Women in undergraduate programs: a case study on the most sought-after computing course in Brazil

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Abstract

This article presents the situation of women in Information and Communication Technology (ICT) undergraduate programs at the Federal Institute of São Paulo (IFSP) in Brazil. It presents a mapping of recent studies involving women in computing, the presence of empirical data, and the representation of Latin America within. Addresses qualitative and quantitative IFSP data to explore gender dynamics in computing. It presents and analyzes the number of students in the Information Systems and Systems Analysis and Development degrees within IFSP. A survey was applied to understand why women at the educational institution chose the ICT area and why they decided to continue in the field. It also correlates trends in Brazil with trends at the institution.

Keywords

women in computer science, undergraduate programs, gender diversity, Latin America, Brazil

1. Introduction

The field of Information and Communication Technology (ICT), although in high demand for professionals, faces a situation where women are underrepresented: they account for only 3% of graduates [21]. In a reality where the number of graduates is much lower than the market demands, gender equality in participation could positively impact this issue, considering that more diverse teams tend to produce better products [22].

The trend of women being outnumbered by men is not a local phenomenon but a global one. Whether in Latin America, Europe or North America, this disparity exists both at the undergraduate level and in the labor market [21] [4] [22] [17].

The interest of women in pursuing courses in the exact sciences and participating in extracurricular activities related to science is relatively low compared to men, and this reality is linked to the narratives shaped during elementary and high school education. According to the United Nations, women enrolled in STEM (Science, Technology, Engineering, and Mathematics) fields represent only 35% [19]. According to U.S. government data from 2013, women held 27% of jobs in science and engineering, and only 12% specifically in engineering [4].

This work is a case study that aims to shed light on the situation of women studying in higher education programs related to ICT at Federal Institute of São Paulo – Campus São Paulo, which will be referred to as "IFSP" in this article. The institution offers two degrees in the ICT area: Systems Analysis and Development and Information Systems, both undergraduate programs. The former is the most sought-after ICT degree in *Sistema de Seleção Unificada* (SISU), which is the largest application platform for public university entrance exams in the country. On this platform, it was the 6th most popular in 2025 [6] and in 2024 it had almost 7000 applicants, which gave it the 7th position on the list of the most popular of the year [15]. The latter program only started in 2023, but is the third most popular since then at the institution.

The main objective of this research is to assess the reasons why IFSP women chose ICT degrees and compare enrollment and drop out rates with those of men, in order to clearly express proportionality in these programs. With that in mind, the following specific objectives were established:

- Present the number of women enrolled in ICT programs at the institution.
- Compare enrollment and student retention rates in higher education ICT programs, by gender, at IFSP and correlate them with the national Brazilian context.
- Analyze the reasons why women choose to continue or drop out of the IFSP program, based on collected data.

Therefore, in order to deal with the topics addressed, the rest of the document is structured as follows: in Section 2 we present the low number of similar studies already carried out on traditional platforms with a focus on Latin America; in Section 3, we present the current situation of women in computing courses in Brazil; in Section 4, statistical data on women in ICT courses at IFSP is presented and analyzed; in Section 5, we present a survey carried out with women at IFSP enrolled in the courses of interest. Finally, in Section 6, we present the conclusion of the work and proposed initiatives.

2. Mapping of studies with similar focus

In order to understand whether empirical studies on women in computing are covered in recent literature, a quantitative mapping of studies on the subject was carried out. This is a simplified adaptation of the systematic mapping referenced by Petersen *et al* [16], as it uses only the following steps: definition of the research questions, scope of the review and search. The classification of the articles found is based on related words in the abstract. The goal is to address three topics: "women and computing", "women in computing and empirical data" and "women in computing, empirical data and Latin America". Future research could analyze specific trends in these topics. This mapping does not take into account duplications and does not make any assessment of quality, in order to fulfill the objective of showing only the quantity of publications on the topic. Only publications between 2020 and 2024 were considered in this analysis, so as to quantify recent data.

