Promotion of scientific careers: the Aquí STEAM-UPC programme

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Background

The "She Figures 2015" [1] European Commission report states that in 2012 the number of male and female PhD graduates was almost equal (between 40% and 60% of women). However, the number of men who intended to select STEM studies was almost twice as high as the number of women. The report confirms that low representation of women in science and engineering fields continues to be a problem. In 2012, women represented just 21% of PhD holders in computing in the EU-28.

The European Institute for Gender Equality (EIGE) provides some data in "Gender equality and digitalisation in the European Union" [2] (for 2017 and 2018) that reveal a high demand for digital professionals and a lack of women in STEM areas. According to the EIGE, the percentage of women who graduated in STEM in the EU dropped from 23% to 22% in the last decade. Participation of women in ICT is 14%. The EIGE considers that this gender segregation is one of the factors that contributes to the gender pay gap in the EU, as the ICT sector is one of the best paid. Within the ICT sector, the pay gap between men and women is lower (13%) than in other professional areas. The EIGE also indicates that women represent 17% of the 8 million ICT professionals in the EU.

The Spanish ministry report "Científicas en cifras, 2017" (Women scientists in figures, 2017) [3] states that horizontal gender segregation is still visible in the number of university students enrolled in bachelor's and first- and second-cycle degrees. In the 2016–2017 academic year, the percentage of female students of engineering and architecture dropped from 26% to 25%. In Catalonia, the Government of Catalonia's Women and Science Committee reveals in its statistical report that the percentage of female students of engineering and architecture (bachelor's, master's and first- and second-cycle degrees) was 24.57% in the 2016–2017 academic year.

The situation at the Universitat Politècnica de Catalunya (UPC) is like that of other technical universities in Spain and internationally. At the UPC in the 2006–2007 academic year, women on first- and second-cycle degrees comprised 24.40% of the total number of students. In the 2017–2018 academic year, women made up 25.00% of all new students. If we compare academic years 2012–2013 and 2017–2018 [4] (the first percentage in the brackets refers to 2012–2013 and the second to 2017–2018), the data on intake of women were respectively: bachelor's degrees (24.8%, 25.0%), master's degrees (33.2%, 35.0%), doctoral degrees (31.0%, 31.7%). However, when we focus on specific areas of knowledge, the situation varies. The proportion of all new students who were women in the 2017–2018 academic year in specific fields were: health sciences (optics and optometry) 71.8%, architecture 46.4%, industrial engineering 15.9%, informatics engineering 13.6% and naval engineering 15.9% (Table 1). The AQU 2017 report on graduate employment included informatics, industrial engineering and naval engineering among the top ten degrees, that is, degrees with the best professional prospects.

The gender gap in STEAM professions and studies indicates a lack of female talent and diversity in engineering solutions to society's needs, and a loss of social mobility opportunities as future STEAM professionals (women represent over 50% of the world's population). The complexity of these barriers goes beyond university boundaries and strategic partnerships are required with social stakeholders who influence this area.

Various sociocultural factors affect the academic degrees and technology careers that appeal to girls and boys when they choose their future studies and professions. These include stereotypes associated with technology and engineering and the existence of female and male roles rooted in family, school and social environments in general (family expectations, teaching methodology in primary schools, participation in classrooms, games and the media, among others), regardless of students' real academic results.

Table 1. Distribution of gender among new UPC students in the 2017–2018 academic year. (a) Bachelor's degrees, (b) master's degrees and (c) doctoral degrees

(a) New bachelor's degree students

UPC 2017–2018

by area of knowledge

Bachelor's degrees					
Field	2017_2018				
	Female	%Female	Male	%Male	Total
50% aerospace and 50% telecommunications	9	19.1	38	80.9	47
Architecture, urbanism and building construction	287	46.4	332	53.6	619
Applied sciences	33	33.0	67	67.0	100
Health sciences and technology	61	71.8	24	28.2	85
Aerospace engineering	61	23.7	196	76.3	257
Civil engineering	46	26.9	125	76.1	171
Biosystems engineering	73	44.0	93	56.0	166
Informatics engineering	71	13.6	452	86.4	523
Telecommunications engineering	105	19.4	435	80.6	540
Industrial engineering	438	20.1	1736	79.9	2174
Naval, marine and nautical engineering	23	15.9	122	84.1	145
TOTAL	1207	25.0	3620	75.0	4827

