From code to community: scaling Niñas Pro for gender equity in computing

Mabel Vidal[1,2,3,*], Sofía Hernández[2,4], Ignacio Osorio[2,5], Pillippa Pérez[2], Karen Reyes[2,4] and Gonzalo Aichele[2,6]

[1]*Department of Computer Science, Universidad de Concepción, Concepción, Chile*

[2]*Niñas Pro, Santiago, Chile*

[3]*ANID - Millennium Nucleus in Data Science for Plant Resilience (PhytoLearning), Santiago, Chile*

[4]*Facultad de Ingeniería y Ciencias Aplicadas, Universidad de los Andes, Santiago, Chile*

[5]*Synopsys, Inc., Santiago, Chile*

[6]*Departamento de Informática, Universidad Técnica Federico Santa María, Santiago, Chile*

Abstract

This paper presents a longitudinal case study of Niñas Pro, a Latin American nonprofit dedicated to reducing the gender gap in computing by empowering girls through coding education. Building on initial efforts documented in 2021, we analyze the organization's growth and the evolving roles of volunteers between 2021 and 2025. Quantitative participation metrics provide a macro-level view of reach and expansion, while qualitative analysis of volunteer testimonies and interviews offers a micro-level understanding of empowerment trajectories. Guided by frameworks of situated learning, STEM identity, social capital, and self-efficacy, we identify a sustainable empowerment cycle in which participants transition from students to mentors, site leaders, and even executive board members. Volunteers describe Niñas Pro as a space of growth, inspiration, and belonging, underscoring the value of role models and community-based learning. We conclude with recommendations for scaling grassroots programs while preserving their values and fostering inclusive, sustainable computing education across Latin America.

Keywords

Education, Programming, STEM, Volunteering, Nonprofit, Community empowerment

1. Introduction

Persistent gender disparities in computing continue to limit the participation and visibility of women and girls in science, technology, engineering, and mathematics (STEM) fields globally [1, 2]. In Latin America, this underrepresentation is especially pronounced, with cultural, structural, and educational barriers that prevent girls from accessing equitable opportunities in computer science education [3, 4]. Initiatives aimed at closing the gender gap have emerged in the form of nonprofit programs, informal education platforms, and grassroots movements—yet few are systematically studied in terms of both individual and organizational impact [5, 6].

Niñas Pro was established in Chile in 2016 with the mission of reducing the gender gap in computing by providing free, beginner-friendly coding workshops for girls and young adolescents. By 2021, the organization had reached over 300 girls across multiple regions of the country, engaging a growing network of volunteers and collaborators [7]. However, since then, the organization has undergone significant growth, both in scale and structure, and presents a valuable case for understanding how grassroots nonprofit initiatives can evolve into sustainable, scalable ecosystems of empowerment.

This paper examines the development of Niñas Pro between 2021 and 2025 as both an educational intervention and an organizational model. We analyze its quantitative expansion, including the number of workshops, students, and volunteers, and its qualitative evolution, including mentorship structures
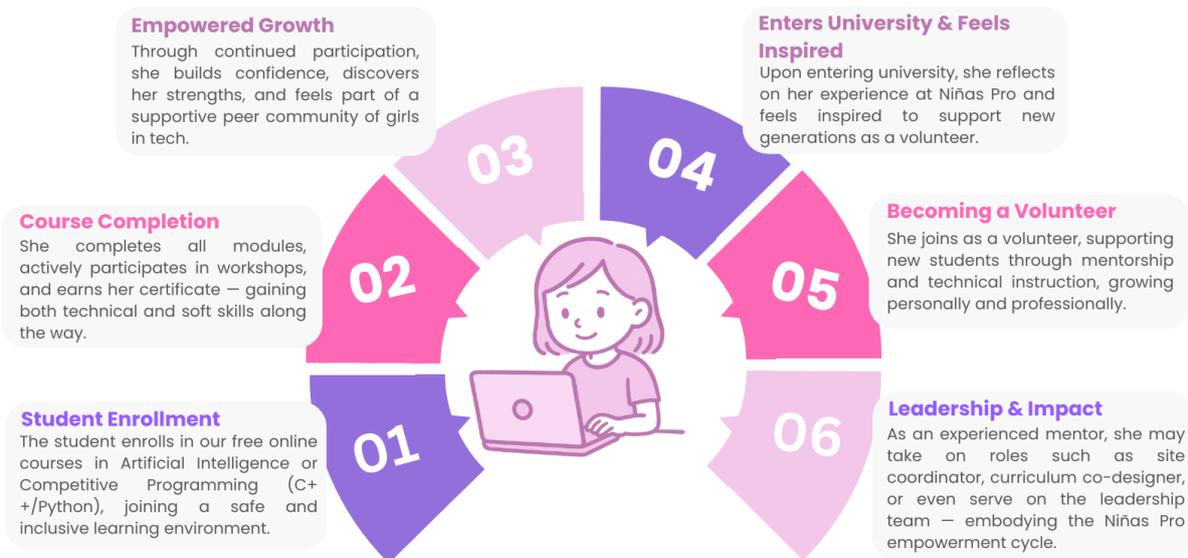
Figure 1: Conceptual model of the Niñas Pro empowerment cycle. The diagram shows the sequential stages participants undergo: Student Enrollment, Course Completion, Empowered Growth, Enters University & Feels Inspired, Becoming a Volunteer, and Leadership & Impact.

