# Gender differences in technologies courses at ICT-UNIFESP Brazil

Lilian Berton
*Institute of Science and Technology*
*Federal University of São Paulo*
São José dos Campos, SP - Brazil
lberton@unifesp.br

Jéssica Aparecida Almeida dos Santos
*Institute of Science and Technology*
*Federal University of São Paulo*
São José dos Campos, SP - Brazil
jessica.santos@outlook.com.br

*Abstract*—This article reports a case study carried out at the Institute of Sciences and Technology (ICT) - Federal University of São Paulo (UNIFESP) in Brazil. To investigate the gender differences among students of technology courses, a questionnaire was made available in order to analyze the main differences in the use of technologies, difficulties in the courses and vision of the labor market. The results pointed out that both genders use various computing devices, spent some time in front of computers and women make more use of social networks while men play more online games. Women have more difficulties in the disciplines, mainly physics and programming. The students like the area and are interested in working in different fields. Also, women are more aware of gender inequality (80%) in the labor market than men (59%). Finally, we present some discussion about the questions addressed in the questionnaire and present some gender equality programs that could be adapted to our university.

*Index Terms*—STEM, Gender differences, Technology courses

## I. INTRODUCTION

Some women excelled at the beggining of computing, such as the mathematician Ada Augusta Byron King known as the first female programmer, Grace Murray Hoper, who worked on programming the Mark I computer series, one of the first digital computers, and Dana Urely that was the first female engineer to participate in a NASA project in Pasadena (California-USA). Nowadays, a lot of women have important positions in several international companies, such as Sheryl Sandberg Facebook's chief of operations, she was the first woman to become director of the social network. Ursula Burns President of Xerox, being the first African-American woman to head a company, Meg Whitman President of HP, Susan Wojcicki President of YouTube, Sue Gardner is the executive director of Wikipedia and others.

This may lead one to believe there is high female participation in the area of technology, but it is not what more detailed researches have pointed out. According to data from the Catalyst website [5], women accounted for less than 30% of the world's research and development workforce in 2013. Womens participation in the labor force in fields such as science, politics and technology has been even lower.

Barbara McClintock, Nobel laureate in 1983, said that science has no gender, and therefore it does not make sense to speak of women or men in science. Nevertheless, in many areas, there are still gender differences. According to the report Gender in the Global Research Landscape released by Elsevier [7], in the exact sciences, women are still a minority. According to the Elsevier survey, publications in areas such as computer science and mathematics have more than 75% of men in the work in most of the countries surveyed.

Many universities have reported an increase in female participation in computer courses, for example, in 2015 Stanford had 214 women in the computer course followed by 208 in the biology course (Figure 1) [10]. Even so, the percentage of women in computing accounted for only 30% of students. In the United States, about 18% of computer graduates are women. This shows the importance of actions that seek gender equality and encourage the participation of women in these courses.
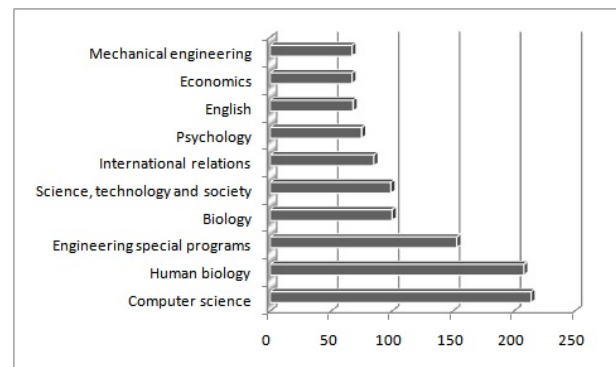


Fig. 1. Distribution of women in the Stanford courses [10].

In Brazil, the census of the Ansio Teixeira National Institute of Studies and Educational Research (Inep) [9] of 2015 shows that while women represent 70% of enrollments in education and health graduations, this percentage drops to 30% in science courses, mathematics and engineering. Figure 2 shows the 10 courses with the highest number of enrollments per sex.