(b) New master's degree students

UPC 2017–2018

by area of knowledge

Master's degrees					
Field	2017_2018				
	Female	%Female	Male	%Male	Total
Others	30	33.7	59	66.3	89
Architecture, urbanism and building construction	196	50.9	189	49.1	385
Applied sciences	37	32.2	78	67.8	115
Health sciences and technology	23	85.2	4	14.8	27
Aerospace engineering	19	18.1	86	81.9	105
Civil engineering	76	30.2	176	69.8	252
Biosystems and agri-food engineering	7	58.3	5	41.7	12
Industrial engineering	161	21.1	602	78.9	763
Informatics engineering	29	22.7	99	77.3	128
Naval, marine and nautical engineering	2	4.9	39	95.1	41
Telecommunications engineering	19	14.5	112	85.5	131
Business management and organization	354	57.2	265	42.8	619
The environment, sustainability and natural resources	22	46.8	25	53.2	47
TOTAL	975	35.9	3620	64.1	2714

(c) New doctoral degree students

UPC 2017–2018

by area of knowledge

Doctoral degrees					
Field	2017_2018				
	Female	%Female	Male	%Male	Total
Architecture, urbanism and construction	28	48.3	30	51.7	58
Sciences	24	27.6	63	72.4	87
Civil engineering	29	31.2	64	68.8	93
Industrial engineering	61	38.4	98	61.6	159
TIC engineering	16	15.8	85	84.2	101
TOTAL	158	31.7	340	68.3	498

Development of the Aquí STEAM programme

The UPC has been groundbreaking in the design of actions to attract talented young people to STEAM degrees. Notable examples are the UPC's DONA programme, which was implemented at the end of the 1990s until 2004 and focused on activities exclusively for girls, as well as the organisation of a summer campus with the same goal. As part of the second and third UPC equality plans (2016–2020), new projects have continued to be generated in recent years that are focused on promoting STEAM careers basically among young people who are in secondary school and upper secondary school education, with progressive interest and participation of schools. In the first phase of the third equality plan, the project +DonesTIC was developed, with the participation of the four schools that offer ICT-related qualifications at the UPC.

As a strategic area within its gender policies, the current commitment of the UPC is based on the Aquí STEAM programme to attract talent and raise the interest of girls who are in the upper cycle of primary school and the start of secondary school, in the age range of 9–14 years. Not only girls are targeted in the activities, but boys and girls together. Given that cultural change has to become in both genders: they will interact in the professional life and the goal is they do not perpetuate gender stereotypes. The programme was designed considering some of the main barriers to the incorporation of women in STEAM professions and studies, such as:

- The lack of female STEAM references and models.
- The existence of gender roles and stereotypes associated with engineering and ICT.
- The lack of knowledge of STEAM professionals and what they give back to society.

The programme is divided into four areas (Fig. 1.): models of reference, professions, stereotypes and reflection.

