LESSONS LEARNED IN PROMOTING NEW TECHNOLOGIES AND ENGINEERING IN GIRLS THROUGH A GIRLS HACKATHON AND MENTORING

Aurelio Ruiz-Garcia[1], Laia Subirats[2], Ana Freire[1]

[1]Universitat Pompeu Fabra, Department of Information and Communication Technologies (SPAIN)
[2]Eurecat (SPAIN)

The under-representation of women in engineering is becoming a matter of concern as it has implications both for the women themselves and for the development of the digital economy sector. To address this issue, a girls hackathon and a mentorship program have been held at Universitat Pompeu Fabra (Barcelona, Spain) with the aim of bringing more women into computing. Questionnaires deployed after the event indicate that it was a powerful initiative to encourage girls to study engineering degrees and to increase the visibility of women in ICT.

Keywords: Hackathon, technology, ICT, women, education, diversity issues.

1. INTRODUCTION

The participation of women in the technological fields is becoming an issue of growing concern as technologies become more and more pervasive in all social and economic environments. In the particular case of Spain, the number of women enrolling in engineering and computer sciences over the past few years has dwindled. Statistics from the Spanish Government collected in 2015 attested that only 34% of students of Engineering and Architecture were female [1]. Table 1 reports these statistics classified by Degree Specialization. Engineering and Architecture forms the only itinerary where the number of women is less than the number of men.

Table 1: Total number of students in all Spanish Universities classified by gender and Degree Specialization. Original Source: [1].

Degree	Women	Men
Social and Legal Sciences	380,020	252,911
Engineering and Architecture	70,808	204,168
Arts and Humanities	82,623	52,617
Health Sciences	164,288	72,573
Sciences	41,604	39,728
TOTAL	739,343	621,997

Focusing on the School of Engineering of Universitat Pompeu Fabra (UPF) in Barcelona, these numbers [2] are in line with the situation in the rest of the country (see Table 2).

Regarding the degrees (see Figure 1), UPF offers four different itineraries: (1) Biomedical Engineering, (2) Audiovisual Systems Engineering, (3) Computer Engineering and (4) Telematics Engineering. The percentage of women is always lower than that of men, except for the Degree in Biomedical Engineering, where the former represent 62.4% of students, seemingly confirming the stereotype that women are more drawn to health-related studies. This also applies to the Master in Brain and Cognition (see Figure 2), where women account for 75% of the students, while being a minority in all other Technical Masters offered by the School of Engineering (UPF). A cause (or consequence) of this imbalance might be the proportion of women involved in teaching technical studies. The School of Engineering at UPF is composed of only 31% of female teachers.

Table 2: Statistics for engineering studies at Universitat Pompeu Fabra (Barcelona), grouped by gender.

Studies	**Women**	**Men**
Degree	22,4%	77,6%
Master	30%	70%
PhD	33,3%	66,7%
TOTAL	24,2%	75,8%