In this paper, a local research was carried out at the Institute of Sciences and Technology (ICT) - Federal University of São Paulo (UNIFESP) - Brazil. The report shows the gender differences related to the use of technologies, the difficulties in the courses and job market.

| Course | Women | Course | Men |
|---|---|---|---|
| Pedagogy | 608868 | Law | 381537 |
| Law | 471674 | Administration | 248817 |
| Administration | 430095 | Civil engineering | 248817 |
| Nursing | 221316 | Accounting sicences | 149406 |
| Accounting sicences | 181314 | Mechanical engineering | 116573 |
| Psychology | 181314 | Production engineering | 111653 |
| Social work | 156458 | Physical education teacher | 98737 |
| Human resources management | 142660 | Electrical engineering | 91701 |
| Physiotherapy | 113326 | Analysis and development of systems | 73077 |
| Architecture and urbanism | 107728 | Physical education | 68068 |

Fig. 2. The 10 courses with the highest number of enrollments per sex in Brazil 2015 [9].

## II. ANALYSIS OF THE QUESTIONNAIRE

Located in São José dos Campos, in the state of São Paulo - Brazil, the ICT - UNIFESP started its activities in 2007 with the graduation course in Computer Science, which followed in 2009 with Computational Mathematics. In 2011 the bachelor's degree in Science and Technology (BCT) was introduced, with a duration of three years, and from 2013 onwards, the form of entry into the institution was only through this course. After concluding BCT, the students can give continuation in their studies in one of the following specific courses (post BCT): Biotechnology, Computer Science, Biomedical Engineering, Computer Engineering, Materials Engineering and Computational Mathematics.

For this work, a questionnaire was made available to groups of UNIFESP students on Facebook, since they are familiarized to answer questionnaires in these groups for disciplines project. The total students of ICT-UNIFESP are around 1200, 122 (about 10%) of the students answered the questionnaire - 53% were women and 47% were men. The 89.3% of the participants were from Bachelor of Science and Technology (BCT) course. The participants are students from the last five years 2017 (23.8%), 2016 (30.3%), 2015 (27.9%), 2014 (10.7%) and 2013 (7.3%).

The questions are divided into different categories: 1) The use of technologies, since communications technologies have a long history of being shaped by the gender of their users. 2) Difficulties in the course, since there are stigmas that men have more easily in the area of exact than women. 3) Job market, since there are prejudices and stereotypes that impact on salary differences and few women in management positions. Our aim is to investigate if there are gender differences among the students from ICT-UNIFESP with respect to these points.

### A. The use of technologies

Since the students from ICT-UNIFESP are from courses related to technologies, we asked the frequency they use online applications and computer devices in their day-to-day. The results showed that women use much more social networks than men (Figure 3) and the social network most used by the participants is Facebook and Instagram. The number of users on Facebook is similar, since the form was applied in this social network. On the other hand, men play more online games than women (Figure 4). Most women do not play any online games.
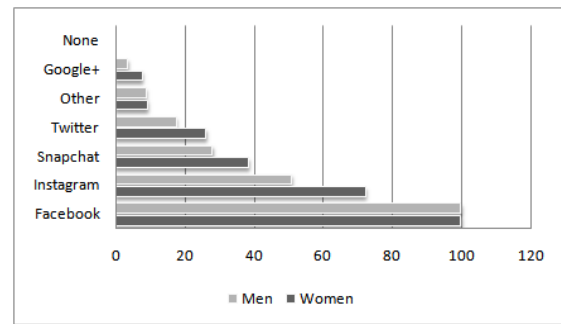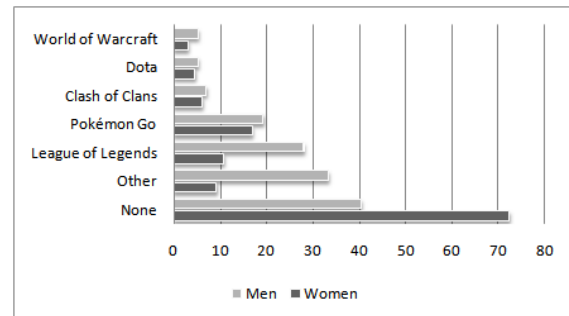


Fig. 3. The use of social networks.



Fig. 4. The use of online games.

With respect to hobbies, both men and women use online applications to watch movies, series and listen to music (Figure 5). And the most practiced activity unrelated to computing devices is reading, sports, and art. Such that women practice more reading and art and men practice sports (Figure 6).
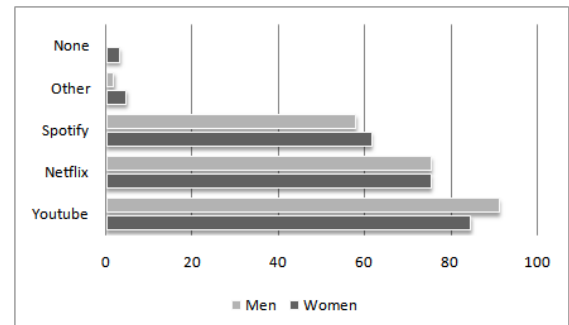


Fig. 5. The use of online apps.