The aim of this mapping is to elucidate two research questions (RQ) on publications between 2020 and 2024 on the topic of women in computing: RQ1) how many studies have been carried out on empirical data? and RQ2) how many studies have looked at women from Latin America and mentioned empirical data?. After filtering out studies from the correct period and using relevant keywords, some abstracts were read to see what other keywords would be important for the mapping. For the initial filtering, only the title was used. The number of studies found is shown in Table 1, under "RQ". To answer RQ1, filters were added to the abstract in order to select only studies that deal with empirical data (quantitative or qualitative) in some way, and the results are in Table 1, under "RQ1". To answer RQ2, more filters were added to the abstract as means to select the Latin American audience, such as the name of the countries that produce the most studies; they are shown in Table 1 under "RQ2". Note that RQ2 articles are also considered valid for RQ1.

The mapping for publications in English was carried out on the ACM and IEEE databases. Interestingly, the addition of the word "survey" in the abstract filter for RQ1 included many articles for the ACM database: without this filter, RQ1 would have only 26 articles. For the IEEE platform, this word didn't make as much difference, resulting in 8 articles when the filter is removed. A choice was made to add this keyword to the mapping because the studies that contained it addressed the topics of interest. Wildcards were used in the search strings in both databases. The "?" character represents and replaces a single unknown letter, and the "*" character represents and replaces an unknown number of letters. In the ACM library, the "Title" field was used to filter the title, and "The ACM Guide to Computing Literature" database was used because it has a greater number of publications. In the IEEE library, the "Document Title" field was used to filter the title. The word "countries_analyzed" in Table 1 represents the list with the names of the Latin American countries that produced at least 1000 studies during the years 2016 and 2020, according to the Institute for Scientific Information [1]; to combine the countries, the logical operator "OR" was used and covers the following countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Guatemala, Jamaica, Mexico, Panama, Paraguay, Peru, Trinidad and Tobago,

Uruguay, Venezuela. Table 1 shows the relationship between the search strings used and the number of studies found.

Table 1
Search strings used and quantity of studies found

Scope	Title search	Abstract search	ACM library	IEEE library
RQ	(wom?n OR gender) AND (comput* OR ICT)	-	156	113
RQ1	(wom?n OR gender) AND (comput* OR ICT)	empiric* OR qualitative OR quantitative OR survey	115	24
RQ2	(wom?n OR gender) AND (comput* OR ICT)	(empiric* OR qualitative OR quantitative OR survey) AND ("latin america*" OR countries_analyzed)	4	2

Based on the mapped data, a graph was created to proportionally understand the topics covered in the articles filtered under RQ. This showed that the ACM library has the majority of its studies (75%) focused on empirical data, and IEEE only has 21%. The studies that did not answer RQ1 and RQ2 are shown in Figure 1 as "excluded". The majority (71%) of IEEE studies does not meet the criteria for relevant studies. There is a notable lack of empirical data on Latin American women, since RQ2 only represents 2% of the overall total of relevant studies (6 articles out of 269 in the 4-year period). The results are show in Figure 1.
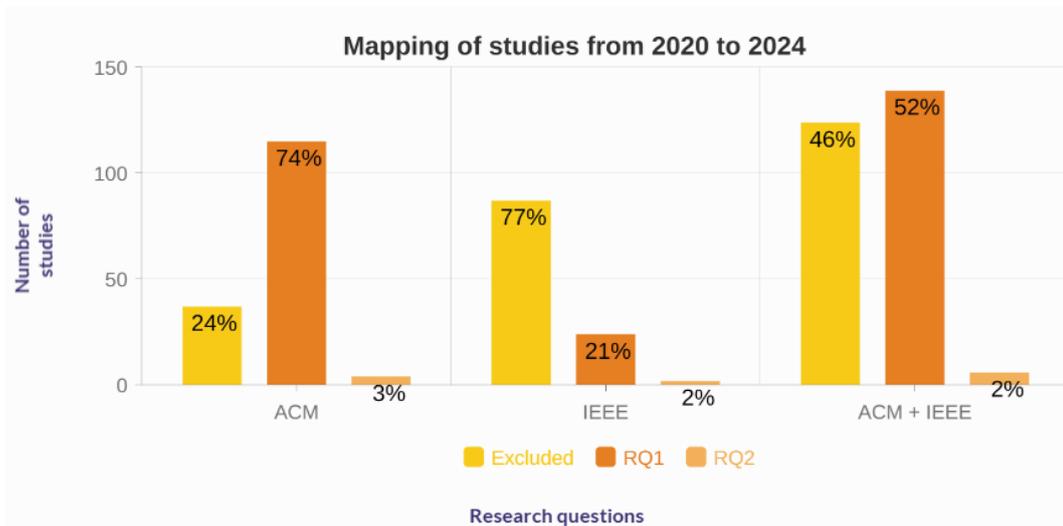