and pathways of leadership. In particular, we focus on the transition of former students into volunteer roles, a phenomenon that aligns with theories of identity formation in STEM [8], situated learning [9], and community-based learning models [10].

Our study draws on three key frameworks as (a) gender and STEM identity theory: research shows that identity formation is critical for girls to persist in male-dominated STEM fields [11] and therefore exposure, recognition, and community validation contribute to stronger STEM self-concepts; (b) Situated learning: According to Lave and Wenger [9], learning occurs through participation in social contexts, moving from peripheral to full participation in a community model reflected in Niñas Pro's student to volunteer cycle; and (c) Nonprofit organizational scaling: drawing from theories on nonprofit development [12], we examine how mission-driven organizations can scale while preserving core values, addressing the tension between growth and fidelity.

To facilitate readers' understanding of the empowerment cycle underpinning Niñas Pro, Figure 1 synthesizes the conceptual model guiding our approach. The diagram illustrates the sequential stages participants experience—from Student Enrollment through Course Completion, Empowered Growth, and the transition to Entering University & Feeling Inspired, culminating in Becoming a Volunteer and ultimately achieving Leadership & Impact.

2. Methodology and data sources

2.1. Research Design

We structured our study around two main objectives:

(1) Organizational growth analysis: to document and analyze the expansion of Niñas Pro in terms of program offerings and participants.

(2) Empowerment pathways: to explore the personal and social transformations experienced by girls who transitioned from students to volunteer instructors within the organization.

To address these objectives, we used descriptive statistics to quantify growth across key dimensions (e.g., number of workshops, enrolled students, volunteer engagement), thematic analysis to extract recurring themes from testimonials, surveys, and interviews with volunteers and staff, particularly those who were once participants and case studies to provide in-depth narratives of four girls who

became active volunteers, tracing their motivations, trajectories, and current roles in Niñas Pro.

2.2. Data sources

Data for this study were collected from multiple internal and external sources, including:

- Program records (2021–2025): Annual internal reports and tracking spreadsheets containing participant counts, course completion rates, volunteer sign-ups, and regional distributions. These were anonymized for privacy and verified for consistency.
- Volunteer feedback surveys: Distributed annually to active volunteers, these surveys included both closed and open-ended questions about their experiences, motivations, perceived impact, and areas for improvement.
- Alumni and volunteer interviews: Semi-structured interviews were conducted with former students who became volunteers, coordinators, and founding members. Each interview was transcribed with consent for qualitative coding.

2.3. Data analysis

We adopted a qualitatively-driven mixed methods design, in which qualitative inquiry played a central role and quantitative data served primarily to contextualize and complement the findings. Quantitative data—such as the number of students, workshops, volunteers, and their geographic distribution—were processed and visualized using Python 3.12 with libraries including `pandas`, `matplotlib`, `seaborn`, and `wordcloud`. Descriptive statistics were computed to characterize annual growth rates, demographic distributions, and participation trends. While no inferential statistical tests were performed, these descriptive measures provided a macro-level overview of program reach and evolution. For the qualitative component, we conducted an inductive thematic analysis following Braun and Clarke's methodology [13], applied to transcriptions of interviews and open-ended survey responses. Coding was carried out manually and supported by the `nltk` and `scikit-learn` libraries for keyword extraction and clustering of recurring themes.

