An experience on virtual hands-on workshops to bring teenage girls to Computer Science in Uruguay

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Abstract

The decreasing presence of woman in the Computer Science area is a well-known issue that has been occurring from nearly the last three decades. There are several international studies and Ibero and Latin American studies that show this reality in several countries. The causes of this phenomena has been analyzed and several influential elements were identified, which promote negative stereotypes that make them walk away from science, technology, engineering and mathematics (STEM) careers, mainly Computer Science. For the last five years we have carried out activities to promote these careers between high school girls, working against these preconceptions and negative stereotypes, in particular with hands-on workshops on the occasion of the Girls in Information and Communication Technologies (ICT) Day. Due to the COVID-19 pandemic, we could not carry out the activities in person as in previous years, so we experimented with virtual hands-on workshops in the Girls in ICT day 2021. The change of format to a virtual one entitles several challenges, both social and technological, as well as opportunities such as allowing girls who live in the countryside, to participate without having to spend on transportation. In this paper we present the experience on two virtual hands-on workshops we carried out on programming and data at the Facultad de Ingeniería (School of Engineering), Universidad de la República, Uruguay, to bring teenage girls to the Computer Science area.

Keywords

Computer Science, gender gap, teenage girls high school, virtual hands-on workshops

1. Introduction

The decreasing presence of woman in the Computer Science area is a well-known issue that has been occurring from nearly the last three decades. There are several international studies and Ibero and Latin American studies that show this reality in several countries [1, 2, 3, 4]. The causes of this phenomena have been analyzed and several influential elements were identified, which promote negative stereotypes that make girls walk away from science, technology, engineering and mathematics (STEM) careers, mainly Computer Science, a few in Uruguay [5, 6, 7]. Elements such as the belief that these careers are for men, or that women are not good at mathematics and science leading to a lack of confidence in their abilities, the lack of stimulus in school and family to pursue these careers, the lack of role models, and specific stereotypes

of the careers, in particular of Computer Science such as programming in the basement, in darkness eating only pizza, and not interacting with people, lead to an unreal vision of the area.

Universities, enterprises and institutions in several countries of all continents [1, 2, 3] are carrying out activities in order to fight these stereotypes and false beliefs and bring more girls to this area. In 2011 the International Telecommunication Union (ITU) defined the fourth Thursday of April as the International Girls in ICT day[1] for universities, enterprises and institutions to open their doors and invite girls to see what this careers have to offer, talk to and interact with women in this areas, taking first-hand contact with different aspects of ICT.

Facultad de Ingeniería (Engineering School) from Universidad de la República (UdelaR) in Uruguay, has been promoting activities for teenage girls from the very beginning of this day celebration. From the 2017 edition we added hands-on workshops with the motto "doing instead of watching" for teenage girls in secondary school to come to the school and engage in activities of STEM disciplines, with a role model approach i.e. workshops were only thought by women teachers and advanced students of the institutes and careers involved. These experiences were described in [8, 9]. Also, in 2018 the project in which these activities are carried out entitled "Promoting ICT careers within teenage girls from high school in Uruguay" was awarded a prize[2] in the gender category from the "Fondo Regional para la Innovación Digital en América Latina y el Caribe (FRIDA)". The Instituto de Computación (Computer Science institute, InCo) which is in charge of the Computer Science careers in FING, UdelaR, has been working on the gender gap in the area promoting these kind of activities within teenage girls from the beginning of the project, and within other projects [10].

In the engineering and technological area in Uruguay, the gender gap is present in the scientific, academic and professional areas. Several diagnosis on the situation of women in STEM were carried out in the last decade to account for the gender gap based on evidence, such as: gender report [11] for The Sistema Nacional de Investigadores (National System of Researchers, SNI[3]), the teachers census [12] for UdelaR, the industry, and recently the national report of Uruguay[7] for the SAGA project of UNESCO, in which Uruguay participated.

Regarding women participation in the Computer Science career in FING, UdelaR, it is interesting to analyze the history of enrollments from its early years in the ninety decade to this days after almost thirty years, which is shown in Figure 1, data from [4]. It can be seen that in the ninety decade the ratio of enrollments women:men is almost 1:2 and 1:3 in most years. After that it only grows apart reaching its maximum 1:7 in 2014 and then, oscillating between 1:5 and 1:6. This fact is in line with what happened in the world. Also, from 2000 the total enrollment in the Computer Science career presents a sustained growth with small oscillations.

