

# Why there is still few women in Engineering? A perspective from female students and professors in an Engineering campus

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**Abstract**—This paper presents the scenario of the Engineering courses of the Faculty UnB Gama (FGA) in relation to the number of male newcomers versus the number of female ones. It is possible to see, through analysis of the data collected, that the number of male students is much higher than that of female ones, from the creation of the campus in the second semester of 2008 until now. This occurs despite FGAs efforts in promoting the Engineering courses on campus using an experimental laboratory, through the Girls in Computing Program, supported by the National Council of Scientific and Technologic Development (CNPq), in partnership with the high schools of the region. Lectures are also conducted, focused on the female public, and looking do debunk the idea that Engineering is a typically male-oriented course, and trying to awaken the vocational interest of women towards Engineering. Through the surveys focused in the low rate of women in engineering courses, some things come up: (1) the lack of stimuli from family and friends when they intend to graduate in this field, and (2), in a way, the stigmatized role of women in Engineering.

**Index Terms**—Women in Engineering, Educational Practice, Feminine Public, Lack of Interest, Prejudice.

## I. INTRODUCTION

The pessimistic scenario for women in Information Communications Technology and for women in Technology generally is even more paradoxical and insidious with respect to women in Computing [1].

The worldwide scarcity of women studying or employed in computing, or in computing related disciplines, continues to be a topic of considerable concern for industry, the education sector and governments [2].

Studies within this field not only report insignificant improvement in the proportion of women in Western countries computing fields, but also alert us of a declining trend. Moreover, that decline has been accompanied or even preceded by years of research and programs that have specifically focused on increasing womens participation in computing. However, they have not had the expected effect. More surprisingly, there has been a significant increase in the representation of women in all other science-related fields and professions [1].

If we consider the female participation in this area, this shortage of professionals is ever more expressive. The lack of womens interest in the field can be noticed from the moment

they choose their undergraduate course. In our particular context, this scenario is clearly identified from the number admissions of the UnB Gama Campus (FGA) of the University of Brasília (UnB). When it first opened in 2008, only 20% of its students were women and, nine years later, they still only account for 22%.

Although the campus is close to the cities neighboring the Federal District, there is a low rate of women seeking the courses offered by the FGA. The possible reasons for that are: no knowledge of how to enter the University; misunderstanding that the courses are focused on men, and the lack of awareness of the local community about the relationship between Engineering and the female role.

Even though Engineering is an area with an increasing demand of professionals, it is observable that women are part of a small percentage of the students that enter university and graduate in this field.

This paper presents the scenario of the FGA in relation to the number of male newcomers versus the number of female ones. The research questions will be answered through a questionnaire, that was answered by all female students and teachers of the FGA.

Through the questionnaire responses, it was possible to identify the reasons that lead to the lack of interest by women when it comes to Engineering, and it was possible to provide a better understanding of the technology involved in these knowledge fields. It is believed that technology, most of the times, is seen as something uninteresting, repetitive, and hard to be comprehended.

This paper is organized as follows. Section II presents the background of initiatives that have been carried out to increase or encourage the number of women in engineering. Section III presents the methodology used to carry out the development of this study. Section IV presents the results obtained from the survey done with the female students of the FGA through a questionnaire. Conclusions and future studies are presented in Section V.

## II. BACKGROUND

There are initiatives launched from different perspectives and at several levels which are being spread around the Information and Communications Technology Framework. Multinationals like [3], [4] or [5] are also getting involved in these actions and so are public administrations and mass media. The lack of minority women in science and professional fields is a major social issue that needs to be addressed by business, education, and government. Simply opening doors to once-restricted career fields has not proven to be enough.

The challenge is to identify programs that work in attracting this population to science and to cultivate sustaining support for those programs. It is then up to all interested parties—policymakers, educators, science and engineering professionals, parents, and the students themselves—to support and participate in these exemplary programs for young minority women, [6]. One such program offered at The George Washington University (GW) and funded by the National Science Foundation (NSF) from 1989 through 1993, utilizes computer technology and cooperative learning in a university setting to interest young minority women in engineering and science careers. [6].

In [7] is presented an enhanced student experience model being designed for undergraduate Engineering women. The model leverages effective practices including learning communities, leadership and professional development, academic support and advising for the Engineering Basic Program, academic preparation for the Engineering field, and state and national resources for inclusive Engineering career awareness, recruiting and teaching.

The model has been designed to improve diversity and inclusion in Engineering, computer, and software engineering programs; improve educational pathways including transfer transitions from community colleges; provide a supportive and integrated student experience; establish a community of practice for faculty; and use research to inform practice.