All participants have some computational device. The most common devices are laptop and smart-phone (Figure 7). Men have more video games. Both men and women spend some time in front of the computer, men use to spend more time. The amount of time varies from one hour to more than five (Figure 8).
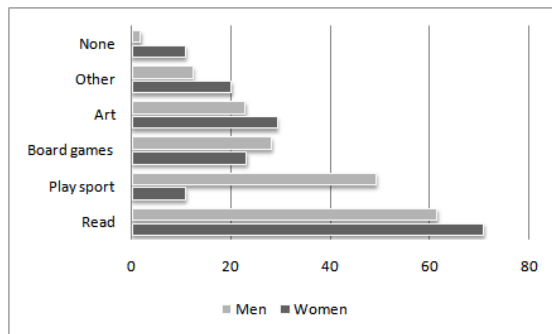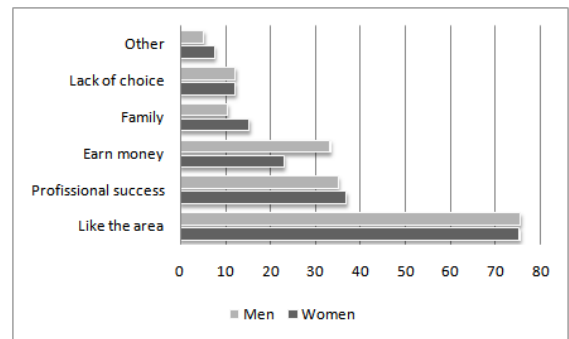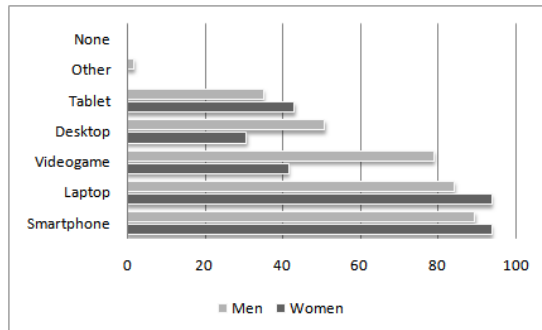
Fig. 6. The hobbies.
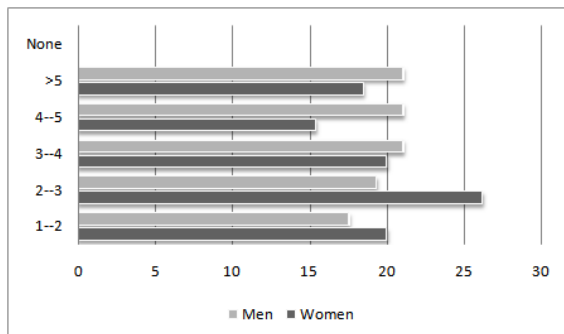


Fig. 7. The use of computer devices.

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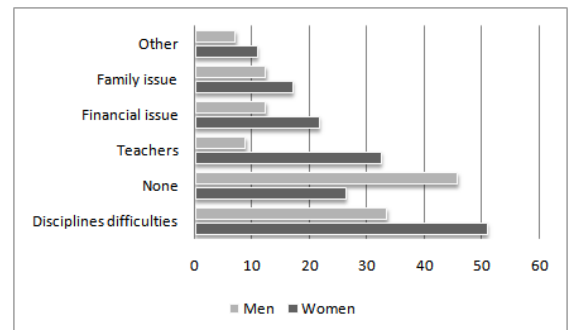


Fig. 8. The quantity of hours per day using computer.

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## B. Difficulties in the course

Many students have difficulties in the exact areas. We asked for the participants which are the main motivations and difficulties encountered in the courses. Most of them choose the course because they like the area, other motivations are to have professional success and make money (Figure 9). The main disincentives during the course, especially among women, are the difficulties in disciplines and teachers (Figure 10). Men suffer fewer disincentives than women.

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Fig. 9. The motivations for choosing the course.



Fig. 10. Main disincentives during the course.

