# Niñas Pro: an initiative to educate, inspire and empower women

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**Abstract**

In this paper, we present the experience of Niñas Pro, a non-profit organization in Chile that has been running coding and computer science workshops and courses for female high school students since 2016. We begin by presenting our educational model, which is divided into four projects, each with a specific objective and target audience. We then present quantitative and qualitative results that have been obtained following this educational model, showing how the organization has matured and grown. Our first course had 32 students, and was run by 10 volunteers – we are now a consolidated network of more than 80 volunteers all over Chile, reaching a total of 1,820 female students throughout these past 5 years. We conclude by presenting a series of lessons that we have learned from this experience, which we believe can be useful to other organizations with similar objectives.

**Keywords**

Education, Programming, STEM, Volunteering, Role-Models, Gender Gap

## 1. Introduction

Historically, women are underrepresented in science, technology, engineering and math (STEM) careers [1], even though STEM majors are in high demand in many countries [2]. To improve women's representation in STEM careers, it is important to help them persist in the educational context, mitigating social and cultural influences beyond the classroom [3]. Several factors affect women's decision to major in STEM: interactions with instructors and peers are key for creating and maintaining a longer-term commitment to STEM [4], along with the existence of role models [5], dispelling stereotypes [6], engaging middle and high schoolers [7], interacting with scientists [8], etc.

Science pedagogy can also be key to improving the representation of women in STEM. Current educational systems rely on massive lectures and students' individual responsibility about their own learning, generating competitive learning environments [9]. As such, the classroom climate can affect women's decision to pursue a STEM career, by affecting their

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self-confidence [10]. However, new teaching styles indicate that collaborative learning practices lead to an increase in female applications in science programs, and positively influence student achievements [11]. Practical and active learning strategies can also reinforce women's decision to major a STEM field, as well as their self-confidence [12]. Particularly, Margolis et al. [13] highlight the importance of connecting computer science to the real world by applying it to social contexts, and Miller et al. [14] in showing how computer science can be used to improve people's quality of life, as a way of increasing women's interest in the field. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO) women are still a minority in engineering and computer science. The number of female graduates since 2000 is particularly marked in high-income countries. However, in Latin America and the Caribbean, the situation is critical, as the total number of women in computer science has dropped by between 2 to 13% since 2000.

In this work, we present the initiative Niñas Pro, where we empower girls and adolescents by teaching them how to code, and inspiring them to consider scientific and technological careers. Our education model is divided into four projects: Empower, Inspire, Incentive and Boost (presented in Section 2). Over the past 5 years, we have reached to 1,820 girls through Niñas Pro, with a volunteer team from all over the country (see Section 3 for results). We have achieved a sustainable educational model for our organization, encouraging the inclusion of new volunteers who identify with our mission and vision to reduce the gender gap in technology in Chile. Moreover, our educational model has allowed us to continue our activities, even though the COVID-19 pandemic. We present the lessons we learned in Section 4.

## 2. Educational model of Niñas Pro

Niñas Pro began in Santiago, Chile in 2016, as a group of female engineering students who taught free programming classes for girls, to promote technology and computer science. During 2019, with a team of 10 volunteers, Niñas Pro officially became a non-profit organization, and opened a second branch in Santiago. In 2020, two new regional branches were opened, one in Coquimbo (northern Chile), and the other in Concepción (in the south). Now, women from all over Chile can participate in different activities and courses in programming and electronics.

Niñas Pro works to break down stereotypes, and lets girls get the experience of being technology creators. Exposing them to computing can also help them make a more informed decision about pursuing a STEM career. We do this by organizing different activities during the year, with the goal of improving female participation in the Chilean Informatics Olympiad (OCI). In 2016, less than 15% of the participants of this programming competition for high school students were female. This motivated the creation of Niñas Pro, with a women's only programming course specifically geared towards the OCI. Figure 1 shows our educational model, organized into 4 projects. 1) Empower, focusing on students' socio-emotional skills, like self-confidence, frustration tolerance, and collaboration. 2) Inspire, a motivational process using role models. 3) Encourage, which uses short courses to motivate girls to continue learning about technology. 4) Boost, that gives students that have already learned the basics of programming an extra push. Students that finish these courses and workshops are more confident in their computing skills and knowledge, and motivated to pursue STEM careers in the future.


**Figure 1:** The Niñas Pro educational model: Empower, Inspire, Encourage and Boost to promote science and technology among girls.