If we zoom in the last fourteen years from 2006 to 2019 as shown in Figure 2, data from [5], it can be seen that in the last five years from 2015, the total enrollment only grows reaching its historical maximum with nine hundred enrollments in 2019. In the last two years women enrollment shows a slightly growth. We still do not have the 2020 and 2021 data which, as we all know, are special years due to the COVID-19 pandemic, where all courses went virtually so

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Year	W	M	Total	%W
1990	120	358	478	25%
1991	151	385	536	28%
1992	147	335	482	30%
1993	141	274	415	34%
1994	141	293	434	32%
1995	142	264	406	35%
1996	94	278	372	25%
1997	125	292	417	30%
1998	135	332	467	29%
1999	89	283	372	24%
2000	130	351	481	27%
2001	79	327	406	19%
2002	80	374	454	18%
2003	113	431	544	21%
2004	101	431	532	19%
2005	90	373	463	19%
2006	83	417	500	17%
2007	100	419	519	19%
2008	92	462	554	17%
2009	103	442	545	19%
2010	118	546	664	18%
2011	108	543	651	17%
2012	104	486	590	18%
2013	107	551	658	16%
2014	82	570	652	13%
2015	97	524	621	16%
2016	99	557	656	15%
2017	99	629	728	14%
2018	144	694	838	17%
2019	158	747	905	17%

Figure 1: Enrollments in Computer Science career, Fing, UdelaR, 1990-2019

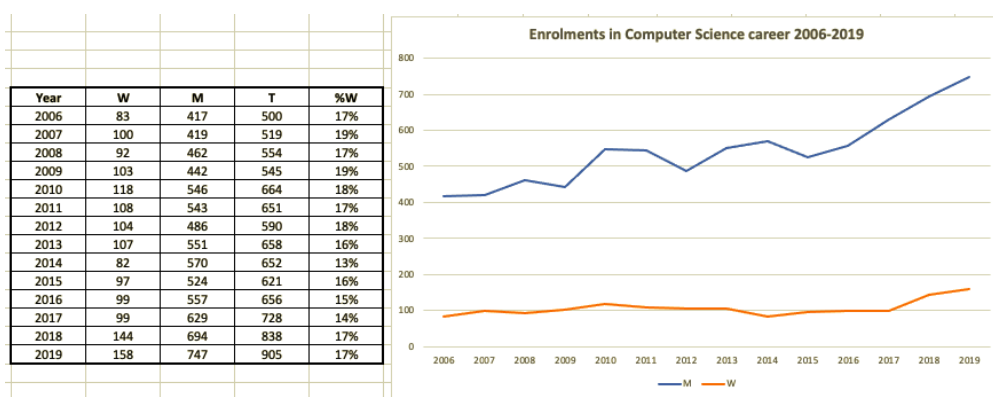| Year	W	M	T	%W
2006	83	417	500	17%
2007	100	419	519	19%
2008	92	462	554	17%
2009	103	442	545	19%
2010	118	546	664	18%
2011	108	543	651	17%
2012	104	486	590	18%
2013	107	551	658	16%
2014	82	570	652	13%
2015	97	524	621	16%
2016	99	557	656	15%
2017	99	629	728	14%
2018	144	694	838	17%
2019	158	747	905	17%

Figure 2: Enrollments in Computer Science career, Fing, UdelaR, 2006-2019

we cannot confirm the tendency.

In 2020 the pandemic situation in Uruguay started in March so we had to suspend in person classes and go virtually with all courses and exams within a short period of time, in order to ensure that students at the university could continue their studies. In particular, the activities for the Girls in ICT day to take place on April had to be suspended, so we launched instead the project web site "Chicas TICS"[6] (ICT Girls) where we upload the registers of the experience from all the editions of the day, as well as other activities. For the Girls in ICT day of this year 2021 we decided to carry out the activity in virtual format creating new workshops from scratch and

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[6]https://www.fing.edu.uy/proyectos/chicastics/

adapting others. In this article we present two of the workshops we proposed for the Computer Science area, and the virtual experience with teenage girls from high school we carried out, showing and discussing the challenges of going virtual and the results of the workshops.

