"ProgramADAmente": educational and social platform to bring programming closer to girls and teenage girls

Rebeca Fernández, Evelyn Kremer and Andrea Delgado

Instituto de computación, Facultad de Ingeniería, Universidad de la República, Julio Herrera y Reissig 565, Montevideo, 11300, Uruguay

Abstract

Worldwide, girls and teenage girls are progressively moving away from scientific areas from the last years of primary school, and particularly from the area of Computing. In the last 30 years, enrollment in the Computer Science career run by the Instituto de Computación (Computer Science Institute, InCo) of the Facultad de Ingeniería (Engineering School, FING) of the Universidad de la República (University of the Republic, UdelaR) of Uruguay, has been growing steadily, mainly by male enrollment, while female enrollment has remained below 20%. A group of female teachers from InCo has been working since 2016 with face-to-face activities and hands-on workshops in our school in the International Girls in ICT Day, for girls and teenage girls in Uruguay. With the COVID-19 health emergency, new virtual workshops were created in 2021 using existing programming platforms. From this initiative the development of the educational platform "ProgramADAmente" arises, named in honor of Ada Lovelace (1815-1852), recognized as the first programmer, with the aim of providing integrated access to various existing programming platforms, providing educational paths for different levels of learning. This article presents the platform "ProgramADAmente" and its main elements, as well as a survey of existing programming platforms, available web technologies and the infrastructure necessary for its operation. The platform was validated in an example of application with data from the workshop held on the International Girls in ICT Day in April 2022, and through its use in the "¡A programar!" ("Let's code!") workshop held in April 2023, where high school girls carried out the proposed exercises successfully, initially validating some of the benefits and capabilities provided and identifying improvement opportunities.

Keywords

Computing, Informatics, gender gap, web programming platforms, girls and teenage girls

1. Introduction

Worldwide, girls and teenage girls are progressively moving away from scientific areas from the last years of primary school, and particularly from the area of Computing, due to multiple social reasons and associated stereotypes[1, 2]. In the last 30 years, enrollment in the Computer Science career run by the Instituto de Computación (Computer Science Institute, InCo) of the Facultad de Ingeniería (Engineering School, FING) of the Universidad de la República (University of the Republic, UdelaR) of Uruguay, has been growing steadily, mainly by male enrollment, while female enrollment has remained below 20% [3, 4, 5].

This reality is worldwide [6, 7, 8, 9, 10] and has several effects on the discipline, firstly the loss of talents who could make great contributions by enriching the academic, scientific and professional areas, their own lives, and the entire society; a highly masculinized career where spaces can be reticent to women, with little diversity and in some specific fields almost none. Furthermore, women are left out of a professional area of work with high incomes in rapid development with many opportunities, and in Uruguay with zero unemployment.

A group of female teachers from InCo has been working since 2016 with face-to-face activities and hands-on workshops in our school in the International Girls in ICT Day, for girls and teenage girls in Uruguay [3, 4], which were published in 2020 in the web site ChicasTICs[11]. With the COVID-19 health emergency, new virtual workshops[5] were created in 2021 using existing programming platforms, in which 102 girls participated in the International Girls in ICT day that year. Specifically, the "¡A programar!"("Let's code!") workshop was created using the Gobstones platform[12], defining an educational path with three exercises provided by the platform for learning variables, repetition and conditionals.

From this initiative the development of the educational platform "ProgramADAmente" arises, which aims to bring the programming closer to girls and teenage girls in Uruguay, but it could be extended to other countries. Although there are several platforms with programming activities for children and young people in general such as Scratch[13], Blocky[14] or Code.org[15], many are in English, do not allow free use and the usage provided is mainly on demand. The name of the platform "ProgramADAmente" honors Ada Lovelace[16](Augusta Ada Byron, London, United Kingdom, 1815-1852), a British mathematician considered the first programmer, creator of the first algorithm for a computer.

Being able to provide more educational and social activities available is a necessary growth tool so that girls and teenage girls do not fall even further behind in their learning and environment, bringing them to programming and to Computer Science careers. In that sense, the platform "ProgramaADAmente" integrates existing programming platforms, including activities and videos to do and watch on demand, as well as real-time online workshops and activities aimed at girls and teenage girls, in which participants can interact with female teachers and female advanced students from InCo and with professional female graduates of the computing careers.