The work proposed by [8] presents reports on self-rated career management knowledge, use, and confidence for women in computer science and engineering before and after participating in a professional development workshop. After workshop, three years worth of participating women gave higher ratings for their knowledge and use of skills such as time management, networking, and productive mentoring relationships, as well as confidence in their promotability.

In [9], they have suggested a number of ways by which Australian universities could stand alongside girls and women and support broadening participation in computer science rather than continuing through silence to assent to border protection campaigns by boys and men.

### A. Initiatives Around the World

The reasons for a female minority have been investigated and discussed by many organizations [10], [11] and research studies [12], [13].

The work [14] addresses this research gap with a system dynamics model illustrating how women are attracted to and

repelled from engineering careers. Because system engineers are found in all engineering disciplines, the model focuses on engineering in general. The results indicate that the success of initiatives does not continue into university education. This is compounded by a high attrition rate strongly affected by an unwelcome work environment for women.

The work [15] study aims to answer the question, why do women engineers in academe persist in a discipline that is generally perceived to be inhospitable to women. Three main challenges, namely gender discrimination, lack of institutional and disciplinary support, and the rigid nature of the workplace, emerged as key impediments to women engineers in the private sector. In contrast, women engineers in the academy identified the flexibility offered by academic environments, the presence of personal support networks, and a passion for teaching and students as critical factors that influenced their decision to remain in academia [15].

Another great initiative is the IEEE Women in Engineering (WIE), which is one of the largest international professional organizations dedicated to promoting women engineers and scientists and inspiring girls around the world to follow their academic interests to a career in engineering [16].

### B. Initiatives at UnB

At the FGA, we have the "Aprendendo Juntas" (Learning Together) program, dedicated for the whole female student body at the Gama Campus. The group seeks to motivate the student body to know each other better, in order to create a tight female community when it comes to graduating in technology areas. It is, therefore, an initiative focused on the following topic: Women, Diversity, and Engineering [17].

In 2014, we had the "Meninas na Robótica" (Girls in Robotics) initiative, whose objective consisted of promoting the Software Engineering course at the FGA, as well as its other Engineering courses, using an experimental laboratory and lectures in order to awaken the vocational female interest in engineering. This was done in partnership with high schools of Federal District, ministering lectures focused in the female public, and looking to demystify the idea that engineering is a typically male course. In this sense, throughout the lectures, successful women were shown as examples (businesswomen, professors, managers, and so on).

In the Computer Science course at UnB, we have another initiative in partnership with public schools of Brasília, destined to attract women to this field of knowledge. Since 2010, the "Meninas na Computação" (Girls in Computing *meninas.comp*) project incentives programming projects and software development in high schools, and shows that professional choice and gender are not related [18].

In the Technology Faculty, we have the "Meninas Velozes" (Fast Girls) project, dedicated to promoting gender equity in the Mechanic and Automotive Engineering fields, by doing extension, academic, and practical activities related to the scientific and technological knowledge related to competitive cars [19].

At UnB, there are other initiatives focused on immersing the female public in the University, through many departments and fields of knowledge, and exploring a number of technological resources, in order to make Exact and Earth Sciences more attractive to girls and make them a more common choice when deciding ones professional career.

### III. APPLIED METHODOLOGY

The search for initiatives that encourage the enrollment of women in the areas of Engineering and/or Computer Science is well known and incentivized by the Brazilian Government. Survey Research was used when carrying out this study, proposed by [20] and [21].

According to [20], [21], although surveys are an extremely common research method, survey based research is not an easy option. Surveys are probably the most commonly used research method worldwide. Survey work is visible because we are often asked to participate in surveys in our private capacity, as electors, consumers, or service users.

This work consists of four major phases:

- 1) **Planning:** A survey study begins like any other, with the formulation of a clearly stated purpose, delineation of a set of research questions, and identification of the target population(s). The researcher should spend much of the initial planning conducting a thorough review of the literature to help justify the need for the study, establish a theoretical or conceptual framework, and identify the variables that should be included in the study. In addition, planning should include decisions about how and by whom the results will be used. In a sense, the preliminary planning stage provides the compass to guide you through the rest of the study. Consequently, scant attention paid to initial planning can lead to a fragmented and poorly designed study.

- a) **Selecting the Respondents** The sample selection phase of a survey study essentially involves deciding who the respondents will be, how they will be selected, and how many are needed. All three decisions are contingent on the purpose of your study and the type of data analyses you plan to conduct. In the case of this work, female students and teachers at FGA.

