Encouraging girls involvement in Information and Communication Technologies (ICT) careers in Uruguay

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Abstract

The gender gap in the fields of science, technology, engineering, and mathematics (*STEM*) is regrettably universal and generally unacceptably broad. This phenomenon refers to women's underrepresentation in those fields, with the most significant disparities occurring in the critical fields of Electrical Engineering and Computer Science (*EECS*) and Information and Communication Technologies (*ICT*). The so-called pipeline problem contributes to this persisting gender gap, where women turn away from math and science at a young age due to negative stereotypes that cause them to believe they do not belong in STEM. All over the world, universities and organizations carry on initiatives to close this gap, showing varying degrees of success. Many of these programs focus on K-12 and high school girls, seeking to expose them to STEM-related activities to encourage girls' enrollment in STEM careers. Involving female teachers, and applying the *role model* approach, these programs offer in campus presentations, talks, or short courses aimed to break down stereotypes. In this article, we describe different sensibilization activities carried out at Facultad de Ingeniería (School of Engineering), Universidad de la República, Uruguay, to promote ICT careers in Uruguay. In particular, we present hands-on workshops for high school girls on robotics, electronic circuits, and geographic information systems on the occasion of the Girls in ICT Day.
Keywords: women and ICT careers, role model approach, International Girls in ICT Day

1 Introduction

The wide gender gap between male and female participation in science, technology, engineering, and mathematics (STEM) degrees, and most notably in Electrical Engineering and Computer Science (EECS) and Information and Communication Technologies (ICT), is a universal problem. International organizations such as the European Union, UNESCO, the Organization of Ibero-American States (OEI), IEEE, ACM, universities in the United States, Latin America, and Europe have tried to design programs to deal with this critical problem, achieving different success levels. Scholarly research reveals that women and minority women are lost at every educational transition point on their way to a STEM career. Women move away from science and math as early as elementary and middle school through the first year of college and again between bachelor and advanced degrees.

Uruguay is not an exception, and the study "Mujeres e Ingeniería en Computación de la UdelaR, Uruguay: Cambios y permanencias"[1] seeks to identify the factors that act as a gender barrier in engineering degrees at Universidad de la República (UdelaR). According to this work, the main factors are the weight of gender roles and stereotypes (for example, the relationship between motherhood and domestic responsibilities with

professional and academic careers), the collective imaginary about what is perceived as reasonable or appropriate for women, the lack of incentives to the insertion of women in scientific-technological disciplines, and the real possibilities of women to achieve high-qualified positions.

In UdelaR, although the number of female students exceeds that of male at the grade level, the proportion of women that choose engineering careers is comparatively small. Women tend to prefer the areas of Social Sciences, Health Sciences, Agrarian, and Humanities. Diverse studies have focused on analyzing why engineering continues to be so reticent to the inclusion of women, as mentioned in [1]. That work presents the results of the analysis of historical data, showing that although there is a sustained increase in the enrollment in the Computer Engineering degree, the gender gap has worsened. In relative terms, more male students choose Computer Science degrees than female students.

Table 1 shows the number of enrolled students in the Computer Science and Electrical Engineer degrees at UdelaR in the last ten years. The table presents, for each year, the number of enrolled female (F) and male students (M), and the percentage that female students represent over the total (% F). The enrollment of women is around 15% and 20% in Computer Science and Electrical Engineer degrees, respectively. A retrospective analysis shows that in the 90s, these percentages were around 30% and 10%, respectively.

Table 1: Female and male students enrollment in Computer Science and Electrical Engineering at UdelaR (2008 - 2018)

Year	Computer Science				Electrical Engineer			
	F	M	T	%F	F	M	T	%F
2008	92	462	554	17%	36	151	186	19%
2009	103	442	545	19%	35	138	173	20%
2010	118	546	664	18%	33	158	191	17%
2011	108	543	651	17%	37	165	202	18%
2012	104	486	590	18%	36	176	212	17%
2013	107	551	658	16%	49	197	246	20%
2014	82	570	652	13%	59	190	249	24%
2015	97	524	621	16%	37	194	231	16%
2016	99	560	659	15%	43	202	245	18%
2017	75	472	547	14%	39	105	144	27%
2018	96	502	598	16%	47	152	199	23%

In Uruguay, the software industry generates exports for more than 190 million dollars, and intensively demands skilled human resources. In this sense, the Uruguayan Chamber of Information Technology (CUTI) claims that one of the challenges for the following years is the increase of the human capital in ICT [2, 1]. The enrollment and permanence of women in Computer Science and Electrical Engineering degrees is, therefore, a central concern, and represents a complex phenomenon marked by various advances and setbacks in gender equality.

In recent years, several initiatives intend to bring science and technology careers closer to women, seeking to reverse the sustained drop in female enrollment. Various actors of education, government, civil society, and the software industry participate, including the Facultad de Ingenieria (School of Engineering) at UdelaR. In particular, the annual celebration of the International Day of Girls in ICT each April has proper levels of participation and dissemination by the media. This article presents different activities carried out by teachers and researchers at Facultad de Ingenieria to promote ICT careers in high school girls in Uruguay.

The rest of the article is organized as follows: Section 2 presents similar initiatives that tend to encourage girls' participation in ICT careers. In Section 3, we present the activities performed at Facultad de Ingeniería in the context of the International Day of Girls focusing on a set of hands-on workshops, while Section 4 discusses collected data and some preliminary results. Finally, Section 5 presents conclusions and future work.

2 Related Work

One of the most outstanding examples of efforts to reach female students at secondary school level in the United States is performed by the Massachusetts Institute of Technology (MIT) through the Women's Technology Program (WTP)[1] and the MIT Women's Initiative (MWI)[2]. The former invites high school teenage girls to college during the summer to receive advanced instruction and encourage them to technological areas

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[1] http://wtp.mit.edu/
[2] https://web.mit.edu/wi/

[3]. The latter sends women affiliated with MIT to high schools to inform girls on different specializations and technological careers.

Some international initiatives, such as Technovation Girls [3] and BlackGirlCode [4], propose competitions where girls have to solve different challenges, guided by specialized mentors. In Latin America, the trend of women's participation in STEM does not escape the global leaning, and there are also specific programs to promote the participation of women in these areas. Several studies presented at the Latin American Women in Computing Conference (LAWCC), a satellite event of the Latin American Conference on Information Technology (CLEI), show similar realities in Argentina, Brasil, Costa Rica, Paraguay, and Venezuela.

The survey "Women in ICT careers: history, present and future challenges", presented at LAWCC, and also published at Novática [4] collects studies describing the problems linked to the low participation of women in ICT careers, also proposing activities to improve girls participation. In particular, it reviews the situation in Spanish universities, paying particular attention to scarce female participation and permanence in ICT careers, accompanied by women underrepresentation in leadership in higher education and faculty staff.

In Brazil, the "Meninas Digitais" program [5] organized by the Brazilian Society of Computing (SBC) endorses a set of practices to encourage the participation of women in ICT, and Educational Robotics Engineering careers, including organizing activities and workshops that involve female high-school students. Since 2011, the Fórum Meninas Digitais at the Women in Information Technology workshop [5] is one of the initiatives of this program to discuss matters related to gender issues in ICT in Brazil, showing success stories and incentive policies to improve girls' enrollment in ICT careers. Also in Brazil, the Instituto Federal de Sao Paulo (IFSP) carries out a program targeted at primary and secondary school girls, but also to IFSP students from fields not related to STEM that includes talks, visits, workshops, and mini-courses [6]. In Minas Gerais, a sensibilization experience on Computer Science topics has been carried out. It involved high-school students (25 girls and 14 boys) that after the activity showed a significant increase in their interest in Computer Science [7].

