

There Is A Low Rate Of Women In Engineering Studies In Chile. Why?

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Abstract: Higher education today is a great opportunity for personal and professional growth in the world, especially in developing countries like Chile. Higher education entities such as universities and professional institutes offer a wide and varied proposal of engineering studies with various specialties from those that are closer to people and business management, such as Commercial Engineering and Human Resources, to those more specific to technology such as Computing and Mechatronics Engineering. Given the wide range of opportunities for higher education, it is surprising that the number of women students in Engineering is absolutely lower than that of the number of men, a situation not common in other areas of study such as pedagogy, medical sciences, and law. Precisely, the main objectives of this paper are to present the results of an exploratory study of the working reality in Chile of women engineers to compare these results with the low number of women studying Engineering in Chile, and thus seek and raise the reasons for that divergence.

Index Terms: Women, Engineering Studies, Chile, Chilean Academy, Universities.

1 INTRODUCTION

The participation of women in the STEM areas, that is, Science, Technology, Engineering, and Mathematics, has been studied in several countries. Those studies used different approaches such as methodologies of discourse analysis in female engineering students [1] and sociological studies related to the reasons why women do not enter or do not finish careers in these lines [2] [3]. Majors in engineering in Chile distinguish by their orientation or specialty, the main focus, and depth regarding their years to finish them. In this way, in Chile, a distinction exists between Execution Engineering, Engineering, and Civil Engineering majors with a usual duration of 4, 5, and 6 years, respectively. According to CNED [4], as shown in Figure 1, the participation of women in engineering careers in 2015 and 2016 in Chile was around 20%. According to [5], the increase in women in engineering studies has not been significant in 10 years: 20% in 2004 and 24% in 2014. These figures are not consistent with the current conditions related to the Gender equity, inclusion and participation of women in Chile, possible to see in other environments of society, such as female entrepreneurship, which is around 40% [6].

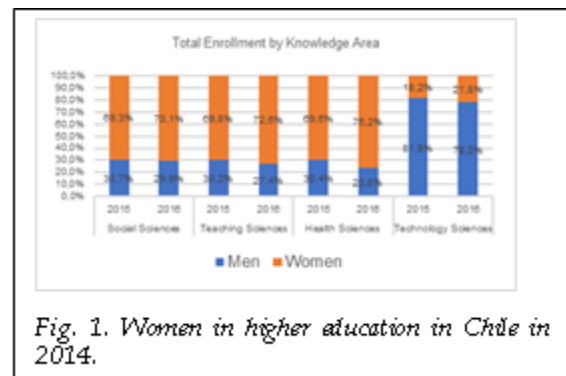


Fig. 1. Women in higher education in Chile in 2014.

Low female participation in Engineering is a global issue. Thus, the Global Compact gender gap analysis tool [7] helps business leaders in the world to identify strengths, weaknesses, and opportunities for improvement to achieve equality in working conditions between men and women. Similar experiences exist in companies such as Facebook and LinkedIn [8]. Those companies created a counseling program for young women in STEAM majors to increase their interest encourage their graduation since, in the United States of America, there is a decrease in the percentage of female graduation in these areas: from 35% in 1985 to 18% in 2015. In higher education in Chile, some universities have already taken measures to provide individual quotas in engineering careers for women [9]. However, this difference is not significant concerning the participation of men, as shown by the other rows in table 1 that represent the percentage of the involvement of men and women in other areas of Engineering. For example, in Mechanical Engineering, and Electronic Engineering and similar, the percentage gap is more significant and closer to 95 percentage points, respectively. In contrast to this low participation, the industrial sector recognizes that social skills, leadership, and the ability to work in teams are key aspects that characterize these professionals, qualities that are highly valued [4].

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TABLE I
LIST OF MAJORS IN THE TECHNOLOGY AREA WITH A GREATER PARTICIPATION OF WOMEN AND MEN IN 2016.

