

Gender Diversity in the Graduate Program in Computing at the University of Brasilia

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Abstract

The area of computing has little gender diversity in graduate studies in Brazil and elsewhere in the world. The low demand of women for majors in computing results in few women in both Masters and Ph.D programs. In this context, this article has two contributions: *i*) a systematic mapping of the literature in publications with the theme of women in graduate programs in Computing in Brazil, and *ii*) an analysis of women in the graduate programs in Computing at the University of Brasília (UnB), Brazil. The results presented in this article show the small number of publications on the subject in Brazil and that few women have received Master's or doctoral degrees at the UnB.

1. Introduction

Both in Brazil and in other countries, the number of female students in Computer Science courses is disproportionate to the number of male students. In Brazil, between 2000 and 2013, the number of male graduates of Computing majors increased by 98%, while the number of female graduates decreased by 8% [1]. According to the Brazilian Computer Society (SBC) the number of women graduating from Computing majors in Brazil was 13% in 2019 [2].

At the University of Brasilia (UnB), the number of women in graduate studies was greater than the number of men in 2017 [3]. However, when looking at Computer Science in particular, the proportion of female students in graduate studies is much lower, reaching only 10% at the doctoral level at UnB [4].

Another important indicator is participation in scientific publications. The number of scientific articles published involving female Brazilian researchers in Computing, between 2014 and 2018, was around 6,380 articles, while male researchers participated in 24,909 articles [5]. Therefore, the researchers represented only 20.39% of publications in Brazil.

In this context, this article presents two objectives: *i*) a systematic mapping of the literature in publications with the theme of women in graduate studies in computing in Brazil, and *ii*) an analysis of women in the graduate programs in computing at the University of Brasília, Brazil. In order to achieve the first objective, this article analyzed the publications of several conferences with the theme of gender among their topics of interest, such as CLEI-LAWCC and WIT-SBC, .

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In addition to the academic bases Google Scholar, Scopus and Web of Science. For the second objective, a survey of all Master's (academic and professional) and doctoral works defended at the Department of Computer Science at UnB was carried out.

This article is divided into four more sections. Section 2 presents the collected data, the research process, and the research questions (RQ). In Section 3, the results achieved are presented, according to the RQ presented in the previous section. Finally, Section 4 presents some conclusions and proposes future works.

2. Methodology

For each objective defined in this article, a methodology and specific research questions were specified. Therefore, this section is divided into two parts: initially, the reading mapping is described, and then the methodology for analyzing UnB data.

2.1. Literature Mapping

For the systematic literature mapping, the methodology used was based on the process defined in [6]. At this stage, the following research questions were defined:

- RQ1) What is the distribution of articles on this topic in recent years?
- RQ2) Which Brazilian states publish the most?
- RQ3) What are the most commonly addressed subjects in these articles?

One of the challenges of mapping is the selection of relevant articles for the study. The following Inclusion Criteria (IC) were chosen:

- IC1: published in the period from 2009 to 2020;
- IC2: related to the topic of women in computing;
- IC3: linked to the graduate (Master and Ph.D) educational level.

Finally, an Exclusion Criterion (EC) was defined:

- EC1: documents with less than four pages.

This mapping is part of a larger mapping that analyzes publications in Brazil at different educational levels, from elementary school [7] to PhD. Therefore, a comprehensive search string was defined to choose relevant articles. For Google Scholar, the search string (Portuguese) "*(Computaçãp) AND (mulher OR gênero OR garota OR estudent)*" was used, with a publication period from 2009 to 2020. In this search string does not only include the graduate level, since one of the research objectives was to find out how many articles on the topic of women in computing in Brazil. Thus, after this first search, only articles that addressed graduate programs were selected. For Scopus and Web of Science, the search string "*(Computing OR "Computer Science") AND (women OR gender OR girl OR female)*" and publications between 2009 and 2020 were used.

Initially, 82 documents were found in Google Scholar, 4 in Scopus, only 1 in Web of Science, 34 in LAWCC-CLEI and 82 in WIT, totaling 203 academic documents. The CLEI proceedings

for 2014 and 2016 to 2020 are available on the event website [8], while the WIT proceedings for 2016 to 2020 can be found at SBCOpenLIB [9]. Applying IC3, the number of documents was reduced to 12. Therefore, only 12 articles from the 203 documents found focus on the postgraduate educational level, that is, only 6% of the total of publications found.

2.2. UnB Data Analysis

For analyzing gender diversity at UnB, the following research questions were defined:

- RQ4) What is the gender distribution by year and by graduate programs at UnB?
- RQ5) What areas of research did women pursue in graduate school?
- RQ6) Do graduate program female students generally choose female supervisors?

For the analysis of graduate program data from the Department of Computer Science at UnB, the methodology applied was, initially, a collection of data in the institutional repository of UnB between the years 2000 and 2020 [10]. This collection resulted in a total of 375 works, of which 324 were by men and only 51 by women. Among the 375 works found, 28 were doctoral theses, with three theses written by women and 25 by men, 141 academic Master's dissertations, with 32 written by women and 174 by men, and 206 professional Master's theses, with 16 tests written by women and 125 by men, as can be seen in Table 1.

Table 1

Number of articles x Gender.

Program	Men	Women	Total
Ph.D	25	3	28
Academic Master	174	32	206
Profissional Master	125	16	141
Total	324	51	375

3. Results

In this section, the results obtained for all the research questions defined in this work are presented.

3.1. RQ1) What is the distribution of articles on this topic in recent years?

Among the articles found by the survey, only 6% addressed the topic of women in graduate studies in the area of Computing. Figure 1 presents the distribution, by year, of all 12 publications that deal with the topic under analysis, and which fit the criteria mentioned in Section 2. Thus, it may be noted that there are publications only in the years 2009, 2013, 2016, 2017, 2019 and 2020, and in the years 2009, 2013 and 2016 there was only one publication in each, and in the years 2017, 2019 and 2020 three.

