Engagement with purpose, key drivers for inspiring impact in STEM

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Abstract*– Higher education institutions and international academic communities play an important role in advancing Sustainable Development Goals related to quality education and gender equality, particularly in STEM disciplines where women remain underrepresented. This study examines an international Latin American volunteer-based initiative dedicated to promoting gender equity in STEM education through activities in education, mentoring, research, communication, professional practice, vocational development, and publishing. The objective of this research is to understand how volunteer participation relates to commitment, identify the types of activities carried out by highly engaged volunteers, explore members' perceptions of the initiative, and propose strategies to strengthen volunteer engagement. A mixed-methods approach was employed using two complementary surveys. The first survey was distributed to the entire community to assess members' perceptions, benefits received, and recommendations for improvement. The second survey was conducted with committee coordinators to identify active and consistently engaged volunteers and document their contributions throughout the annual cycle. Preliminary results indicate that members primarily associate the initiative with community, networking, learning, professional growth, collaboration, and the promotion of women in STEM. Participants highlighted the importance of strengthening cross-committee collaboration, expanding networking and professional development opportunities, and increasing member engagement. Analysis of active volunteers revealed that the most common activities include event organization, coordination, research, publications, peer review, outreach, and the development of new initiatives. Engagement and commitment depend on an individual's motivations, organizational management and the relational environment. People commit deeply when there is clarity in activities, flexibility and internal organization, mainly when there is alignment with ethics.

Keywords—Women in STEM, Engagement, Higher Education, Innovational education.

I. Introduction

Higher education institutions, both individually and as a group, have aligned themselves with the Sustainable Development Goals defined more than 10 years ago. They have focused on strengthening student education and fostering a culture based on the established values and goals. Among these are the goals of Quality Education (SDG 4) and Gender Equality (SDG 5), which seek to ensure inclusive and equitable quality education [1,2, 3,4].

Efforts have been made to further promote and strengthen this culture in engineering, science, and technology (STEM) schools, where the gender representation gap is greatest, and to address the structural, cultural, and pedagogical barriers that lead to the underrepresentation of women in these disciplines [4,5]. Universities are implementing measures such as more inclusive admissions policies, offering scholarships specifically designed for women in STEM, establishing mentoring programs and support networks, and working to eliminate implicit biases in academic settings. In addition, they are promoting awareness campaigns to inspire more women to pursue careers in these fields, highlighting role models and fostering a university culture that values diversity and equity as essential drivers of innovation and progress.

These initiatives are developed through formal institutional channels created and implemented by the university, with the aim of fostering and strengthening a culture of gender equity. This involves establishing institutional policies, designating functional units to promote this culture, offering training programmes to faculty and staff, and implementing initiatives to integrate this culture into the curriculum and classroom practice. Resources and teams are allocated to ensure implementation, guided by a culture of impact measurement, whether through operational or, to a lesser extent, effectiveness indicators.

Various initiatives have been created by the private and public sectors, including governments and foundations. These initiatives allocate resources through calls for proposals to foster collaboration among universities (both nationally and internationally), as well as with industry and the government itself. This creates various types of tripartite initiatives.

Another type of initiative is the informal kind that stems from students and female faculty members. Professional women also play a vital role in fostering a culture of gender equity in STEM fields. Typically emerging from a shared need for solidarity, peer support and community building, these grassroots efforts take the form of independent mentoring circles, student-run chapters, voluntary coding bootcamps and community outreach events. Driven by personal commitment rather than institutional mandates, these activities provide crucial safe spaces for sharing experiences, challenging stereotypes and encouraging young women to pursue technical careers. Table I shows the classification of initiatives by context, which are divided into two types: (1) Formal initiatives, initiatives that are formal, institutionalized, officially budgeted and integrated into workload and policy. And (2) Informal initiatives, these are grassroots, volunteer-led, self-organized initiatives carried out by teachers and students, professional women, or society at large [5,6,7].

TABLE I
CONTEXT TYPES

Context	Internal	External
Formal Initiatives	Strategies and policies for gender equity. Peer and faculty mentorship programmes in degree requirements. Curriculum redesign for gender inclusive and STEM approaches. Professors' training programs on gender equity and inclusion. [8,9]	Elementary and Middle school outreach partnerships Government and industry women in STEM scholarships Institutional STEM camps and workshops for girls Corporate sponsorship and internships
Informal Initiatives	Women in engineering/science clubs. Student groups. Peer-support networks. Ad-hoc workshops, coding boot camps, hackathons. Voluntary faculty mentorship.	Community-based science fairs and pop-up events Independent social media campaigns Female scientists visiting local schools Community networking meetups and alumni panels.