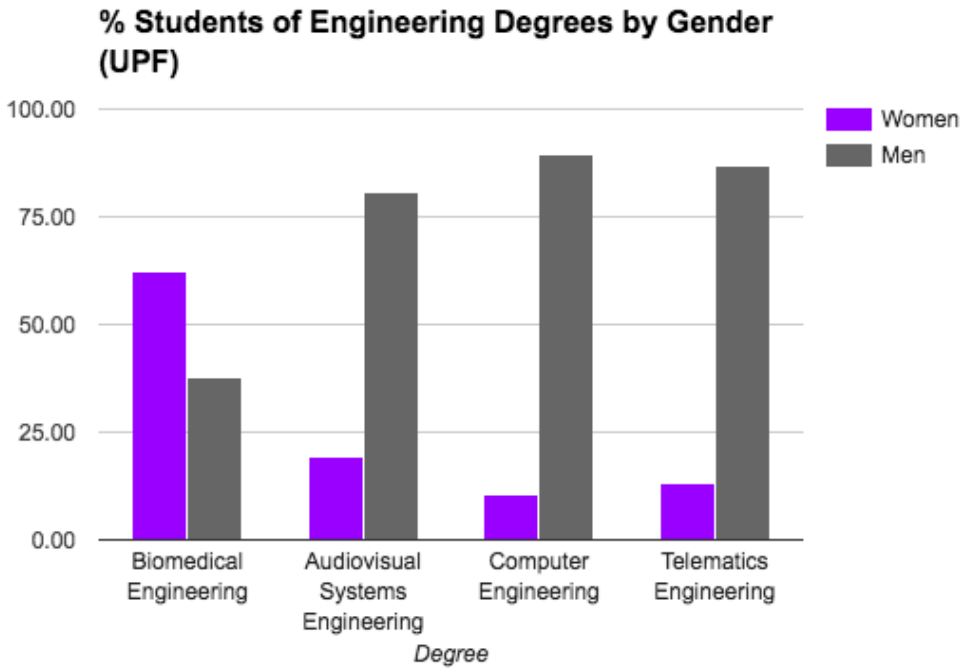

Figure 1: Percentage of women/men studying Engineering Degrees at UPF.

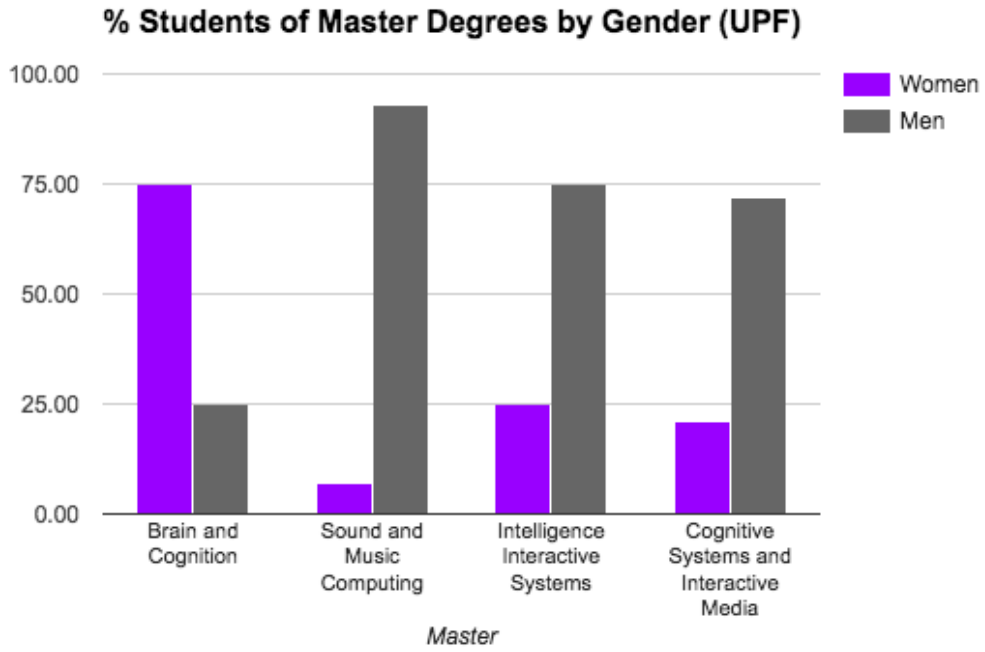

Figure 2: Percentage of women/men studying Engineering Degrees at UPF.

Studies indicate that girls still tend to avoid maths, even if their mothers are scientists [3]. The implications of this imbalance are huge, not only for women themselves (not taking part in a growing professional and economic sector) but also for the development of the digital economy sector [4].

This paper aims to introduce two initiatives conducted by Universitat Pompeu Fabra (in collaboration with other institutions and companies) and to evaluate the power of such initiatives in bringing more girls into Information and Communication Technologies (ICT). One of these activities was a hackathon comprising several technical workshops for young girls. In parallel, some mentorship sessions were offered to young girls interested in contacting women professionals in technical fields. Questionnaires were delivered to all participants after the event, in order to analyse the impact of these activities and to identify the aspects in need of improvement.