The rest of the document is organized as follows: in Section 2 we present the workshops and the activities we defined within each one, and in Section 3 we describe and discuss the experience with the virtual workshops. In Section 4 we present related work and finally in Section 5 we draw some conclusions and future work.

2. Virtual workshops

In this section we present the definition of the new virtual workshops.

2.1. Programming workshop

The programming workshop was named "¡A programar!" ("Let's code!") to try to motivate girls into participate. This workshop was defined from scratch for the virtual format, since in the in person format the main workshop for programming was the "Butia" robot[7] workshop[8, 9]. We designed this virtual workshop with focus on giving the girls motivating activities to have fun coding online and at the same time learning a few key concepts of programming.

For doing this, we searched and compared several online web programming platforms, checking as the most important characteristic the provision of Spanish language for the interaction with the graphical user interface (GUI), as well as for coding. We also looked for programming with code blocks in which each instruction is mapped as a block, putting concepts within the reach of children, based on the experience of "Butia" with TortugArte (Sugar activity inspired by Logo). Although there are several coding platforms around, most of them are only in English and not always allow free use. Among the ones that we looked at are Scratch[8], Blocky[9], Code.org[10], and Gobstones[11]. Also, the Uruguayan governmental Plan Ceibal[12] provides platforms and open educational resources (OER) for uruguayan elementary schools and high schools.

We selected the Gobstones platform since it provides a web environment easy to learn and to use, with pre-defined exercises[13] and teachers material[14] provided within the Argentinian program.AR[15] initiative. The Gobstones platform was designed by the Universidad de Quilmes, Argentine, and takes it name from the Harry Potter's magical game of marblessince marbles are a key element in the language. In Figure 3 the general view of the Gobstones platform is shown with the basic marbles exercise.

The web environment is organized in three main spaces: it uses an initial board with the problem to solve (c) and using the code blocks provided (a) the program code is defined (b).

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[7]https://www.fing.edu.uy/inco/proyectos/butia/

[8]https://scratch.mit.edu/

[9]https://developers.google.com/blockly/

[10]https://code.org/learn/

[11]http://gobstones.github.io/

[12]https://www.ceibal.edu.uy/es/plataformas-inicio

[13]https://gobstones.github.io/gobstones-jr/?course=program-ar/proyectos-gobstones-jr

[14]https://program.ar/descargas/cc_para_el_aula-1er_ciclo_secundaria-fichas.pdf
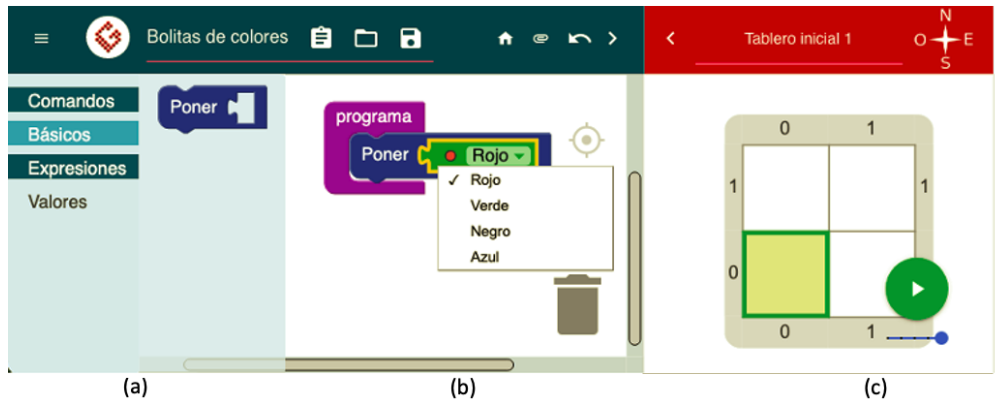
[15]https://program.ar/

Figure 3: Gobstones platform general view with the basic marbles exercise

When executed over the board (using the green arrow) the final board with the result of the execution is shown (when there are no errors). It also provides a compass on the right superior corner in order to be able to move the program head across the board. The example exercise in Figure 3 asks to build a program to put four marbles, one of each provided color in the (0,0) cell of the board. The program must change the state of the board i.e. from the initial board we have to go to a final board. It can be seen that in this trivial example there is one primitive (procedure) provided in the command option which is "Poner" meaning "Put" with one argument, and in the expressions option, the values to choose from: red, green, black, blue. There is also an option to show the program code in text form.