Figure 1: Percentage of studies found separated by research questions.

There is a worrying gap in information about women in computing in Latin America. This scenario emphasizes the importance of "woman and computing" focused periodicals, specially within Latin America. Since more traditional platforms don't often encompass many relevant studies on the topic, a specific one helps bridge the data gap. Researcher Hildebrand *et al* [8] discusses the search for reliable data with a focus on gender, Latin America and STEM combined in higher education, and argues that the current scenario lacks structured open data and that data is often non-existent or impossible to use and reuse. She also argues that this data is essential to highlight existing problems, produce new knowledge and address new research questions.

Data is fundamental to scientific progress. In order to change the underrepresentation of women in the field in question, they are essential guides for making decisions that will have positive impacts [8]. The current work aims to help tackle the problem of the lack of data on women by providing an in-depth study of computing degrees at the institution that has the most sought-after computing course in Brazil.

3. Current situation of women in Brazilian ICT degrees

To understand the situation of women in ICT programs in Brazil — specifically the enrollment rates compared to men — data from the Higher Education in Computing Statistics Report 2022, produced by the Brazilian Computer Society (SBC) [18], was used. These data are a cross-section of the 2021 census conducted by the Ministry of Education in partnership with the National Institute for Educational Studies and Research Anísio Teixeira (MEC/INEP). In Figure 2, it is clear that women are a minority in terms of enrollments, and their numbers over the past 15 years have remained relatively stagnant, never surpassing 50,000. This is in a context where, since 2016, total enrollment has exceeded 200,000 [18].
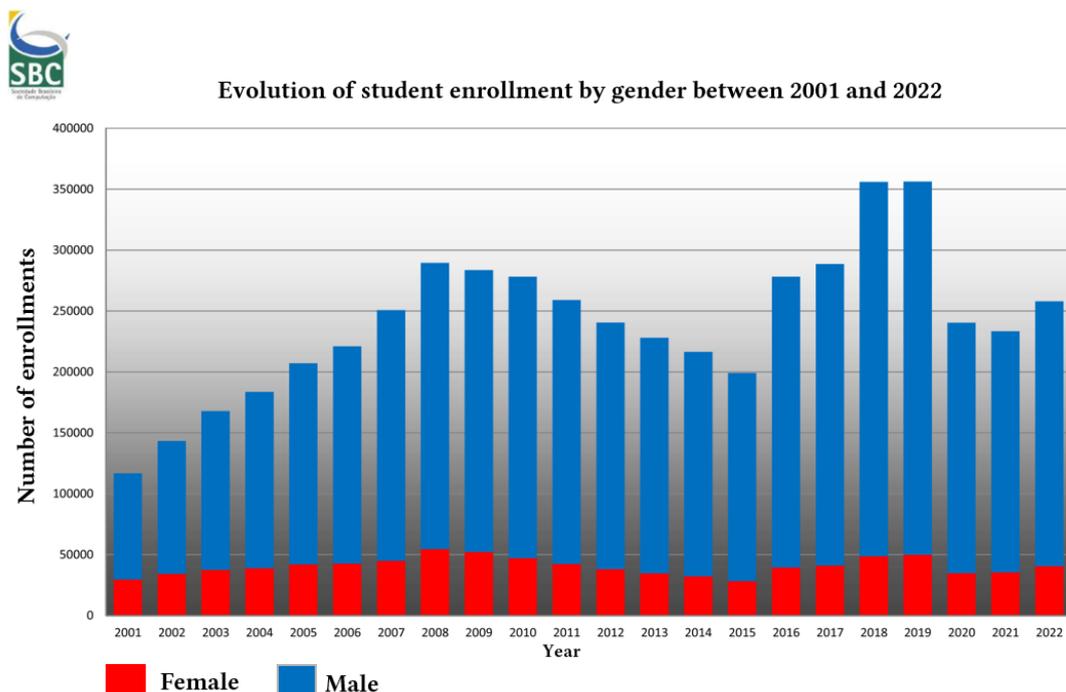
Figure 2: Evolution of student enrollment by gender between 2001 and 2022, via Higher Education in Computing Statistics Report [18], translated to English by the author.

