the degree of innovation, the social and environmental impact, and the quality of the presentation.

Figure 3: Participants of the WISE Latin America program at UGB 2024, who were also contestants in the competition. Retrieved from: WISE-UGB El Salvador Program Results Report.

3. Methodology

A parallel-convergent mixed-methods design was adopted to address the research objective, which required the integration of quantitative measurements and qualitative insights. This design involved the parallel collection of quantitative data, through surveys, and qualitative data, through a focus group with participants from the WISE Women in STEM Entrepreneurship program at Gerardo Barrios University. Both sets of information were analyzed separately and then integrated, which allowed us to identify significant connections between the results and thus capture both the general trends and the contextual elements that influenced the participants' trajectories. The methodological structure is based on Creswell's [23] principles on the value of convergence in complex social research.

The qualitative dimension of this research employed thematic analysis [24], facilitated by Atlas.ti software (version 25), and aligned with the methodological framework outlined by Braun and Clarke.

Population and sample

The population of this study comprises all participants of the WISE Women in STEM Entrepreneurship program implemented by the Gerardo Barrios University in El Salvador during the year 2024. The sample consisted of 25 women entrepreneurs in STEM fields who completed the program in its entirety, including the three components: training course, mentoring (this was only granted to 10 ventures), and final competition. The participants represented diverse scientific-technological fields and different stages of entrepreneurial development, from initial ideas to projects in the implementation phase.

As part of the qualitative component of the study, a focus group was conducted with four selected participants from this sample. Following the recommendations of Krueger and Casey [25], smaller groups are particularly effective when addressing complex issues with highly engaged participants, as they encourage more enriching discussions and minimize dominance in group dynamics. The decision to work with a small group was in line with the study's objective of exploring individual experiences and perceptions in detail, in an environment that encouraged open and meaningful dialogue.

3.1. Ethical considerations

Prior to data collection, informed consent was obtained from all participants, clearly explaining the objectives of the study, the procedures to be followed, and the use that would be made of the information collected. Confidentiality and anonymity were guaranteed in the treatment of the data,

using pseudonyms to protect the identity of the participants. Also, they were informed about the voluntary nature of their participation and their right to withdraw from the study at any time without negative consequences.

3.2. Techniques and instruments

For the collection of quantitative data, a structured questionnaire was designed with a five-level Likert scale (from "Strongly disagree" to "Strongly agree"), organized into four dimensions: business training, resources and support, professional growth and networking experiences. The instrument was validated by expert judgment and pilot tested to ensure its reliability.

Qualitative data were collected through a focus group with 4 participants, following a semi-structured protocol that delved into the experiences, challenges and learning of the participants during the program. In addition, during the focus group, participants collectively completed a matrix of technological, gender and financial challenges that was shared via Google Docs. The session was recorded with prior authorization, through informed consent, and later transcribed for analysis.

3.3. Data analysis

The quantitative analysis included descriptive statistics to establish frequencies and percentages for each item (indicator) evaluated in the questionnaire. The qualitative analysis used an inductive approach with Atlas.ti V.25 for the thematic coding of the transcription of the focus group and the results of the participatory matrix exercise.

Finally, the integration of both data sets was carried out following the methodological triangulation model, contrasting the quantitative findings with the qualitative narratives to understand in a broader way the perceptions and experiences of the participants in the WISE program.

4. Discussion of results

The analysis of the results obtained offers insight into the impact of the WISE program on participants, providing both quantitative and qualitative evidence to understand its effectiveness from multiple perspectives.

4.1. Quantitative analysis

The quantitative results, derived from the surveys applied to the 25 participants, reveal generally high levels of satisfaction with the WISE program in the four dimensions assessed.