The remainder of this paper is structured as follows: in Section 2 we review the current approaches to promote gender equality in ICT. Section 3 describes the two activities developed at Universitat Pompeu Fabra to bring more girls into ICT: a girls hackathon and a series of mentorship sessions. Section 4 presents the results obtained after deploying a questionnaire to the participants in the aforementioned activities. Section 5 summarizes our main conclusions and proposes a set of guidelines towards increasing the presence of women in technology.

2. EXISTING INITIATIVES

A large number of initiatives are being carried out around the world to bring more women into computing. The USA enjoys a long tradition in creating networks to support female professionals in computer science. The Association for Women in Computing [5] was founded in 1978. The Anita Borg Institute [6] (originally Institute for Women and Technology) has its roots in a digital network of female computer scientists created by Anita Borg already in 1987. More recent nation-wide nonprofit organizations include the National Center for Women & Information Technology, created in 2004 to “correct the imbalance of gender diversity in technology and computing”. The most recent well-known initiatives, such as Girls Who Code [7] or she++ [8], both founded in 2012, are shifting the focus from supporting female professionals to bringing more women to computing, as the number of women entering computer science has been decreasing over the last years. These initiatives attempt to address specific factors contributing to this decrease (such as female-only training via summer

programs in the case of Girls Who Code; or taking actions to dismantle stereotypes, in the case of she++).

Other initiatives focus on products or apps that aim to promote programming among young girls. An example is Jewelbots [9], a company that sells bracelets that girls can customize by programming sounds and colours. Another initiative is Vidcode [10], where students can create custom video filters using advanced JavaScript, and motion reactive videos using computer vision.

If we focus on Spain, despite a growing number of isolated actions being promoted, the country still lacks reference initiatives like the ones in the USA, specifically targeting girls. Nevertheless, Spain has produced initiatives such as the building of a Wikipedia which enhances the visibility of the role of women in the new technologies [11, 12].

The group of women Girls in Lab [13] launched one year ago for the first time a hackathon in a school in Barcelona, with the main objective of raising awareness among younger girls that technology is also a field to which they belong, as well as to develop a longer-term program of actions to support the participation of women in technology. In parallel, the Department of Information and Communication Technologies at Universitat Pompeu Fabra had started actions along the same lines within its community, supporting initiatives such as the Anita Borg Alumni Celebrations and female-only professional groups such as PyladiesBCN, a collective of female Python programmers.

Both groups started to work together at late 2015 in order to increase the critical mass involved in their respective actions. As a result, they have co-organised 2 larger-scale hackathons (under the label #GirlsHack) which have managed to involve over one thousand people, including girls over 7 years old, students and alumni (male and female) from engineering degrees, as well as researchers and professionals. The aim of these actions is twofold. First, to contribute to overcome some of the barriers (especially stereotypes [14]) holding back not only the girls themselves, but also their families. Second, to provide girls with a first contact with the technological resources at their reach, in order to promote their willingness and receptiveness to continuing on their own and/or making use of the many existing initiatives that promote technology among kids and youngsters (both male and female).

In the second hackathon, an additional track targeted at women over 15 took place, along with specific workshops, talks and the possibility to hold a 30-minute interview with a female professional to obtain feedback on aspects of their specific interests with respect to career development.

3. METHODOLOGY

We developed two different initiatives: a hackathon and a mentoring session.

a. Hackathon

The hackathon comprised several workshops for girls from 7 to 17 years old: scratch, app inventor, virtual reality, 3D printing, Yoway, personalities in robots, building your home automation, Lego NXT and Arduino. An important lesson from the first hackathon was the convenience to split into 2 tracks according to age: 7-12 and 12-17. This is due not only to the different activities being offered, but also to the fact that tickets for the younger girls sold out very quickly as they (or rather their parents) registered early, in contrast with the older girls. Eventually, all tickets for 12-17 got sold out as well, but at a slower pace. This suggests that as they grow, they are more difficult to reach (while when they are younger, their parents decide).