According to IBGE [10], in 2019 women accounted for only 13.3% of enrollments in on-campus undergraduate programs in the computing sector in Brazil. Several studies address the reasons behind women's low participation in this field [12]. Among them, researcher Teague [20] points out two main reasons why women are not drawn to computing: they believe the career is not of interest to them, due to a mistaken perception; and there is a prevailing stereotype about what computing professionals are like.

Gender stereotypes—which occur across all ages, genders, and racial groups—lead women to lose interest in the field, as they not only consider career prospects when choosing a course, but also look at the people already in the field to determine whether they would succeed or be accepted [5]. Some of these stereotypes includes — but are not limited to — the ideas that computing is an isolated field (with no societal impact); that it is a hostile environment for women; that people in the field are obsessed solely with computers and programming, excluding other interests from their

lives; that they are socially awkward and lack interpersonal skills; and that they are inherently intelligent or geniuses [5] [17].

Notably, men entering higher education show more confidence in their computing abilities than women. Even men who do not intend to graduate in the field believe more in their skills than women who are actually pursuing ICT degrees [17]. Both men and women tend to believe that men perform better in computing, even though there is no significant difference in performance between genders [5].

The way these perceptions are built and spread directly influences who enters the field, as women often feel they do not belong in that environment. The media, with its ability to communicate, reinforce, and transform narratives, becomes a powerful factor in either encouraging or discouraging women from pursuing careers in STEM. In the case of computer science and related areas, women who have contact with information that doesn't propagate the stereotype are more interested in pursuing a degree in the field. This represents an opportunity for initiatives and policies to focus on how the career should be disseminated. [5].

4. Exploration and analysis of current situation of women in IFSP with quantitative data

The data presented here was collected by the institution's *Sistema Unificado de Administração Pública* (SUAP, the platform the faculty use for administrative processes). They are quantitative data relating to students on the Systems Analysis and Development and Information Systems undergraduate program. The data presented below is from 2019 to 2024 for the Systems Analysis and Development course, and from 2023 to 2024 for the Information Systems course. No information from 2025 has been considered to ensure that the data is up to date, because when a student transfers or drops out, it can take some time for their record to be updated in the system, and also because the 2025 semester has not yet been completed at the time of writing this article.

The data mentioned is unpublished and has been made available exclusively for analysis in this article. At the time of this research, the authors could find no other study on the numbers of IFSP computer-related undergraduate students broken down by gender. Also, the data was made available as a spreadsheet list, so the numbers grouped below were calculated using aggregation functions from the authors local SQL Server (a relational database). To calculate data related to the students' application process (such as the acceptance rate and spots offered), a spreadsheet provided by the Brazilian Ministry of Education on SISU (the most widely used platform for public higher education applications) [14] was also uploaded to the author's local database, and after relevant filters to obtain only IFSP courses, aggregation functions were also used.

Descriptive and comparative statistics were used to explore the data. This data was analyzed using Albers' approach [2] on how a quantitative analysis should be done. He argues that the most important part of a study is not how the data is collected, but the analysis of the data, because it is from the analysis that we draw important information about the object of study. So, during the comparisons that will be made below, it is important to point out that these are not just numbers, they are the quantification and proof of how much women are the minority in the field of computing. Although the female presence is increasing in the STEM area, they are still the minority - and if we get more specific and analyze the female presence in computing, this difference is more noticeable [22]. In order to ensure that women are included in such a promising and important area, and to create support policies and interventions (both inside and outside IFSP) if necessary, reliable gender-focused data is extremely important.