The platform was validated in an application example with data from the workshop held on the International Girls in ICT Day in April 2022, and through its use in the "¡A programar!" ("Let's code!") workshop held in April 2023, where girls from high school carried out the proposed exercises successfully, initially validating some of the benefits and capabilities provided and identifying improvement opportunities.

The rest of the document is organized as follows: in Section 2 we present the survey we carried out on existing programming platforms, in Section 3 we describe the platform "ProgramADAmente" along with its main functionalities and in Section 4 we present the validation we carried out. In Section 5 we describe the related work and finally in section 6 we present some conclusions and future work.

2. Survey of existing programming platforms

The main objective of the survey is to find existing programming platforms to be integrated into the "ProgramADAmente" platform, not to develop a new language or a programming platform, but to provide a platform that integrates different existing options, with offers of different languages and exercises to be used. Among the most important characteristics to evaluate in existing programming platforms are: language (Spanish, English), target age range (school children, teenagers), programming approach (blocks, code, object-oriented, icons, puzzle, 3D elements), cost (free, trial, paid, premium), presentation of activities (on demand, online, real time), type of activities (predefined, personalized). To find the largest number of existing platforms, we carried out several searches on the web with different search strings that allowed to be obtain results in the defined direction. First, we carried out searches in Google and Google Scholar with a search string in English ("programming teaching websites for children") to cover as many results as possible, and then with a specific search string in Spanish ("Español herramientas para aprender a programar para niños") to focus the results specifically on the Spanish language, which was the main interest. Table 1 presents the results of the survey of programming platforms and their main characteristics.

Of the 25 platforms analyzed, it can be observed that the majority are recommended for people over four years old, covering a wide range of ages. In terms of the languages in which the activities are available, more than two-thirds provide activities in English, a third in Spanish (and English), and approximately a quarter in symbols. About two-thirds are free but half of them include the premium extension for more features. More than three quarters are web (some also mobile), the vast majority offer on-demand activities, and as a programming language they are mainly divided between block and code languages, providing mostly predefined activities. Among the platforms surveyed, the following were selected as relevant platforms for integration: Scratch, Blocky, Code.org, Gobstones, Pilas Blocks, because they are web and provide predefined activities in Spanish.

3. Platform "ProgramADAmente"

The educational and social platform "ProgramADAmente" is web, made with free software, and free to use, although registration is required to participate in workshops and other activities, as a way to generate community with educational institutions. The main characteristics include the definition of activities with the possibility of creating associated teaching material and integrating exercises from existing programming platforms. These activities can be simple (exercise, workshop, webinar, talk) or compound (day that includes workshops or courses), have an associated format (in-person, virtual or hybrid), and can be carried out synchronously (the day and time defined) or asynchronous (activities accessible on demand). It is allowed to integrate activities from different existing programming platforms such as the ones listed in Section 2: Gobstones, Pilas Blocks, Blocky, Codepip, Tynker, among others. Figure 1 shows the initial screen with the list of activities, registration and login. Figure 2 shows exercises for some of the programming platforms integrated.