## 2.1. Empower Project

This core project focuses on teaching competitive programming in the C++ language, seeking to enhance students' socio-emotional skills such as self-confidence, tolerance to frustration and collaboration. It is a 54 hour theoretical-practical course, divided into 18 classes, where computational thinking skills are developed through competitive programming tasks. Competitive programming has different interactions with students' learning styles, and this differs by gender. Studies demonstrated that female students tend to value cooperation over competition and therefore, have different educational needs in computer science [15, 16]. For this reason, we have encouraged a strong community environment in our organization, specially related to this project, as it is the longest running activity during the year.

## 2.2. Inspire Project

The goal of this project is to introduce students to professional women from different STEM fields, as role models, who program in some way as part of their work. These women are encouraged to tell their personal stories and inspire the girls to leave their fears and insecurities behind. Introducing role models has proven to be an effective technique for motivational processes, since it helps students envision the paths they can follow to achieve their particular goals [17]. Effective role models that can inspire minority students to be perceived as competent, are of the same gender or ethnic group as the audience, and have achieved important success in a mutual area of interest [3, 18, 19]. It is also important for role models to communicate the challenges they have faced [20].

Our students have expressed in surveys (administered after these talks) that the event allowed them to see beyond the stereotypes in STEM and increased their motivation to pursue a career in related fields. They also stated that the example of woman's experience increased their perseverance during difficult times in their education. In literature, it has been observed that male role models do not increase girls' interest in STEM careers, causing a dissimilarity in the future, since it does increase boys' interest [21, 22]. On the other hand, the exposition to female role models increases women's interest in STEM and contributes to retaining female students [23, 24, 25].

## 2.3. Encourage Project

This project consists of short workshops, lasting between 2 and 6 hours, in which some practical programming activities are taught and carried out. The aim is to bring girls closer to technology and to encourage them to continue their learning on these subjects. Initially, this project was though to be part of the Empower Project to provide our students other tools beyond C++ (or Java at that time). After noticing that our students were motivated to learn more and explore other technologies, this instance was extended to new students, who had not been part of the annual course.

Other initiatives that provide similar workshops in Chile are The Hour of Code (https://horadelcodigo.cl), the International Girls in ICT Day organized by Technovation (https://technovation.cl/dia-internacional-ninas-tic-2019-1/), and Ingeniosas (https://ingeniosas.org/chile/). The differentiating factor between those initiatives and Niñas Pro is the division of participants into small groups of 5, with personalized guidance by a mentor. In most cases, the mentors are female students of STEM careers. Through this project we have been able to reach more girls than through the annual course, and collaborate with other public and private organizations interested in reducing the gender gap in STEM fields.

Our students have expressed in the workshop exit surveys that this type of experience motivated them to learn more about programming and explore other STEM fields. We notice that the close guidance during workshop sessions leads to better understanding of key concepts, and increases motivation, participation and engagement of students [26].

## 2.4. Boost Project

This initiative identifies talented students who want to deepen their knowledge about competitive and applied programming. The goal of this project is to enhance the skills of those students that already know basic programming and are interested in furthering their knowledge and abilities. This project arose because at the end of the Empower Project, several students were motivated to participate again in the course and learn more. The activities under this project are executed since 2020 in collaboration with Millennium Institute for Foundational Research on Data (https://imfd.cl).

The Boost project consists of three parts: 1) an advanced programming course; 2) an intensive course to prepare students to compete in the OCI, and 3) an Arduino programming challenge (Arduino Quest). The advanced programming course is the first activity in the Boost Project, and it runs parallel to the annual course of the Empower Project. It consists of an annual course, but the students have already taken the regular one and want to learn more advanced topics.

The intensive course for the OCI was first launched in 2020 and consists of a 4-week intensive course that occurs after the end of the annual course. The students from the Empower project and the advanced course practice and develop strategies to solve problems and to face them in a competition context. They work weekly, solving problems from past competitions and attending a 3 hour class every Saturday. The goal of this course is to help the students participating in the OCI reach a higher level of proficiency.

The Arduino Quest was created in 2020, and is performed during the winter break (in the middle of the Empower Project annual course). The students learn about Arduino in 3 stages:

a theoretical stage, a simulation stage, and a practical application stage where the students perform a personal project with an Arduino kit and sensors that were sent to their homes.