4.1.1. Entrepreneurial training

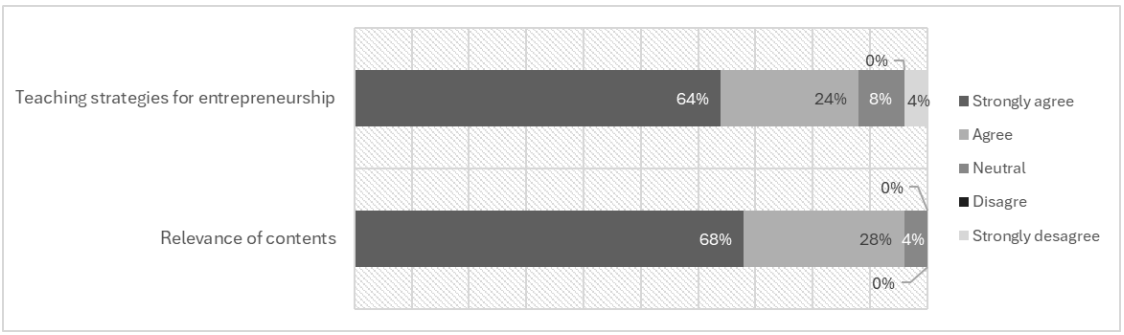

Figure 4: Evaluation of Entrepreneurial Training by WISE Latin America Program Participants at UGB 2024.

The high satisfaction levels observed in Figure 4, with 88% of participants positively valuing the didactic strategies and 96% finding the contents relevant, validate the effectiveness of the WISE program's approach. These findings align with previous research [15] [16] that positions experiential methods as superior to traditional approaches in entrepreneurship training. The program's success in providing relevant content supports the assertion by [14] that up-to-date material is essential for driving innovative entrepreneurial thinking. The program appears to have effectively addressed the varying needs of women entrepreneurs at different career stages [13] while implementing the support systems highlighted as crucial by [17]. These elements collectively contribute to addressing the gender gap caused by the double masculinization of STEM and entrepreneurship [1], representing a practical application of Zimmerman's empowerment theory [7] in the context of women's STEM entrepreneurship.

Resources and support

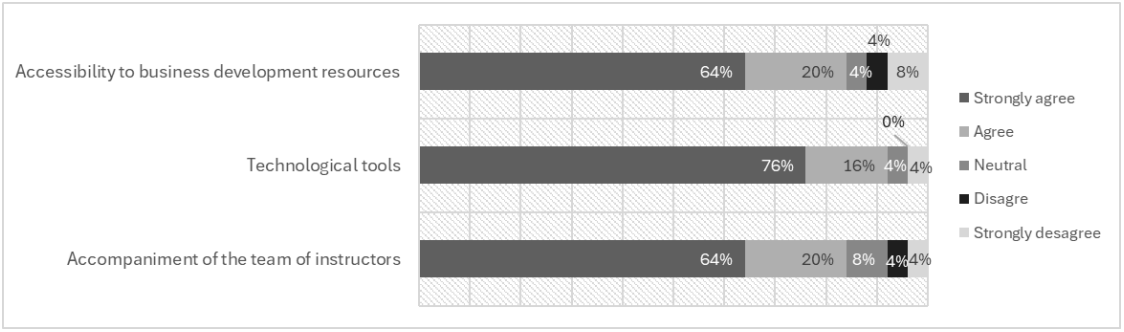

Figure 5: Evaluation of Resources and Support by WISE Latin America Program Participants in UGB 2024.

The results in Figure 5 show a very positive evaluation of the resources and support provided by the WISE program, with 92% of the participants approving of the technological tools offered. The support provided by the team of instructors and the accessibility of resources for entrepreneurial development both reached 84% approval, confirming what was stated by [17] on the importance of instructor accompaniment in entrepreneurial learning and by [18] on the accessibility of complementary resources as determining factors in the development of entrepreneurial skills. These results suggest that the program has managed to provide a comprehensive support infrastructure that facilitates the learning and entrepreneurial development of the participants, effectively creating an enabling environment that addresses the specific barriers faced by women in STEM entrepreneurship as highlighted by [1] and aligning with the Communities of Practice concept [8] where collaborative learning enhances innovation in technological environments.

Professional growth

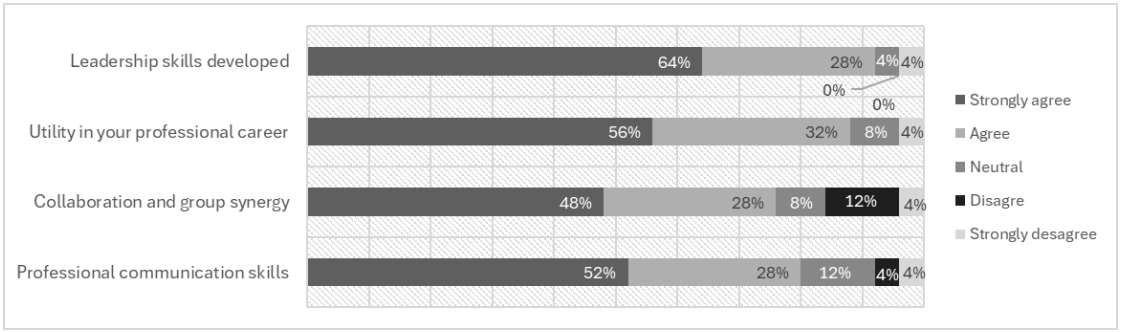

Figure 6: Evaluation of Professional Growth by WISE Latin America Program Participants at UGB 2024.