- 2) **Data Extraction (Document analysis, Survey through questionnaire).** Data extracted were through a questionnaire. A questionnaire is a predefined set of questions, assembled in a pre-determined order. The question content and wording, together with the order of the questions, are extremely important. The elaborated questionnaire contained 21 questions, with 5 alternative answers: Completely Agree; Agree; Neutral; Disagree and Completely Disagree.
- 3) **Data Analysis.** Our data analysis and synthesis involves the combination of both quantitative and qualitative data.
- 4) **Report.** Report writing is one of the most important components in the survey research cycle. Survey findings need to be presented in a way that is readable

and technically acceptable. Good writing is essential to ensure the importance and usefulness of the findings are not lost. We elaborated the reports with the results obtained with the questionnaires.

The evidence established by the female teachers of Software Engineering in the classroom regarding the expressive male presence in the FGA courses awakened an interest in carrying out a more thorough analysis, based on the information stores by the academic system of the University of Brasília (UnB), and through a survey with the students.

The steps adopted in this study were divided as follows:

- 1) Identification of evidence regarding the low number of women;
- 2) Specify the research questions;
- 3) Search for the data on UnBs database (analyzing FGAs quantitative);
- 4) Extraction and classification of the data;
- 5) Analysis and synthesis of the data.

The analyzed data was collected from the second semester of 2008 (2008.2), when FGA was created, until the second semester of 2017 (2017.2 - the last semester). The steps adopted in this study are shown in Figure 1.

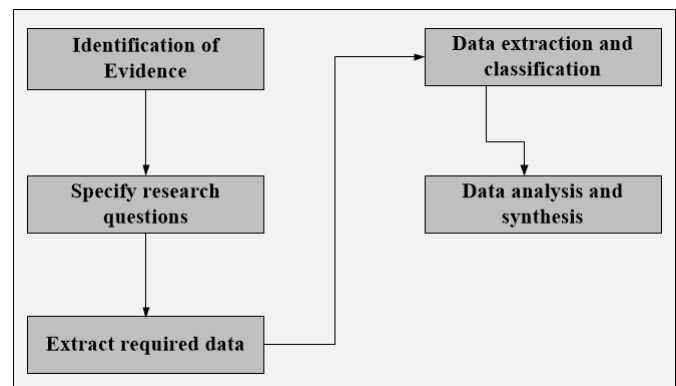


Fig. 1. The methodological plan adopted

#### A. Research questions

In the second step adopted in this study, the research questions (RQ) to be answered were defined so as to find answers in the female community of the FGA. The specified questions are:

- 1) Which are the reasons that lead women do not to take on Engineering?
- 2) Is the FGA environment woman-friendly?
- 3) Is it common to hear prejudiced comments from people at the FGA?
- 4) Why is any of the five engineering courses chosen?
- 5) Is the educational practice adopted by the professors adequate to the feminine public, since the majority of FGA professors are male?

The research questions will be answered through a survey to be taken by all the female students and professors at FGA, looking to identify the reasons that lead to the low interest of

women in the courses offered by the Faculty. Another objective will be trying to find mechanisms to improve women's role in Engineering and their acceptance in an Engineering Campus with a predominantly male roster.

#### *B. Data search on UnBs database*

The University of Brasília (UnB) possesses a system called CITSMART, developed in order to efficiently manage the catalog of Information and Communication Technology (ICT) services available to the academic community. Through a web interface, it is possible to request services related to all the information that the Institution has. The requisition of the necessary data for the analysis in this article was done through the available on-line form.

#### *C. Data extraction and classification*

The extraction of data was done by the appointed division at UnB, which manages the data and makes it available to the academic community through CITSMART.

The classification of the collected data was accomplished based on the restrictions specified in the requirement form, namely:

- 1) Number of existing male and female students in all Engineering courses of the FGA campus;
- 2) Number of male and female students in each of the five courses of the FGA;
- 3) Number of male and female students in the undergraduate vs postgraduate courses in the FGA;
- 4) Number of male and female professors in all Engineering courses of the FGA.

#### *D. Data analysis and synthesis*

Evaluating the data extracted since the creation of the FGA (period between 2008.2 and 2017.2), it is possible to identify a 2% increase in the number of female students, over the last nine years. In the second semester of 2008 (2008.2), 80% of the enrolled students were male against 20% female. From 2008.2 until the second semester of 2011 (2011.2), this number decreased by 5%, with only 15% of enrollments in Engineering being from women, as observed in Figure 2.

In the first semester of 2012 (2012.1), there was a slight improvement, with the number of women enrolling increasing to 17%. In 2012.2, there was a jump to 20%, which decreased again to 15% on 2014.2. In the first semester of 2015 (2015.1), an increase of 2% was seen, and the second semester of 2017 (2017.2) reached 22% of enrollments coming from women. Therefore, as seen in Figure 2, it can be said that the scenario at FGA has improved over the last two years, even if in an inexpressive manner.