## 3. Results

The data in this section were collected using questionnaires, forms and interviews, which were administered to measure our students' satisfaction with each activity. Both the students and their parents signed informed consent forms.

### 3.1. Girls enrollment and profile

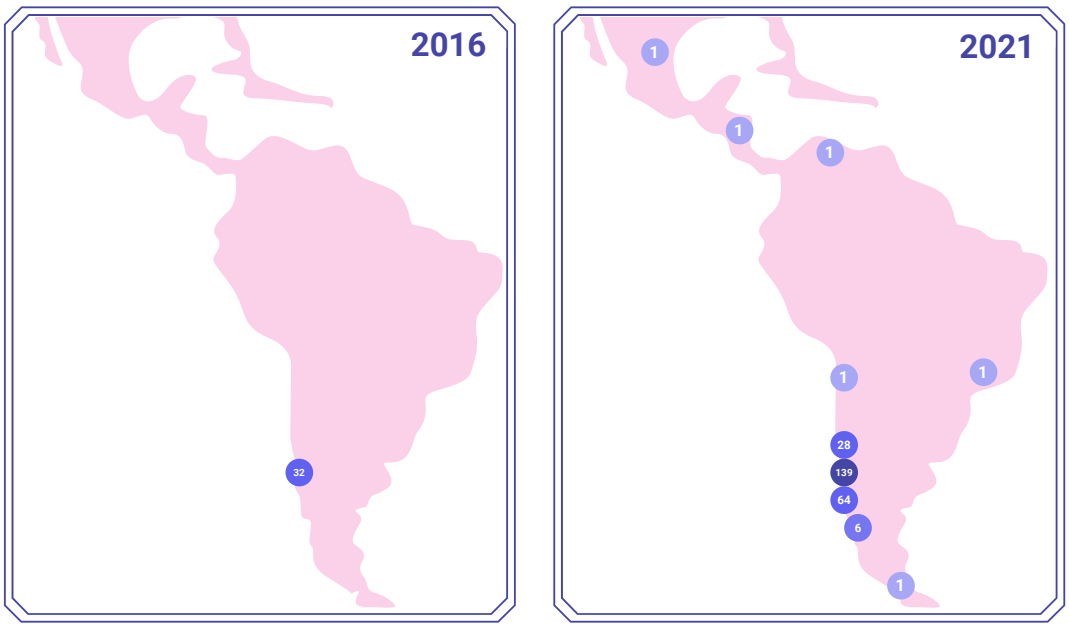
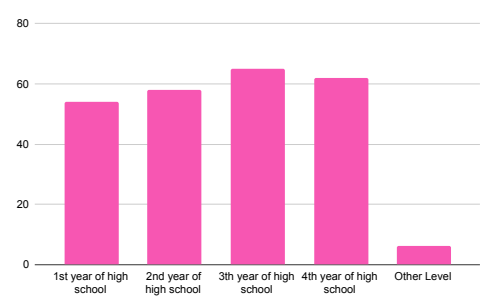



**Figure 2:** Students enrollment in Niñas Pro. The map highlights the number of students per geographic location of the annual Empower Project course.

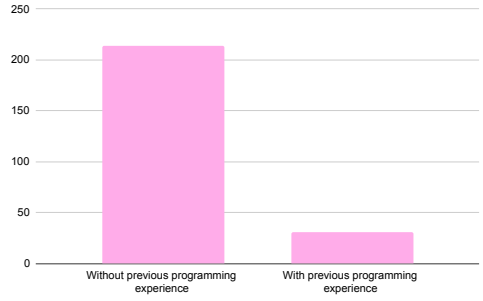
The number of enrollments in the Niñas Pro activities has increased over the years. In 2021, the number of girls enrolled in the annual Empower Project course reached 245. These students are geographically distributed throughout the country, and even encompassing other countries such as Panama, Mexico, Venezuela and Brazil as shown in Figure 2. The figure represents how much our organization has grown, not only in terms of numbers, also geographically.

Girls from different levels of high school partake in this course. As shown in Figure 3a, they are homogeneously distributed among the 4 levels of high school in Chile. There are also a smaller number of participants who were admitted to the program, despite being in lower levels.