The results shown in Figure 6 demonstrate a positive impact of the WISE program on the professional development of participants, with 92% positively valuing the leadership skills developed, which aligns with the importance of leadership roles highlighted by [20] in the entrepreneurial trajectory. Additionally, 88% acknowledge the program's usefulness for their professional career, confirming its overall effectiveness. Although professional communication skills (80% approval) and group collaboration (76%) are also well-regarded, they show slightly lower percentages, suggesting areas for improvement in these aspects identified by [19] and [16] as fundamental for entrepreneurial success. The program appears to be fulfilling its objective of training not only entrepreneurs but also leaders capable of transforming the regional technological entrepreneurial ecosystem [6], thus contributing to reducing the gender gap in STEM entrepreneurship.

Linkage experiences

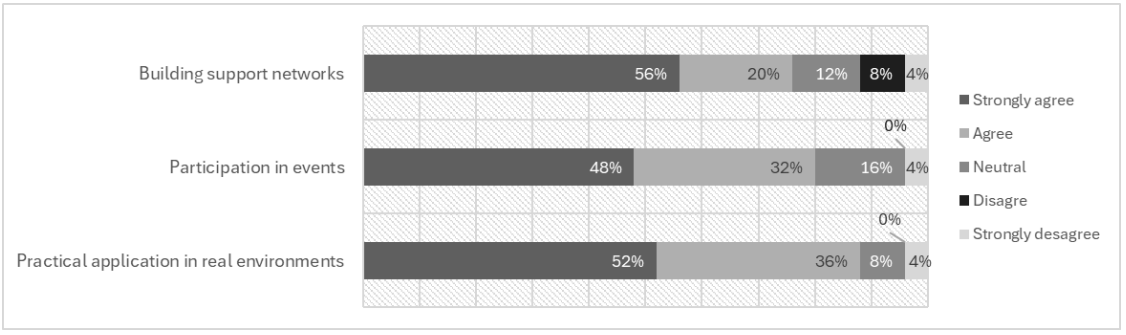

Figure 7: Assessment of Linkage Experiences by WISE Latin America Program Participants at UGB 2024.

The results on networking experiences show that 76% of participants positively value the construction of support networks, which supports what was indicated by [22] regarding the importance of creating collaborative networks and trust for entrepreneurial success. The practical application in real environments obtains 88% approval, confirming what was proposed by [21] about the relevance of bonding experiences as practical application. Meanwhile, participation in events reaches an 80% positive assessment. Although these results are favorable, the percentage of neutrality (12-16%) suggests that there is room to strengthen these aspects, especially support networks that are fundamental to overcoming the particular barriers faced by women entrepreneurs in STEM fields [1], particularly in contexts where cultural norms do not favor female entrepreneurship [12]. Strengthening these networking components aligns with Wenger's concept

of Communities of Practice [8], where collaborative learning and professional networks enhance innovation in technological environments.

4.2. Qualitative analysis

This qualitative part of the study involved an 80-minute virtual focus group, conducted in April 2025. It had four participants from diverse regions of El Salvador who underwent the WISE program in 2024. The subjects shared narratives about their professional journeys, challenges, and program impacts. The Microsoft Team transcription feature transcribed the session, and the second researcher analyzed it inductively using Atlas.ti V. 25 for thematic coding. The qualitative strand also utilized a participatory matrix exercise where participants collaboratively categorized challenges into three pre-established categories: technical, gender-related, and economic, providing also a space for emergent categories.