#	Major	% Men	% Women
1	Food Engineering and similar	32,30%	67,70%
2	Biomedical Engineering.	40,20%	59,80%
3	Automotive Mechanical Engineering	97,50%	2,50%
4	Electronic Engineering and similar	97,30%	2,70%
5	Industrial Engineering and similar	96,20%	3,80%
6	Electrical Engineering and similar	96,20%	3,80%
7	Automation, Industrial Control Engineering and	95%	5%

This article describes a previous exploratory study [10] and highlights part of its results regarding the reality of work for engineer women in Chile. We compare those results with the low number of women studying engineering in Chile for analyzing common characteristics of women. Specifically, this work aims to answer the following questions: What does determine that a young woman decides to study engineering? What are the variables that influence her decision? and Are these variables standard in female students and women engineers?

2 WOMEN AND ENGINEERING AROUND THE WORLD

Such as the work of [11] mentions, there are fascinating contributions of women in the areas of science and engineering in the history of the world. From Xilingshi in China, who led the development of silk and industrial fabric cultivation, Cleopatra, an alchemist, who probably lived in Alexandria, Egypt. The work of the alchemists represents the precursor of modern chemistry, and Cleopatra illustrated the first drawings of chemical substances. Likewise, Ada Lovelace, who lived from 1815 to 1842 (today there is a programming language in his honor), is considered the first person who described a computing programming process. As indicated by [12], as early as 1999, according to a study by the Massachusetts Polytechnic Institute (better known as MIT for its acronym in English), there was already concern about the various and special barriers to women in the faculties of

science and engineering in the university world. The work of [12] also indicated that, even when there was a growing increase of women in science and engineering faculties, there was still a very low representation regarding the participation of men. This reality continues similar in various places, such as in Spain, for example, where only 25% of engineering students are women [13]. According to [14], on average, women in the world employed in Research and Development (R&D) in 2014 only represented less than a third (28.8%) of the total number of people employed in that line. According to [15], in England, 2017, surveys indicate that 11% of the engineering workforce is female, which represents a positive change of 9% in 2015. As noted by [16], there are many barriers for a woman in engineering, commonly of men, and female engineers are examples of survival.

3 WOMEN AND ENGINEERING IN CHILE

For the focus or depth levels of engineering majors in Chile, the results of [17] about the labor participation in engineering in Chile, Figure 2 shows that the female participation in engineering is 18%. Figure 3 shows that the greater involvement of women is in the area of Engineering and Business. Note that Business is considered a particular field of engineering in Chile. Next, we detail our study and results, and a comparison with the results of [17].

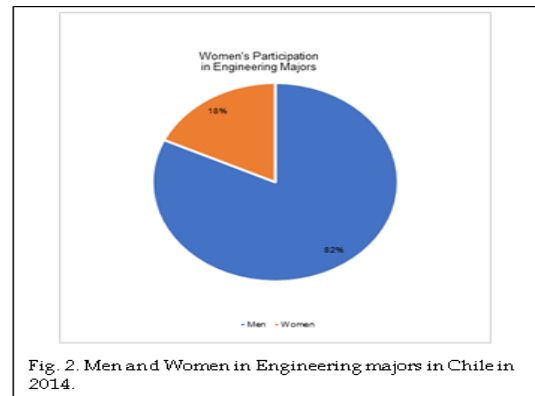


Fig. 2. Men and Women in Engineering majors in Chile in 2014.

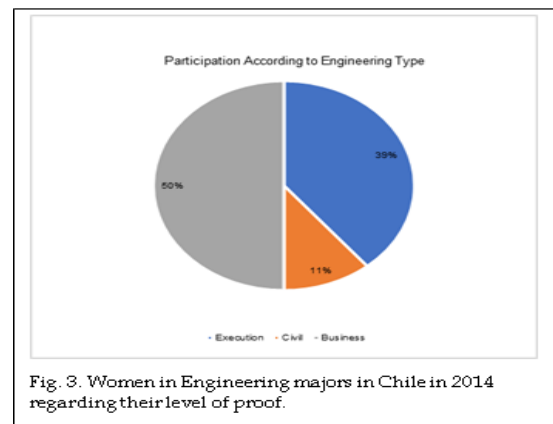


Fig. 3. Women in Engineering majors in Chile in 2014 regarding their level of proof.

