Affirmative action for attracting women to STEM in Chile

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ABSTRACT

Women are currently almost half of the work force in Chile, but very few of them work in the software industry. In part, this is because there are strong cultural stereotypes about what careers are "for men" in Chile. This idea has been further cemented by the standardized admissions process used by Chilean universities, where female mathematics scores have historically been lower than that of their male peers. In order to break these stereotypes and attract more women into STEM careers, the Faculty of Mathematical and Physical Sciences at the University of Chile has created the Gender Equality Admissions Program (PEG, for its name in Spanish, *Programa de Ingreso Prioritario de Equidad de Género*) in 2013. Under this program, 40 extra women are selected into the most competitive engineering and science program in the country. In the five years that the PEG has been in place, the number of women accepted into the engineering and science program has grown from 19% to more than 32%. Moreover, we have started to see an increase in the enrollment of female students in Software Engineering courses. This growth goes beyond the 40 new female students per year.

CCS CONCEPTS

• **Social and professional topics** → **Women**; *Computer science education*;

KEYWORDS

STEM careers; female participation; Latin America; gender

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1 INTRODUCTION

There is a growing demand for software engineers [8], who must be technically competent, but must also effectively communicate with clients and users, work in and lead teams, and solve problems [4], among other tasks. Even though these jobs are generally highly lucrative, women are underrepresented, both in computing and other science, technology, engineering and mathematics (STEM) fields [10]. One of the reasons for this is that there are few female STEM students to begin with [10], and gender biases in the work environment later contribute to worsen the gap [7, 13]. Overall, women are more likely to work part-time, face discrimination at work and earn less [10].

Chile has a low number of female STEM students, especially computer science and engineering programs [3]. Strong gender stereotypes in the region, like that women should be caretakers, narrow down the choices that students have when thinking about their future [9]. For example, the OECD Programme for International Student Assessment (PISA) 2015 database[1] showed that in Chile, boys outperformed girls in mathematics. Moreover, 50% of 15-year-old boys' parents expected that they would work in a STEM field. However, only 16% of girls' parents hoped that their daughters would do so [5].

This is further evidenced by the gender gap in PSU scores[2], a highly competitive, standardized admissions exam used by Chilean universities. Historically, women have performed worse than men in the mathematics part of this exam, meaning that fewer women can apply for and obtain a place at competitive STEM programs in Chile. A opposite-sex twin pairs study from 2016 showed however that there was no gender gap in standardized non-competitive mathematics exams [11]. The general consensus is that the mathematics gender gap in Chile are mostly due to the negative perceptions that Chilean women have about their mathematical abilities, as well as stress and anxiety in competitive situations [10].

These performance gaps have not changed much in recent years, and are important because they drive occupational segregation. If this situation continues, it will be very difficult to close the gender gap in Chilean STEM fields like the software industry, and it will be even harder to break the glass ceiling. For example, women participate in less than 5% of Chilean company boards, and only 25.3% of managerial positions are occupied by women (whereas the OECD average is 31.2%) [10].

[1] http://www.oecd.org/pisa/data
[2] In Spanish: *Prueba de Selección Universitaria*

Given this context, the Faculty of Mathematical and Physical Sciences (FCFM, for its name in Spanish) sought to recruit more female students for its science and engineering programs. All students apply to a common science and engineering program, and during their third year, they pick their major (one of nine engineering programs, or a science degree). Historically, the students at our campus have been predominately male (80-90%), and we get over 5,000 applications for one of the 735 available places. All universities use the same admissions process, where a score is calculated for each student based on their PSU scores and school grades, and the top 735 students are accepted into the program. We cannot change this standard admission process, so the FCFM created extra places specifically for women: the Gender Equality Admissions Program (PEG in Spanish). Under this initiative, the FCFM now also admits the next 40 women from the selection list, starting from position 736. The program is very competitive, so the last woman recruited through the PEG initiative has a similar score to that of the last student selected through the regular admission process.

During the five years that the PEG has been in place, the proportion of women entering the program has grown from 19% to more than 32% and we have started to see an increase in the enrollment of female students in Software Engineering courses. This growth goes beyond 40 students, meaning that PEG may be helping change women's self-perception about their place in STEM careers in Chile. In the rest of this position paper, we first discuss initiatives to reduce the gender gap in other Computer and Software Engineering programs. We then describe the PEG initiative in more detail, as well as the results we have seen so far. We end by discussing ongoing work and actions.