Table 1
Survey of existing programming platforms results

| Name	Age	Languages	Cost	Technology	Programming	Presentation	Type
Alice[17]	10+	ENG	free	desktop	Object Oriented	On demand	Pred+Per
Blocky[14]	8+	SPA,ENG	free	web	Blocks	On demand	Pred
CheckIO[18]	7-13	ENG	trial+paid	web	Code	On demand	Pred
CodaKid[19]	9+	ENG	trial+paid	web	Code	On demand,online	Pred+Per
CodeSpark[20]	5-9	symbols	trial+paid	web,desktop	Puzzle	On demand	Pred
Code.org[15]	4-14	SPA,ENG	free	web	Blocks	On demand	Pred+Per
CodeCombat[21]	7-16	ENG	free/premium	web	Code	On demand,real time	Pred
Codemancer[22]	6-12	symbols	paid	desktop,mobile	Puzzle	On demand	Pred
CodeMonkey[23]	9+	ENG	free/premium	web	Code	On demand	Pred
Codepip[24]	5-18+	SPA,ENG	free/premium	web	Code	On demand	Pred
Corkthevolcano[25]	8-18	symbols	paid	desktop,mobile	Puzzle	On demand	Pred
CodingGames[26]	4-16	symbols	free/premium	web	Puzzle	On demand	Pred
Flowlab[27]	12+	ENG	free/premium	desktop,mobile	Diagrams	On demand	Per
GamestarMechanic[28]	7-14	ENG	free/premium	desktop	icons,elem. 3D	On demand	Per
Gobstones[12]	6+	SPA	free	web,desktop	Blocks,Code	On demand	Pred+Per
Hopscotch[29]	10-16	ENG	free/premium	mobile	Blocks	On demand	Pred
Kidlo[30]	4-9	symbols	free/premium	web,mobile	Puzzle	On demand	Pred
Kodable[31]	4-11	symb.,ENG	trial+paid	web,mobile	Blocks,Code	On demand	Per
KoduGameLab[32]	8+	ENG	free	desktop	icons,elem. 3D	On demand	Per
Lightbot[33]	4+	symbols	trial+paid	web,mobile	Puzzle	On demand	Pred
MakeCode[34]	9+	ENG	free	web	Blocks,Code	On demand	Pred
Pilas bloques[35]	5-12	SPA	free	web,desktop	Blocks	On demand	Pred
Scratch[13]	8-16	SPA,ENG	free	web	Blocks	On demand	Pred+Per
Snap![36]	13+	SPA,ENG	free	web	Blocks	On demand	Pred+Per
Tynker[37]	5-18	SPA,ENG	trial+paid	web,mobile	Blocks,Code	On demand	Pred
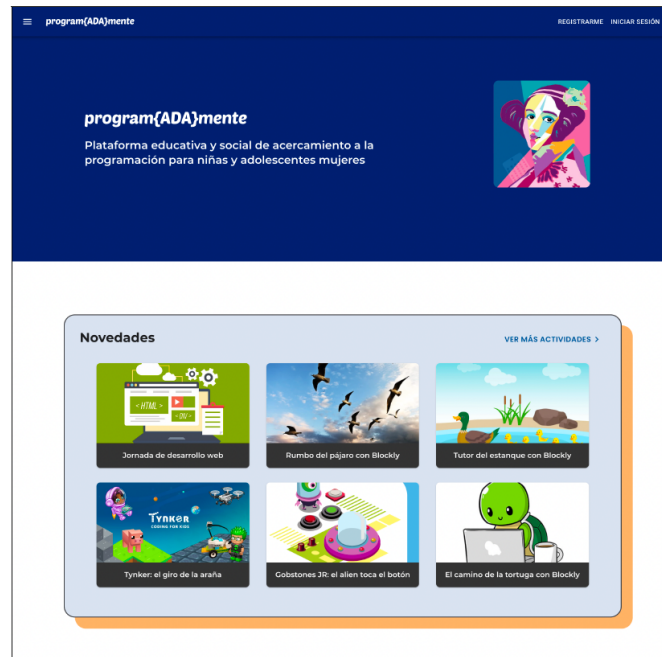
Figure 1: Platform "ProgramADAmente" initial screen with list of activities

For both on-demand activities and workshops, we are interested in being able to define educational paths that allow students to increasingly build knowledge based on previous activities. Educational paths refer to activities that are not specific, but are blocks of exercises that follow a logical predefined learning path. The activities can be defined as private or public, in the first case, they remain visible only to the teachers in order to continue editing the activity, adding teaching materials or activities in the case of compound activities. Public activities are visible to any user browsing the platform, but to participate in synchronous activities, registration is required, in the registration period defined prior to the date of the activity, which may be individually by a participant, or in a group form by a referent (for example from an institution with an associated group of participating girls). Registrations must be approved by teachers of the activity, allowing confirmation and record of the places granted. For this, support is provided for user administration and data collection of registrations and use of the platform. Once the activity was carried out on the defined date, its use is released on demand, so that any user can carry it out, including visitors (see Section **??** Validation of the Platform).

As social features, users are allowed to comment on activities carried out, as well as follow activities and users on the platform and publish news. The integration of an exchange forum is planned, among other functionalities, that allow providing a social network to bring girls and teenage girls closer to the area. We are also interested in generating a network of women in computing that connects the educational dimension with the professional and scientific practice, bringing women in the area and their experiences closer to girls.