With regard to difficulties in the disciplines, the women presented many difficulties in physics and programming. Both have difficulties in math and men have more difficulties in chemistry (Figure 11). Given these difficulties both have many reprobations in disciplines, ranging from one to more than five. Students who do not have re-probation in most cases are students in the first year, that not complete any discipline. (Figure 12).
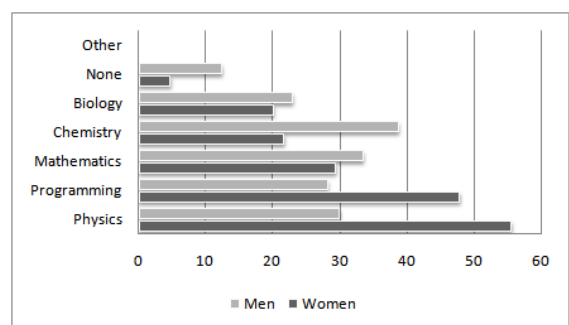


Fig. 11. Disciplines with more difficulties.

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## C. Job market

We asked about the labor market, what are their job claims. Most of the students intend to work in the area in which they are studying, and few still have doubts (Figure 13). More
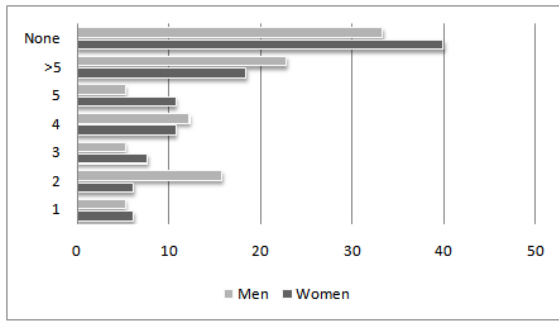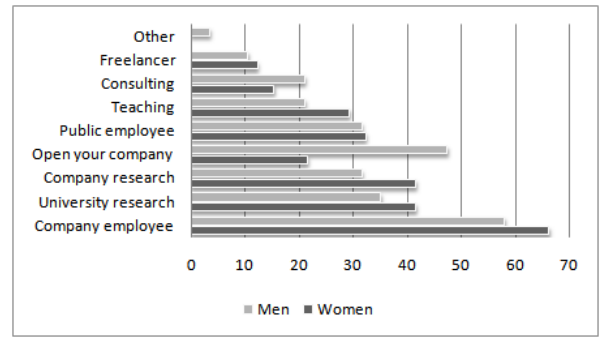
Fig. 12. Number of reprobations.



Fig. 15. Job pretensions.

women have someone as a reference in the area (Figure 14). Most students intend to work as an employee in a company. More women have the intention to work as researchers, in companies or universities, while more men intend to open their own business (Figure 15).
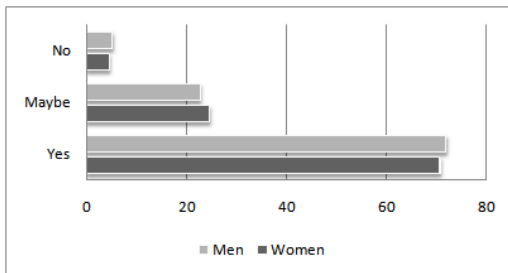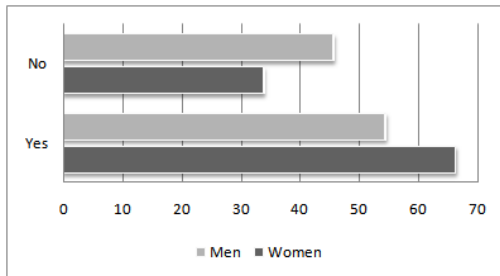


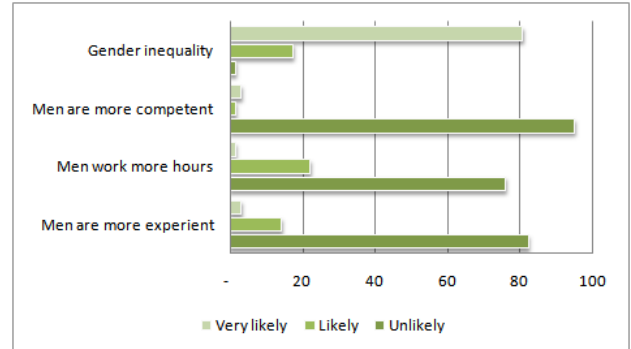Fig. 13. Intention to work in the area.