The Systems Analysis and Development is an undergraduate degree at IFSP. This course offered by IFSP is the most popular in Brazil in the area of computing, with an acceptance rate of 0.65% in 2024, surpassing some more traditional courses such as medicine [6] [15]. In Figure 3 we can see that from 2019 to 2023, men represented more than 80% of those enrolled; only in 2024 did women begin to represent more than 20% of enrollment, and in 2020 the class was made up of only men.
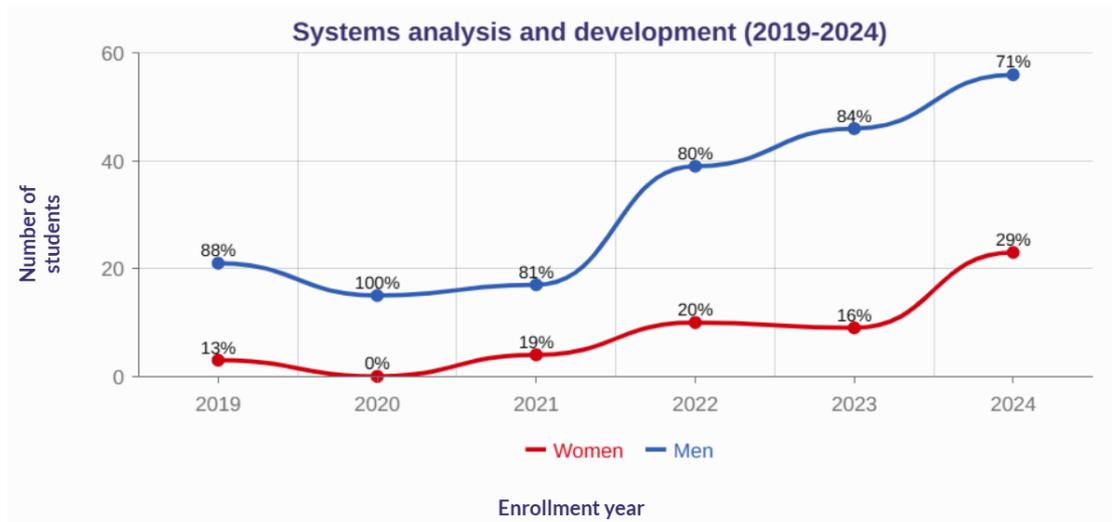
Figure 3: Evolution of enrollments for Software Analysis and Development students from 2019 to 2024.

The bachelor's degree in Information Systems is also offered at IFSP, and is the third most popular course at the institution. It is a new undergraduate program that only opened in 2023, but has already had over 2,500 applicants (acceptance rate = 1.59%) in its first year, and in 2024 it had over 3,000 applicants (acceptance rate = 1.31%); 40 spots were offered each year [14]. Women accounted for 24% of the class of 2023, while in 2024 there was a 13% increase, and they accounted for 37% of the overall total. The exact reason for the increase is unclear, but the factors that influenced these students to pursue the field are linked to encouragement and exposure, as demonstrated by Wang [22] and reinforced by the results of the qualitative research with these students (see figure 5). Figure 4 shows the relationship between enrollment status (X axis) and the number of students (Y axis) in 2023 (A) and 2024 (B).
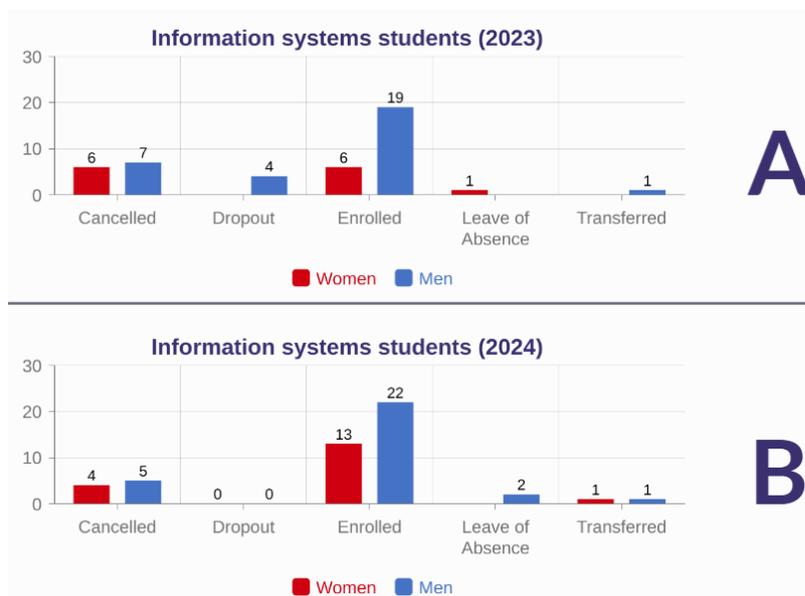
Figure 4: Enrollment status of Information Systems students in 2023 (A). Enrollment status of Information Systems students in 2024 (B).