To provide some context, it is important to acknowledge the impact of these initiatives, which depend on the voluntary commitment of female and male academics, students, and professionals, as well as their time and energy. However, evidence suggests a recurring phenomenon, particularly among women, in initiatives aimed at promoting gender equity in STEM fields [7,10,11]:

a) A disproportionate burden on women: Female researchers and faculty members often take on a much larger proportion of institutional and informal work related to gender equity, which is often invisible [6,8].
b) Impact on professional development: As most academic evaluation systems prioritise publishing articles and securing research grants over community service and voluntary mentoring, this unpaid work may hinder the career progression of volunteers.
c) The need for formalisation: There is a growing trend among universities to formalise and institutionalise these activities, to ensure their financial sustainability and explicitly recognise these work hours as part of official academic workloads.

International initiatives stemming from commitments made by universities or university associations aim to promote a culture of gender equity in STEM fields. These initiatives can be formal or informal, depending on the perspective of the institution or organisation of the participants. This research focuses on international initiatives primarily involving women from different Latin American countries. The activities carried out by these women stem from the commitment of volunteers, as well as collaboration with other universities and institutions seeking to maximise their impact.

The research is part of an international initiative — a community established since 2020, by three institutions comprising leaders from engineering schools in Argentina, Colombia and another Latin American association. The initiative aims to promote gender equity in STEM academic programmes by providing career guidance, education, professional practice, outreach, mentoring and research. The initiative comprises over 280 volunteers from 18 Latin American countries, 92% of whom are women and 8% men.

The research focuses on understanding the impact of volunteers' commitment and the types of activities they carry out. The aim is to define strategies that will increase participation and commitment among volunteers in initiatives of this nature (international ones that have no direct ties to the university or to the volunteers' performance as students). The research questions are: How does volunteer participation relate to their commitment to the initiative, association, or group in which they participate? What types of activities do volunteers with active, consistent commitment design or coordinate? What is the perspective of volunteers on the initiative in terms of continuous improvement? What strategies can be developed to increase the level of commitment among volunteers?

II. APPROACH

The mixed methodology utilizes two instruments to provide statistical and qualitative information from the perspectives of two groups: the coordinators of the committees that make up the initiative or international community, and the volunteers who serve on each committee [12]. The research phases consist of:

1. Research design, including its phases and the target population;
2. Design of the instruments: one is administered to volunteers to gather feedback from the community at large and the other to coordinators to distinguish between active, consistent and committed volunteers.
3. Application of the instruments to both populations during the annual cycle closure phase.
4. Qualitative and quantitative analysis of the results and conclusion-drawing. For the qualitative analysis using Copilot, prompts were created by analyzing the most frequently used words in open-ended questions.

As shown in Table 2, two surveys targeting different stakeholder groups were conducted. These surveys were used to validate the types of activities carried out by active and committed volunteers, and to assess community members' perceptions of what they receive and opportunities for improvement.

TABLE II
SURVEYS

Instruments	Sample	Objective
Survey 1	Survey sent to the entire population that is part of the	The aim is to understand how they perceive what the community offers them and

	community and is registered	the areas they think could be improved in terms of how activities are carried out.
Survey 2	A survey was sent to the committee coordinators to identify active participants in the one-year cycle and the types of activities carried out.	The goal is to issue a letter recognizing their active commitment, which can serve as evidence of their activities on behalf of their institution or organization outside of their normal duties.

Survey Two was completed by one of the committee coordinators. Depending on the activities carried out or the size of the committee, there may be two or three coordinators. Furthermore, it has been observed that they support one another in cases where one of them is unable to follow up on scheduled or planned activities. The community consists of 8 committees (7 thematic committees and 1 manager committee), each with a different number of volunteers (see Table III).