Considering the beginning of two existing programs for the immersion of women in the engineering courses at FGA, an analysis of the graph in Figure 2 indicates that the current growth is almost stagnant. Evaluating the results between 2008 and 2017, it can be concluded that the average ratio of students at the FGA is at 80% male students to 20% female students.

An analysis of the existing Engineering courses at the FGA, it is possible to identify that the most attractive course for women is Energy Engineering. In the first entrance exam of the college, which occurred in 2008, the course with the highest amount of enrolled women was Energy Engineering, in which they represented 22% of the total number of enrollments, as can be seen in Figure 3. The course with the lowest women interest in that same semester was Software Engineering, in which they made up only 6% of the enrollments, as shown in Figure 3.

In the second semester of 2016 (2016.2), women made up 46% of the Energy Engineering students. Since the creation of the FGA, this was the semester with the highest amount of interest by women for the Energy Engineering course, and the result repeated itself in 2017.2. In contrast, in this same semester, the Automotive Engineering course had a meager 10% women representation. According to the graph presented in Figure 4, it is also possible to claim that the course with highest women interest at the FGA is the Energy Engineering course, which opened with a 22% female representation, and rose to 46% on the last entrance exam, having an exponential growth of 24%.

The second course with a considerable growth, going from 6% and reaching 15%, is the Software Engineering course, which had a total growth of 9%, as seen in the graph presented in Figure 3 and 4. The Electronic Engineering course grew only 5% over its nine years, starting 2008.2 with a 17% female representation and reaching 22% in 2017, as seen in the graph presented in Figure 3 and 4, an inferior number than in 2014.1, when it was 24%.

The Automotive Engineering course is the one that has shown the highest lack of interest by women. As shown in Figure 3, the course started with a 10% representation in 2008.2, reached an all-time high of 16% in 2010.1, and finished 2017.2 with only 10% (4). This scenario of lower interest by women was an isolated case, identified only in this course.

Figures 3 and 4 presents the evolution in the number of female students in the courses of the FGA, from its conception until its latest entrance exam. From the graph, we can conclude that the courses with the highest growth are:

- 1) In first place, Energy Engineering;
- 2) In second place, Aerospace Engineering and;
- 3) In third place, Software Engineering.

Figure 5 presents a situation related to the total number of professors at the FGA. Currently, the campus has 129 professors, 91 if which are male, and 38 are female, which comes down to a 71% to 29% ratio. The courses with the highest and lowest numbers of female professors are the Energy Engineering course, at 45%, and the Aerospace Engineering course, at 14%, respectively. This can be seen in Figure 5.

#### **IV. ANALYSIS OF QUESTIONNAIRE RESULTS**

The questionnaire prepared to answer the research questions was made available to all female students of the five Engineering courses of the FGA through its official website