Also, in the platform design we considered non-functional characteristics defined based on the ISO 25010[38] standard including: Performance, Usability, Security, Compatibility, Portability
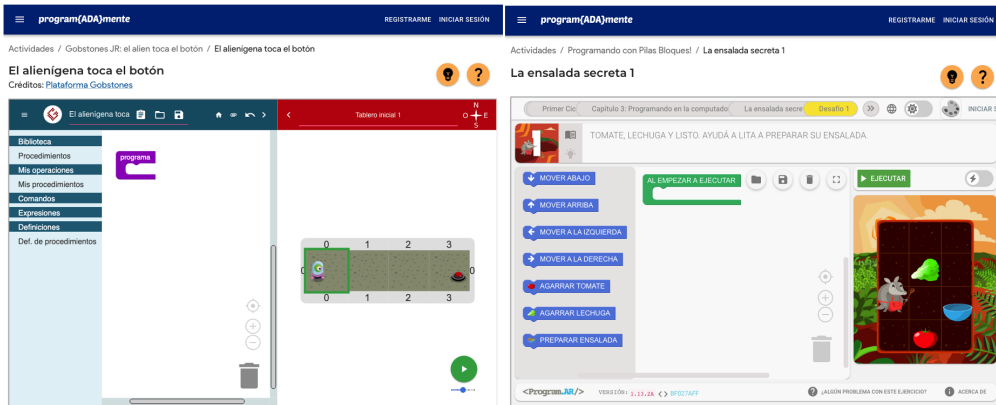
(a) Integration of platforms Gobstones and Pilas Bloques
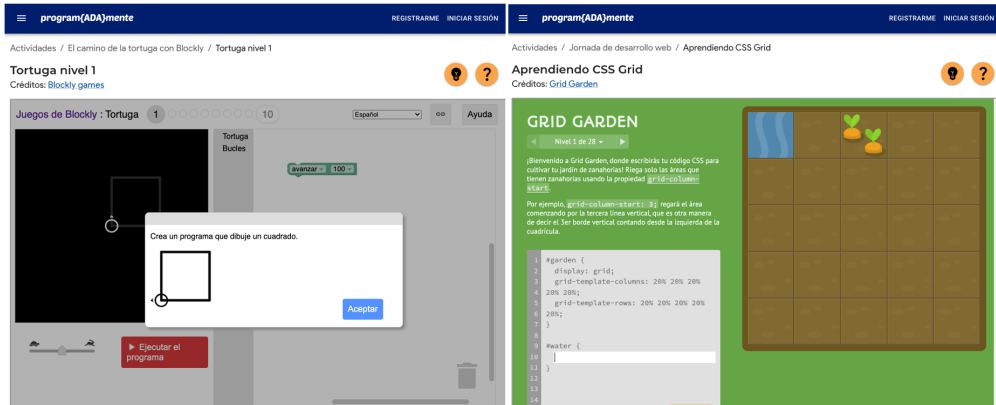
(b) Integration of platforms Blocky y Codepip

Figure 2: Platform "ProgramADAmente" integration of existing programming platforms

and Maintainability, which are not detailed due to space reasons. Relevant aspects include the use of the platform with concurrently connected users, the usability of the graphical interface with attractive design, images and appropriate color tones, security with roles and permissions for users and encrypted passwords, a responsive design for desktop and mobile devices, the integration of existing programming platforms and the possibility of integrating new ones, among others.

4. Validation of the platform

The platform was validated in an example of application with data from the workshop held on the International Girls in ICT Day in April 2022, and through its use in the "¡A programar!" ("Let's code!") workshop held in April 2023, where high school girls carried out the proposed exercises successfully, initially validating some of the benefits and capabilities provided and identifying improvement opportunities.

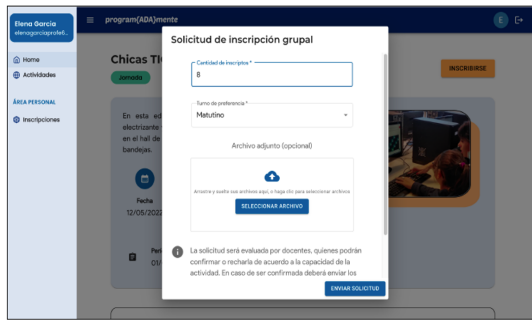### 4.1. Example of application in workshop Chicas TICs 2022

The application example focuses on the programming activity "¡A programar!" of the workshop Chicas TICs 2022 edition held on the International Girls in ICT Day on April 28, 2022. In that edition, we maintained the same content of the workshop from the virtual format carried out in 2021[5], in which the Gobstones platform was used, proposing an educational path of three programming exercises with blocks to work with variables, repetitions and conditionals. The information about the activity and the personal data of its participants and references in charge of registration were taken into account, to show a complete cycle of use of the platform.