3. Organizational growth of Niñas Pro

Since its founding in 2016 and particularly following its initial report at LAWCC in 2021, Niñas Pro has experienced sustained growth in both reach and community engagement. This section presents an overview of the organization's expansion from 2021 to 2025, focusing on two main pillars: student participation and the development of a robust volunteer network.

3.1. Student participation

Between 2021 and 2025, Niñas Pro reached a total of 1,316 girls across Chile and Latin America through its workshops, camps and programming tracks. Annual participation figures show a dynamic evolution shaped by factors such as post-pandemic transitions. In 2021, Niñas Pro engaged 334 students, followed by a drop in 2022 of 170 participants, attributed primarily to a reduction in operational capacity as the organization adapted to hybrid and in-person formats. Participation rebounded in 2023 with 289 students and remained steady in subsequent years, with 259 participants in 2024 and 264 in 2025 (Figure 2a). This sustained engagement reflects the program's expanding geographic and curricular reach. Notably, in 2023, a third site was launched in Santiago, hosted by the Pontificia Universidad Católica de Chile, reinforcing the initiative's presence in the capital. The following year, a new regional hub was established in Valparaíso, in collaboration with the Universidad Técnica Federico Santa María.

In 2025, Niñas Pro also introduced a new Artificial Intelligence (AI) workshop, offered in parallel to its longstanding tracks in basic and advanced competitive programming. This innovation responded to growing student interest in emerging technologies and global trends in computing education. The AI
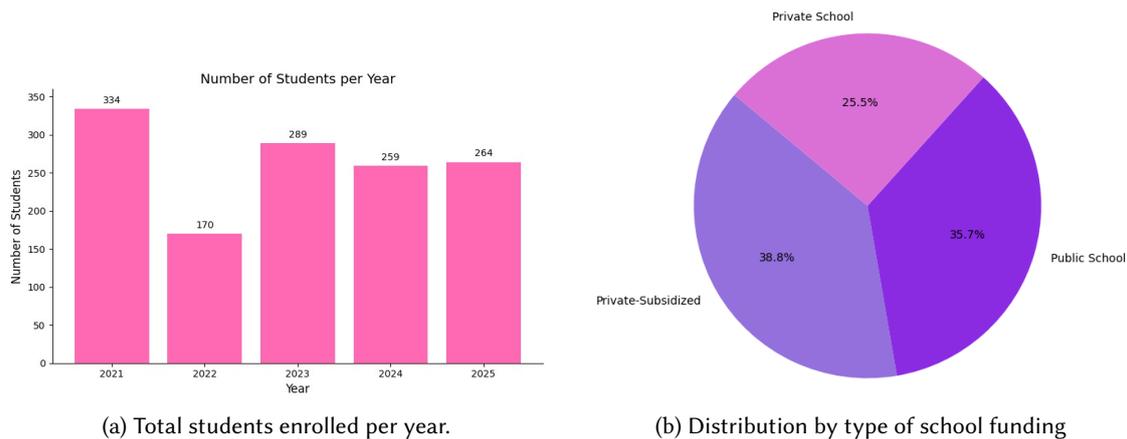
(a) Total students enrolled per year.

(b) Distribution by type of school funding

Figure 2: Distribution of girls enrolled in the annual courses of Niñas Pro from 2021 to 2025.

track was designed to be exploratory, creative, and accessible, integrating ethical discussions, interactive tools, and real-world applications.

In Chile, the school system is divided by funding source into private, public, and subsidized private schools, with school type often reflecting the socioeconomic status of a student's family. At Niñas Pro, we aim to eliminate financial barriers by offering all our programs free of charge, ensuring that girls can participate regardless of their household income or school background. Of the total participants, 25.5% came from private schools, 38.8% from subsidized private schools, and 35.7% from public schools. This distribution highlights the program's ability to attract girls across socioeconomic levels (Figure 2b).