We summarize the workshop's contents below.

- **Scratch** (organized by Lorena Recalde and Marie Monique Schaper). With Scratch girls can schedule their games. During the process, they learn to create and to express themselves through the computer, not just interact with it. To control the game characters, Scratch faceplates are created, as if they were Lego pieces. Each block is one of the game characters.
- **App inventor** (organized by Helena Bantulà, Helena Cuesta and Guillem Galimany). App Inventor is a Google Labs platform to create software applications for the Android operating system.

- **Virtual reality** (organized by Sergi Armengol Suquet, Clara Borràs Coll, Nadia Campo Woytuk and Xavi Salleras). The objective is to build a handmade virtual reality viewer. Viewers of virtual reality can be made of very cheap materials. Once participants have mounted their viewers, they have the opportunity to see virtual reality applications that are available on the Internet. This workshop is inspired by Google Cardboard.
- **3D printing** (organized by Ramón Encinas and Joan Puig). In this workshop we perform the steps to design an object and then print it with a 3D printer.
- **Yoway** (organized by Mai Bonjoch, Joaquin Colàs and Ayman Moghnieh). The idea is to build your own urban game. Girls can create their own urban game, compose scenes, etc. A clear theme is suggested and they make the story. After that the game will be published and shared.
- **Personalities in robots** (organized by Maria Blancas Muñoz, Sock Ching Low, Anna Mura and Vicky Vouloutsi). In this workshop, girls can program a Nao, a humanoid robot used in research, education and therapy. They learn to use chorégraphe, a piece of software designed to develop behaviors that are then implemented in the physical robot. Thus, they learn to use chorégraphe to simulate the desired behavior and, as a result of comparing the simulation and the physical robot, learn the value of using simulations and prototypes.
- **Building your home automation** (organized by Ferran Fàbregas and Jordi Binefa). In this workshop you can easily discover the first steps in the world of robotics using Scratch. In this project girls can interact with light sensors and temperature.
- **Lego NXT** (organized by Beatriz C. Daniel and Jonathan Ferrer). In this workshop girls can learn basic concepts and to program some tasks with robots.
- **Arduino** (organized by Esteban Martín). Girls are given an introduction to the open source platform Arduino, and and explanation is offered as to why Arduino is so popular among developers, artists and makers. In this workshop a simple project is performed that reads data from a LDR (light sensor) sensor and this act turning on and off a LED depending on the intensity of light received.

After the 2nd hackathon, the following evaluation questionnaire was administered to 111 participants:

- Which workshops have you participated in?
- What was your route? (there were different routes depending on the workshops you participate)
- Is it the first time you come to a girls hackathon of GirlsInLab and UPF?
- How do you think we could improve?

Answer the questions below from 1 (most) to 5 (least):

- How would you rate the hackathon?
- Has it been easy to sign in?
- The information I had before coming was sufficient
- The workshops have been interesting
- I have understood what workshop teachers said
- I liked the material covered
- From today, I will continue learning this technology on my own
- I will explain to my friends what I have done in the workshop
- Now I am more interested in engineering

b. Mentoring

The mentorship was offered to girls over 15 years old. The main objective of this session was to connect girls with women working in ICT areas in order to advise them on their future. We invited female engineers or professionals in other fields such as entrepreneurship, tech marketing, etc. interested in being mentors. Once we had the volunteers, we published their profiles online in order to motivate girls to apply for a mentorship. During the application, girls should indicate their interests and questions they want to ask. Then, each mentee was assigned to a mentor and they had a 30-minutes interview.