2.2. Programming activities

We selected three exercises from the Gobstones platform, providing a logical path from the first basic exercise to the third, building knowledge upon the previous one. The first exercise focus on using primitives and variables to solve a problem step by step; the second exercise adds repetition to the first one, and the third exercise adds conditionals to the second one. We also took into account how attractive would be the proposal for the girls, including the clothing for the board (i.e. adding visual elements to provide a user friendly experience).

Exercise 1 - Lucho turns on the lights The first exercise takes us to the space, where the robot Louie (Lucho as they affectionately call it which means Lou) has to go through the cells that contain lightning bulbs and turn them on. Two procedures are provided: "Move Lou to:" (in Spanish "Mover a Lucho a:") to move the robot through the board, and "Turn on the light" (in Spanish "Encender la luz"). In this exercise the idea is to find the best way to move the robot through the cells that have light bulbs to be turned on, using the best strategy to travel the board without extra movements using the primitives provided. We also prepared questions to discuss the solution: i) what can they say about the robot movements within the board?, what is the effect of such movement blocks regarding program length and readability? Could we have a basic block of movements and repeat the block instead of repeating movements every

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time? Figure 4 shows a) the initial board, b) a partial solution board showing the first three movements of the robot to achieve the task, and c) corresponding block code.
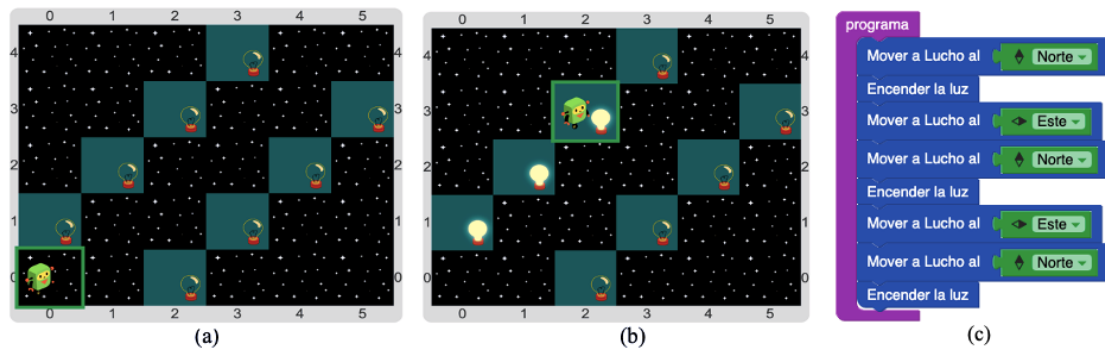

Figure 4: Lucho turns on the lights exercise: a) initial board, b) partial solution board, c) block code

Exercise 2 - SuperLucho 1 The second exercise changes the setting of the initial board so Lucho has to go through an unknown number of cells in the space to the get to the finish line, turning on the bulbs in each cell. In this exercise the robot has to move East and several initial boards are provided, over which the code is executed randomly. This helps ensuring that no fixed repetitions can solve the problem, since each initial board has a different number of cells. The goals of this exercise are twofold: i) add a repetition block code to solve the problem detected in the previous exercise and ii) add a conditional in the repetition block code to end the loop, as opposite as counting the cells to do it. Figure 5 shows a) the initial board, b) solution board, and c) corresponding block code. We also prepared questions to discuss: why is it not possible to repeat the code block a fixed amount of times as in the previous exercise?, why we need to check if Lucho reached the finish line and not something else?
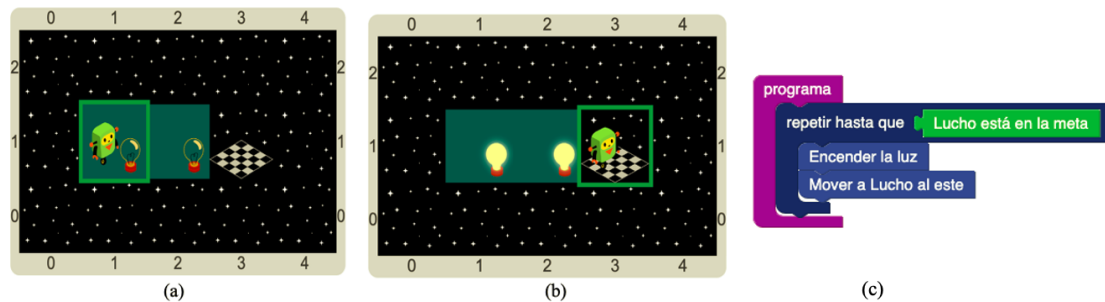