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Fig. 16. Women's view of gender difference in work.
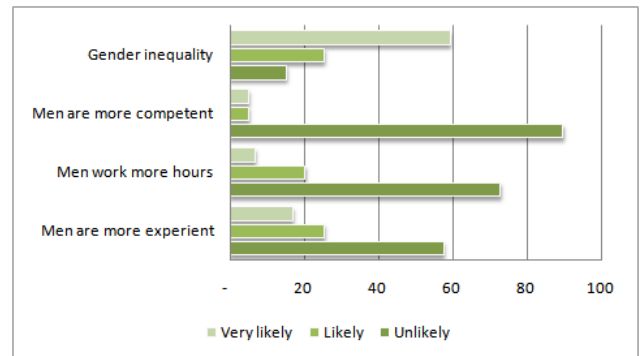


Fig. 17. Men's view of gender difference in work.

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Fig. 14. Reference in the area.

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To investigate students' opinions about the gender difference in work, we made the following question: assuming that in a company a man and a woman assume a similar position, but the man earns more. Which of the following has the most influence on the wage discrepancy? Women pointed more gender difference to such a fact than men. More men have pointed out it is likely or very likely that this will occur because the man has more experience or work more (Figures 16 and 17).

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## III. DISCUSSION

Men are more likely to use social media to seek information and looking to form new relationships, while women use social platforms to connect with people and relationship maintenance [12]. They post about different things and prefer certain platforms. This was also noticed in our survey, where women use more social networks than men, especially Instagram and Facebook. Some studies show that female users generally prefer visual platforms, while men prefer more text-oriented mediums [1].

Our survey points out that men prefer more online games than women, this is also noticeable in this international re-

search [13], where 46% of gamers across 13 countries are women, while men make up the majority of gamers. Developers and marketers working on games should be actively engaging female gamers, as the games market matures, the gender divide is closing.

A concern regarding the use of social networks is that women receive more abusive comments when expressing their opinions. A Twitter experiment conducted by British journalist [2], show that he created a spoof account in which he pretended to guest-tweet as different male and female celebrities. When he presented himself as a woman, the account received significantly more offensive comments, and even misogynist ones. Another research conducted by The Guardian found a similar behavior [4]. An analysis of 70 million readers' comments on their website showed that 8 of the 10 most abused journalists were women. These results indicate the importance of examining individual differences in online behavior.

Our report shows women have more difficulties in disciplines from technological courses, mainly related to physics, programming and math. A study published in the journal Science showed that from the age of six, girls begin to find themselves less intelligent than boys in school, and not only have they adopted these stereotypes into their own thinking, they are also acting on them [3]. Activities to encourage women or monitors to helped them in the disciplines are interesting. Stanford program introduce more teaching assistants for the introductory Computer Science classes to increase the number of women in this area [10].

Gender influences the salary of women in many countries. The (Inep) [9] report shows the proportion of average earnings of women in relation to the average remuneration of men with higher education in 2014. Notice that Brazil is below the average of the OCDE countries (*Organizacão para a Cooperacão e Desenvolvimento Econômico*) (Figure 18). Female students are more aware of this situation than men, as our questionnaire pointed out. It is necessary to develop actions that make everyone aware and that men also support gender equality.

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Fewer female students intend to open their own business, actions that encourage women to become entrepreneurs and have leadership positions should be taken. Young women that are a reference in Brazil are: Bel Pesce approved in 2006, with only 17 years old at the Massachusetts Institute of Technology (MIT). She released the book "The Girl from the Valley" and worked in some companies in the United States; and Camila Fernandez Achutti that is a software engineer at Iridescent, a non-profit American science and technology education for children and youth. In addition, she is the leader of the women's movement in technology, being the founder of the blog Women in Computing and ambassador of Technovation Challenge Brazil.