Girls also filled in an evaluation questionnaire that allowed us to obtain useful feedback about this initiative. It was designed to provide us with information about the interests and backgrounds of the attendees and to give us feedback about the quality and value of the sessions. The questionnaire included the following questions:

1. How old are you?
2. Which is your current situation?
   a) I am at Secondary School
   b) This is my first/second year at University
   c) I am about to finish my Degree at University
   d) I've finished University studies and I am looking for options regarding my future.
   e) I am already working.

   In case you are still at Secondary School, how do you see yourself in the future?
   a) Health professional
   b) Engineer
   c) Lawyer
   d) Teacher
   e) Researcher
   f) Other

   If you are a university student, which of the following areas represent better your choice?
   a. Technology
   b. Health-care
   c. Arts
   d. Economy

   Why did you apply for a mentorship?
   a. To gather information about what to study next.
   b. To know the job prospects of technical studies.
   c. To meet women working in technology.
   d. Other

   How long was your mentorship?

   Do you think the duration of the mentorship was appropriate or would you prefer longer sessions?

   Rate your mentorship session from 1 (unsatisfactory) to 5 (excellent).

   Would you recommend these sessions to other people?

   Do you think these mentorship sessions would be helpful before choosing your degree?

   Please, write some suggestions about how we can improve these sessions.

4. EVALUATION

In this section we provide the evaluation of both the hackathon and the mentoring sessions.

a. Hackathon

The workshops that the 111 participants of the questionnaire did are the following: Scratch and virtual reality (24), 3D printing and Scratch (16), Scratch Jr. and virtual reality (13), app inventor and Yoway (13), personalities with robots and 3D printing (12), automation house (10), Scratch Jr. and app inventor (8), Lego NXT (8), Yoway and personalities with robots (2), app inventor (1), Lego NXT and virtual reality (1), Scratch and app inventor (1), Yoway and personalities with robots (1).

Regarding the question whether it was the first time they came to a girls hackathon of GirlsInLab and UPF, 11 answered no, and 100 answered yes.

In Table 3, the mean and the standard deviation of the ratings of the hackathon are provided. As it can be seen, the highest mean goes for the information before coming to the hackathon and the lowest mean goes for about what you think about the hackathon.

Table 3: Mean and standard deviation of the ratings of the hackathon.

Question	Mean	Standard deviation
How would you rate the hackathon?	1.27	0.45
Has it been easy to sign in?	1.63	0.88
The information I had before coming was sufficient	2.32	0.98
The workshops have been interesting	1.41	0.55
I have understood what workshop teachers said	1.61	0.69
I liked the material covered	1.45	0.55
From today, I will continue learning this technology on my own	1.79	0.94
I will explain to my friends what I have done in the workshop	1.74	0.81
Now I am more interested in engineering	1.65	0.88

In this section we will try to predict the last attribute, which is the interest in engineering. The prediction is performed using the data of the participants and BigML [15]. With this prediction, we are going to see which are the most relevant attributes ordered by percentage of importance for this prediction. This is useful in order to see which attributes impact most in the interest in engineering. The following attributes were obtained as field importance:

1. From today, I will continue learning this technology on my own: 42.42%
2. The workshops have been interesting: 17.81%
3. I will explain to my friends what I have done in the workshop: 9.02%
4. The information I had before coming was sufficient: 7.25%
5. I have understood what workshop teachers said: 5.86%
6. Which workshops have you participated in?: 5.78%
7. I liked the material we covered: 5.40%
8. Has it been easy to sign in?: 2.57%
9. What was your route: 2.10%
10. How would you rate the hackathon?: 1.78%

Figures 3 and 4 depict a scatterplot using three dimensions, generated with BigML. Notice from Figure 3 that the more interest a person has in the workshops, the more interest she has in engineering. In addition, the more a person will continue learning the technology on her own, the more interest she has gained in engineering. On the other hand, in Figure 4, as can be seen, the less you use the technology on your own and the less you tell your friends about what you have done in the workshop, the less interest you have gained in engineering. In any case, we can see that most of the population report that they will continue learning this technology on their own, that they will explain to their friends

about what they have done during the workshop, and that they are now more interested in engineering.