3 Girls in ICT Day

Since 2011 the Girls in ICT Day[6] is a worldwide initiative promoted by the ITU (International Telecommunication Union) to encourage and empower girls and young women to consider studies and careers in the growing field of ICTs. A key element is to open the doors of academic institutions, ICT companies, and scientific-technological spaces to girls in elementary school and high school, and give them the opportunity to contact these areas. For several years, the Facultad de Ingeniería has celebrated this day inviting high-school students to visit research labs at Computer Science Institute (InCo) and Electrical Engineering Institute (IIE). In the following section we describe this activity.

3.1 General Description of the Activity

The activities evolved from posters exhibitions and guided tours to hands-on workshops for groups of female high school students. Adopting the motto "doing instead of watching" since 2017, girls can experiment directly with the technology, working in different assignments related to ICT. All the activities are organized by female teachers and researchers of InCo and IIE, following a role model approach, as a way to show girls female participation in fields like electrical engineering and computer science. Figure 1 shows the posters for the 2017 and 2018 editions, and the upcoming 2019 edition of the Girls in ICT Day.

Three workshops lasting an hour and a half each were carried out, so that girls could interact with the "Butiá" robot [7], experiment with analog circuits, and create digital maps. For the 2019 edition two new workshops were added to play with mathematics and experiment with physics. The call for participation was spread by the university teachers themselves, so as to establish direct contact with educational institutions and sensitize their authorities to the issue regarding the low participation of women in ICT careers, and to engage them into participating.

In 2017 the activity was realized in two shifts, and each group of girls could participate in two different workshops in each shift. In 2018, in order to increase the number of participating groups, three shifts were carried out, but each group could take part in just one workshop. Both editions included an initial activity where the Dean of Facultad de Ingeniería welcomed the girls and the stand-up group Bardo Científico [8]

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[3]https://technovationchallenge.org/
[4]http://www.blackgirlscode.com/
[5]http://csbc2019.sbc.org.br/eventos/13wit/
[6]https://www.itu.int/en/ITU-D/Digital-Inclusion/Women-and-Girls/Girls-in-ICT-Portal/Pages/Portal.aspx
[7]https://www.fing.edu.uy/inco/proyectos/butia/
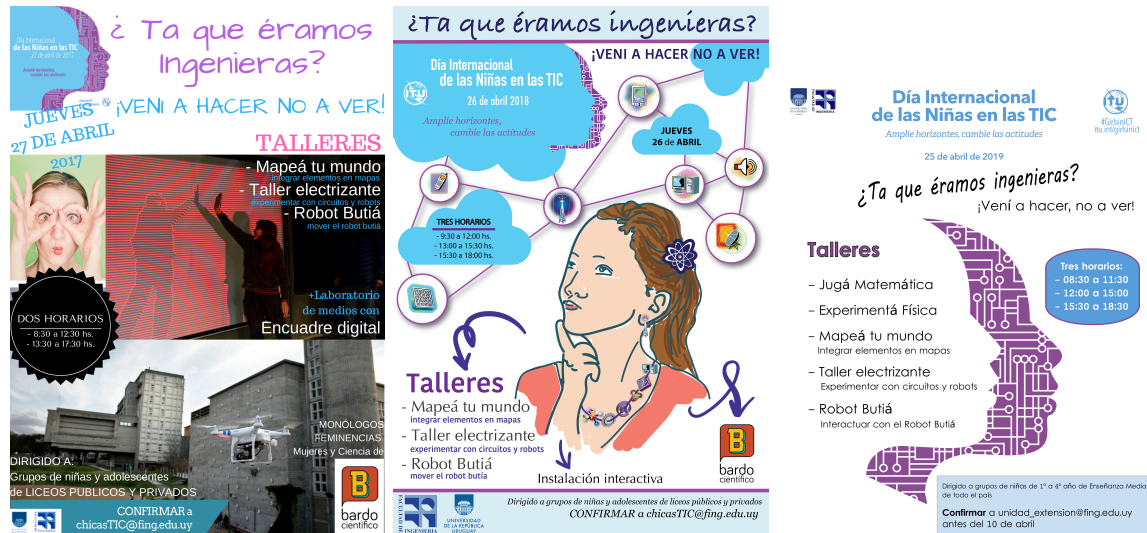[8]http://bardocientifico.com/

Figure 1: Posters for 2017, 2018 and 2019 editions of Girls in ICT Day.

performed monologues about famous female scientists. In addition to the workshops, the MediaLab group [9] set up an interactive installation "Encuadre Digital". For the 2019 edition we kept the three shifts definition of the 2018 edition but taking the two workshops per shift from the 2017 edition: the first workshop will be on mathematics or physics, and the second one will be any of the original three workshops.

We describe in the following the three workshops carried out in the 2017 and 2018 editions entitled: "Robot Butiá", "Mapeá tu mundo", coordinated by InCo teachers, the later with help from the Instituto de Agrimensura (Land surveyor Institute), and "Taller Electrizante", coordinated by IIE teachers. We also describe the interactive installation that accompanied the workshops. The mathematics and physics workshops are new to the 2019 edition so they are not included in the description.

3.2 Description of the workshops

In the days prior to the event, the teachers in charge of the workshops prepared the materials needed for the activities and trained some Engineering students and teachers from other disciplines who volunteered to help. The event counted with logistic and financial support from Facultad de Ingeniería, InCo and IIE. In the following, information about the most relevant aspects of each workshop is presented.

3.2.1 Computer Science Workshop "Robot Butiá"

The project "Butiá educational robotics" [10] is a simple platform that puts within reach of school and high school students the necessary tools to allow them to internalize with the programming of behaviors for robots.

The Butiá project seeks to expand the sensory and performance capabilities of the XO computer of the OLPC project (or another educational netbook), transforming it into a mobile robotic platform. Currently the implementation 2.0 of the project is being used as a kit, distributed to more than 100 schools in Uruguay, with a set of sensors and parts that allow changing the location of the sensors on the mobile platform where the computer is placed.

In addition, the Butiá project was developed taking into account the fact that adding new sensors or actuators to the platform is very simple, this opens up the possibility that users interested in hardware can easily implement their own sensors and actuators. Even the design of the robot is open, which allows it to be made with recycled or low-cost materials.

In this workshop, we seek to generate interest and motivation in robotic students, through the use of Butiá robot and to introduce it as another educational tool. The workshop consisted of two parts, first, a small expository class and then a workshop where the students used the Butiá robot. During the presentation, the following topics were discussed:

- Brief presentation about the MINA group of the InCo, in particular, some of the research projects that are being carried out.

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[9] https://www.fing.edu.uy/grupos/medialab/
[10] https://www.fing.edu.uy/inco/proyectos/butia/

- Brief introduction to robotics, where among other things, was explained what a robot is, what an actuator is and what a sensor is.

- Presentation of the Butiá project.

- Presentation of the Butiá robot, its parts and how it is used.

- Programming of the Butiá robot, based on the challenges.

All the groups showed great interest and enthusiasm in the workshop. In Figure 2 you can see a group of girls performing the challenges in the Butiá robot.