2 RECRUITING MORE WOMEN TO STEM

Improving the gender balance in STEM fields is an important issue for many countries, gaining ground and relevance every day.

Klawe et al. [6] reported on initiatives considered important to motivate and attract girls, and that have worked in practice. (1) Expose girls to positive role models in the STEM fields and dismantle computing-career myths and stereotypes. For example, the idea that computing is a "white male profession with head phones and zero social skills" discourages girls and minorities from pursuing STEM careers. (2) Give accurate information to key influencers of girls (teachers and parents) since they may have unconscious biases that can subtly discourage girls from pursuing computer-related fields. (3) Give girls the chance to work with hands-on technology activities in an age appropriate way. (4) Enroll girls in summer computer programs in which they have the possibility of an immersion experience with technology. (5) Motivate girls through the potential of social impact that their work in technology could have.

MIT and CMU have been leaders in closing the gender gap on their campuses, and more specifically, in their computer science programs[3]. At both institutions, this has been the fruit of a combination of different factors: (1) university leaders strongly committed with closing the gender gap; (2) the creation of pipeline programs for high school students; (3) the creation of targeted recruiting programs; and (4) changes to how applications are analyzed and considered for offers. It is important to note that these changes to the admissions process have not made it "easier" for women to get admissions offers. For example, Guy Blelloch, the associate dean for Undergraduate Programs in the School of Computer Science at CMU, indicated that the average SAT scores, grade point averages and class rank for the 2016 cohort were higher than those of the previous cohorts. Note that unlike the Chilean system, SAT and ACT scores are only part of the admissions process.

The Harvey Mudd College has taken a different approach to close the gender gap in computer science. With around 55% of women in the incoming class, this college is graduating more women in computer science than men[4]. Here the focus was on making sure that everybody started their degree on equal footing. To begin with, the college redesigned its introductory computer science course, emphasizing the practical uses for programming and team based-projects. As a result of the changes, women who take this introductory course are more likely to have positive opinion about programming. They also try to engage women by picking student projects that will help the community.

There are also reports of many initiatives from different countries showing what they are doing to solve this problem. Germany created a nationwide Girls' Day, where the goal is to familiarize teenagers with work in STEM fields. They also created the National Pact for Women in STEM Careers, this pact set out to increase the proportion of female first-year STEM students, in order to reach European levels, recruit women for STEM careers in proportion to the graduation rates, and increase the number of women in executive positions at science organizations by 1% annually [1]. In England, Smith [12] reports that there are several governmental and industrial initiatives trying to reduce the gender gap by showing girls how important it is for them to participate in STEM fields and make them aware that they are capable of following STEM careers.

3 THE PEG INITIATIVE

As discussed in the previous section, leading American educational institutions have tweaked their admissions policies in order to reduce the gender gap at their institutions. The admissions system in Chile is standard for most universities, so this is not an option for our institution. In this section, we first give a brief overview of some historical facts about our institution that contributed to the gender gap that motivated the creation of the PEG initiative. We then describe the initiative in more detail.

The University of Chile was founded in 1842, and the School of Engineering in 1853 (which afterwards became the FCFM). Female students were only allowed after 1887, but only in 1913 did the FCFM get its first female student, and she graduated in 1919[5]. However, the university continued to have few female students, and by 1960, only 10 female engineers had graduated from the University of Chile. Culturally, the STEM fields are considered as "masculine" in Chile, so this low amount of female students is not surprising.

Moreover, the number of female students on campus seemed to stagnate around 2013, stabilizing in the 17-20% range (see Fig. 1). This situation was quite concerning: extrapolating the data from Fig. 1, at this pace we would need sixty years to reach 40%! The FCFM put in place some initiatives to recognize the role that women

[3] See https://goo.gl/BYdxEc and https://goo.gl/xn7wrn

[4] https://goo.gl/TUHLnB

[5] Justicia Espada Acuña – she was also the first female engineer in South America.