For the Information Systems course, we also have data on other enrollment statuses. During these years, 20 men and 12 women dropped out (and here we are counting all statuses other than "enrolled"); this means that 12 out of 19 women (64%) and 20 out of 41 men (49%) are no longer studying. This shows that the course has a high drop-out rate, and it is 15% higher for women. For this course we also had access to the students' IRA (academic performance index, which can range

from 0 to 10), and we ran a T-test to see if there was a difference in performance by gender. For this test, only currently enrolled students were considered, and the significance level considered is 0.05. The difference in academic performance between women (M = 7.7225; SD = 0.4134) and men (M = 7.7689; SD = 0.9936) was not statistically significant (t = -0.1798; p = 0.858). This is in line with research by Beyer *et al* [3], who also carried out a similar test with computer science students, and also found no differences between the performance of the genders.

Overall, the institution's situation is no different from the rest of Brazil. The tendency for there to be more men than women on computing courses remains true, and the drop-out rate is high. This brings to light the problem of labor shortages: the number of graduates does not meet the market's need for professionals [22]. IFSP, but also other institutions, could benefit from creating inclusion and welcoming programs, so that in addition to providing support for their students, they can also help to meet the needs of the market.

5. Exploration and analysis of survey conducted on IFSP students

To achieve the objectives set out in this work, a survey was carried out on female students in higher education courses in the ICT area at IFSP, in order to elucidate their reasons for continuing/dropping out of their careers, as well as acquiring new empirical data. An electronic questionnaire with open and closed questions was created to explore the student's relationship with their area, the pillars of support they had, the environmental factors that influenced them, and how they evaluate their experiences with technology as a whole, in order to better understand any woman who has already passed through the area, and who has studied at IFSP.

The data obtained from this survey questionnaire was analyzed using the approach of Albers [2] and Mayring [13]. Albers explains the importance of exploratory analysis to really understand the data collected and its relevance to the research topics, and orients how to not focus on numbers but on the information that they can offer. Mayring specifies techniques for qualitative content analysis, and in this work we will use his methods, in special the summarizing, with intracoder agreement to ensure stability and therefore reliability. This survey used relevance sample as defined by Krippendorff [11], as it only accepted responses from women in computing degrees whitin IFSP.

Firstly, let's explore the characteristics of the sample. The questionnaire was answered by 29 female undergraduates (2 other women answered, but as they were not enrolled in the relevant courses, they were disregarded from the analysis); the median age of the respondents is 21; 41.3% of the students are from the Systems Analysis and Development course (N=12) and 58.6% are from the Information Systems course (N=17) (for students who transferred between courses, only the course they are currently on was considered); all of them still work or study in the area, so despite having a section in the questionnaire dedicated to female dropouts, it was not possible to gather data; 22 out of 29 were at the institution at some point in 2023 or 2024; the year they entered the institution ranges from 2018 to 2025; the majority (23 out of 29) are still completing their degree and for the others, the year they completed it ranges from 2022 to 2024. Note that all questions were created and answered in Portuguese, and only their final form were translated to English by the author.