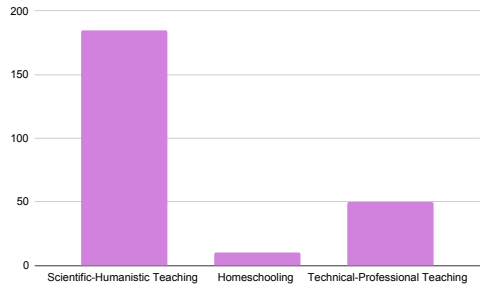
The course program is designed for girls who have no previous programming experience, although a percentage of girls decides to continue participating for more than a year and to



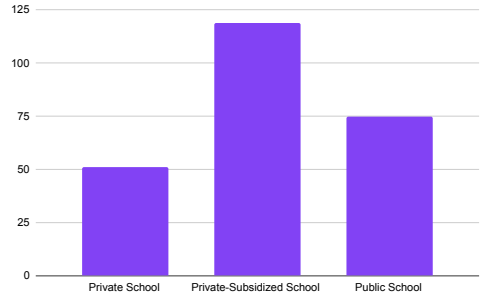

(a) Distribution by educational level




(b) Distribution by previous programming experience




(c) Distribution by type of education imparted by students' schools




(d) Distribution by type of school funding

**Figure 3:** Distribution of girls enrolled in the annual course of the Empower Project in 2021

reinforce their knowledge with the Boost Project. Figure 3b shows the distribution according to programming experience this year.

In Chile, schools are categorized by financing type into private, public and private-subsidized schools. Generally, the financing of the school in which the girl studies is correlated with her family's socioeconomic level. In our programs we seek to offer free courses so that girls can participate regardless of their families' income level. This year most participating girls attend private-subsidized or public schools as shown in Figure 3d.

Another relevant categorization is the type of education that each school provides, which can be either scientific-humanistic or technical-professional. Additionally, an increasingly common option in the country is home schooling. As shown in Figure 3c, girls participating in this year's course attend schools belonging to these different categories. Most of the girls attend schools that provide scientific-humanistic education. This type of school prepares its students to take the University Transition Test (PTU) and to continue a university career after high school. However, a significant number of participants attend technical-professional schools and declare their interest in complementing their studies with technological skills that will help them in their professional future.

### 3.2. Projects results

In the Inspire Project talks, the participants have realized that programming can be used in other areas of interest that they would not have imagined. In general, the speakers teach the participants lessons that they have been learned from their experience as professionals, making the students identify with them. In 2020, we had 22 talks to all public reaching 300 women and 20 talks to the students of the Empower Project during the classes. Thanks to forms filled out by the participants at the end of each talk, we can see that the speakers inspire and motivate them to continue studying programming and computer science. Below we share the answers of some participants to the question "What did you think of the talk, did it motivate you?":

> "Yes, it is very cool to see the different areas to which programming can be applied and how fundamental it is."

> "I found it very good!!! and I thought the guest is very talented. I learned about how programming can be used to find patterns in the brain fibers, and I realized that we can program in any area we want and we don't have to limit ourselves."

In 2020, we conducted 6 workshops relating to the Encourage Project with a total of 166 participants and our first event in 2021 attracted 71 participants. In those workshops, students can learn the basics of the Python programming language, how to develop animation with Scratch language, electronic basics, and new media arts.

In 2020, the Empower Project annual course reached about 95 girls, including the 4 branches. By the end of the course (i.e., four months later) there were 62 students participating regularly. In the last month of the course, we conducted a perception study through survey and focus groups with the participation of 56 students in the surveys stage, and 11 students in the focus groups; all from the different branches of Niñas Pro. This study measure the students' opinion on the course in general, contents, methodology, academic interests, among others. We found that the general perception of the students is that the course is interesting, useful, and with a suitable length. Also, what they like the most are the contents, the sorority, and the environment. On the other side, what they find most challenging is the advanced topic on the course and relating to their peers (due to COVID-19 pandemic).

As a result of the Boost Project in 2020 for the first time, 2 students of Niñas Pro reached the last phase (the third one) of the OCI with other 12 people. Two times before students of Niñas Pro had reached the second phase but never to the last. We believe that the intensive course was fundamental to this achievement. In the Arduino Quest event, 41 students participated in the first stage of the quest, and in the last stage, 34 students received the Arduino Kit. At the end of the course of the Empower Project, we asked the girls what class or activity they liked the most and many of them answered that the Arduino Quest because they could use programming for something more tangible than competitive programming exercises.