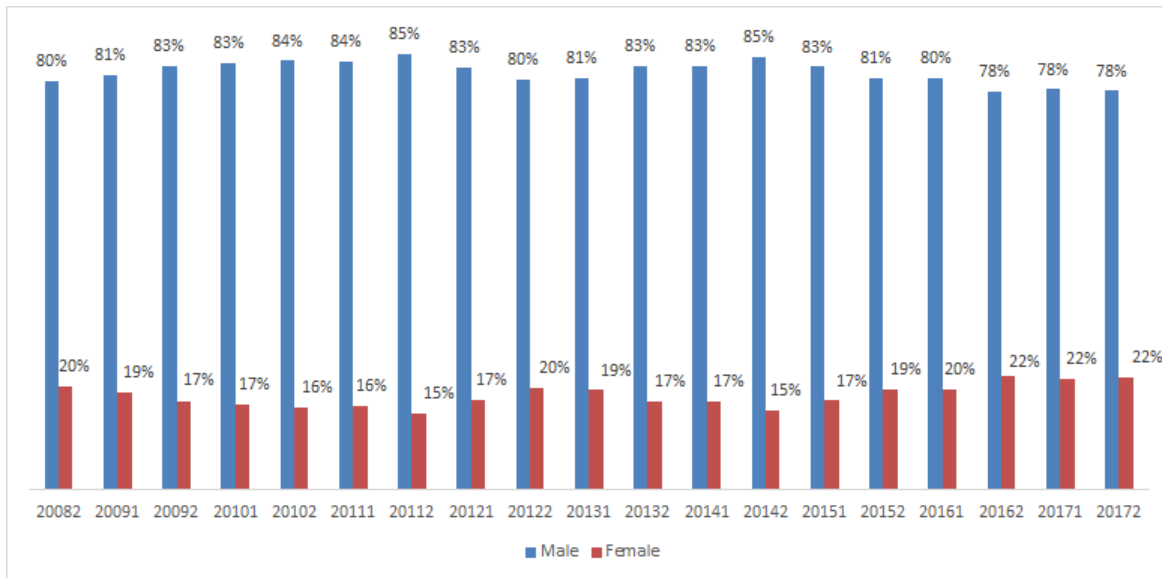


Fig. 2. Quantity of male and female students between 2008.2 and 2017.2

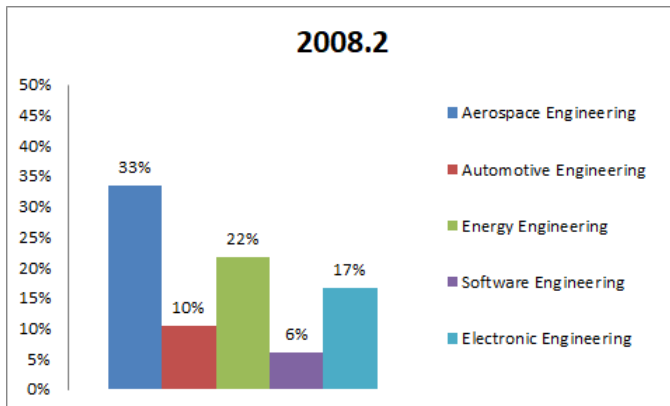


Fig. 3. Quantity of female students 2008.2

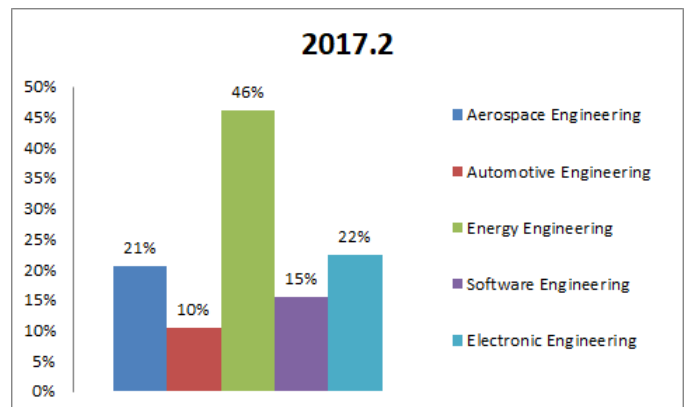


Fig. 4. Quantity of female students 2017.2

and Facebook page. Currently, the FGA has **2405 students**, with 1878 male students and 527 female ones. The available questionnaire **We collected answers from 315 students**, representing a total of 59.77% of FGAs female students. In relation to the research questions, we can conclude that:

**RQ1. Which reasons lead women not to take on Engineering courses?**

To this question, 38% of the students answered that it is because of society's prejudice. 35% declared that it is because of how hard Engineering courses are, and 3% mentioned family prejudice as the cause. 22% did not specify. Figure 6 shows the results of the research obtained from the students answers.

**RQ2. Is the FGA environment woman-friendly?**

In this question, 34% of the students agree that the environment is friendly and 39% think that it is somewhat adequate. 11% believe that the environment is not adequate. 13% think the environment is not proper, and only 3% believe that it