Figure 2: Girls doing the challenges in the Butiá robot.

In the second part of the workshop were created groups of 5 students, a robot per group was given and different challenges were presented. As they solved each challenge, more difficult new ones were presented. Most of the groups could solved the most difficult one, which consisted in making a program that allows the robot to avoid obstacles.

Below are all the activities that should have been resolved during the workshop. The code to solve the activities is available in Figure 3.

- Activity 1: The robot must go forward for 2 seconds, go backward for 3 seconds and stop.

- Activity 2: The robot moves to describe the shape of a square.

- Activity 3: Connect a button sensor, while no one presses the button, the robot must remain still, when someone presses the button, the robot must advance for 4 seconds and stop.

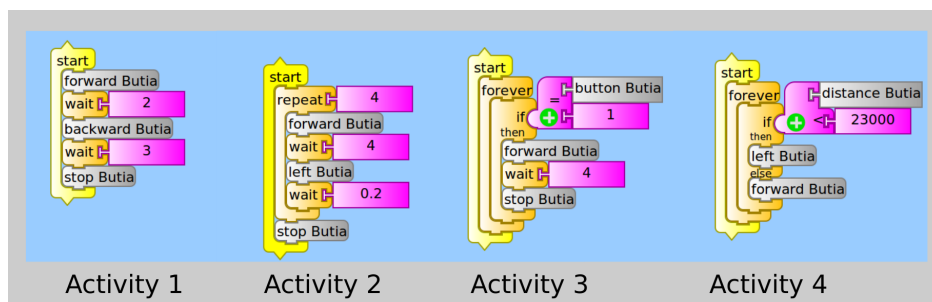- Activity 4: Connect a distance sensor and avoid obstacles using that sensor.

Figure 3: Activities to resolve during the workshop.

Butiá robot   The Butiá robot (see Figure 4) is a low-cost robotic platform, which seeks as its primary objective to make the most of the computer as an element of the robot and not as a tool to only program its behavior. This use was made at the level of computing power, storage, communication, and sensory capabilities (camera and microphone) present on the computer.

The Butiá robot also increases the sensory and acting capabilities of the computer through additional hardware that connects to the USB port, the USB4Butiá board, transformed the computer into a mobile robotic platform with high interaction power with the environment.

The robot is distributed in kit format, allowing through acrylic pieces to change the location of the sensors available on the platform, opening a range of problems that can be solved depending on how they are arranged.

The USB4Butiá board is a USB device that allows control of sensors and actuators. The USB4Butiá device can be manufactured both manually, with components and tools available in the local market, and in scale production. The board has six generic ports of input-output to connect sensors and actuators of the kit with plug and play and hotplug support.

TortugArte is a Sugar activity inspired by Logo, which puts programming concepts within reach of children, through an iconic graphic interface, where each instruction is mapped as a block. The Butiá project made modifications to TortugArte by adding some plugins (see figure 4) in the form of pallets that allow controlling different robotic kits, including Butiá.

The Butiá robot has plug and play and hotplug support for the sensors/actuators that connect to it, changing the color of the blocks corresponding to the sensing/acting elements according to what it is connected to the robot.
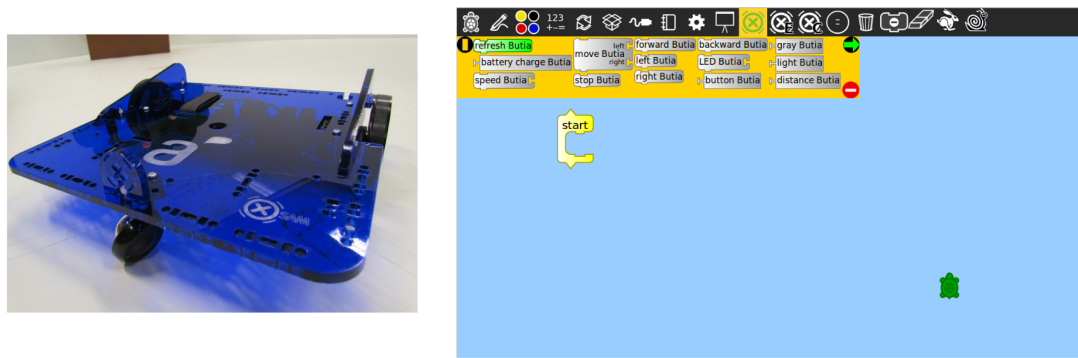

Figure 4: Butía robot (left) and the plugin for TortugArte to program the robot (right).

It is important to highlight that we had the support of Butiá project, which borrowed us the robots and everything that was necessary to carry out the workshop. Is also important to point out the support of other InCo teachers, students and graduates of the Computer Career who helped students so that they could meet the challenges.

3.2.2   Electrical Engineering Workshop "Taller Electrizante"

The aim of this workshop was to show several aspects of the different disciplines related to Electrical Engineering. Particularly, the activities focused on electronics, robotics, programming, wireless communication and signals. The two activities proposed, "Laser Communication" and "Robotics with Arduino", were conducted by teachers of IIE and Electrical Engineering students. In the following both activities are described in detail.

Laser Communication.   The goal of this activity was that participants could make an approach to the area of data transmission through the interaction with analog circuits. The idea was to assemble a distance communication system consisting of a transmitter, which receives luminous impulses and reproduce them in the form of laser light, and a receiver with a light sensor that transforms the laser light emitted by the transmitter into an audio signal through a speaker. See Figure 5.

The transmitter consisted of two main modules: voltage regulator and light detector. On the other hand, the receiver had a light detector module and an audio emitter module. Light Dependent Resistors (LDR) were used in the light detector circuits. See the schematics in Figure 6 and the list of the electrical

components and its characteristics in Table 2. The circuit design was done by advanced female students with the assistance of electronic teachers[11].
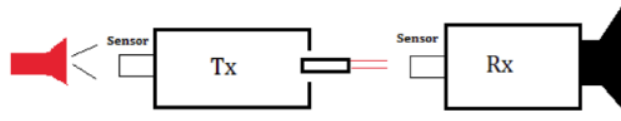

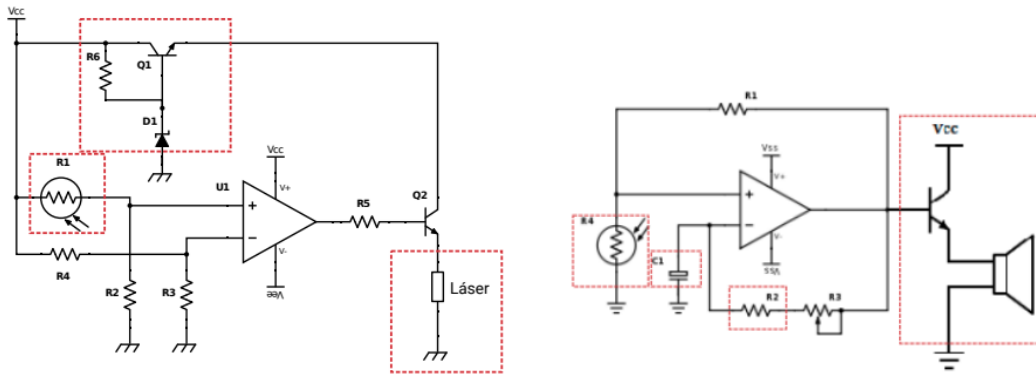Figure 5: Laser communication system.