Figure 5: SuperLucho 1 exercise: a) initial board, b) final board, c) blocks code

Exercise 3 - SuperLucho 2 The third exercise changes again the assumptions of the initial board so Lucho still has to go again through the unknown number of cells in the space to the East, until it gets to the finish line turning on the bulbs as in the previous exercise, but now

some cells are empty i.e. there are no bulbs in each cell but in some cells. Again there are several initial boards that are randomly executed with the solution code. In this exercise the goal is to add a conditional if block to check whether there is a lightning bulb to turn on in each of the cells visited. Figure 6 shows a) the initial board, b) solution board, and c) corresponding block code. We also prepared some questions to discuss with the girls: why do you have to check if there is a lighting bulb in the cell? What if they don't check it, did it happen to them?
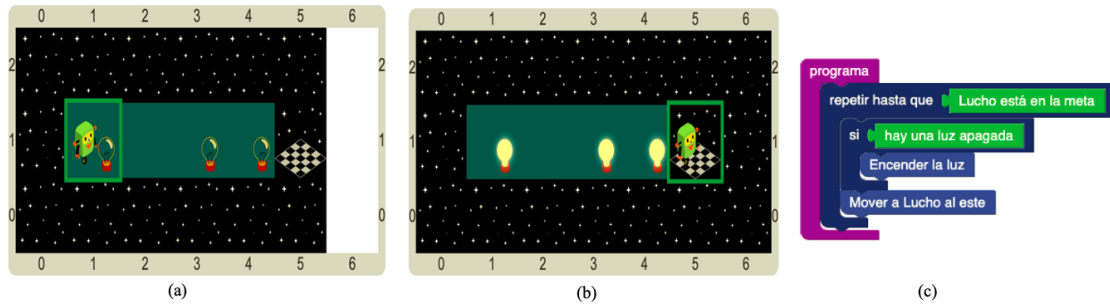

Figure 6: SuperLucho 2 exercise: a) initial board, b) final board, c) blocks code

2.3. Data workshop

As well as the Programming workshop, the data workshop was defined for this edition. However, it was the first time that an activity focused on data was included. The workshop was named "Taller de datos" which is translated to "Data workshop" and its main purpose was to introduce girls to the importance and value of data. Our objective was to perform the hands-on activities through the use of a platform that allows loading, managing and viewing data. The chosen platform had to enable loading a csv file, showing it in a table format, filtering data, and preferably generating charts. With all these features in mind, we decided to work with Airtable[16]. With Airtable you can create an account and load data for free, for a trial, and access the data afterwards. We created a database called "Chicas TICs", in which the girls would perform the activity. The main page shows the grid view (initially empty), and allows selecting different forms of presenting data and adding an application which is the way of adding charts. The web page is in English, which was one of the main concerns before doing the activity.

2.3.1. Data Activities

The workshop was structured in three activities with incremental complexity, and each of them depending on the previous one.