The general workshop proposal follows the definitions made since the beginning of the workshops in 2017 [3, 4, 11] offering hands-on workshops where teenage girls from 1st to 4th grade of high school (12 to 15 years old) carry out activities of programming, circuits, maps, data and robotics, taught by female teachers and advanced female students from the Computer Science and Electrical Institutes, with a "role model" approach. The 2022 edition of the International Girls in ICT Day was the first of the returning to face-to-face activities that was held with workshops again at the Engineering School (FING), UdelaR, after the virtual activities carried out in 2021 [5], and the suspension in 2020 due to the COVID-19 pandemic (launch of the Chicas TICS website [11]). In 2022, the workshop was repeated on May 12 to reach more institutions that could not attend the original day in April, and due to the returning to in-person attendance, where more institutions wanted to participate after the virtual period.
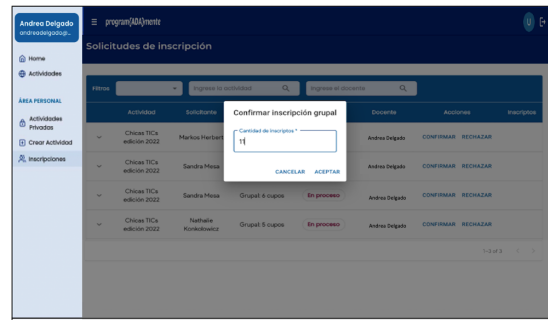
In both instances, the same scheme was repeated and the same five workshops were given: T1: Data Workshop, T2: Map your world, T3: "¡A programar!" Workshop, T4: Electrifying Workshop and T5: Morse-Vail Workshop, totaling 364 girls participating in the two days in all the workshops. The number of girls participating in the "¡A programar!" workshop was of 105 in both days, using for the validation the data from the day held on May 12 with 75 participants registered, as well as their representatives and institutions.

Figure 3 shows the registration screens on the platform "ProgramADAmente": (a) group registration by representatives of the participating institutions and (b) confirmation of participation quotas by teachers. Figure 4 shows the definition of the workshop as a compound activity and the workshop "¡A programar!" as one of the simple activities included in it. You can see the three exercises defined in the educational path to be carried out in the workshop with the Gobstones platform: (1) "Lucho turns on the lights (basic)" with variables and simple repetition; (2) "Super Lucho 1 (basic +)" adding conditional repetition and (3) "Super Lucho 2 (basic ++)" adding conditional within the repetition. The details of these exercises can be seen in [5] where the definition of the workshop "¡A programar!" for the virtual format is presented.

The example of application with data from the 2022 workshop in the International Girls in ICT Day allowed us carrying out several complete use cycles on the platform "ProgramADAmente", validating its suitability. In particular, teaching materials were created, a compound activity of the 2022 edition of the workshop Chicas TICs was defined, with date May 12, 2022, as well as the simple activities included, in particular the "¡A programar!" workshop with integration of the Gobstones platform and exercises. The registration request of the 75 participants for the workshop was recorded by representatives of the educational institutions, and the confirmation of the participation quota (for the "¡A programar!" workshop) for each request was recorded by the teachers. This allowed us to validate the functionalities provided on the platform.