Although Niñas Pro is based in Chile, its reach has extended beyond national borders. Over the past five years, the program has welcomed participants from a variety of countries, including Venezuela, Brazil, England, Panama, Mexico, Peru, Paraguay, Argentina, Colombia, Ecuador, the Dominican Republic, and Uruguay. This international presence reflects both the accessibility of online programming and the growing regional interest in gender inclusive computing education across Latin America and beyond (Figure 3).

3.2. Volunteer network expansion and engagement

At the heart of Niñas Pro's growth is its volunteer network, a cornerstone of the organization's mission and sustainability. Volunteering in this context goes beyond technical instruction; it signifies a commitment to mentorship, gender equity, and community building. Volunteers serve not only as educators, but also as role models who help girls envision themselves in computing spaces traditionally dominated by men.

The growth of Niñas Pro's volunteer base has been equally transformative. In 2021, the organization had 95 active volunteers. By 2025, that number had grown to 153 volunteers, including instructors, mentors, logistics coordinators, and communications staff. Volunteers now include university students, professionals in STEM fields, and former students who rejoined as mentors. Recruitment efforts shifted from ad hoc calls on social media to structured onboarding cycles, complete with training workshops and mentoring guides. This professionalization of volunteer engagement helped ensure consistency in program delivery while fostering a strong sense of belonging. Many volunteers reported that their involvement in Niñas Pro enriched their own professional and personal development.

Interviews with 24 current volunteers revealed a shared sense of purpose and community. Volunteers also played a key role in shaping the curriculum, suggesting new course themes and adapting content to different age groups. As the organization expanded, experienced volunteers began taking on leadership roles, organizing regional chapters, and training new cohorts of instructors. To further understand the impact of Niñas Pro on its volunteers, we conducted a text mining analysis on responses to the open-ended question: "How has your experience in the corporation been?". Using natural language processing
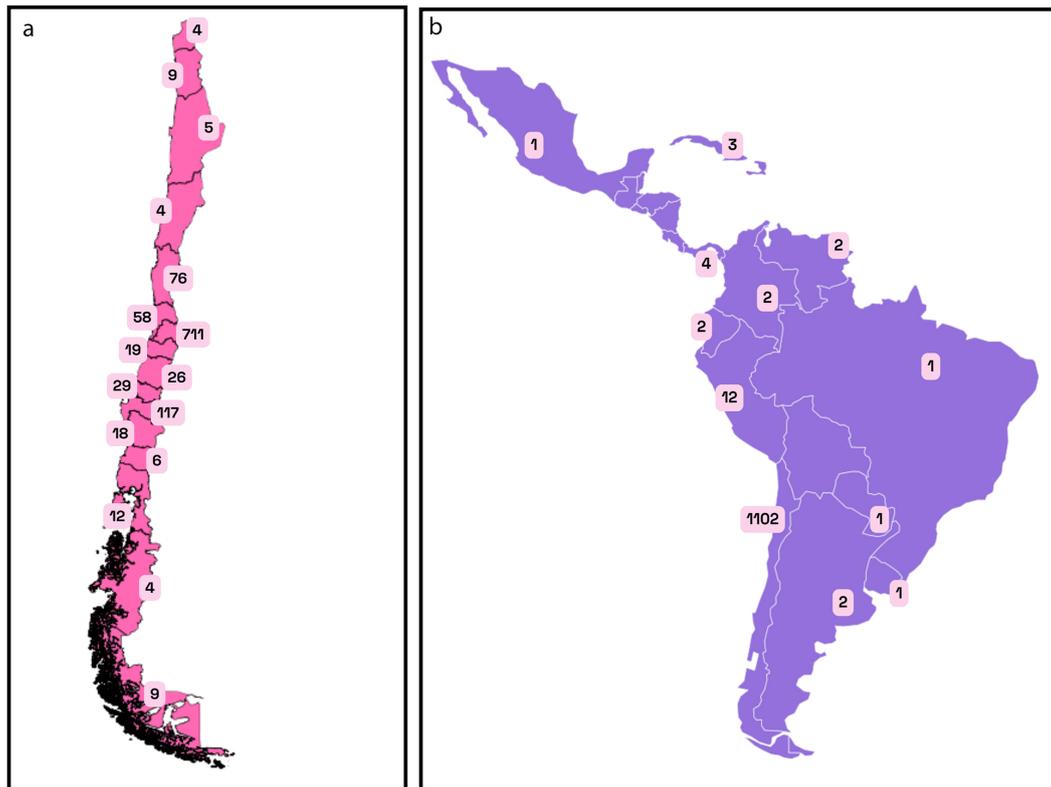
Figure 3: Students' enrollment in Niñas Pro from 2021 to 2025. The map highlights the number of students per geographic location of the annual workshop in competitive programming in (a) Chile and (b) Latin America.