Figure 6: Schematic circuits of transmitter (left) and receiver (right). The boxed components were removable and had to be placed in the circuit by the participants. (*) Participants experimented with different values of R_2 in order to obtain different sound frequencies.

Table 2: Electrical components of schematics of Figure 6.

Transmitter		Receiver	
R_1	LDR	R_1	$10k\Omega$
R_2	$100\ k\Omega$	R_2	(*)
R_3	$100\ k\Omega$	R_3	$10\ k\Omega$ potentiometer
R_4	$1.8\ k\Omega$	R_4	LDR
R_5	$56\ k\Omega$	operational	TL072
R_6	$82\ \Omega$	C_1	$1\ \mu F$
Q_1/Q_2 transistors	BC547C	transistor	MJ413
U_1 operational	TL072		
D_1	1N4732		

The participant girls were organized in two groups: one worked on the transmitter and the other on the receiver. At the end of the workshop, the groups tested the communication between them. Each group was provided with a kit for the circuit assembly (either transmitter or receiver) and a support guide with the description of the elements to be used.

The workshop started with a brief introduction by the instructors, which comprised the operation of circuits and basic security rules. Then, the girls were organized in teams and the assembly kits were distributed. With the assistance of the instructors the teams tested the developed circuits, and finally, tested the connections between the transmitters and receivers.

For some teams, the guidance and constant assessment of the instructors was essential. It was also necessary to have spare components in case of failure or loss. Every team completed the task successfully. Figure 7 shows girls working in the Laser Communication Workshop.
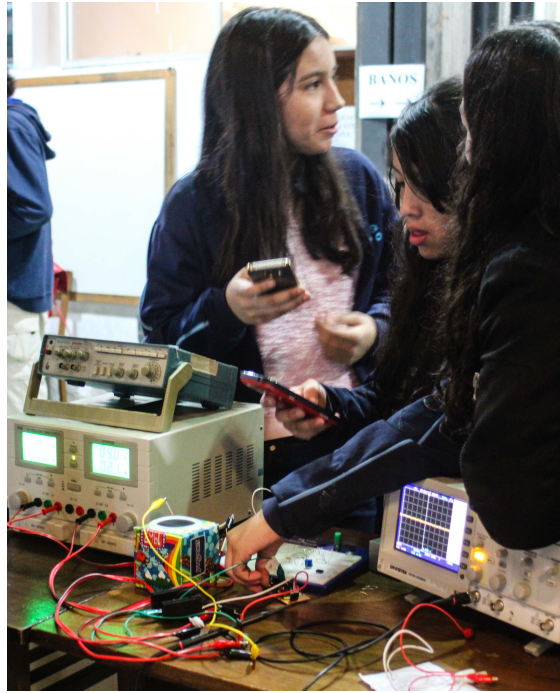

Figure 7: Electrical Engineering Workshop: Laser Communication.

Robotics with Arduino. The goal of this activity was that participants could have their first contact with micro-controllers and robotic systems. The girls were provided with a guide that included programming tips and a detailed description of the activity. During the workshop, the advantages of free hardware and software were highlighted.

The workshop started with a brief introduction of the instructors, followed by a presentation of the activities. Then, girls were organized in teams and instructions were provided to perform three sub-activities. The first one focused on the experimentation with simple code on Arduino[12] (turning a led light on and off). For the second activity, each team was provided with a simple robot (the kit consisted of a DC-engine[14] and two wheels connected to an Arduino board) and a basic example of Arduino code. Participants had to understand the code and modify it in order to achieve different tasks with increasing level of difficulty. The main idea was to move the robot in different ways controlling the digital and analog outputs of the micro-controller. The third activity consisted of the use of light and ultrasound sensors to control the robots.

Although for the most girls this was their first experience with programming and robots, all the teams managed to complete the proposed tasks.

3.2.3 Computer Science Workshop "Mapping your world"

This workshop was proposed by teachers and researchers from the Geoespatial Information Technologies Group[15]. The workshop starts with a brief history of cartography and the Earth representation, an introduction to Geographic Information Systems, Systems on Internet, map servers, viewers and some applications. This part is based on PPTs but it's about being interactive with the participation of girls.

The second part of the workshop is hands-on, where students work in pairs, in the computers lab, to complete the following challenges:

- Interactively explore a customized web map viewer that shows information of Montevideo and has a marker on the Engineering School (with options to activate and deactivate several layers of data[16]).

- Find the location of their own high school and capture its coordinates.

- Edit javascript code to add a marker on their high school location.

- Use visual tools in spatial exploration, measuring distances and areas.

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[12] Arduino UNO[13]
[14] Driver: L298D
[15] Group with researchers of the Computer Science Institute and the Survey Institute
[16] Data published as Open Data: https://catalogodatos.gub.uy/

- Access the Map Server Admin Interface to change the configuration of layers symbology.

During these years all the teams managed to complete the proposed tasks, and several teams explored beyond the aspects proposed. Some teams added extra reference points to the maps besides the one proposed by the teachers, some teams explored the area of their highschool and hers homes. Figure 8 shows girls working in these activities. The workshop is based on free software: GeoServer[17] as Map Server and Open Layers[18] as Map Viewer, both running on a local Tomcat Apache Server[19].

Figure 8: "Mapping your world" Workshop.

The software and instructions for the hands-on part of the workshop were prepared the first year with Computer Science female students that also helped during the workshop. The map viewer was customized to show the coordinates with the double-click, as showed in Figure 9.
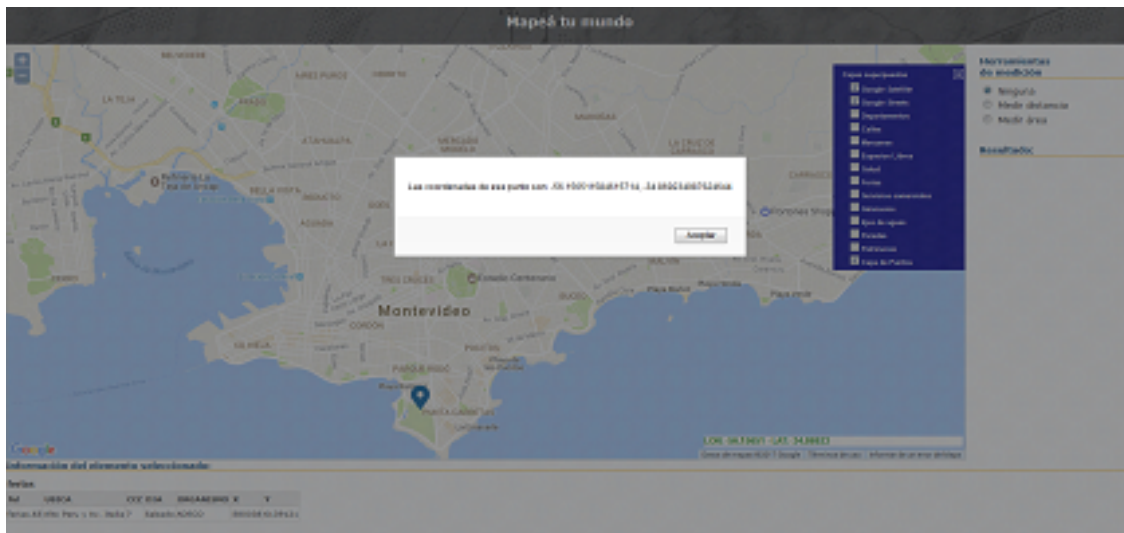
Figure 9: Coordinates Capture.