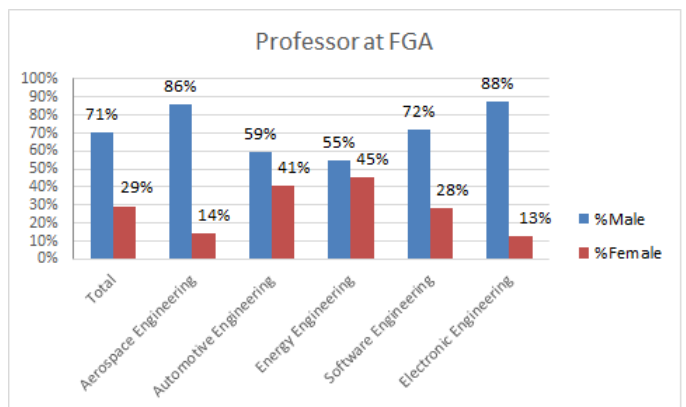


Fig. 5. Total FGA Professors

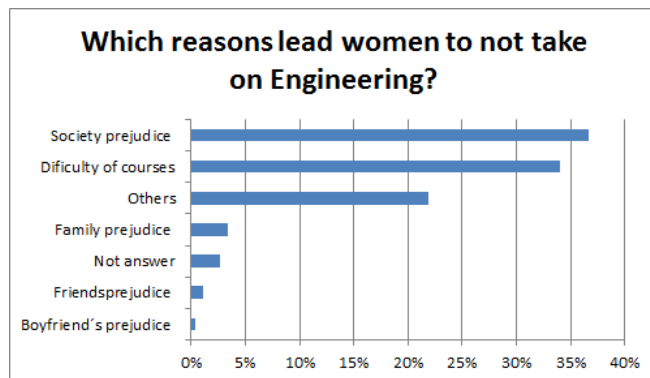


Fig. 6. Students answers to RQ1

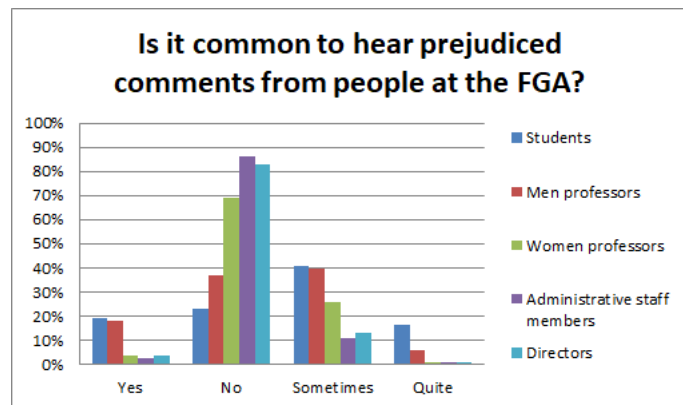


Fig. 8. Students' answers to RQ3

is very friendly. Figure 7 presents the results of the research based on the students answers.

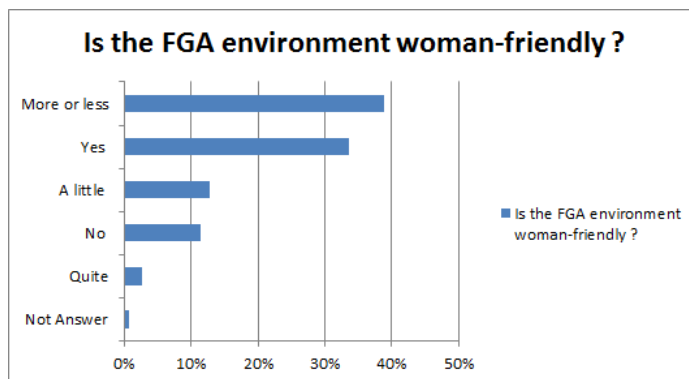


Fig. 7. Students answers to RQ2

### RQ3. Is it common to hear prejudiced comments from people at the FGA?

18% of the students answered that it is common to hear mean comments from professors, and 37% said it is not. Only 6% said it is very common, and 39% said they sometimes hear comments. Regarding their colleagues, 19% of the students said it is common to hear comments, and 17% reported that it is very common to hear these comments from male students. 41% hear it only sometimes, and only 23% do not hear it at all.

As for the comments coming from female professors, 69% said they do not make mean comments, and 26% that they sometimes do. 4% said they do, and 1% that they constantly do. As for the general staff, 86% claim that they do not make mean comments and only 2% do. 11% of the staff sometimes make comments, and 1% do it a lot. When it comes to the campus administration, 83% do not do it and 3% have the habit of doing it. 13% do it sometimes and 1% make very mean comments. Figure 8 presents the results of the survey obtained with the students answers in relation to mean comments by professors, the administration, general staff, and other students.

### RQ4. Why is any of the five engineering courses chosen?

79% of the students who answered the questionnaire claimed that they chose one of the five engineering courses because they like Engineering, and 11% said it was because of job opportunities. 5% chose it because of the campus placement, 3% chose it for lack of better options, and 1% due to family pressure. Figure 9 presents the students reasons for choosing one of the five Engineers of the FGA.

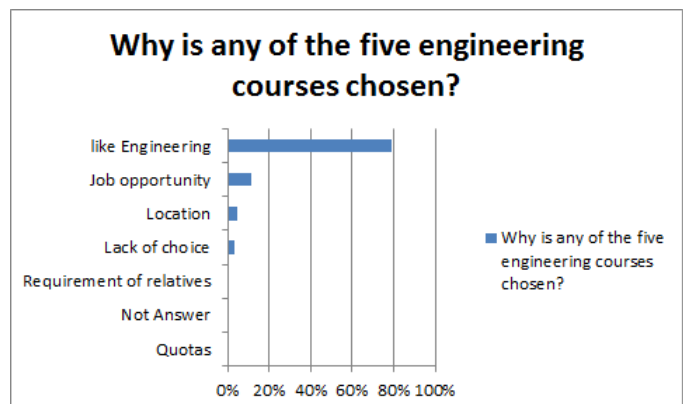


Fig. 9. Students answers to RQ4

### RQ5. Is the educational practice adopted by the professors adequate to the feminine public, since the majority of FGA professors are male?