tools, we extracted key themes and emotional tones across the corpus. Figure 4a shows the most frequently mentioned terms, including community, confidence, growth, learn, support, and safe space. Volunteers consistently described their experience as enriching, empowering, and transformational. Many highlighted the dual nature of the experience, not only teaching programming to girls, but also growing personally and professionally through collaboration and shared purpose. One recurrent theme was the idea of mutual learning, where teaching became an avenue for gaining confidence, communication skills, and a renewed sense of vocation. The emotional salience of the responses also underscored how Niñas Pro functioned as a supportive environment during the pandemic, offering belonging and connection at a time of social isolation. These findings reinforce the role of volunteerism as a powerful vehicle for personal development and community building within gender equity initiatives.

As part of our qualitative analysis, we also explored volunteers' personal reflections on the meaning of volunteering. We identified recurring themes such as responsibility, empowerment, inspiration, community, and social impact. For many, volunteering was framed not merely as a task, but as a transformative commitment to closing the gender gap in STEM by serving as role models and mentors. Responses reflected a deep sense of purpose and emotional connection, emphasizing the reciprocal nature of the experience volunteers not only teach but also grow alongside the students. One volunteer metaphorically described their role as "the training wheels on a bicycle", helping girls gain the confidence to navigate a field that often feels exclusive or intimidating (Figure 4b).

4. Student to volunteer transition

A central aspect of Niñas Pro's long-term impact lies in its ability to transform program participants into community leaders. Between 2021 and 2025, a growing number of girls who initially enrolled in Niñas Pro workshops later returned as volunteer instructors, mentors, or local coordinators. This phenomenon represents more than a successful educational outcome; it reflects the emergence of a
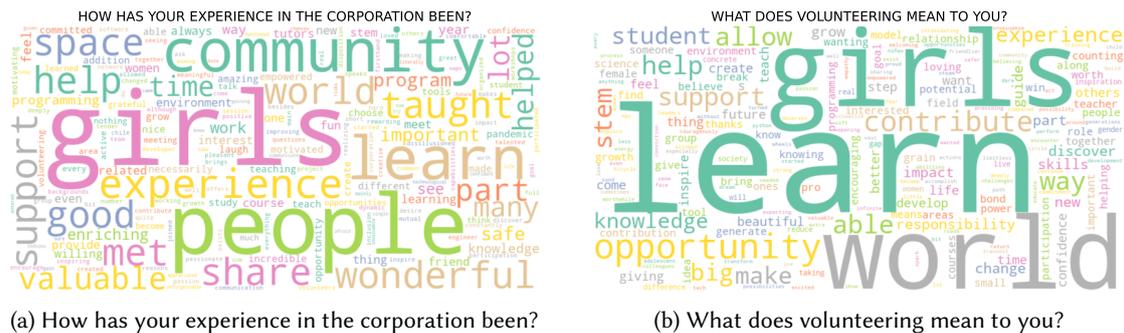
(a) How has your experience in the corporation been?
(b) What does volunteering mean to you?

Figure 4: Wordcloud generated from volunteer responses to the question (a) "¿How has your experience in the corporation been?", where the top five words used were girls (100%), people (61.5%), community (53.8%), learn (53.8%) and experience (46.2%). Highlighting the emotional, collaborative, and empowering nature of the volunteer experience within Niñas Pro. (b) "¿What does volunteering mean to you?", where the top five words used were learn (100%), girls (92.3%), world (84.6%), opportunity (84.6%) and contribute (53.8%).