Emergent themes in the focus group:

- **Empowerment and Personal Transformation**. participants of the WISE program mentioned significant increases in self-efficacy and entrepreneurial decision-making. Jasmine, for instance, shared: "*Part of the course also helped me a lot because it not only opens the perspective that one stagnates sometimes, but also knowledge now on the subject of technologies, I think, is very important. So, for me it has been quite important to develop in that branch"* to which Rose added: "*Whatever I knew how to do and I think WISE, was one of the programs or projects that helped me to be confident of myself, to say that I can and why not start showing what I know.*" Both statements resonate with Zimmerman´s empowerment theory [7], which emphasizes psychological empowerment as the foundation for active participation agency.
- **Mentorship as a catalytic scaffold.** was repeatedly mentioned during the session, Violet, affirmed: "*And this was not a woman, but it was a man, and super, super effective. I'm super grateful to her too. For everything he shared with me and that also allowed me to explain in detail, what deficiencies I had and which were the ones that best guided me.*" Rose also noted: "*I needed a point where they would tell me or give me constructive criticism, telling me the weak points I had. So that participation helped me focus more on aligning my project.*" These statements are directly connected to Vygotsky's (1978) Zone of Proximal Development, where more capable others provide scaffolding that enables learners to reach their potential.
- **Access to STEM opportunities.** Lily, "*I liked the idea... Free course for entrepreneurs... virtual*", then Violet noted: *"At first, I was invited by a friend who was in a course for businesswomen, then she told me, about this one with a STEM focus... delving into technology... it benefited me a lot.*" These insights reflect the alignment of the WISE program with gender-sensitive pedagogical frameworks [9], which prioritizes accessible STEM training to counter structural inequities.
- **Networks of support and sorority.** Violet reflected on the value of community: "*That impetus that women have to excel, right? Why do we also have a fairly broad capacity to be able to exercise, to assert our ideas, above all? But then I think so. It is necessary to maintain that bond between people, no matter how small the group is*". Lily added: "*So I do believe that as women in the country, it is important to train ourselves to move forward.*" This highlights the social learning dimensions of Bandura´s social learning theory [26], where mutual modeling and reinforcement enhance behavioral outcomes. The emphasis on sorority also aligns with feminist pedagogical approaches.
- **Technology as a tool and a hurdle**. Lily discussed digital challenges, *"virtual, for example, artificial intelligence, this Canvas that I had never heard of, that is, programs that helped us make this accounting book and things like that*". Violet added, "*Not to be afraid to project ourselves to a market abroad, I think it is also a little innovative, to say the ease that*

technology allows us, that's why I outlined my idea with the technology part". This duality mirrors Nambisan's [10] conceptualization of technology as both an enabler and a disruptor in marginalized entrepreneurial contexts.

- **Sustaining learning through the WISE community and Access.** There was a unanimous plea to continue accessing the materials on the platform and maintain the connection with participants beyond the WISE program as an entrepreneurial network, and to create a sustained learning ecosystem. Jasmine expressed: "*I think it is important to create a community within the country where one identifies, that takes out the enterprise, it is important because part of that not only helps one, it helps one with another not only as a person, but it is also opening doors to generate employment".* Regarding their connection, Lily said *"But I find it quite interesting that you gave us the opportunity even though we were not from the area where you taught the course...*" Jasmine stated: *"Getting to know the East, then, has been important for me as creating that network of contacts".* These comments show how they share the same goals and would like to continue their interaction to build more knowledge, similar to Wenger's (1998) Communities of Practice.

Emergent themes from the collaborative written exercise

The participants completed a chart with information about their challenges along the way for the WISE program, highlighting the financial, technical, and gender rooted ones. Many of the participants expressed that "*having to learn new virtual tools or AI*" posed a challenge, as well as having connectivity issues in the area where they lived "*at first, I had trouble managing my social media".* They also wrote down that they "*had financial difficulties accessing funds*" and the need to invest time and resources into their business ideas [1] [18]. Gender also played a role as part of their difficulties, one participant stated, *"the challenges of starting a business in El Salvador a big for a company led by a woman*," which echoes the findings of [1] regarding the double masculinization of both the STEM area and the entrepreneurial ecosystem. However, the participants also noted that the program provided them with "*tools to grow*" and helped them take advantage of the experience and "*use AI to stay at the forefront of publicity*," demonstrating how this intervention can mitigate Nambisan´s [10] Technological Ambivalence.

4.3. Integration of quantitative and qualitative results

The cross-analysis between quantitative and qualitative data confirms the effectiveness of the WISE program in multiple dimensions. The experiences narrated by Jasmine on the expansion of perspectives and acquisition of technological knowledge empirically validate the methodological proposals of [15] on experiential pedagogies and [14] on the relevance of updated content to foster innovative entrepreneurial thinking.