After applying the Mayring [13] method to summarize the answers to the open question (OQ1) "What was the reason you chose the area?" three categories were found: K'1) they believe it is a promising career, highlighting: financial gains and flexibility; K'2) they were influenced by people, highlighting: parents and friends; K'3) they had opportunities to get to know the area and managed to fit in well. The method was also applied to the open question (OQ2) "What made you enter and *stay* in the area?", which generated the following categories: K'1) they understand that it is an all-encompassing career that promises financial gain, professional growth and flexibility; K'2) they have support from family, friends and teachers; K'3) they have an affinity and aptitude for technical subjects, as well as a resilient and constant approach to their studies.

It is interesting to note that the reason they chose this career and the reason they continue are closely linked, with categories K'1 and K'2 for OQ1 and OQ2 being very similar, and to some extent category K'3 as well. But the nature of the reasons are different: for OQ1, they are reasons that

arose before they entered the area, and they mention the opportunities they had as a reason for choosing to follow, as well as the influence of people close to them in choosing the area; for OQ2, they are reasons that make them stay in the area, and at this stage they highlight the need to keep up to date, as well as the support they receive from people around them. Future research could analyze the nature of the influence, opportunities, and support mentioned. Figure 5 shows the frequency with which each answer fell into the established categories. Bear in mind that a response can have more than one category (not mutually exclusive).
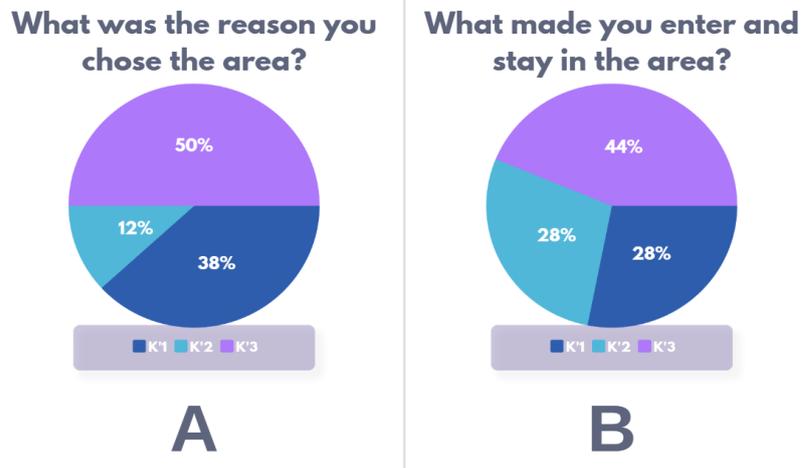
Figure 5: Answers to open question 1 (OQ1) separated by their categories (A). Answers to open question 2 (OQ2) separated by their categories (B).

When asked, in a closed question, which factor most encouraged their interest in the area, the following answers were given: family (43%), mentor/role model (29%), teachers (21%), the job market (4%) and friends (4%). This importance of family in women's academic careers was pointed out in the thesis presented by Gulshan [7], which also found that "family, mentor, teacher", in that order of relevance, was an influential factor for women in computing.