self-sustaining, intergenerational learning ecosystem rooted in belonging, identity, and leadership. The transition from student to volunteer typically begins with continued participation at multiple workshop levels, followed by encouragement from existing mentors to assume support roles. Many former students expressed a desire to "give back" to the community that introduced them to computing, often citing a sense of responsibility and inspiration from their own instructors (Figure 5).
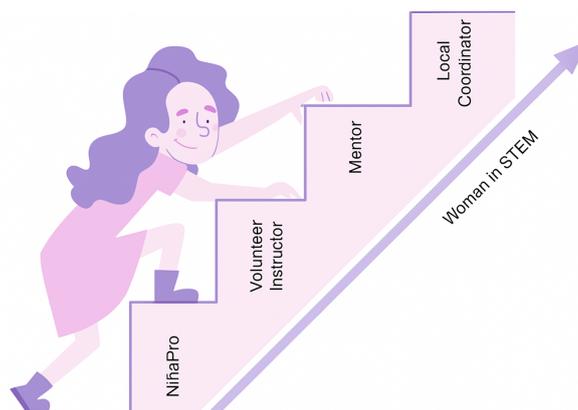

Figure 5: Empowerment ladder showing how "NiñasPro" puts school girls on a path to becoming women in STEM and how being a part of this ecosystem keeps them in constant growth within the scientific community.

Qualitative analysis of interviews with six former students who are now active volunteers revealed key patterns. First, they reported an initial lack of confidence in their technical abilities, which gradually changed as they gained exposure to collaborative, female-led learning spaces. Second, they emphasized the emotional importance of representation, seeing women teaching and leading in computing roles, declaring that it helped them "see themselves in the future. Third, these young women reported significant growth in soft skills such as public speaking, teamwork, and problem solving as a result of volunteering.

For example, Karen (age 24), who joined Niñas Pro at age 17, is one of the most emblematic student-to-volunteer transition in Niñas Pro. She is a former participant who has since become a volunteer, local site leader, and currently serves as president of the Organization. In her reflection, Karen emphasized the central role that opportunity played in her journey, stating that before joining Niñas Pro, she had never envisioned herself in the world of technology. It was the presence of relatable, university-aged female tutors who openly shared their academic and personal struggles that allowed her to see herself in them. This experience highlights the profound importance of representation and proximity in role modeling: being able to admire not distant figures, but everyday women who generously give their

(a) Experience as a student influenced to be a volunteer

(b) Moments with significant impact to transition into a volunteer

(c) Encourage another girl to enroll Niñas Pro

Figure 6: Wordcloud generated from open-ended responses of former Niñas Pro students who later became volunteers, reflecting on their motivations, transformative experiences, and advice to future participants.

time to others. Karen described her motivation to volunteer as a form of giving back, transmitting the same sense of belonging and potential that she once received. Her trajectory exemplifies the power of a community of practice, where learners gradually move from peripheral participation to central leadership roles. Moreover, she frames Niñas Pro not only as a technical education space, but as a profoundly human and emotional support network—one where girls are allowed to explore, fail, grow, and feel backed by others. Her story reflects a core strength of the organization, creating an ecosystem in which women support each other intergenerationally, reinforcing collective empowerment while opening pathways for future leaders in STEM.

All six participants described their initial experience as students as transformative not only for sparking their interest in programming and technology, but for helping them develop a stronger sense of identity and purpose. Several cited the impact of discovering a learning environment free from gender stereotypes, where female tutors acted as both educators and role models. This exposure not only illuminated the gender gap in STEM, something many had not previously been aware of, but also inspired a desire to "give back" by occupying the same mentoring role that had once empowered them. One participant spoke of programming as a feminist act, contrasting the sense of belonging she felt in Niñas Pro with exclusionary experiences in mixed gender tech spaces. Another emphasized that it was through the workshops that she first understood her own preferences and strengths. The recurring theme across these narratives is that volunteering is not an isolated activity, but rather a continuation of a profoundly personal learning journey, one rooted in gratitude, social responsibility, and a commitment to expanding opportunities for the next generation of girls in tech (Figure 6a).

When asked about the moments that influenced their decision to become volunteers, former students consistently pointed to emotionally significant experiences and community-building activities that left a lasting impression. Inspirational talks by women in STEM emerged as a recurring theme, serving as pivotal moments where participants first envisioned themselves as engineers, developers, or mentors. These encounters humanized the world of technology and made it feel accessible, planting the seeds of aspiration. Others recalled joyful, seemingly simple moments such as winning a Kahoot game or attending a virtual sleepover on Discord during the pandemic as powerful affirmations of belonging

and achievement. These moments, while informal, built a sense of confidence, connection, and visibility within a supportive peer network. Some students were struck by the authenticity and vulnerability of their tutors, who shared personal academic challenges and everyday experiences, showing that success in STEM does not require perfection, but perseverance. This modeling of resilience encouraged participants to envision themselves as future mentors. These testimonies reinforce the idea that transformative educational models are rooted as much in emotional resonance and representation as in curricular content (Figure 6b).