54% of the students believe that the educational practice adopted by the professors is adequate to the female students of the FGA, even if most professors are men. 11% claim that the practice is not adequate and only 5% claim that it is very adequate. 23% believe it to be somewhat adequate. The results of RQ5 are presented in Figure 10.

#### A. Analysis of the Professor Questionnaire

A questionnaire to answer the research questions was also made available to all female professors of the five Engineering courses of the FGA, through the official website, the Facebook page, and the institutional e-mail. Currently, the FGA has 129 professors, 91 of which are male, are 38 female. The

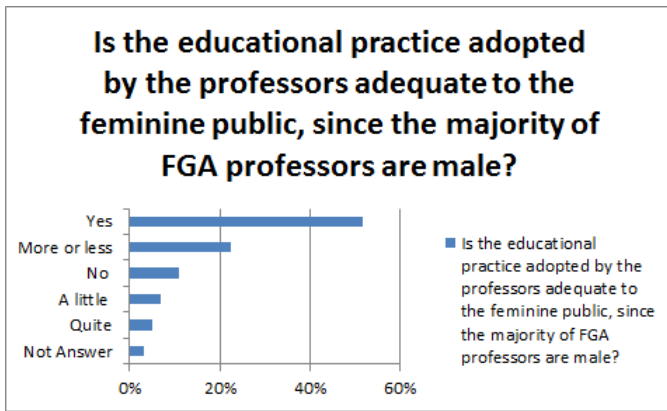


Fig. 10. Students answers to RQ5

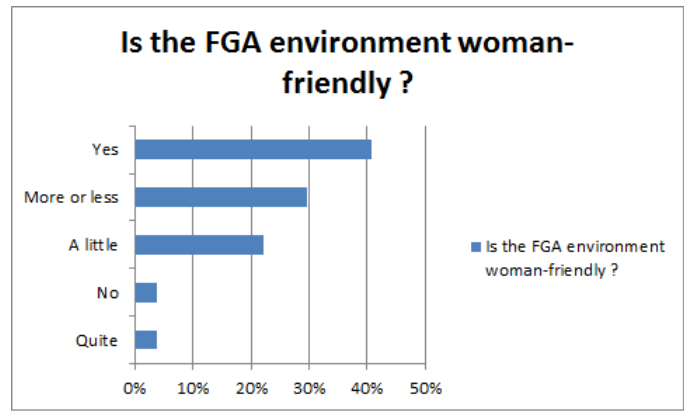


Fig. 12. Professors answers to RQ2.

questionnaire was answered by 27 professors, representing a total of 71,05% of FGA professors.

**RQ1.** In the survey answered by the professors, 22% said the reason is the difficulty of the courses, and 19% mentioned family prejudice. 48% claim that it is for other reasons, and 11% that it is because of society's prejudice. Figure 11 shows the survey results according to the professors' view.

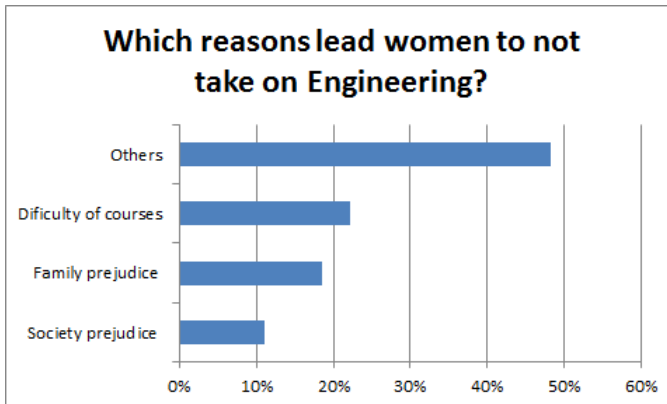


Fig. 11. Professors answers to RQ1.

**RQ2.** In this question, 41% of the professors answered that the environment is women-friendly. Only 4% of the professors said that the environment is unfriendly, and 22% think it is a bit unfriendly. 30% think it is somewhat friendly. This result is shown in Figure 12.

**RQ3.** 23% of the professors answered that it is common to hear mean comments from other professors, and 38% claim that they sometimes hear mean comments. 38% say it is not common to hear such comments.

62% of the professors answered that it is not common to hear mean comments from female professors at the FGA, while 12% said that it is common and 27% that it is somewhat common. In regards to comments by the general staff, 69% said that it is not common to hear comments, and 27% that it is somewhat common. Only 4% claimed that it is common to hear such comments from the staff. As for the Campus

administration, 74% said that it is not common and 15% that it is. 11% said that they sometimes hear it. This result is shown in Figure 13.