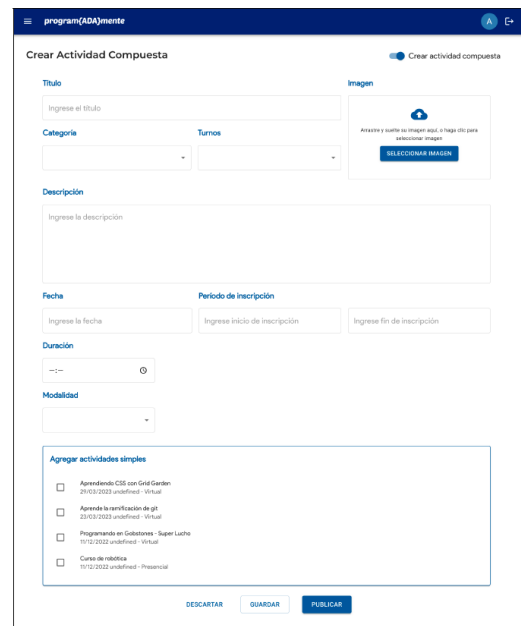(a) Group registration by institution representative   (b) participation quotas confirmation by teachers

Figure 3: Example of application workshop Chicas TICs 2022: registration and quotas

(a) Compound activity including simple activity   (b) Form to define compound activity

Figure 4: Example of application workshop Chicas TICs 2022: activities defined

4.2. Use in the "¡A programar!" ("Let's code!") workshop Chicas TICs 2023

The platform was used in the workshop "¡A programar!" ("Let's code!") of Chicas TICs 2023 workshop edition, held on the International Girls in ICT Day on April 27, 2023, in person at the Engineering School (FING), UdelaR. Same as in previous editions several workshops were held: T1: Data, T2: Robotics, T3: Programming, T4: Electrifying, T5: Code Hunters, totaling 230 girls participating in the day in all the workshops. In this opportunity, 76 girls participated in the "¡A programar!" workshop corresponding to T3 (40 in the morning shift and 36 in the afternoon shift). Although the "¡A programar!" workshop content used was the same
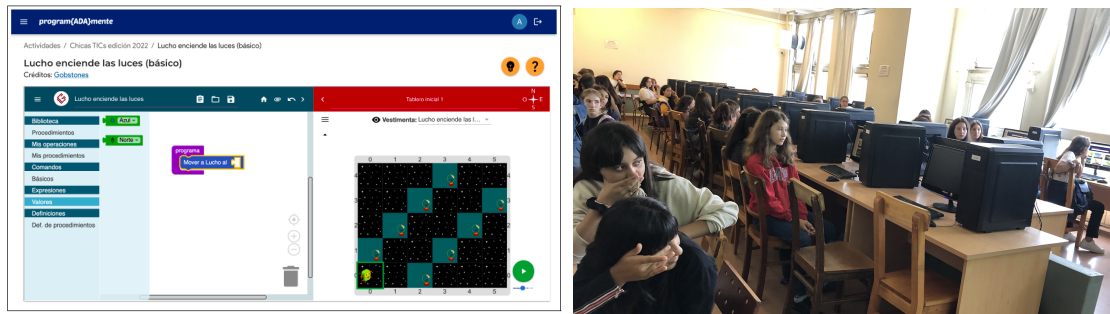
(a) Exercise with embedded Gobstones

(b) Computers room photo and participating girls

Figure 5: Use of the platform in the "¡A programar!" ("Let's code!") workshop in Chicas TICs 2023

as the one carried out virtually in 2021 and in person in 2022, the exercises were carried out on the platform "ProgramADAmente". That is, instead of accessing the Gobstones platform as before to carry out the exercises, we accessed the workshop day and specifically the "¡A programar!" workshop in "ProgramADAmente" and from there each exercise is executed with embedded Gobstones. Figure 5 shows: (a) the basic initial exercise "Lucho turns on the lights" with embedded gobstones, and (b) a photo of the computers room and the girls participating in the afternoon shift workshop, which was the one in which the platform was used. You can see on the screens the home page of the platform "ProgramMADAmente" with the activities loaded.

Although the registration cycle and confirmation of participation quotas could not be carried out through the platform due to availability on the dates of the event, the platform was used by participants to carry out the exercises from the "¡A programar!" workshop with embedded Gobstones, allowed for a complementary validation to the one previously presented. In this we focus on elements of usability, access and concurrent use of the platform and the exercises, as well as the execution of embedded Gobstones. Additionally, a small survey was carried out[1] to the participants to evaluate some of the main aspects of the platform, which although it had a small number of responses shows favorable indications in the girls' perception. In Figure 6 the answers to the questions asked are shown.