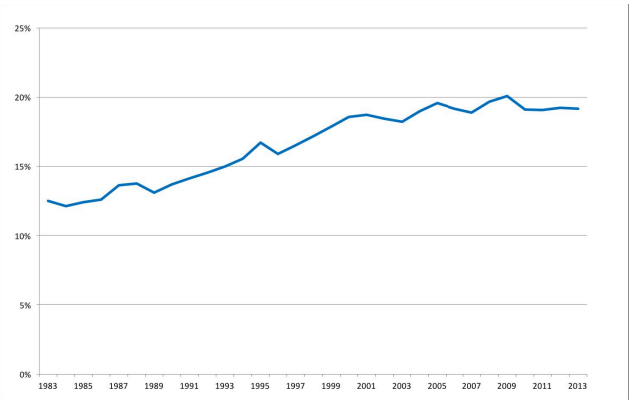

Figure 1: % of women students at the FCFM (1983 - 2013)

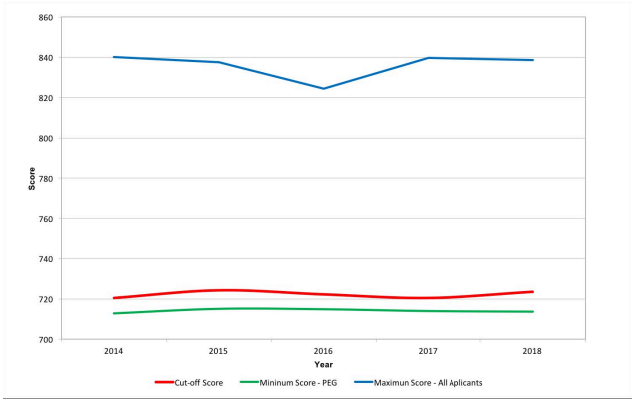

Figure 2: Distribution of scores: regular and PEG applicants.

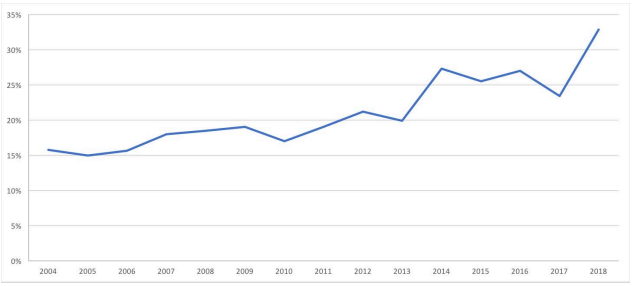

Figure 3: % of first-year female engineering students

engineers have, for example, changing the word "Ingeniero" to "Ingeniera" on female graduates' diplomas. While being very commendable, this measure, introduced in 2008, did little to increase the number of female students.

In an earlier study, Celis [2] studied a sample of FCFM engineering students from 2000 to 2003 ($n = 2,240$). Celis found that 73.47% of these students obtained their degree. Just 17.04% of this sample completed their degree in the expected amount of time, and the mean time to obtain the degree was 7.29 years. Celis also discovered that female students are more likely to complete their degrees at a faster rate than male students.

This brings us to 2013 and the PEG initiative. This program recognizes the contribution that women can bring into engineering and science, and therefore aims to attract more women into these areas. PEG was proposed by a group of female faculty members[6].

The main goal of this initiative is to minimize the gender gap introduced by the PSU, the highly competitive university entrance exam taken by all students that want to attend a select group of Chilean universities. The exam is standard, but each university decides how to weigh the different parts of the exam and student grades for each program. The formula for the common science and engineering program at the FCFM is $0.1G + 0.2R + 0.1L + 0.45M + 0.15S$, where G and R are the student's high school average and their ranking within their class, and L, M and S are the language, mathematics and science parts of the PSU exam. G, R, L, M and S are scored individually, with a maximum score of 850. During the regular admissions process, the FCFM selects the 735 applicants with the highest scores. With the PEG initiative in place, since 2014 the next 40 female applicants after the cut-off point are also invited to apply at the FCFM.

This mechanism was design by analyzing the gender distribution of the applicants from previous years. Only 6% of the first 100 applicants to the FCFM were female, only 12% of the next 100 were female, and only 30% of the last 100 applicants were female. In other words, there are more women applicants towards the end of the FCFM selection list. However, women in general take less time to graduate and have a slightly lower drop off rate than the male students. This initiative also took into account that female scores for the mathematics part of the PSU are usually 10-12 points lower than that of the male applicants, which has a high impact in their application scores (45%). The goal of the PEG initiative was to address all these differences.

[6]This group is called "Adelina Gutierrez", honoring the first Chilean woman to obtain a Ph.D in astrophysics. She was also the first woman to become a member of the Chilean Academy of Sciences, and she worked at the FCFM, where she helped set up the Astronomy department.

4 OUTCOMES OF THE PEG INITIATIVE

The PEG initiative was not fully supported during its inception. There was a lot of backlash from both current and former female students of the FCFM, who saw this program as a "devaluation" of their efforts. Many female students were concerned that people would assume that they had entered the FCFM with much lower scores than their male peers, that they had not "earned" the right to be there. The PEG initiative was also considered unfair: why not just accept the next 40 students on the selection list, independent of gender?