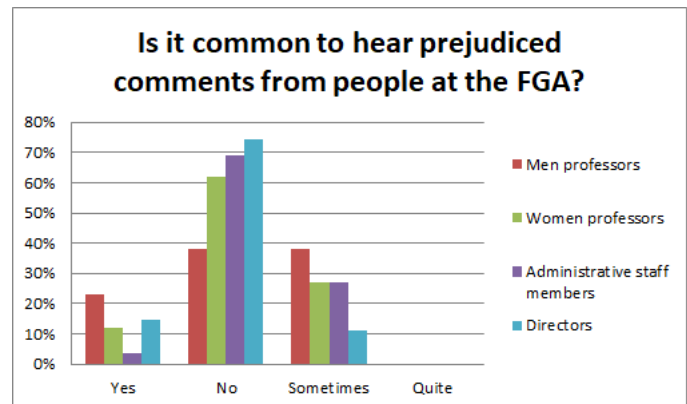


Fig. 13. Professors answers to RQ3.

**RQ4.** As for the reason professors chose to work at the FGA, 35% informed that the campus proposal is interesting, and 35% said that it is because they like engineering. 23% said that it is due to a lack of better options, and 7% because they enjoy challenges. Figure 14 presents this result.

**RQ5.** In regards to the practice adopted by professors, 42% claimed that it is indifferent and disregards sex. 23% said the practice is adequate and 19% that it is somewhat adequate. 12% assure that it is a bit adequate and 4% that it is inadequate. Figure 15 presents the result of this survey done with 27 professors of the FGA.

## V. CONCLUSION

According to this research, it was possible to identify that the course with the highest number of female students and professors at the FGA is Energy Engineering, totaling 45% of professors and 46% of students.

When investigating the reason for such scenario, we added a question to the survey: If you have chosen the Energy Engineering course, what reasons did you have for doing so?



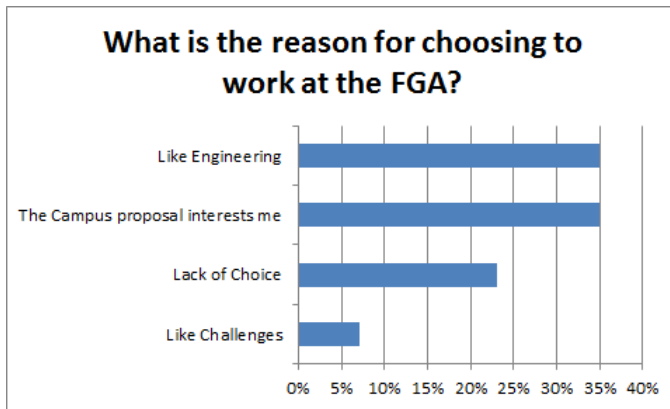


Fig. 14. Professors answers to RQ4.

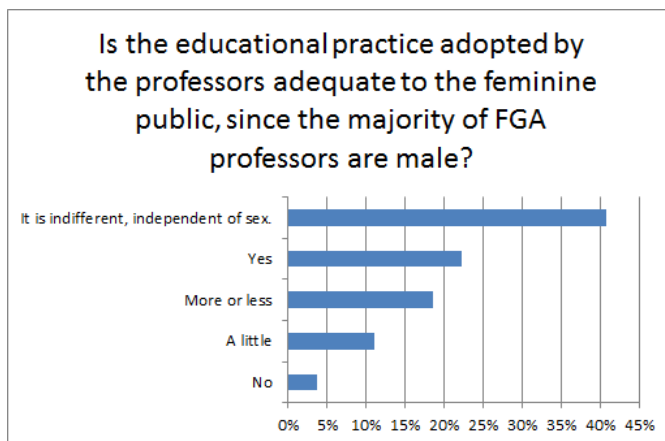


Fig. 15. Professors answers to RQ5.

48% of the students did not know how to answer, and 39% said that it is because the course has a more interesting syllabus than the other FGA courses. 9% claim that it is due to better job prospects.

Since the Energy course has seen a lot of interest from students as well as teachers, this study intends to monitor the growth of interest in this course over the next five years, and compare it with the current scenario, so that we can evaluate if the growth continues and what might be the reasons behind it. As for the environment at the FGA, we can conclude that students and professors think it is generally friendly to women.

The existence of prejudice regarding the woman was confirmed in the study, though it was believed it would have been more present, due to the daily events to which we are subject, as well as the communication between groups of professors a situation reported by students. The proposal is to do this survey again over the next years and see if there have been any changes in the results, keeping an eye to see if actions to insert women in Engineering and the search for gender equality inside UnB have had any effect at the FGA.

## ACKNOWLEDGMENT

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