The technological duality manifested in testimonies such as Lily's "*artificial intelligence, this Canvas that I had never heard of*" and Violet's "*not to be afraid to project itself to a market abroad [...] the ease that technology allows us"* perfectly illustrates the concept of technological ambivalence proposed by [10], where technology functions simultaneously as a facilitator and as a barrier. This phenomenon complements the high quantitative valuation of technological tools (92%) and justifies the incorporation of specific digital competences pointed out by [17].

Testimonials about personal transformation and increased self-efficacy, *"WISE was one of the programs that helped me to be confident in myself,*" exemplify the psychological empowerment described by [7] as a foundation for women's agency and active participation in predominantly male environments such as STEM. This empowerment relates directly to the development of leadership skills (92% approval rating) identified by [20] as a critical component for navigating adverse environments.

The evaluation of the accompaniment and mentoring expressed by Violet "*super effective [...] explained in detail what deficiencies I had"* and Rose "*constructive criticism [...] helped me focus more*"

empirically evidences the importance of formative scaffolding indicated by [16] for women's entrepreneurial development. This dimension is particularly relevant in contexts where, as the results of the collaborative exercise indicate, women entrepreneurs face "*challenges of starting a business in El Salvador [...] for a company led by a woman*".

The unanimous expressions on the importance of networks, "*maintain that bond between people,*" and communities of practice, "*create a community within the country*," validate the theoretical framework of [8] on situated learning and [22] on the centrality of collaborative environments for innovation in STEM. The request to maintain access to the platform and continue post-program interaction reflects the importance of continuous learning, noted by [18] as a determining factor for the sustained development of entrepreneurial capabilities.

The challenges identified in the written exercise regarding technical "*trouble managing social media*", financial "*difficulties accessing funds*", and gender constraints coincide with the structural barriers identified by [1] and [9], confirming the relevance of specific interventions with a gender approach for the regional STEM entrepreneurial ecosystem. The appreciation of "*tools to grow" and the ability to "use AI to stay at the forefront of publicity*" evidences how the WISE program is effectively mitigating these barriers through strategies aligned with [11] on the dual role of women as business leaders and change agents.

5. Conclusions

The quantitative analysis of the perceptions of the WISE program participants reveals a remarkable consistency in the positive assessment of the training experience, suggesting an effective alignment between the program design and the specific needs of women entrepreneurs in STEM fields. This evaluative consistency, especially in aspects related to content, technology, and leadership, allows us to infer that the intervention has managed to overcome several of the traditional obstacles faced by women in these sectors, contributing to reducing the gaps in female representation in scientific-technological and business environments. The aspects with relatively lower ratings, although equally positive, point to strategic opportunities for the future strengthening of the program, particularly concerning the creation of sustainable networks that transcend the training period.

The qualitative findings indicate that the WISE program fostered a strong sense of personal empowerment and entrepreneurial transformation among participants. Through mentorship, experiential learning, and exposure to new technologies, the women developed greater confidence in their abilities. These outcomes suggest that well-structured support systems significantly enhance women's capacity to engage in STEM entrepreneurship and promote ongoing learning networks. The participants also faced notable challenges; however, the program's inclusive design, emphasizing practical tools, accessibility, and community building, allowed them to overcome them. This demonstrates the importance of context-sensitive interventions that help address the systemic inequalities of entrepreneurial ecosystems.

The results of this research suggest implementing a permanent digital platform that maintains access to content and interaction among post-program participants, responding to the need to sustain communities of practice. It is recommended to strengthen the professional networking component through formal links with business organizations and financial entities. At a theoretical level, this study contributes to the knowledge on the intersection between entrepreneurship training and gender perspective in Latin American STEM contexts, providing evidence on the effectiveness of interventions designed to address specific structural barriers.

As future work, it is proposed to develop longitudinal studies that evaluate the medium and long-term impact of the WISE program, focusing on the sustainability of entrepreneurship. It is pertinent to undertake comparative research between different regional cohorts and to design standardized measurement instruments to facilitate analysis.

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Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT, Claude, and Grammarly in order to: Grammar and spelling check, improve writing style, Text translation, Paraphrase, and reword. After using these tools/services, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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