Exercise 1 - Loading Data   In this exercise, the aim was to show the girls how the use of an appropriate tool can completely change the way data is presented. First of all, they had to open a raw csv file, with covid-19 uruguayan data, in any data editor, and we showed them the difficulties of reading such file in order to motivate the use of auxiliary tools. The csv file is

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[16]https://airtable.com/

shown in Figure 7 a). After that, the girls were guided into loading the file into an airtable table, called *covid19*. The tables obtained are shown in Figure 7 b). When this was finished they were able to compare both data structures.
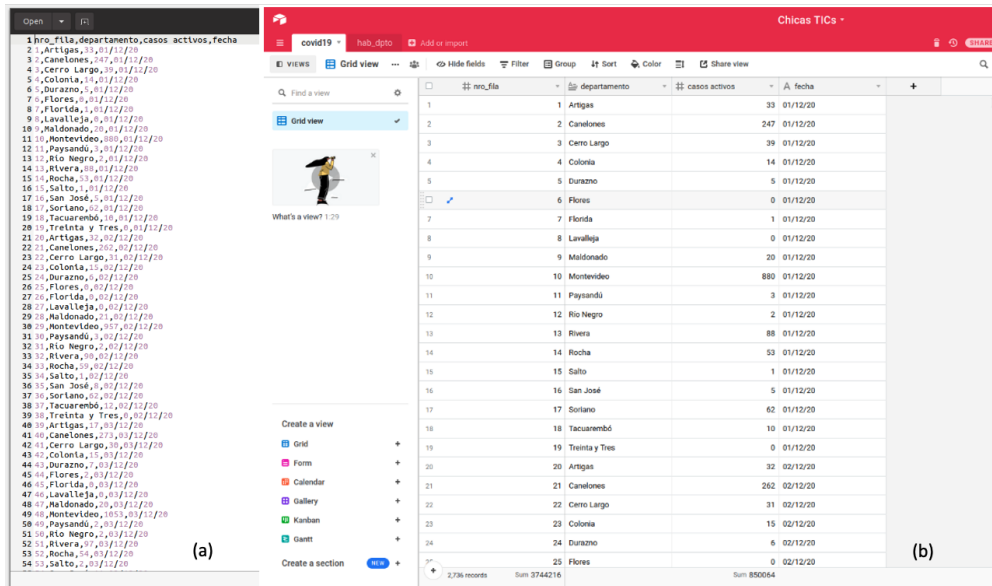

Figure 7: COVID-19 data to analyze: a) csv file format, b) airtable table format

With the data loaded into the application, the second step was to link more than one table. In order to do so, one of the columns of the *covid19* table is changed to a lookup value in a second table. The table chosen to interact with, was one including population per department, so we could calculate the average amount of infected people. To conclude this step, after generating the lookup to the other table, they had to add a column containing the average. The average step is shown in Figure 8.

Exercise 2 - Adding Chart   One of the main advantages of using tools to manage data is the capacity of visualization. Using airtable, we helped them to construct a pie chart that showed the average amount of active cases per department.After this first step, we gave the girls some freedom for exploring what other type of charts could be done. We also asked them what other interesting information they would like to obtain from a chart, and helped them to construct the different options.