The questions of this study are classified in General Data (16 questions), Personal characteristics of the pre-university life of the respondent (7 questions), Characteristics of the respondent's life in basic education (15 questions), Characteristics of the life of the respondent in middle school (18 questions), Self-concept and motivation of the respondent (13 questions), and Pre-university life - Career choice (11

questions), that is, the survey is made up of 80 questions.

4 STUDY RESULTS

We keep the original survey data as much as possible so that to reflect the point of view of women who have studied a major involved in engineering. For the integrity of the results as far as graphics are concerned, only the responses of the people who have completed the survey presented above have been taken into account, which becomes 80% of the total population surveyed, that is, a figure very significant. Among the most significant results, the following stand out: i) The most chosen specialty by female engineers is Civil Engineering, and, on the other hand, the least chosen is Execution Engineering. ii) Women engineers currently belong mostly to the first generation of professionals in their family. iii) The degree of satisfaction of the career choice is far superior to the option of having chosen another vocational training option for female engineers. iv) Similarly, respondents have responded that, if a teacher was involved in their decision to study engineering, said teacher would be in the area of mathematics. v) Of the women engineers who currently practice their profession, most of them are in a management position. vi) The religion that predominates among the respondents is Catholic. vii) Family members of a large part of the population surveyed have not encouraged career choice. We carried out a data crossing for emphasizing on i) Average of mathematics in primary education vs. secondary education along with the relevance of teachers in their subjects according to training areas; ii) Games in childhood (extracurricular activities); iii) Family support of career choice; iv) Family motivation for the selection of an engineering career; v) Relevance between professional generation in the family vs. family support for the chosen career; vi) Level of subjectivity of recognition and/or academic requirement; vii) Gender relevance of influencers in career choice; viii) Extracurricular activities in secondary education; ix) Graphs of self-perception in adolescence; x) Activities frequently carried out with friends.

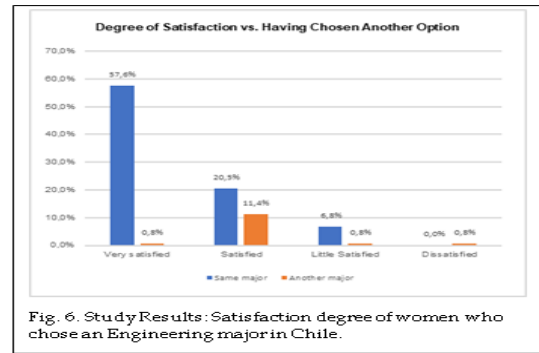


Fig. 6. Study Results: Satisfaction degree of women who chose an Engineering major in Chile.

Figures 4, 5 and 6 show the significant results of this study for the first three variables already mentioned: 1. Percentage of choice of the type of Engineering. 2. Distribution of women in the generation of professionals in their families. 3. Degree of satisfaction of women who chose Engineering in their professional training along with the percentage of them willing to follow another professional training if that were possible. Figures 7 and 8 present results for the averages scores in mathematics for primary and secondary school, and the relevance of the professors according to their area of knowledge and subject.

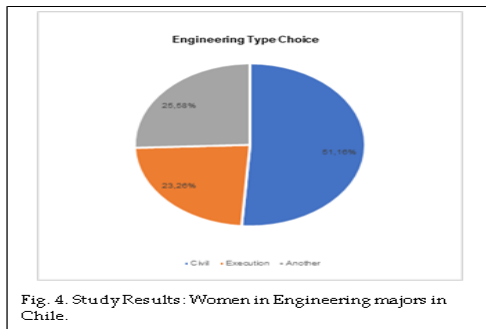


Fig. 4. Study Results: Women in Engineering majors in Chile.

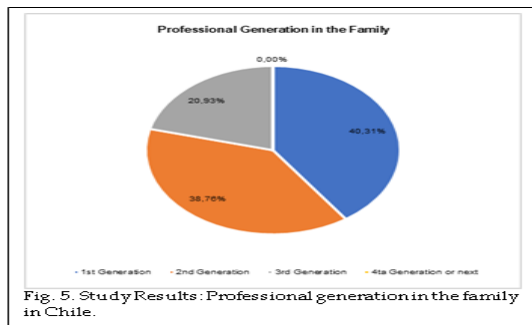


Fig. 5. Study Results: Professional generation in the family in Chile.