The students have some hints to edit javascript to include the coordinates of their highschools. This is showed in the Figure 10. The material and activities were planned to be carried out in an hour and a half

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[17]http://www.geoserver.org

[18]https://openlayers.org/

[19]http://tomcat.apache.org/

without previous knowledge of javascript or mapping. The map viewer offers many possibilities to explore spatial information, but the workshop focuses on programming and the web server administration to change map appearance.

```
155    //----------------------
156    // AGREGAR NUEVO PUNTO
157    //----------------------
158    // point = new OpenLayers.Geometry.Point(x,y);
159    // point = point.transform(proj4326, map.getProjectionObject());
160    // coordenadas.push(point);
161
```

Figure 10: Javascript Code with hints.

An extra bonus is that high school teachers were provided with the instructions, the code, and the data used in the workshop to replicate the experience at school. The software of the workshop can be downloaded from https://www.fing.edu.uy/~raquels/apache-TallerMapea.zip.

3.2.4 Interactive Installation "Encuadre Digital"

"Encuadre Digital" is an interactive installation developed by the MediaLab of InCo. In this installation the girls' movements were tracked and converted into real-time graphics. A movement sensor was used to capture the poses of the visitors interacting with the installation. The positions and forms of the captured bodies were used to paint colorful forms on the digital canvas that was projected on the white screen. The movement was reflected in the changes of the generated graphics. By means of a midi controller the girls could also change the parameters of the image such as the size of the objects, the time of their persistence on the screen, the type of forms used to paint on the screen, etc. Figure 11 shows a girl interacting with the installation.

We explicitly invited the girls to interact with the installation at the end of each workshop, but it was accessible all the time and the girls could freely experiment with it during the whole event. The goal of this installation was to show the potential of areas such as programming, networks, and graphic computing, for creating interactive spaces, multimedia projects, and art.
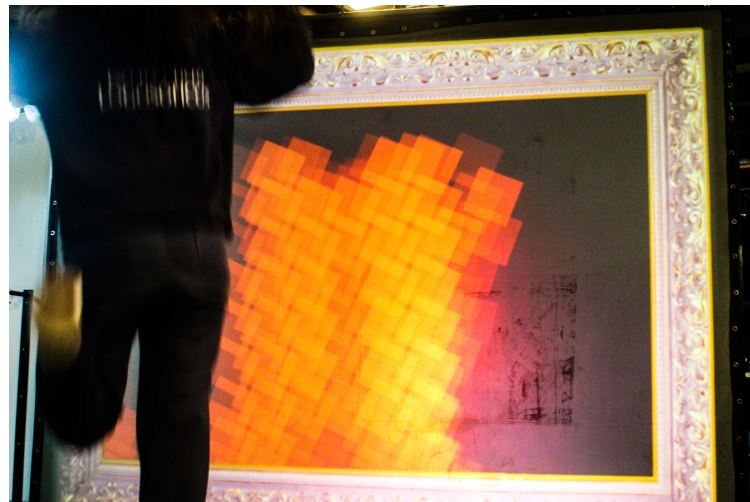

Figure 11: Girls interacting with "Encuadre Digital".

The installation was introduced by a short speech where the main research lines of the MediaLab were presented. Also concepts such as human-computer interaction and art with new media were introduced in a playful way. The different data inputs (peripherals such as mouse or keyboard, but also motion sensors, microphones or midi controllers) and data outputs (projected image, sound) were mentioned. Finally, the creative work of programming the link between the input data and the generated output was highlighted.

4   Results

Some preliminary results were published in our previous article presented in LAWCC2017 [8]. We now summarize the main results of the 2017 and 2018 editions, and preliminary data from the participation in the 2019 edition. We will also present feedback from students and schools from the 2018 edition, and dissemination of results for all editions.

4.1   Participation in the activities

More than 600 high school girls from all over the country participated in the activities, from several high schools. As mentioned, only groups of girls were invited, with ages mostly between twelve to fifteen years old, attending high school years just before the definition of an area of specialization (i.e. scientific, social, arts, among others). We defined a number of participants for each workshop (due to space and materials restrictions, teachers availability and so on) so for each shift, we had a maximum capacity that can be assigned. Nevertheless, we registered alternates so if an institution cancelled, we can give the place to another institution. In table 3 we present the main numbers of both editions. In 2017, each workshop was dictated twice in the morning and twice in the afternoon, however in 2018 we concentrate the population in three shifts (morning, noon and afternoon). In the 2019 edition, as mentioned, we kept the three shifts defined in 2018.

Table 3: Participation in 2017, 2018 and 2019 editions

Edition	Number of students	Number of public schools	Number of private schools
2017	320	11	10
2018	260	13	5
2019	215	11	4

As it can be seen in table 3 the number of students participating in each edition decreased each year, due to several factors influencing the participation of institutions and girls each year. In the first place, in the 2017 edition we were able to confirm the participation of institutions and girls not only by email but also by phone, which allow us to instantly select an call an alternate to participate in case of cancellation. Secondly, the complete holy week is holiday in elementary school, high school and universities in Uruguay, which could affect the coordination for attending the event with families. Finally, due to teachers availability, in some editions we had to reduce the available places in the workshops for each turn, which lead to less participants.

The distribution of participating institutions in each edition is as follows: in 2017, 16 high schools from Montevideo participated in the activity, and 5 from other cities. In 2018, the distribution was concentrated in Montevideo and surroundings but, unlike 2017, we received students from technical high schools and other social institutions. In 2019, 2 high schools were from other cities, and we continue receiving high schools and technical high schools from Montevideo. In table 4 we present the participating schools for each edition and location in the country (Montevideo, other cities).

The main extra-costs of the events were concentrated in food, workshop materials (such as batteries, cables, etc.) and stationery. During the day of the event we provided fruits and drinks. Also, at the end, each student received a participation certificate and promotional stickers. It is important to emphasize that some institutions (like Liceos from Rocha or from Colonia, both located 200 km from Montevideo) had expensive transport costs. In 2017 and 2018 editions, those expenses were paid totally by the schools. In the 2019 edition, thanks to the FRIDA award we received in 2018 (see Section 4.3) we were able to help high schools from other cities with transport costs to travel to Montevideo: one was 110 km away and the other 233 km.

4.2   Evaluation and discussion

To gather information regarding the activities and workshops we constructed two types of evaluation forms: one for students and the other for the participating institutions. We used mostly quantitative questions with ordinal scales (from one to five), and questions with Yes/No answers, adding also some free text questions for participants to express their opinions. We also asked for some personal and work information, to be able to contextualize the answers.

After processing the forms we found several improvements for the questions which would allow us to perform an in depth evaluation of some elements we could not analyzed with the questions as they were first defined, so we included those improvements for future editions. In the following we present the evaluation forms we used to gather information regarding the event from the participating girls and institutions for the 2018 edition.