TABLE III
COMMITTES

Committee	Objective	# of Volunteers
Vocational Development	Facilitating career exploration in engineering through dynamic programs and the visibility of role models, highlighting their potential to transform the future.	8
Education	Providing activities and training to equip educators and professionals with resources to promote equality and diversity in the field of engineering	23
Mentoring	Empowering the personal and professional development of female students and professionals through the creation of effective mentoring networks.	11
Professional Practice	Fostering the development and leadership of women in engineering by connecting experiences, opportunities, and partnerships across academia, industry, and government, with the aim of promoting their professional growth and overcoming local and international barriers.	6
Communications	Broadcasting stories, achievements, and challenges of women in engineering to raise awareness and celebrate their contributions to the field.	9
Research	Developing research and projects that generate knowledge on gender and equity in engineering, strengthening inclusion from within academia.	43
Editorial	Building the community's editorial ecosystem through policies, call for papers, and publications by highlighting gender gaps, initiatives to close them, and inspiring stories of women in STEM.	12

III. RESULTS

The responses were analyzed by type of instrument, and the analysis by survey is presented below. Copilot was used as artificial intelligence for qualitative analysis, since the form was generated as a Microsoft Teams tool. This facilitated the analysis with prompts that were generated with the help of the AI itself. All AI-generated outputs were subsequently reviewed and validated by the research team against the original survey responses to mitigate potential algorithmic bias.

Figure 1 shows the percentage of participation in the first survey, with 77 respondents out of a total of 280. It is interesting to note that 19% of volunteers are not members of a committee but do attend community-organized events.

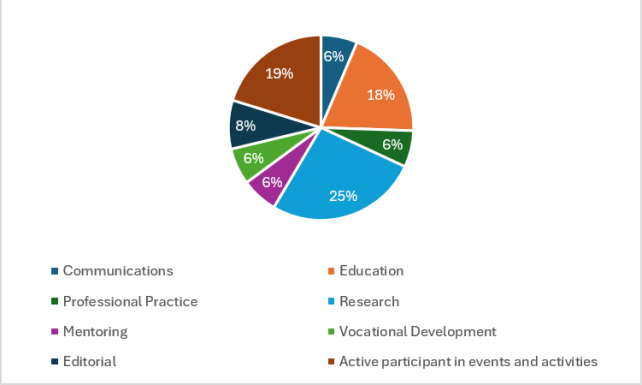


Fig. 1 Survey Participation Rate 1

Survey 1 asked "What has it mean to collaborate, participate, or be a member of the community (international initiative?" The most common responses to this survey were:

- Community y Network: sense of belonging and professional connection.
- Experience, Learning y Growth: personal and professional development.
- Women, Engineering y Vocations: promoting women's participation in STEM.
- Sharing, Contribution y Commitment: active collaboration and creating an impact.

The analysis generated a word cloud, provided by Copilot. Analysis of member perceptions shows that the International Initiative is primarily associated with community, learning, professional growth, collaboration, networking and promoting women in engineering. The most frequently mentioned concepts reflect a strong sense of belonging and commitment to STEM vocations across Latin America, as well as a desire to share knowledge and contribute to the field.



Fig. 2 Word Cloud

The recommendations for the next cycle focus primarily on strengthening collaboration among committees, creating more networking and knowledge exchange opportunities, increasing member engagement and expanding collaborative projects with a measurable impact. Members also emphasized the importance of improving communication and visibility, developing mentoring opportunities, fostering in-person connections, and continuing to promote gender equality and STEM careers across Latin America.

In response to the question asked regarding continuous improvement, participants were asked if they had any recommendations or proposals to bring forward for the next work cycle. Some people indicated that everything was fine or that they were willing to help with what came next. However, a few ideas were put forward for strengthening the community. The key ideas were:

Strengthening Collaboration Across Committees. This was the most frequently mentioned recommendation. With greater interaction, cross-committee projects and initiatives, sharing plans, activities and achievements and invitations for collaboration. They also proposed promoting interdisciplinary and network-based work.

Create networking and knowledge exchange opportunities. Members requested discussion forums, roundtables, workshops, webinars, virtual and in-person meetings, spaces to share experiences and best practices, and increased networking opportunities.

Increase active engagement. More involvement in activities was identified as a priority. Suggested changes included: greater participation, more voice for less active members, follow-up and engagement mechanisms and better student integration.

Expand training courses and professional development opportunities. More courses and diploma programmes, specialized workshops, leadership training, continuous professional development opportunities and STEM-related training are some of the proposals.