Exercise 3 - Adding Filter   Finally we explored the possibility of adding a filter and obtaining data of interest. For this step we asked them what simple question they would like to answer and helped them to add it. They mainly asked for the number of cases in the place they lived, so we filtered data by department. In Figure 9, an example of filter by department is shown. After adding the filter, the changes could be observed not only in the table but also in the chart.
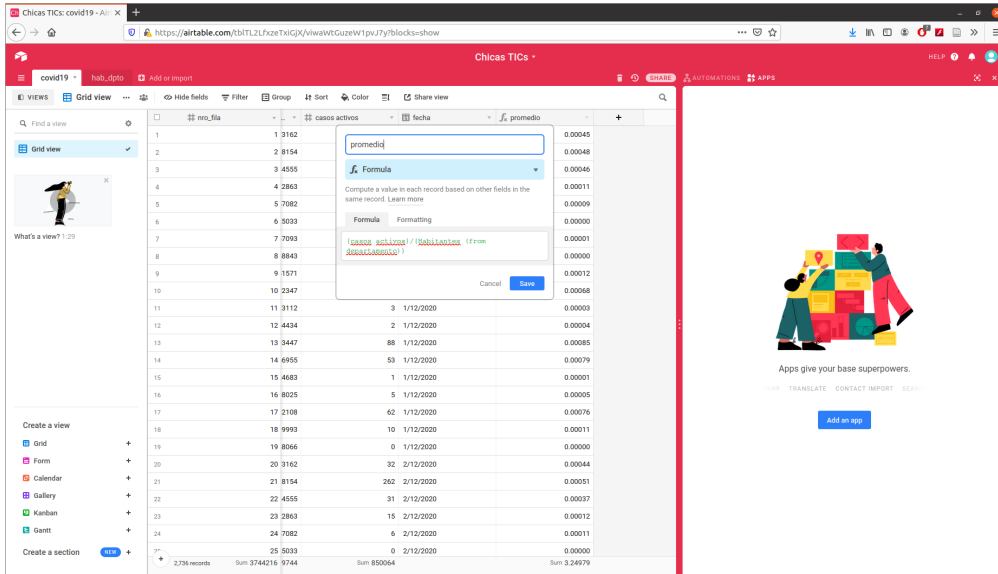
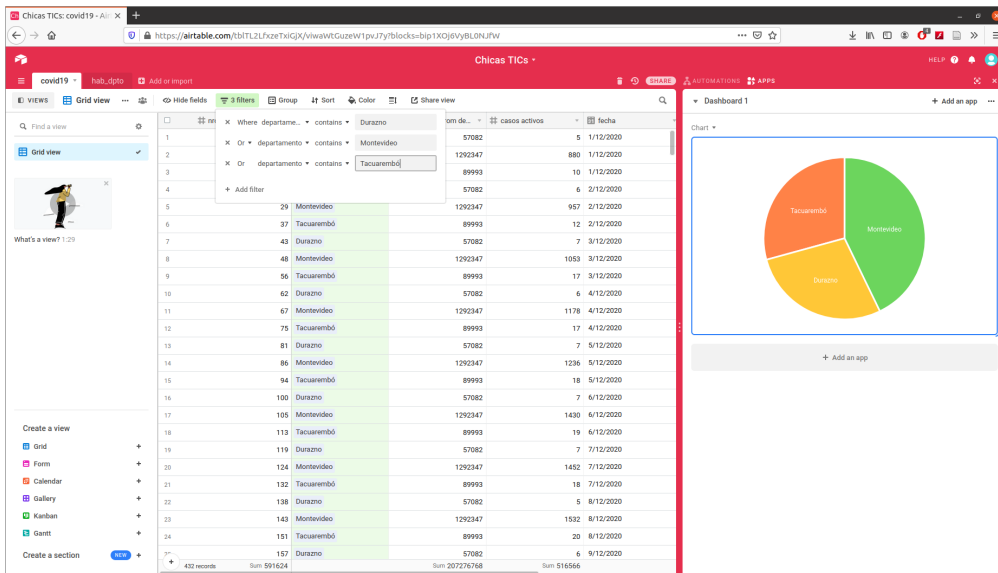**Figure 8:** Airtable average calculation of infected people

Figure 9: Filter by department

3. Virtual experience

For this edition we defined two shifts for the workshops, one in the morning and one in the afternoon. As in previous editions, we prepared a poster to disseminate the call between high school, institutions, FING and UdelaR and the general public and we opened registrations two weeks before the event. For this edition, the final number of inscriptions was near a hundred

girls from both Montevideo and the countryside. In Table 1 the number of registrations is presented along with the institution, origin department and type of institution.

Table 1
Number of registrations to the workshops by institution and department.

Department	# Institutions	Registrations
Montevideo	10	27
Canelones	2	16
Paysandú	3	24
Soriano	2	10
Durazno	2	20
Florida	1	1
Salto	1	2
Total registrations	**21**	**102**

It can be seen that most participants correspond to countryside institutions with a total of 75 registrations while from Montevideo the registrations were 27. This is the opposite from previous years when workshops were in person, due to transportation cost and time that are needed for countryside institutions to go the Engineering School. Also, most registrations came from public institutions 14 of them corresponding to 61 registrations, and 7 private institutions corresponding to 41 registrations.