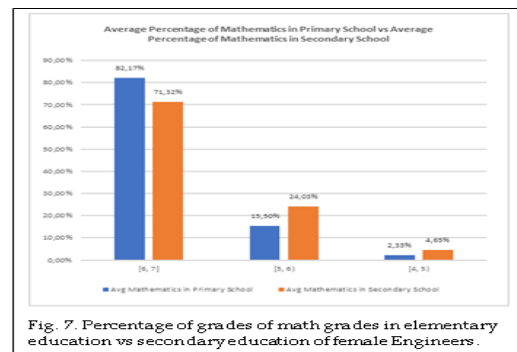


Fig. 7. Percentage of grades of math grades in elementary education vs secondary education of female Engineers.

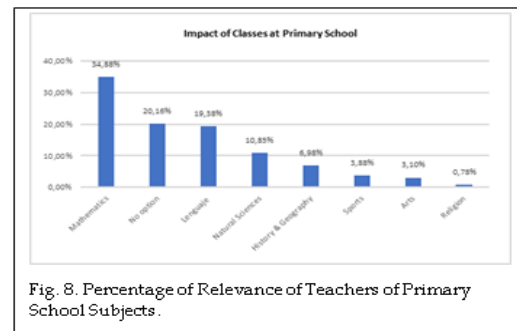


Fig. 8. Percentage of Relevance of Teachers of Primary School Subjects.

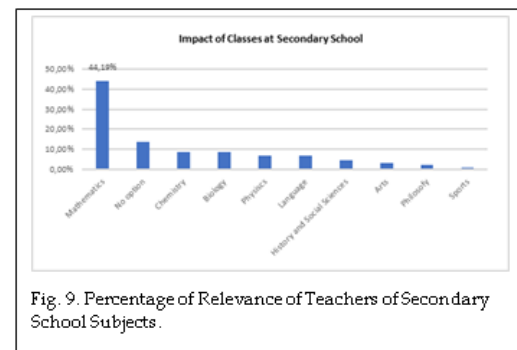


Fig. 9. Percentage of Relevance of Teachers of Secondary School Subjects.

5 DISCUSSION RESULTS

According to Figure 4, about 50% of the women in the study are Civil Engineers, even though Figure 2 indicates that a higher percentage of women choose Business Engineering or Execution Engineering. That may mean that the rank of women studying Civil Engineering and completing their studies is high. Figure X reaffirms this idea since there is a high degree of satisfaction of female engineers in their professional training versus the percentage of women willing to choose another professional training. There is a high percentage of female engineers who, although satisfied with their choice, would be ready to select another training option. That can be, such as [18] indicate, for the wage gap of women and men in engineering. The data crossings in Figures 5 and 6 confirm the high degree of affinity for the mathematics of women in Engineering in Chile, with a high average rate between 6 and 7 (in Chile, the minimum grade is one, and the maximum grade is 7), and the impact of math teachers. So, to answer the questions, what determines that a young woman decides to study engineering? What are the variables that influence her decision? and Are these variables standard in female students and women engineers? With the results of this study, it is clear that mathematical training, as well as the role of the math teacher in pre-university studies, are highly determinant and common factors for students — women engineers for their training choice.

6 CONCLUSIONS

Engineering is one of the professions that since its inception has been considered only for men possibly. Still, the time in which women were not interested in an engineering career has already passed, so the current number of women participating in the formation of engineering careers should be higher than the data presented here. However, as a study has shown, the distribution by sex of enrollment in engineering perceives data very similar to those of a long time ago, thus evidencing a stagnation of women's interest in studying an engineering career. Seeking equity between men and women is very important today, and that the possible prejudices Why women do not want to be engineers? Disappear, since a large number of studies, including this same work, show that the abilities of men and women for mathematics, technology, and science can be the same, and the difference has nothing to do with the gender of the student. We can affirm that in Chile, mathematics and sciences education, as well as the professors of those subjects, are determining factors for women to choose Engineering for their professional education. Thus, the educational system in Chile should invest in the training and preparation of teachers in the areas of science for primary and secondary school. That is of absolute relevance in the current context in Chile, where it seeks to achieve non-sexist education in all areas of training.

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