Survey 2 is designed to register active and consistent committee members, to document—through a letter that serves as evidence for their institutions or organizations—the commitment and leadership they have demonstrated throughout the cycle and its activities. The active and consistent participants who demonstrated commitment and leadership in the committee's activities are representatives from eight Latin American countries: Argentina, El Salvador, Mexico, Peru, Colombia, Venezuela, Costa Rica, and Chile. As shown in Figure 3, the main involvement takes place in the research committee, where they maintain formal, documented records of their meetings, which are scheduled throughout the year and feature ongoing activities.

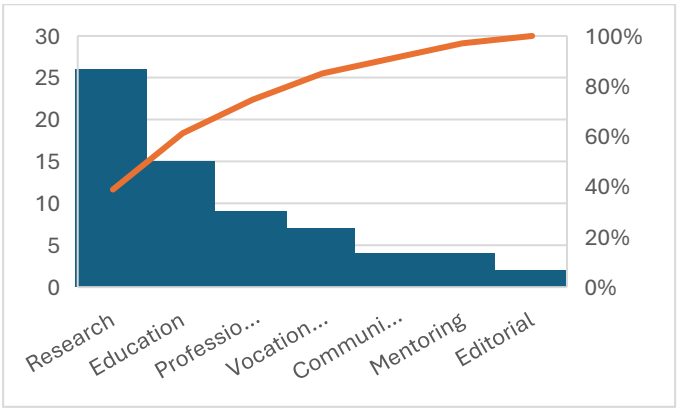


Fig. 3 Number of people registered by committee as active and regular members

The following activities were listed in response to the question about which activities active and committed volunteers participate in most:

- Active participation in one or more events.
- New Activity Suggestions.
- Reviewer of articles, essays, and other works.
- Coordination of one or more activities.
- Publications in collaboration with other members of the community.
- Research in collaboration with other members.

The list includes the possible activities in which an active, consistent, and committed member participates—ranging from collaboration to leadership or coordination and even proposing new activities. This is illustrated in Figure 4, where participation in one or more activities, as well as proposing new activities, are shown as the main characteristics of these volunteers.

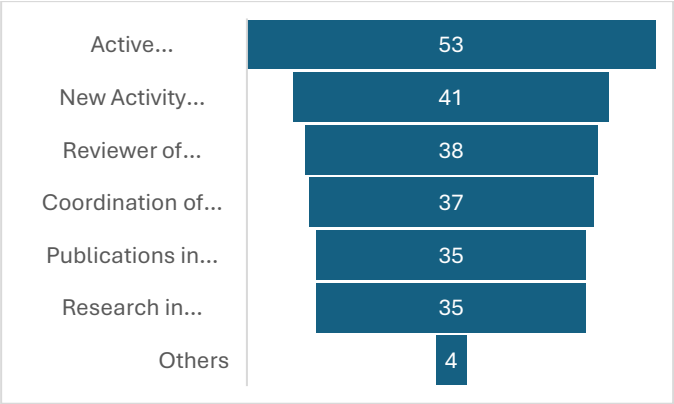


Fig. 4 Committed members' activities.

Participation records show that the members primarily engage in research, publication, peer review, committee coordination, event organization, STEM outreach and collaborative projects. This reflects a strong emphasis on knowledge generation, professional development and community impact. Figure 5 shows the main activities mentioned by the coordinators that were carried out by active and committed members; these will be described in the letters as evidence of their participation and leadership in the community.

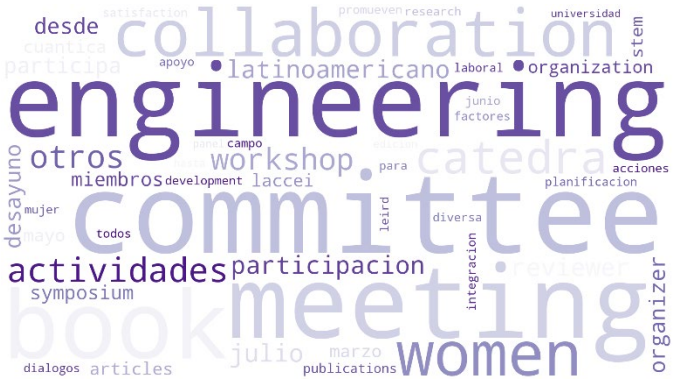


Fig. 5 Committed members' activities.

To complement the survey findings and strengthen the evidence base, we integrated qualitative testimonies from the attendance records with quantitative documentation of active participation. This triangulation highlights how members' perceptions of community, leadership, and professional growth are directly reflected in their concrete actions within the initiative. The following comparative Table IV illustrates the alignment between what volunteers express as meaningful experiences and the activities they carry out, thereby reinforcing the validity of the results. The records are anonymized.