Figure 2 shows that the scores for students accepted through the PEG program are quite similar to those accepted through the regular application process: there is a difference of just 10 points between the cut-off score for regular applicants and the score of the last selected PEG student. The 40 PEG students only represent 5% of each cohort, a substantial increase in itself. However, this program had a clear but unanticipated side effect: overall, more women are applying to the FCFM. In fact, in 2018, 32.8% of our incoming students are female, a record for Chilean universities (see Fig. 3). It

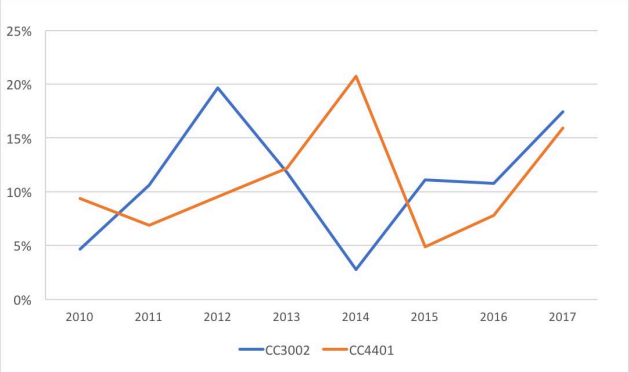

Figure 4: % of female students in the first two SE courses.

is expected that in 2018 the first cohort of PEG students finish their programs, so it is not possible to report about the graduation rate of the PEG students yet.

How has the PEG initiative affected our computer science engineering program? During their third year at the FCFM, students must pick a specialization degree, one of which is the computer science engineering degree. The FCFM started offering a bachelors in CS in 1979, with its first female graduate in 1987. In 1986, we started offering a computer science engineering degree. By 2013, only 10-15% of our students have been female. For example, Fig. 4 shows the percentage of female students enrolled in the first two Software Engineering courses. Note that the peaks and valleys for 2012-2015 are because we made changes to the program curriculum, so two cohorts coincided in CC3002 in 2012 and CC4401 in 2014. We see the effects of PEG during 2017, where we finally reached more than 15% of female students.

5 ONGOING WORK

It is still early to draw any strong conclusions, but we expect to surpass the 35% threshold for incoming students at the FCFM in the short term, at which point we no longer expect to be treated as a minority on campus. We have also seen an increase in the percentage of women graduates at our CS engineering program, although this cannot be attributed solely to the PEG initiative (see Fig. 5). Chilean women are staring to consider STEM fields, our challenge is to now attract them to computer science.

There are several national and regional initiatives to attract women to technology. For example, since 2011 we help organize ChileWiC[7], a yearly conference for women in computing in Chile. We also held the first version of the Latin American Women in Technology (LAtINiTY)[8] conference in Santiago. Start-Up Chile created "The S Factory"[9], an accelerator for companies with female founders. And in order to increase the visibility of women in this area, the Chilean government created InspiraTEC[10], an award celebrating women in technology.

[7]http://chilewic.cl/
[8]https://latinity.info
[9]http://www.startupchile.org/the-s-factory-here-are-the-winners-of-generation-6/
[10]http://www.premioinspiratec.cl/

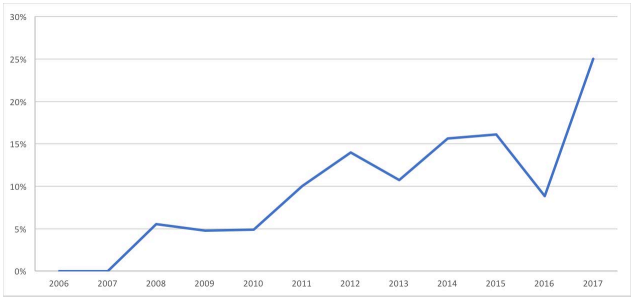

Figure 5: % of CS engineering graduates that are female

Special enrollment for women is a measure that is effective in the short term, but to transform it into a long term initiative, it is necessary to work on spreading the word in elementary and high school girls as well. We are convinced that initiatives like PEG will help girls visualize engineering and computer science as an attractive and real career option, and therefore affirmative actions will soon be unnecessary. In this context, families should support their daughters when considering STEM as their future studies and activities, and not push them into more traditional women' choices. It is well known that computer scientist women are highly recognized not only for their technical competences but also for their ability for team work and communication, specially appreciated in new trends such as agile software development.

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