Table 4: Participating schools in 2017, 2018 and 2019 editions

Edition	Location	Public schools	Private schools
2017	Montevideo	Liceos 1, 12, 13, 21, 53, 56, 64, 65.	Anima BT, Crandon, Latinoamericano, Logosófico, Ma. Auxiliadora, Santa Luisa, Santa María, Santa María HHMM.
	Other cities	Liceo Solymar and Liceo de Pando from Canelones, Liceo 3 from Rocha, AUIC from Rosario, Colonia	Liceo IUA from Punta del Este, Maldonado
2018	Montevideo	Liceos 1, 3, 13, 23, 29, 53, 57; Centro educativo comunitario UTU - CEC Vencedor, Áreas pedagógicas CES-INAU, UTU Paso Carrasco	Santa María, Palloti, Impulso, Christian Andersen, Santa Elena
	Other cities	Liceo 2 from La Paz, Liceo from Pando, UTU from La Paz, Canelones	
2019	Montevideo	Liceos 5,13,14,41,55,56,71 and UTU	Liceo Francés, Santa María, Inglés and Cervantes
	Other cities	Liceo de Piriápolis, Maldonado, Liceo No. 3 de Durazno, Durazno	

4.2.1 Evaluation forms

The evaluation forms we defined were published on line for the 2017 edition and printed for the 2018 edition: one for students[20] and the other for the institutions[21]. In those questionnaires we ask about some elements regarding participants perception about the activities and the organization of the event, and we also ask about other information and suggestions to help us improve the event for future editions and to help us measure possible impacts of the event both in girls and institutions.

Regarding the girls it is of interest to gather data about the high school year they are attending, if they have family references about university studies (i.e. professional parents), and if they would be interested in studying an ICT career associated with the workshops of the event. We also ask about the workshops they attended including an evaluation of the activities, the teachers that participated, the materials we distributed and other elements regarding the event location and their staying at the Facultad de Ingeniería.

Regarding the high schools that participated, it is of interest to gather data about how they hear about the event, which was the role of the person going with the girls, which was the transport used to get to the Facultad de Ingeniería and how those expenses were payed. We also asked them to evaluate the activities of the workshops regarding content, organization, etc. and also to suggest any modifications they would introduce. We also ask about the coordination activities we carry out previous to the event to assign the places for the institution groups, and also during the event regarding the relation with the girls, the materials we distributed, the food and location of the event, and the general evaluation of the event.

As an example, in figure 12 we show some questions from the evaluation forms for girls and in figure 13 we present some questions from the evaluation forms for high school institutions, only evaluation information.

Finally, in both evaluation forms we ask if they would participate again in the event, and if they are willing to participate in other activities of the Facultad de Ingeniería. We ask the girls if they would recommend the event to their friends and we ask the institutions if they would like the Facultad de Ingeniería to carry out some activities in the educative location itself.

In the 2017 edition we sent by email the link to the evaluation surveys a week after the event took place. This was a problem since we obtained few answers from which we could not draw representative conclusions. Due to the few answers we got via the web form, in 2018 we decided to print and distribute the evaluation forms to be completed at the end of the workshops, so we had 240 answers from the participating girls, apart from the ones from the institutions. By the deadline of sending the article the evaluation forms from the 2019 edition were not yet processed, since it was a week after the event. In the following we present some of the results obtained from the evaluation forms from the 2018 edition that were processed.

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[20]Students survey: https://www.fing.edu.uy/node/30911
[21]Institution survey: https://www.fing.edu.uy/node/30903

Figure 12: Part of the Evaluation form for students

4.2.2 Evaluation results

As mentioned before, the results we present here correspond to the 2018 edition for which we processed 240 answers from students and several from the participating institutions. Figure 14 left shows the distribution of students participating in the workshops, by high school years, and right shows whether the students parents have university studies.

In Figure 14 Left, the years of high school against the number of participating girls from each year are presented.As mentioned before, the focus of the activities were girls from 1st to 4th years (from twelve to fifteen years old), since in 5th and 6th years they've already chosen the area for their university studies (i.e. science and engineering, arts, biology, social sciences, economics, etc.). Nevertheless, we accepted a few girls from 5th in the 2018 edition. Also, since we did not define quotas for each years participation, the majority were girls from the 2nd and 3rd years, and less from 1st and 4th year. We put the focus of the activities on 1st to 4th high school years with the hope of being able to show girls some things of the ICT careers that maybe motivate them into choosing studies in this areas.

Regarding the university studies of the parents, in Figure 14 Right, it can be appreciated that most of the parents do not present university studies, corresponding to around a 70 percent of the participants. We could not gather data at the time of the 2018 edition to correlate this fact with the type of institution and places where they are located i.e. correspondence with public or private institutions, and institutions from Montevideo or other cities of the country. We believe these results are correlated (also based on other educational studies that were carried out at the country level), since students with college-educated parents are more likely to attend and complete college, which can be mainly attributed to economic reasons, but also to other elements such as role models. However, in the last ten years several university students (attending different university school areas) are being the first college students in their families. In the event, students and teachers who conducted the workshops come from different parts of the country, public and private high schools and different economic realities, which can also contribute in this aspect. In the 2019 edition we modified the evaluation forms in a way that will allow us to relate those variables, including in the personal information questions regarding the institution and location they come from, along with the question about the university studies of their parents.

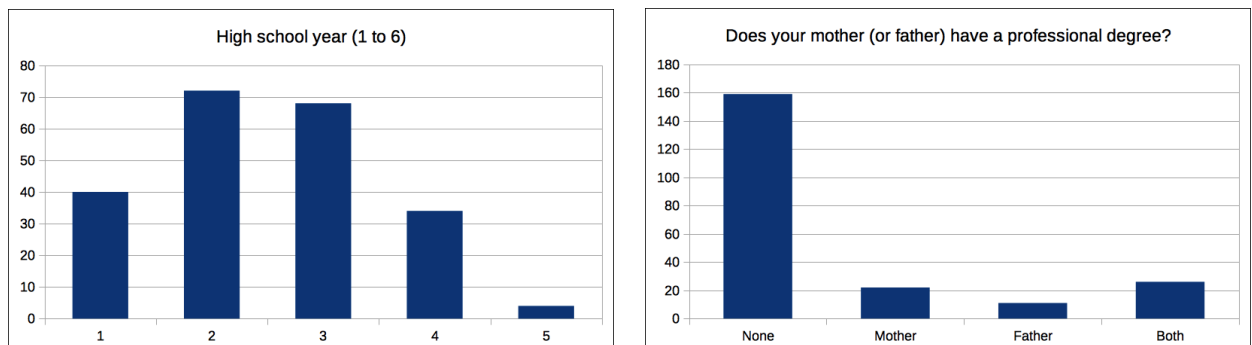Figure 13: Part of the Evaluation form for institutions.

Figure 14: Left: Distribution of students in high school years. Right: Parents with university studies.

Figure 15 left shows the students motivation in careers related to ICTs. The answers show an expected result: women tend to prefer other areas, and engineering careers continue to be a reticent space for women, mostly chosen by men. With the event, we seek to bring them some knowledge of the disciplines of ICT careers and encourage them to choose careers in the area, also showing them that there are female students and teachers in these careers. For the 2019 edition we added two new workshops to extend the scope of the event to basic disciplines: mathematics and physics, so girls should first participate in one of the basic workshops, and after that in one of the technological ones.