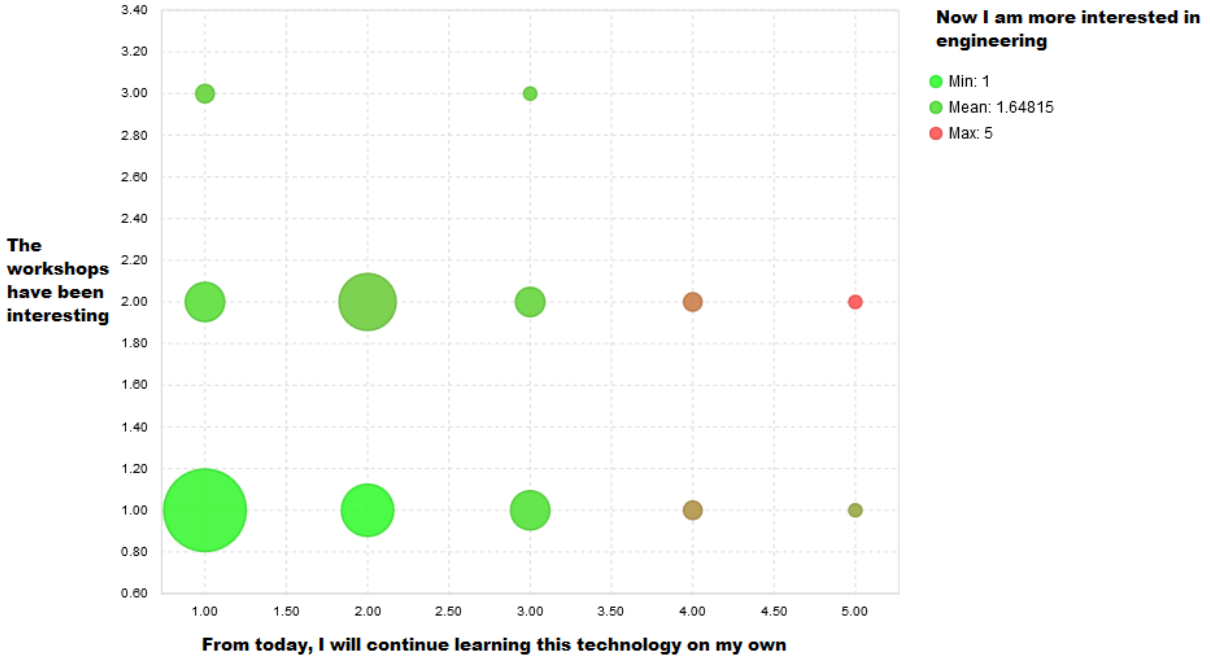

Figure 3: Scatterplot of the interest in engineering, the continuity of using the technology on their own, and the interestingness of the workshops.