At the end of the activities and courses, we usually conduct social dynamics to find out the girls' perspectives. One of these dynamics is to invite them to identify themselves as a *Niña Pro* while asking them to draw and list the characteristics that a *Niña Pro* has. As shown in Figure 4, it is common for girls to identify themselves as a girl who interacts with technology and mention other skills such as perseverance, curiosity, resilience, or commitment.

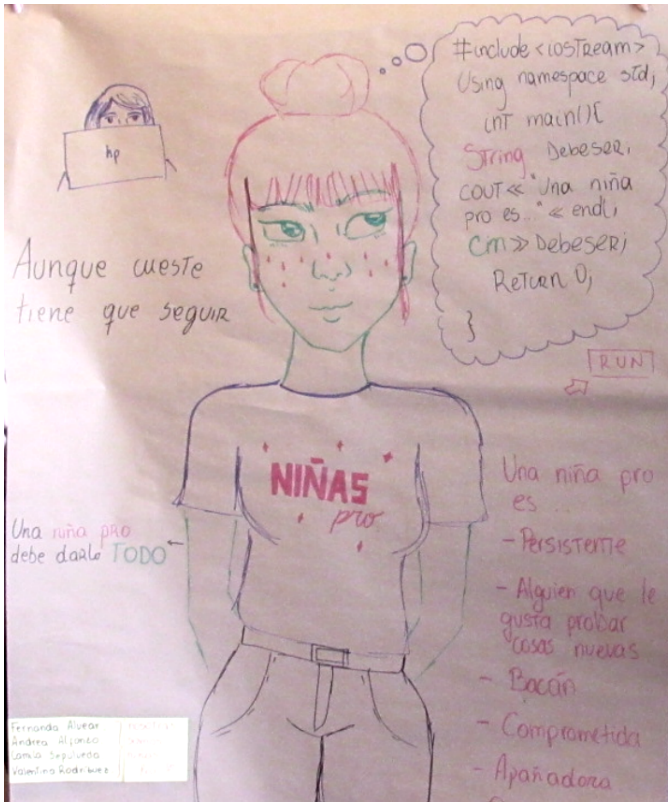



**Figure 4:** A drawing made by students at the end of the course. Phrases such as "even if it's difficult, you have to keep going" and "a *Niña Pro* is persistent, cool, someone who likes to try new things, committed" stand out.

### 3.3. The role of the volunteer tutor

Volunteer engagement is defined as a form of social participation that promotes a sense of community and represents a social action to serve the common good [27]. Therefore, volunteers are an essential part of Niñas Pro because as a non-profit organization, all the courses that we implemented work under a volunteer system. We have observed that the volunteers have similar interests and share a strong emotional identification with our organization. They have also accepted our goal and values, making a big effort during the year. 90% of them declared to be willing to take part in other activities besides the annual course. The only reasons volunteers have stated for withdrawing are scheduling problems or academic or workload.

Motivation, satisfaction, and responses to frustrating events all affect volunteer retention [28]. In Niñas Pro we have noted that volunteer motivation is closely related to community formation. A special case is in the Universidad de los Andes (Chilean university), where there are a small number of women in the Engineering Faculty, and all of them are part of the volunteer team at that location. Moreover, the volunteers involve their peers, such as college classmates, and even male volunteers who share the same ideals. Currently, 5 volunteers were students of the annual course from the Empower Project and study a STEM career.

## 4. Lessons Learned

We have organized the lessons we have learned over the past 5 years around five main topics: (1) defining the Niñas Pro educational model; (2) creating a diverse and multidisciplinary volunteer team; (3) professionalizing the volunteer program; (4) creating strategic partnerships; and (5) enabling continuous evolution.