Figures 16 and 17 (Left and Right) show the students perception of the event, and their recommendation they would make to participate in it and their willingness to participate again in another edition. The positive evaluations exceed the neutral and negative ones, so we can conclude that the event met most participant expectations. In particular, the event (materials, venue, etc) and its workshops were rated extremely high, confirming that the definitions and work proposed in the activities are well received by participants. In Figures 18 left and right the evaluation from the institutions reaffirm the students opinion.
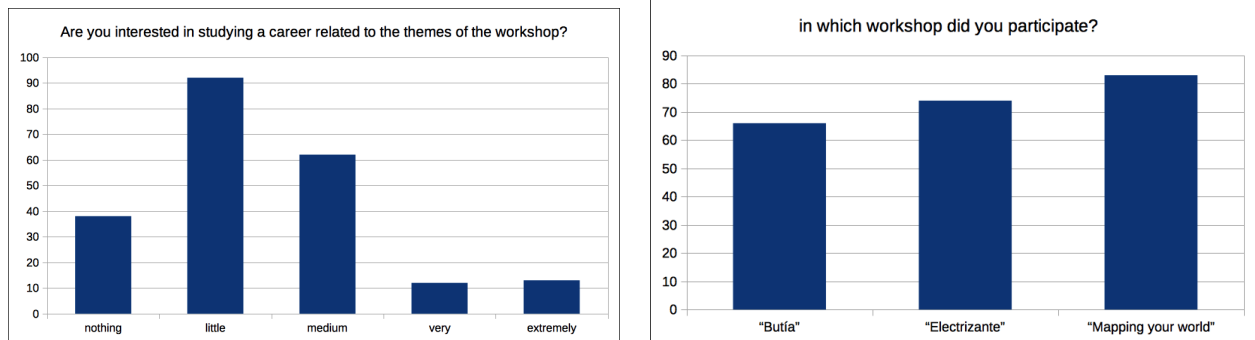
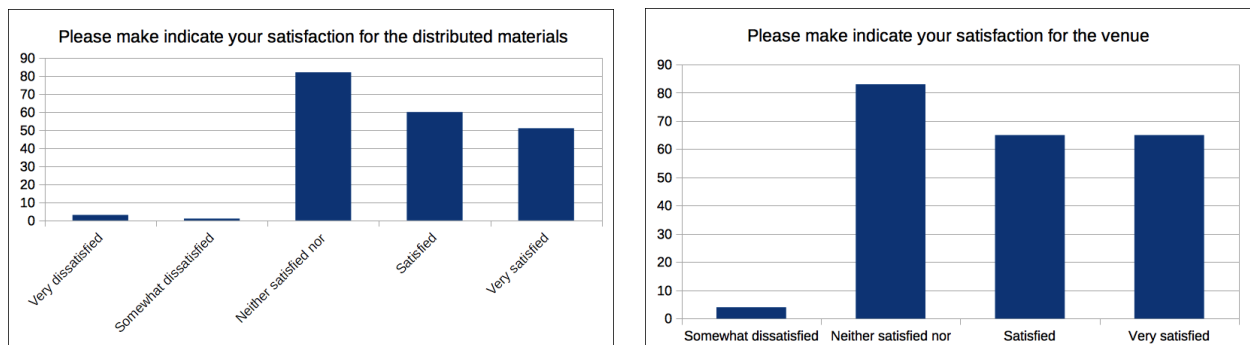Figure 15: Student motivation in engineer or in careers related to ICTs

Figure 16: Student feedback about Left: the distributed materials and Right: the venue.
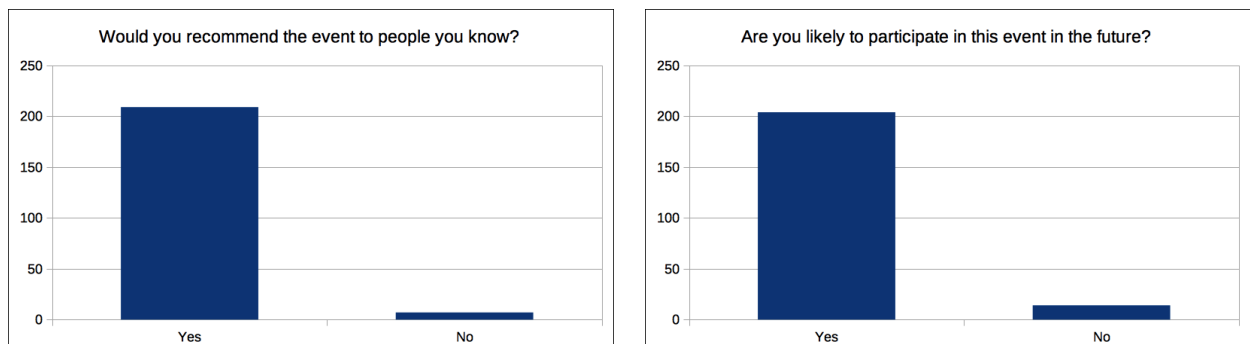

Figure 17: Left: Student feedback about how likely are students to tell a friend about this event. Right: Interest in future editions.
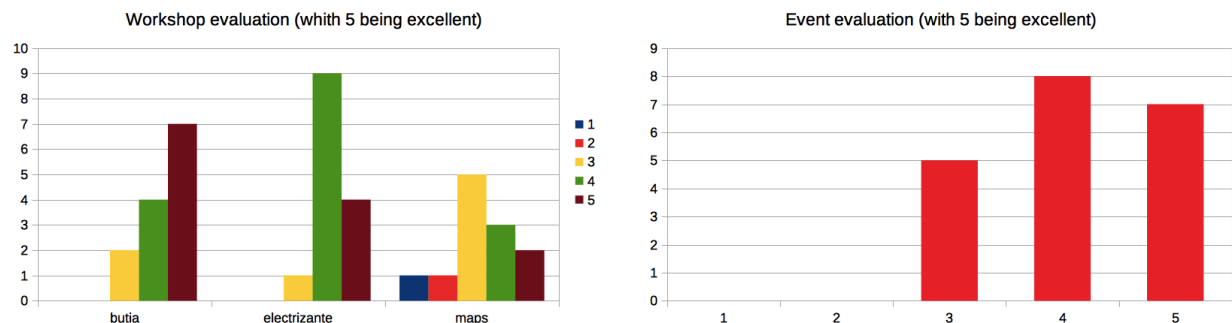

Figure 18: Institution feedback about Left: workshops and Right: the event.

Due to the fact that in 2018 the distribution of the institutions was concentrated in Montevideo and surroundings, most participants used public transportation (it is shown in Figure 19 Left). Also in Figure 19 Right it is reflected that the related costs were covered mostly by students' parents. This represents a
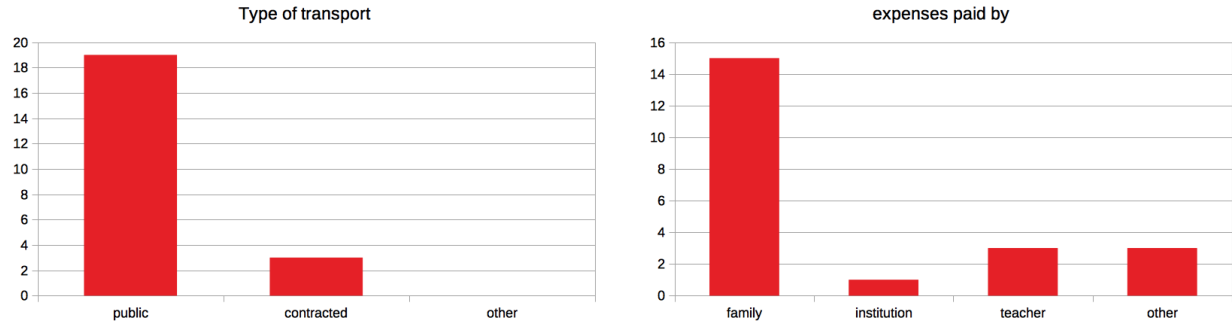
Figure 19: Left: Institution feedback about the type of transport used. Right: Who paid the expenses?

strong limitation, which we tried to overcome by providing help for transportation costs in the 2019 edition, thanks to the FRIDA award we received in 2018 (see Section 4.3).