Finally, when asked how they would encourage other girls to go through the whole Niñas Pro track, former students now turned volunteers unanimously emphasized the transformative nature of the experience, both technically and personally. Their reflections portray Niñas Pro not merely as a learning environment, but as a community of support, identity, and discovery. Participants described the workshops as well-structured, inclusive, and engaging, offering both technical skills and emotional growth. Several noted that even for those who may not ultimately pursue careers in STEM, the experience remains deeply valuable. Programming is framed as a life skill, on par with reading or writing, and as a way to expand one's sense of possibility. What stood out most was the appreciation of Niñas Pro as a safe space, a place where girls feel seen, supported, and inspired by women who dedicate their time to accompany them (Figure 6c).

These personal narratives demonstrate how Niñas Pro fosters a cycle of empowerment: girls become learners, then mentors, and eventually leaders within their communities. This model aligns with situated learning theory [9], where individuals move from peripheral to full participation within a community of practice, and with feminist pedagogical frameworks that emphasize relational knowledge, collaboration, and empowerment [14].

5. Implications and challenges

The evolution of Niñas Pro from a small grassroots initiative to a growing nonprofit with regional reach offers valuable insights into the dynamics of scaling inclusive computing education in Latin America. The findings presented in this paper have several implications for organizations seeking to promote gender equity in STEM through community-driven approaches.

1. The success of Niñas Pro demonstrates the potential of peer-led, identity-affirming learning environments to foster long-term engagement in computing [15]. The transition of students into volunteer mentors not only strengthens the organization's capacity but also reinforces role modeling as a transformative pedagogical strategy. This cycle of empowerment aligns with feminist and situated learning frameworks, underscoring the importance of relational, inclusive, and locally grounded educational models [16, 17].

2. The central role of volunteering as a leadership pipeline suggests that programs should invest in the personal and professional development of their volunteers. Many of Niñas Pro's most committed mentors began as hesitant participants, highlighting the value of creating safe, supportive environments that nurture both technical and soft skills. Recognizing volunteering as a mutually beneficial process can enhance retention and build stronger, more cohesive communities [18].

3. The organization's rapid growth has also introduced essential challenges. One recurring issue is maintaining quality and consistency across an expanding number of workshops and regional chapters. As the number of volunteers increases, ensuring that all mentors receive adequate training and ongoing support becomes critical to preserving the program's pedagogical integrity. In response, Niñas Pro has begun formalizing its onboarding and mentorship processes.

4. Another challenge relates to sustainability and funding. While much of the growth has been fueled by volunteer energy and open educational resources, expanding and professionalizing operations, especially across borders, requires stable funding streams and institutional partnerships.

5. Digital equity and access remain persistent concerns, particularly in rural or underserved areas. Although hybrid and online formats have increased reach, disparities in internet access and device availability still limit participation for many girls who could benefit most from the program.

In sum, the experience of Niñas Pro points to the promise and complexity of building inclusive, scalable, and community-rooted computing education initiatives. Its model offers a roadmap for others, while also raising important questions about how to preserve mission-driven values in the face of organizational growth.

6. Conclusions and future directions

This study documents the longitudinal development of Niñas Pro from 2021 to 2025, illustrating its role in reducing the gender gap in computing through community-based education and peer mentorship. A central finding is the establishment of a sustainable empowerment cycle, whereby former participants assume volunteer mentorship roles, reinforcing STEM identity and self-efficacy within identity-affirming environments.

One of the most compelling findings is the emergence of a sustainable empowerment cycle, where former students return as volunteer mentors, becoming active agents of change in their own communities. This dynamic not only strengthens the organization's capacity but also validates its core pedagogical and social approach: that learning and leadership thrive in safe, identity-affirming spaces. The voices of volunteers further reinforce this view, describing their experiences as personally transformative and socially meaningful.