3.1. Carrying out the workshops

We faced several challenges regarding the virtual format when defining the logistic for carrying out the workshops. One was how to manage the zoom link which for security reasons will not be public, also to be able to work with the girls in subgroups, which zoom provides, but only one level not nesting sub-rooms. Other challenges refer to assuring that at least one girl for each subgroup can connect with a computer in order to access the web platforms and share screen with the rest, and also, the need for an adult responsible (either parent or teacher, no gender restriction) to stay with them during the event. We decided to provide the zoom link in the confirmation email we sent for the registration of the girls with the shift assignment asking that a responsible adult connects with them and stays during the workshops and the need for a computer. This link will be the initial room to welcome them and after that, one workshop stays in the room and the other one provides another link.After the welcoming message, each workshop followed a similar script for activities, by first introducing concepts and the problems to tackle, and for each exercise dividing the room into sub-rooms where sub-groups of four/five girls worked together. Teachers visited a couple of sub-rooms in order to see what the girls where discussing and help them to think and solve the problems. After each exercise, we returned to the main room and discussed with all girls what things they analyzed, how they solved the exercise and the problems they had, if any, reasoning over the questions we prepared. Figure 10 shows zoom rooms screenshots of the programming workshop.

In previous editions, after the workshops the girls were asked to complete a form evaluating the activities. For this edition it was not possible to update and make it available online, but it will be added in the editions to come.
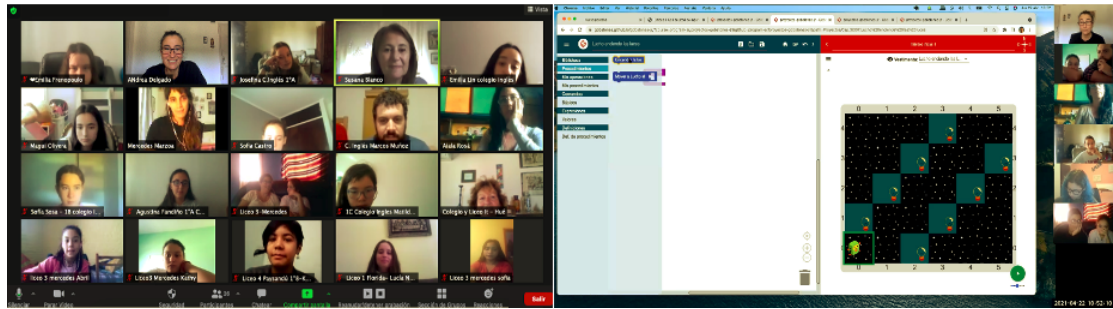
Figure 10: Virtual workshops experience zoom rooms: a) general room, b) sub-room with Gobstones

4. Related work

There are several international, Ibero and Latin American initiatives to encourage girls into STEM careers that also work with girls in hands-on workshops and courses mostly in person as we did in previous years. It is worth mentioning analysis and initiatives from MIT[1], Carnegie Mellon[2], Spain [3] and Meninas Digitais from Brazil [13]. In recent years, most Ibero and Latin American countries have shown similar realities and presented several studies and initiatives in the Latin American Women in Computing Conference (LAWCC) [14], such as: Argentina, Bolivia, Brasil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, España, Panamá, Paraguay, Uruguay and Venezuela. Regarding virtual experiences, platforms and initiatives we found, offer mostly videos and exercises on demand, differently to our proposal.

5. Conclusions

Although creating new workshops in virtual format for the event was a challenging task, we believe the final result was successful both for participating girls as well as for teachers. Working in sub-rooms with groups of few girls was a good approach that allowed us to closely interact with girls in the reasoning to solve the problem with them. The tools we chose (Globstones and Airtable) proved to be adequate to introduce the basic concepts of programming and data use, and also were easy to use for most of the girls. The experience was very rich, not only from the perspective of the technical aspects the girls were able to contact with, but also from the perspective of their questions and concerns with respect to their future careers, experiences as engineer students, and professional lives. We could gave them a place and moment, where they felt comfortable for expressing their feelings with respect to the possibility of studying engineering and technology-related careers. Also, the virtual format allowed girls from institutions in the countryside to participate for the first time in the activities. Although the experience of participating "in person" activities was valued in previous years, the virtual experience was also welcomed as a way to make contact with the area.

We believe that it is important for girls to know that there is room for them in the Computer Science area if they like it and want to pursue a career in the area, so they do not walk away for the wrong reasons. Too many talents are being lost that could make contributions to our discipline, enriching their lives, the scientific academic and professional areas, and the society.

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