1. Defining the Niñas Pro educational model has been an iterative process. Initial activities focused almost exclusively on teaching students how to code, in order to prepare them for programming competitions. This is still the core of the Niñas Pro educational model through the Empower project, but Niñas Pro now offers a much broader range of activities, like advanced classes for those that have already completed the Empower project course, and talks given by role models in STEM. The main focus of the educational model should be on creating student interest in STEM, but it also needs to keep volunteers motivated, since they are the moving force behind Niñas Pro.
2. Creating a diverse and multidisciplinary volunteer team is key in order to achieve sustainable growth over time. The initial group of founders and volunteers were all female computer engineering and computer science graduate students. As the organization grows, tasks in different levels of management arise. In order to manage this tasks this team has become more diverse, with both students and professionals participating as volunteers and organizers. For example, pre-service teachers helped define teaching strategies, and administration students helped evaluate student satisfaction with activities. It was also important to define organizational goals and a strategic plan to achieve these goals. Here, the support of administration and industrial engineering students was crucial. Niñas Pro now also has male volunteers, usually in supporting roles behind the scenes, like creating materials for activities, so that students see women in more visible roles. We invite other organizations to diversify their team to ensure growth in all areas.
3. Professionalizing the volunteer program is strongly recommended, since volunteers can affect students' views and perceptions about computing and STEM careers. In addition, we observed that the permanence of volunteers is closely related to their interests and motivation. To maintain these concepts at Niñas Pro we provide them with development opportunities according to their skills, for example, event management, material development, tutoring, among others. On the other hand, we periodically report the results of their work and how it impacts and contributes positively to the students and to create a trust environment, we organize casual events for volunteers to get to know and interact with each other. In terms of course materials, these are collaboratively created in a centralized manner, so that students get the same content and experience, wherever they are. We also use several tools to provide support for administrative and teaching tasks. For example, we use Slack and Notion to organize and document everyday activities, and Google Meet and online tools such as Google Classroom to provide automated feedback about student solutions. We are in the process of piloting the use of Niñas Code [29], our homegrown tool for giving students richer feedback about their code. All this effort requires work, but makes it easier to onboard new volunteers and start new branches. For example, we were planning to open the Coquimbo and Concepción branches before the

COVID-19 pandemic, with in-person activities, like the two Santiago branches. Once the lockdowns started, all Niñas Pro activities moved online, and the shared virtual spaces have helped strengthen the ties with the new branches. We have also seen a strong increase in student enrollment since going online because of the COVID-19 pandemic, as students no longer have to live near one of the four branches in order to participate. As shown in Figure 2, we now even have international students.

4. Creating strategic partnerships as a way of securing resources. Universities with computer science and engineering programs usually have computer laboratories that they can loan out over the weekend, and are an obvious initial partner. Institutions such as the Millennium Institute Foundational Research on Data or public initiatives such as the Explora National Program (https://explora.cl/) are also strong allies. Niñas Pro is a non-profit organization, but there are also operational costs like website hosting, event catering and printing. In the beginning, we negotiated sponsorships per event, working with tech companies like Microsoft and Entel Ocean. We are now moving to long-term sponsorship plans with companies like Fintual, giving Niñas Pro more flexibility when it comes to organizing activities. A rich online presence is key for attracting sponsors, and it is also a place where the community can build a shared identity. For example, Niñas Pro has its own website, as well as Twitter, Instagram, Facebook and LinkedIn accounts. Niñas Pro also frequently collaborates with other local women-in-technology groups like Technovation, Girls in Tech and Women Who Code, organizing larger events in order to help raise awareness about the low participation of women in technology in Chile.
5. Enabling continuous evolution through data collection and process improvement. We want to know if we are moving toward accomplishing our goals as a non-profit, and how we can carry out our mission more effectively. We are already collecting data about the execution of the various projects and programs that we run, but we need to systematize this process even more. We have also started working with a sociologist and a psychologist, in order to carry out more qualitative studies about the effects that our activities have on participants.

## 5. Conclusions and Next Steps

Girls need to hear about STEM careers early on, preferably from other women, to encourage their interest in them. In the case of computing, one-off programming workshops have a limited impact on participant aspirations. Women and girls need a safe space in which they can explore and learn what they can do with technology, as well as become part of a community of women with similar interests. To do this in a sustainable manner, you need to recruit a diverse and multidisciplinary volunteer team. Volunteers should to feel fulfilled by and supported in their work, which means that certain tasks, like creating course content, need to be centralized, and computational tools can also be used to improve student and volunteer experiences. This also enables the organization to expand its reach through the creation of new branches, with growing participation both in and outside Chile. It also means that Niñas Pro is more resilient in the facing with events such as the COVID-19 pandemic.

Organizations like these must look for support from universities, institutes and companies,

since its volunteer-based activities still require funding and resources. These institutions are interested in supporting initiatives such as Niñas Pro, since there are few women working in STEM industries and they are looking to decrease the gender gap in their own workplaces through encouraging girls and women to choose STEM careers. We are now in the process of defining new expansion strategies, like creating new branches in Chile and Latin America.

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