The questions are answered on the Linker scale from 1 to 5 with 1 = a little, 5 = a lot and are: Q1-Did you like the design and colors used on the platform?, Q2-Did you find the platform easy to use? , Q3-Did you like the exercises carried out on the platform?, Q4- Were you able to do all the proposed exercises?, Q5-Have you already used programming sites?, Q6-Would you like to do more activities on the platform?, Q7 -Would you recommend the platform to other students? It can be seen that the majority of the responses are in the range of 4 and 5, question P5 indicates that more than half of the girls who answered had used little or no programming platform, and those who did indicated knowing Scratch. This tells us that providing a platform like "ProgramADAmente" integrating different programming platforms and languages, as well as defining educational paths to guide programming learning, would be of great importance to bring girls closer to programming and to the computing area. In this way, we added another validation with focus on the users of the platform by carrying out an activity and its exercises.

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[1]Evaluation of use questionnaire platform "ProgramADAmente" 2023 https://forms.gle/rUB8WGqFoqZyc94q9
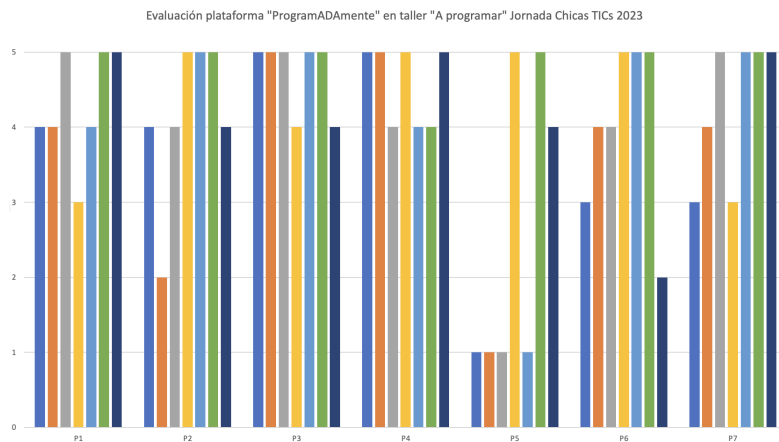
Figure 6: Answers to evaluation of platform "ProgramADAmente" workshop 2023

5. Related work

There are various international, Ibero-American and Latin American initiatives to promote STEM careers among girls and teenage girls, with a variety of approaches such as workshops, talks, courses, etc., generally in face-to-face format. Those from MIT[6, 7] and Carnegie Mellon[8] from the USA, from Spain [9] and Meninas Digitais from Brazil[39] can be highlighted. In recent years, several studies and initiatives have been presented in most Ibero-American and Latin American countries at the Latin American Women in Computing Congress (LAWCC)[40] from Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Spain, Panama, Paraguay, Uruguay and Venezuela. [41] presents a survey of some of these initiatives that are being carried out to reduce the gender gap in IT, with various projects and workshops. Regarding programming platforms, the survey that we present in Section 2 shows several existing platforms that mainly provide videos and exercises on demand, but do not provide or allow defining educational paths and do not have a gender focus as our proposal does.

6. Conclusions

In this article, we presented the educational and social platform "ProgramADAmente", which provides a web environment with integration of existing programming platforms (and associated survey), for the definition and implementation of activities and educational paths, to bring programming closer to girls and teenage girls. Exercises from several existing programming platforms such as Gobstones, Pilas Blocks, Blocky, etc. were successfully integrated, being extensible to others. The teachers can create exercises within educational paths that the participants can carry out in compound and simple activities, with teaching materials of different types. Support is also provided for users management and registrations to activities in real time that have participation quotas associated and must be confirmed by teachers.

The validations carried out allow us to initially confirm some of the features and capabilities

provided by the platform, and identify improvement opportunities for future versions. We plan to do more validations in specific activities, for example within the Ada Lovelace Day[2] which has been celebrated on the second Tuesday of October since 2009, in which the achievements and contributions of women to Science, Technology, Engineering and Mathematics (STEM) are recognized. We believe that the use of the platform could have a great contribution in the social area and will contribute to continue bringing programming closer to girls and teenage girls in our country, with specific activities defined in an environment which contributes to their motivation, interaction with and visualization of women working in the area.

As future work we plan to extend the platform with functionalities that have not yet been integrated, such as forums, and financing is being sought to be able to release it for open use not only in Uruguay but throughout Latin America and Ibero-America, for which we should consider some additions and infrastructure as multitenant.

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