4.2.3 Discussion

Although the evaluation forms include only a few questions to assess students and institutions perception of the event, we think they provide valuable information both regarding the attendants and their valuation of the activities for the 2018 edition. This evaluation helped us improving the 2019 edition for example, by detecting the monetary efforts parents were doing to help institutions to attend the event. Regarding this, we tried to help them in the 2019 edition with transportation costs, as mentioned before.

Also, by reflecting on the workshops we provided and how to promote a more complete view on the ICT careers and their contents, a key change we added was two new workshops with mathematics and physics activities, to be taken by each participant prior to the technological ones. Although we don't have the evaluation results for this change yet, as participants and institutions told us in the event, they were really attractive and interesting for the girls.

Regarding the girls participating in all editions, although few of them declared to be interested in pursued ICT careers paths, we are aware of some girls that have chosen the ICT specialization path in 5th and 6th year of high school, after participating in the workshop activities. However, it is not until the 2020 generation and further ones that we will be able to quantify the impact of the event if some girls are enrolled in ICT careers in the Facultad de Ingeniería (i.e. the ones in 4th year of high school in 2017 and later editions).

Apart from the data of the evaluation forms, there were comments that both students and institutions made in the forms and talking to us at the event, that help us confirming several perceptions we had and providing us with new insight regarding the perception of students and high school teachers. In the first place, both students and teachers prefer attending to activities in the Facultad de Ingeniería than the workshops being held in their educative locations. Secondly, they are glad for this type of activities to be carried out only for female students, to help changing stereotypes and roles that society defines for women and men, also changing the general perception of ICT careers and professionals. Finally, they are eager to participate in the following years and also in other activities through the year in Facultad de Ingeniería.

4.3 Results publication and dissemination

For each edition we published both the call to attend and a photo gallery at the web site from the Facultad de Ingeniería: year 2017 [22] [23] year 2018 [24] [25] year 2019 [26] [27]

We also use social networks institutional channels such as in Facebook [28] to disseminate the calls. Apart from that, we also publish the event in the ITU portal [29] to register the activities in the international site.

We also registered the 2018 edition in a video that we uploaded to youtube (https://youtu.be/KPz4LgriXWo) thanks to a social project from the University with focus on the gender gap in STEM areas in which we were also working with the Social Sciences School [30]. Although the video is in Spanish the participating girls,

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[22] https://www.fing.edu.uy/noticias/area-de-comunicacion/dia-internacional-de-las-ninas-en-las-tics
[23] https://www.fing.edu.uy/galerias/area-de-comunicacion/dia-internacional-de-las-ninas-en-las-tic-2017
[24] https://www.fing.edu.uy/noticias/area-de-comunicacion/26-de-abril-de-2018-dia-internacional-de-las-ninas-en-las-tics
[25] https://www.fing.edu.uy/galerias/area-de-comunicacion/dia-internacional-de-las-ninas-en-las-tic-2018
[26] https://www.fing.edu.uy/noticias/area-de-comunicacion/25-de-abril-de-2019-dia-internacional-de-las-ninas-en-las-tics
[27] https://www.fing.edu.uy/galerias/area-de-comunicacion/dia-de-las-ninas-en-las-tics-2019
[28] https://www.facebook.com/fingudelar/posts/2316404415242278
[29] https://www.itu.int/en/ITU-D/Digital-Inclusion/Women-and-Girls/Girls-in-ICT-Portal/Pages/Portal.aspx
[30] https://www.fing.edu.uy/inco/proyectos/mstem/

teachers and students and the work in the workshops can be appreciated, and the Facultad de Ingeniería where the activities took place.

In 2018 we submitted the project proposal to the FRIDA Awards [31] in the category Technology and Gender which was a new category that year, and we won one of the prizes of the category [32] [33]. The FRIDA money prize will help us to continue with these activities and also to carry out a pilot edition of a new project which we describe in Section 5.

5   Conclusions and future work

The International Day of Girls in ICT activities from last years made it possible to confirm the great demand, both on the part of the girls and the educational institutions, generating a list of contacts from public and private high schools that are strongly interested in participating in activities of this type in Facultad de Ingeniería. It was also detected that the girls find it very attractive to be able to attend the Facultad de Ingeniería to carry out activities, rather than doing activities in their institutions.

Based on the evaluation forms defined in the 2018 edition, we were able to gather valuable information regarding the perception of and satisfaction with the event, and possible improvements to make in further editions. Most of the girls and institutions were very satisfied with the workshops and the venue and most of the elements that comprise the event. Thanks to the FRIDA award we obtained in 2018, we were able to help institutions from outside of Montevideo with partial transportation costs to attend the event in the 2019 edition.

Main future work we plan to carry out is a pilot on the "MATE: Mujeres en el Área cienTífico-tEcnológica" project, which still does not have funding. It proposes a week of courses for girls in the Facultad de Ingeniería (programming, mathematics and electrical) with the general objective of incrementing the science and technology learning opportunities for high school girls who can then choose STEM careers, in particular Computer Science and Electrical Engineering, generating confidence in their abilities in those areas, and expectations of success in this election. We will use part of the FRIDA award to cover the costs of a pilot project with only the basic elements. We are also planning to add more activities for other national and international events such as the International day of Women and Girls in Science on February 11th, and the week of the Science and Technology that takes place in Uruguay at the end of May, among several others.

As main result of the activities we carried out in the workshops and of the future ones we are working on, our expectation is to motivate more high school girls into studying STEM and specifically into ICT careers, increasing their enrollment to the Facultad supporting their success in their studies. We also expect to improve and consolidate the coordination with secondary education in those areas, mainly with focus on girls but also for other general activities such as the ones that Facultad de Ingeniería has been carrying out in the last several years regarding talks in high schools and tours in the Facultad for high school students.

We believe that this type of activities with high school girls -and other ones as mentioned before- are key to promote ICT careers among female students, also contributing to the elimination of stereotypes about STEM careers and in particular ICT careers and professionals, making visible the participation and contributions of women to the area, as well as promoting "hands on" contact with elements of ICT that allow girls to evaluate first hand whether they like it or not, beyond the social impositions that exist on these and other careers.

We are also aware that this type of efforts in isolation will hardly make things different by its own, but will definitely contribute and, in conjunction with other efforts that are being carried out in the country [34], we hope will help in changing the reality and future of women in ICT careers.

Acknowledgements

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[31] https://programafrida.net/en/awards

[32] https://programafrida.net/en/selected-projects-2018

[33] https://programafrida.net/en/archivos/project/promoting-careers-in-ict-among-secondary-school-teenagers-in-uruguay

[34] https://www.miem.gub.uy/sociedad-y-genero/mesa-interinstitucional-mujeres-en-ciencia-innovacion-y-tecnologia-mimcit

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