Beyond situated learning and STEM identity, the Niñas Pro model also draws on social capital and self-efficacy to explain sustained STEM engagement. Social capital highlights how community networks provide access to resources, mentorship, and role models, which Niñas Pro fosters through its multi-level participant interactions. Self-efficacy underscores the importance of confidence in one's abilities; by offering peer role models, and a supportive environment, Niñas Pro strengthens participants' belief in their capacity to succeed in computing, increasing persistence in STEM pathways.

Our findings align with patterns observed in similar initiatives aimed at increasing female participation in STEM. For example, programs such as Chicas en Tecnología and Technovation Girls also leverage mentorship, peer collaboration, and project-based learning to build both technical skills and confidence among participants. However, Niñas Pro's sustained engagement model, where graduates transition into volunteer and leadership roles, appears less common and may strengthen long-term community bonds and social capital. These comparative reflections suggest that while the core mechanisms for empowerment are shared across contexts, structural features that promote intergenerational continuity could be critical for amplifying impact and ensuring sustainability in gender equity initiatives.

Future efforts will focus on formalizing a regional volunteer training academy, developing an alumni network to monitor long-term outcomes, and expanding collaborations with public and private sectors to ensure program sustainability and amplify its impact on gender equity in technology.

Declaration on Generative AI

The authors have not employed any Generative AI tools.

References

[1] K. Kwon, S. J. Lee, K. Kim, Gender disparities in k-12 computer science education: Status, contributing factors, and instructional approaches, Computers and Education Open (2025) 100253.

[2] S. Cheryan, A. N. Meltzoff, S. Kim, Classrooms matter: The design of virtual classrooms influences gender disparities in computer science classes, Computers & Education 57 (2011) 1825–1835.

[3] Cracking the Code: Girls' and Women's Education in STEM, UNESCO, 2017.

[4] M. Holanda, D. Da Silva, Latin american women and computer science: A systematic literature mapping, IEEE Transactions on Education 65 (2021) 356–372.

[5] C. Holgersson, J. Hvenmark, Gender in nonprofit organizations: A critical review and research agenda, Nonprofit Management and Leadership 34 (2023) 195–209.

[6] J. D. Lecy, H. P. Schmitz, H. Swedlund, Non-governmental and not-for-profit organizational effectiveness: A modern synthesis, Voluntas: International Journal of Voluntary and Nonprofit Organizations 23 (2012) 434–457.

[7] M. Vidal, J. Maldonado, T. Bracamonte, F. Miranda, A. Labarca, J. Simmonds, Niñas pro: an initiative to educate, inspire and empower women., in: LAWCC@ CLEI, 2021, pp. 35–46.

[8] S. J. Correll, Talking about leaving: Why undergraduates leave the sciences, Contemporary Sociology 26 (1997) 644.

[9] J. Lave, E. Wenger, Situated learning: Legitimate peripheral participation, Cambridge university press, 1991.

[10] B. Rogoff, Apprenticeship in thinking: Cognitive development in social context, Oxford university press, 1990.

[11] E. Seymour, N. M. Hewitt, Talking about leaving, Westview Press, Boulder, CO, 1997.

[12] P. N. Bloom, A. K. Chatterji, Scaling social entrepreneurial impact, California management review 51 (2009) 114–133.

[13] V. Braun, V. Clarke, Using thematic analysis in psychology. qualitative research in psychology, Qualitative research in Psychology 3 (2006) 77–101.

[14] B. Hooks, Teaching to transgress, Routledge, 2014.

[15] C. Desalvo, S. Dossa, B. Modungwa, Disrupting learning and evaluation practices in philanthropy from a feminist lens, Gender & Development 31 (2023) 617–635.

[16] N. Matthews, P. Green, D. Hall, I. Hall, The role of volunteering in transitions from higher education to work, Transitions from education to work: New perspectives from Europe and beyond (2009) 150–166.

[17] H. Colley, Engagement mentoring for'disaffected'youth: a new model of mentoring for social inclusion, British educational research journal 29 (2003) 521–542.

[18] A. J. Stewart, K. Kuenzi, The nonprofit career ladder: Exploring career paths as leadership development for future nonprofit executives, Public Personnel Management 47 (2018) 359–381.