TABLE IV
ANALYSIS OF THE PERCEPTIONS OF COMMITTED COMMITTEE MEMBERS

Dimension	Evidence of Perception (Survey & Testimonials)	Evidence of Action (Participation Records)
Community & belonging	"Sense of belonging, solid bonds"	Participation in Latin American Breakfast, mentoring circles, networking events
Leadership & Commitment	"It is an honor to be part of the Chair"	Coordination of workshops, panel organization, mentoring manuals, leadership in committees
Professional Growth	"A space of inspiration and renewal of efforts"	Research projects, article reviews, contributions to Matilda Books, training sessions
Continuous Improvement	"Greater interaction between committees"	Proposal of CAL Matilda Observatory, cross-committee collaborations, new activity suggestions
Visibility & Impact	"Contributing to reflection and resources"	Publications, outreach activities in schools, dissemination campaigns, symposium participation

Within an international community that promotes gender equity and careers in STEM programs—composed of volunteers from various Latin American countries—24% of the members identify as active, consistent, and committed volunteers who provide impactful leadership and share responsibility for events not only within the community but also at their own universities or organizations. They foster connections that amplify the impact of the results.

IV. CONCLUSIONS

The findings show that volunteering has seemed associated with a sense of community and belonging, as well as professional growth and a commitment to advancing gender equity in STEM. Participants perceive the initiative as a collaborative network that provides opportunities for learning, knowledge sharing, leadership development and promoting women's participation in engineering and science. These results suggest that sustained engagement is supported by the

initiative's mission and the social and professional value generated through interactions among members across Latin America. Furthermore, volunteers identified important opportunities for continuous improvement, particularly in terms of increasing collaboration among committees, expanding networking and professional development opportunities, strengthening communication and visibility, and creating additional mechanisms to engage members more actively. These findings directly address the first and third research questions by demonstrating that commitment is linked to a strong sense of purpose and community. Participants' recommendations also provide a roadmap for enhancing volunteer experience and increasing long-term engagement.

Regarding the second and fourth research questions, the study found that active, consistently committed volunteers are characterized by their involvement in a broad range of leadership and knowledge generation activities. These include coordinating events, proposing new initiatives, conducting and collaborating on research projects, publishing scholarly work, reviewing articles and supporting STEM outreach efforts. Approximately 24% of the community were identified as active, committed volunteers who assume leadership responsibilities and extend the initiative's impact through their institutions and professional networks. These results indicate that volunteer commitment is closely associated with opportunities to contribute and lead.

The extent to which a volunteer is involved in a cultural change depends on a combination of individual, organizational and relational factors. Transformative leadership committed to a cause is rooted in deep-seated ethics and values seeking real change and is aligned with personal convictions — hence the lasting commitment. It is therefore important to implement strategies such as development plans, leadership pathways (progressive micro-leadership), training in soft and technical skills, and the creation of spaces for co-creation and participatory decision-making. These strategies should also focus on fostering a culture of recognition and impact. It is important to highlight the efforts of those who take on greater responsibility and commitment, so that they may inspire others on this path of leadership that transforms individuals, institutions, and societies.

This study focused on analysing motivation within a volunteer-sustained network, drawing on opt-in participation surveys—an approach that intentionally biases the sample toward individuals already highly involved in the initiative's activities. For instance, Survey 1 reached a 27.5% response rate (77 of 280 registered members), and similarly, the identification of the 24% of volunteers characterized as "active and committed" relied on nomination by committee coordinators. Future iterations of this research could address both non-response bias and nomination bias in how "active and committed participant" is defined (for example, by incorporating additional data sources such as attendance records, meeting minutes, activity logs, self-report instruments, or peer nomination) so as to capture contributions from volunteers who are less visible to formal coordination structures, as well as perspectives from other, more peripheral ("satellite") forms of participation in the network. Beyond improving participant identification, future research could It can increase the sample size of responses from study participants to ensure statistical validity. And also could investigate the factors that promote sustained engagement within the network by examining how motivational drivers vary across different national contexts. Rather than treating Latin America as a homogeneous setting, country-level or subregional analyses could identify context-specific facilitators of participation and leadership, adopting a situated and intersectional perspective that better reflects the diversity of the eighteen national communities represented in the network.

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