Some companies have launched campaigns to encourage women in computer science area, one example was Microsoft that launched the second edition of the #MakeWhatsNext campaign, which seeks to alert the unimportant numbers of
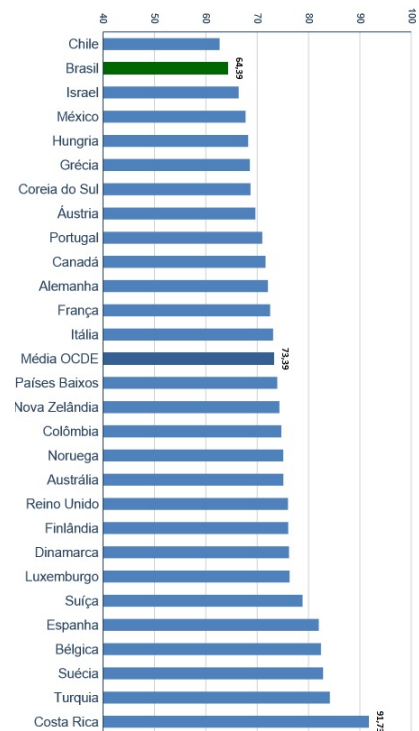


Fig. 18. Proportion of average earnings of women in relation to the average remuneration of men with higher education - 2014 [9].

women in the areas of the STEM (Science, Technology, Engineering, Math) [11]. According to data from the World Economic Forum, only 16% of women students around the world graduate from these courses. There is also the Technovation[1], that every year, invites teams of girls from all over the world to learn and apply the skills needed to solve real-world problems through technology.

Gender inequality in the workplace is common, some authors [17] investigated why men do not get involved in change programs aimed at increasing gender parity, and one reason is that they experience lowered levels of psychological standing than women, other possible explanations, such as possible prejudicial attitude or sexism on the part of men, were taken into account. The organizational leaders need to explicitly communicate that all employees, regardless of their gender, have a stake in and can meaningfully contribute to gender parity programs.

## IV. GENDER EQUALITY PROGRAMS

In order to bring positive change in mentality and practices, in 2010, Sciences Po[2], an international French research university, created PRESAGE, a gender studies, and research program. The pioneering nature of this commitment was recognized by the UN Women HeForShe program[3]. Moreover, Sciences Po proposed 10 measures for gender equality, that could be adapted to our universities:

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[1]http://technovationchallenge.org
[2]https://www.sciencespo.fr/en/what-sciences-po
[3]http://www.heforshe.org/en

- The Student Life Charter [15] refers to the principles of gender equality.
- Regular awareness-raising activities on everyday sexism.
- 10 recommendations [16] were sent out to all faculty to ensure equality in the classroom.
- A guide to help to raise awareness throughout the Sciences Po community about sexist acts and sexual violence.
- A Non-Sexist Communication Charter [6].
- A network of gender equality advisors is active in each of Sciences Pos divisions.
- Women students can participate in training workshops on core career skills.
- The 13-member Sciences Po Executive Committee now includes five women.
- Selection committees for the recruitment of permanent faculty must be gender-balanced.
- A charter to restrict work-related email after-hours is in place to promote a better work-life balance, and a campaign has been conducted to encourage men to take their paternity leave.

Numerous studies document a lack of female role models in management and leadership cases studies, as well as in textbooks, and in business programs [8]. The universities should help mitigate the under-representation of women in management and leadership positions in the corporate world. The Principles for Responsible Management Education (PRME) [14] was created by over 25 faculties in 7 countries, it includes case studies, syllabi, research, publications, other course materials on the integration of gender issues into management education. Their mission is: "to bring together academics and employers to provide support and resources for integrating gender issues and awareness into management education curricula and research". Some recommendations for change:

- Expand discussions of managerial and executive career paths with undergraduate and graduate women students.
- Identify and address pipeline issues for female faculty and deans. For example, provide advice on how to best spend pre-tenure time, provide a mentor, encourage joint authorship possibilities. Provide information to female undergraduate and masters degree students on the opportunities for, and potential benefits of, pursuing traditionally male-dominated fields, and doctorate degrees.
- Encourage more female full professors to apply for associate dean and department chair positions.
- Encourage on-going informal professional development for women faculty and administrators.
- Foster an inclusive educational environment in which all male and female students, faculty and administrators can thrive.
- Conduct more research on gender issues. Actively work with and engage male (as well as female) faculty and administrative colleagues in fostering gender equality.

## V. Conclusion

This article showed an analysis of gender difference among students of the technology course at ICT-UNIFESP. Actions that reduce gender inequality should be started in preschool, since women in general are minorities in the exact areas, and present more difficulties in the disciplines. The university should encourage women to pursue technology courses, regardless of their difficulties, because success and failure are part of the life, and women can do whatever they want if they have confidence. Companies and society, in general, should also value women in the labor market by offering equivalent salaries and career growth opportunities.

As future work, we will give lectures on awareness of the low number of women in technology areas and extension projects in schools to motivate girls to pursue careers in STEM areas.

## VI. Acknowledgments

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