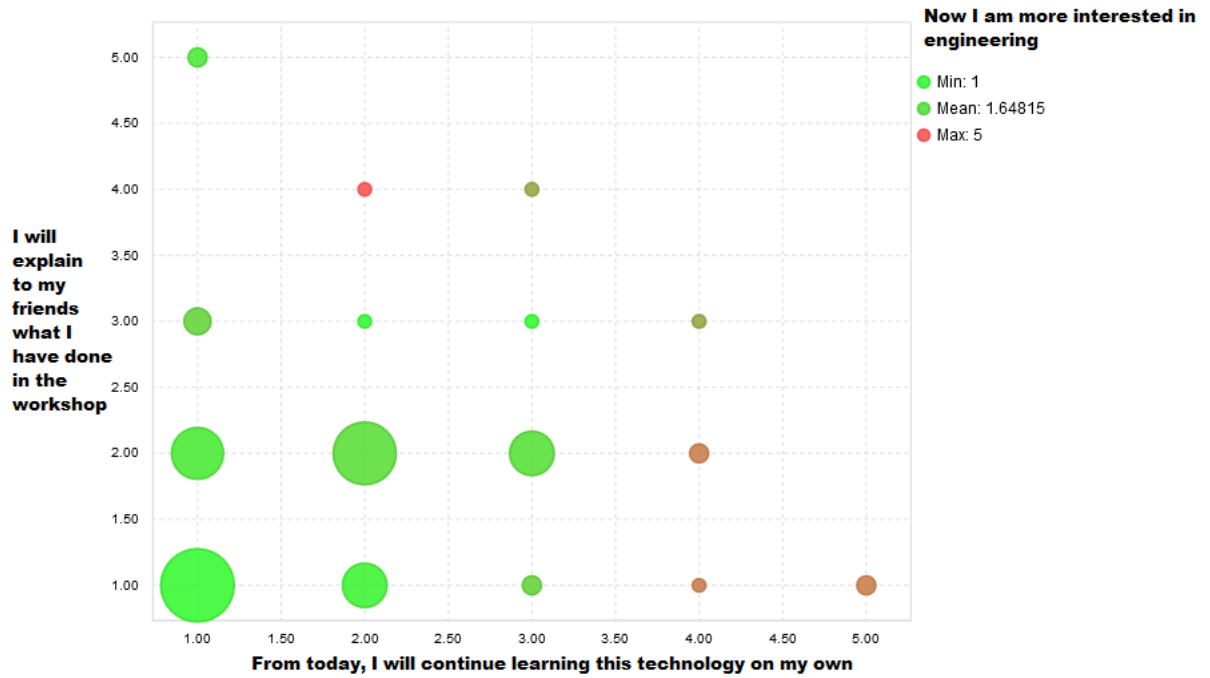

Figure 4: Scatterplot of the interest in engineering, the willingness to continue using the technology on their own, and the explanation to their friends about the workshop.

b. Mentoring

Although 18 mentees received a mentorship, we set 37 interviews, as some mentees were interested in talking to several mentors, based on their different profiles. The questionnaires were sent to the participants several days after the event, and only 6 gave us their feedback. In any case, we obtained interesting feedback.

Although 66% of the participants were already studying at University or working, it is worth noting that 80% of the participants had a background in Arts and only 20% in Technology. As for the reasons to apply for a mentorship session, 83% of the mentees cited the possibility to meet professional women involved in Technology, while 16.7% were seeking advice on what to study next. Interestingly, none of the attendees asked about the job prospects in the ICT field. Although this can be partially explained by the fact that the unemployment rate in ICT is known to be very low, this leads us to wonder if there is a lack of reference women to promote or guide young girls towards technological studies.

Regarding the quality of the sessions, their duration (15-30 minutes) was appropriate for most of the participants, although around 30% of them suggested longer sessions. The overall rating that participants awarded to the activity was 4 out of 5 (5 means “excellent”) with a standard deviation of 1.54. Mentors were rated 4.3 out 5 in average (5 means “excellent”) with a standard deviation of 0.81. Almost 84% of the participants would recommend attending these mentorship programs to other people and all of them agreed that they would be definitely helpful before choosing a degree.

5. CONCLUSIONS

This paper evaluated two initiatives to bring more girls into ICT: a hackathon and a mentorship program. The results of the hackathon questionnaire indicated that they will be continue exploring on their own the technologies they learnt, as well as explaining them to their friends. The most successful feedback is that they are now more interested in studying engineering degrees. Regarding the mentorship session, almost 84% of the participants would recommend attending these mentorship programs and all of them agreed that they would be definitely helpful before choosing a degree.

In general we can conclude that this was a powerful initiative to promote girls to study engineering degrees and to increase the visibility of women in ICT, but more effort is still needed to continue disseminating ICT among young girls and increasing the number of professional female references and teachers in technical fields.

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