Encouragement to pursue an ICT career has a greater impact on women than on men, as those who receive it are more likely to enter the field. Although family is the main factor, encouragement from others (teachers, mentors, friends, the media) is also highly relevant [22]. Following Gulshan's [7] thesis, questions were asked to understand how the pillars mentioned affected the students, in which they had to say how much, in a likert scale (1 to 5), each topic helped them to pursue their careers. The results are shown in Figure 6, and indicate that the factors had a major impact on the lives of most of the respondents.
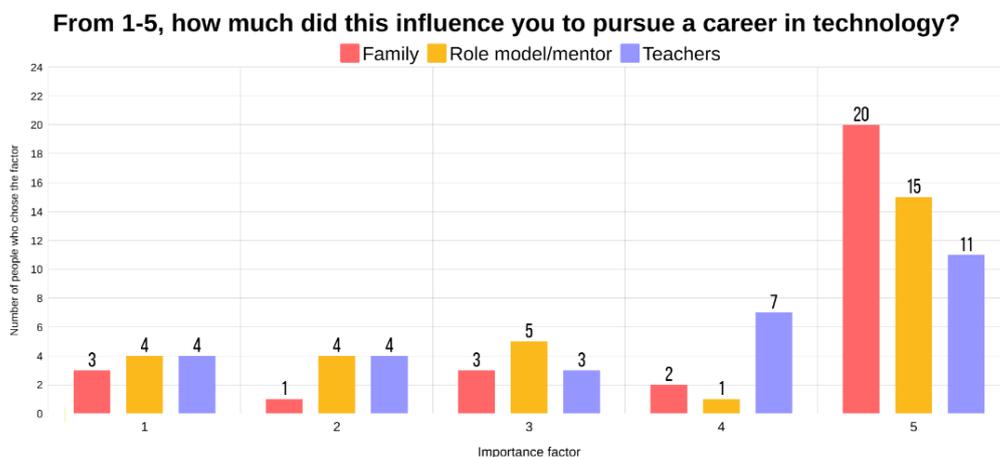
Figure 6: Response distribution for the level of importance of "family", "role model/mentor" and "teachers".

There are several studies on the prejudice against women in computing, and how it effectively affects their entry and permanence in the field [12]. In view of this scenario, and to understand the students at the institution, the questionnaire asked (closed question) if they had ever suffered prejudice in the area simply because they were women, 68% of whom said no. On the other hand, they were asked if they had ever received benefits or facilities for being a woman, 79% of whom said they had not. Future research could analyze the characteristics of such prejudice/advantage.

6. Conclusions

Female participation in the field of computing has low numbers. A mapping to analyze whether there is recent empirical data on women in computing, and to check whether there is data on Latin America in traditional journals, revealed that only 2% of publications between 2020 and 2024 address the subject (only 6 out of 269). This highlights the importance of journals and events focused on the underrepresentation of women in computing in Latin America, since traditional journals do not usually provide much empirical information on the subject. And this also makes this article an important piece of information, as it provides unpublished empirical data on the most popular computing course in Brazil - especially as this data is focused on gender.

After conducting a quantitative and qualitative analysis on computer science students at IFSP, it is possible to state that these courses are mostly male-dominated; also, for the Information Systems course, there is a high drop-out rate (this rate is 15% higher for women), and there is no difference in academic performance between the genders. It is also possible to state that the reason IFSP women choose computing is the support they receive, the idea that they are pursuing a promising career, and the influence of people close to them. As for the reasons why they continue in computing, we can mention the support they receive, the vision they have of the career, but also the affinity they have gained for the area and the constant study to keep up to date. The influencing factors for women to enter and remain in their careers are, in this order of importance: family, role models/mentors, teachers. These women's motives are in line with what the literature says are the reasons that attract women to the area.

In short, to ensure a welcoming environment for women at the institution, intervention policies can be made to change the current scenario, in which they are the minority and have a dropout rate (for the Information Systems course) of 64%. As the situation is not something local, but the reality of Brazil, public policies would also be appropriate to deal with and try to minimize the disparity in female participation. Useful interventions for the institution include, but are not limited to: support groups for the exchange of experiences between women and the dissemination of women's scientific achievements. Useful public policies would be: disseminating the importance of family support to facilitate women's entry into the field, funding medium and long-term projects that introduce computing to women (through programming or robotics, for example), always taking care to convey a non-stereotypical and diverse vision. All of the above interventions have been proven to be effective, and would therefore be of great value for women to enter and remain in the field.

Declaration on Generative AI

During the preparation of this work, the authors used DeepL Translator AI, in order to: Translate from Portuguese to English and check grammar and spelling. After using these services, the authors reviewed and edited the content as needed and takes full responsibility for the publication's content.

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