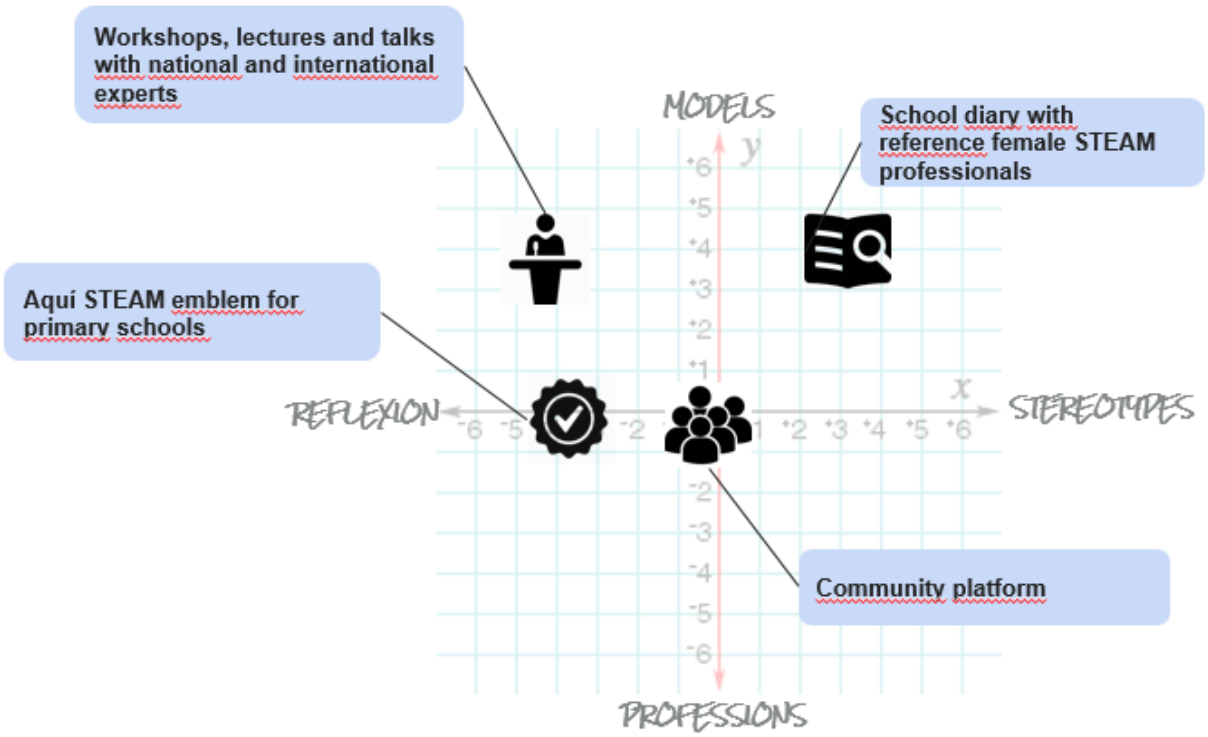

Fig. 1. Strategic model of the Aquí STEAM programme

A set of actions have been planned that are designed to act directly on the elimination of these barriers.

- **"Aquí STEAM" emblem for schools**: the aim of this project is to provide tools for schools to bring STEAM studies into classrooms and include the gender perspective. A network of primary schools will be created that facilitates the exchange of experiences, good practices and concerns. There will be an initial 15-hour training programme (given by the UPC's Institute of Education Sciences and accredited by the Government of Catalonia's Ministry of Education), based on the principles of coeducation and on encouraging an interest in technology.

- **Workshops, lectures and talks**, among other resources: activities undertaken on request of schools that will enable girls and boys to experience STEAM professions first-hand and see the social applications of engineering. These actions are led by female STEAM professionals or researchers and help to break some of the stereotypes that dissociate engineering and technology from women.

- **Aquí STEAM school diary**: a project that, with the collaboration of other Catalan institutions, focuses on providing examples of female STEAM professionals in the classroom and knowledge of STEAM professions and studies for girls and boys, through a tool that is commonly used by students, that is, the school diary.

- **Cycle of reflection: "Mujer y tecnología, un tándem de futuro" (Women and technology, a tandem for the future)** (scientific supervision by the UPC, held in the Palau Macaya of Obra Social La Caixa). Duration of the cycle: January 2019 to December 2019. The cycle examines the paradox of a world in which women are in the minority in engineering and technology, even though they make up over 50% of the world's population.

This cycle reflects generally on the role that women play in technology and how we can bring about a richer, more diverse future with their full incorporation. The challenges that are set out are:

1. To share knowledge and initiatives to encourage girls to take technology degrees and women to advance professionally in technology environments.
2. To share local and international good practices.
3. To reflect on potential future strategies and propose activities in all areas of society.

The cycle is organised around two talks: an opening talk on ethics and engineering and a closing talk entitled "Gender quotas: from politics to business". Between these two talks are three thematic blocks (training block, employment block and society block). The blocks are divided into three specific workshops, with a round table to present the conclusions at the end of each block.

- **Aquí STEAM platform**: stakeholders, actions, resources and projects are coordinated in Aquí STEAM under the umbrella of a platform, an interactive community, so that Aquí STEAM becomes a network for exchanging the knowledge and practices of people and organisations who work to empower girls in their future careers. The platform is designed to create synergies and thus enhance the efficiency and impact of activities that are undertaken. The platform will promote interaction between new and existing programmes and initiatives, such as +NoiesTIC, the UPC mentoring programme M2m and "Una ingeniera en cada escuela" (A female engineer in every school), among others.

Conclusions

The fact that few women choose careers in the STEAM area is a great incentive to reconsider the type of relationship required between universities and society in order to change gender trends whose origin is markedly cultural. Increased awareness of the problem's complexity and the need for a multidimensional, network response to help change it have encouraged the UPC to establish a programme that is focused on generating a community of stakeholders and projects in a network, studying influences and exchanging knowledge to generate a joint proposal.

The Aquí STEAM programme, which started during the 2018–2019 academic year, has no quantitative results yet. The aim of this document is to share the qualitative approach.

References

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