In Figure 1 it may be seen that there is no constant or linear growth in the number of publications in recent years. In addition, it is noted that from the year 2017 there was an

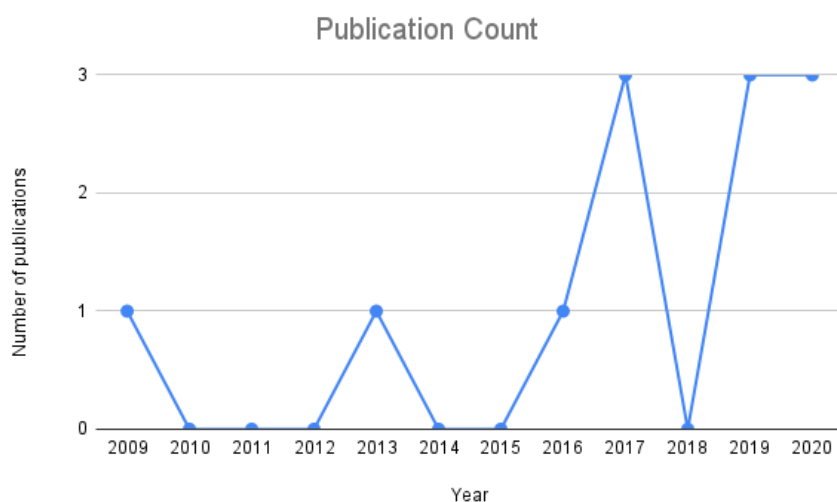


Figure 1: Distribution of publications by year on women in graduate studies in Computing.

Table 2

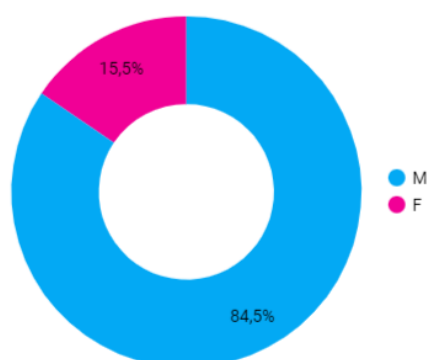
Tabela de assuntos abordados.

Topics	Articles
Graduate female professors in computing	[11] [12] [13]
Computing course graduates	[14] [15] [16]
Gender difference and female participation	[17] [18] [19] [3]
Profile of graduate students	[20]
Analysis of the inclusion of women in graduate studies and their motivations	[21]

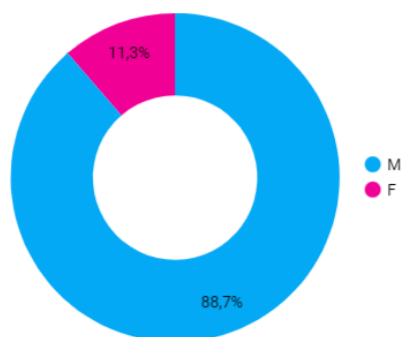
increase in the number of publications, but in the following year no articles were found. In this way, the analysis shows that the topic of women in graduate studies in Computing has not been a subject much discussed in academic publications in Brazil, despite the large volume of articles that discuss gender diversity in undergraduate Computing.

3.2. RQ2) Which Brazilian states and regions publish the most?

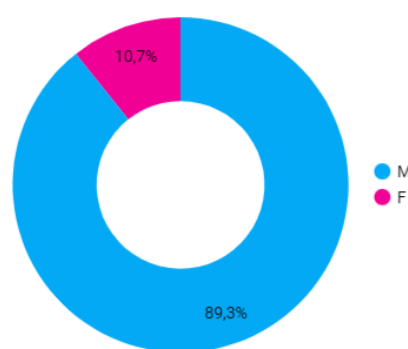
To understand whether any Brazilian state or region has addressed the issue of women in graduate studies in Computer Science, a survey was carried out of the Brazilian states from which the published articles originated. This link was made from the university to which the authors belonged, so some articles may belong to more than one state, as it is possible to have authors from different universities and states in the same article. The remaining documents are well distributed across the country. Thus, the publications are linked to 9 States and the Federal District, highlighting the States of São Paulo (SP), Bahia (BA) and the Federal District



(a) Professional Master's.



(b) Academic Master's.



(c) Doctorate.

Figure 2: Gender Difference between UnB Programs.

(DF), which had two publications, the others only one.

As for publications by region in Brazil, there are publications in all regions, at least one article on the subject, with the Southeast and Northeast regions being the regions with the most publications, each with 4. Then appear the Central-West Regions and North with 2 publications and, finally, the South Region with only one published article.

3.3. QP3) What are the most commonly addressed subjects in these articles?

Table 2 presents the main subjects presented in the articles. The most discussed topic was “Gender difference and female participation”, which presented four articles. The topics “Teachers in graduate studies in computing” and “Graduates from computing courses”, which presented three articles each, also stand out.

The articles [11], [12] and [13] address the subject of female professors in graduate studies in

computing, the first two were published by UFBA (Federal University of Bahia). The first of which was co-authored by a researcher from UFPE (Federal University of Pernambuco). The [13] was published by authors linked to the UFG (Federal University of Goiás).

The subject of graduates from undergraduate courses in Computing, which shows that many women go on to graduate school, is addressed by three articles [14], [15], and [16]. The article [15] is presented by the DIVAS Digital project of UNIOESTE (State University of Western Paraná). The [14] is from the UFPB (Federal University of Paraíba). The [16] features a survey on the profile of graduates through a *survey*, published by UFOPA (Federal University of Western Pará) and IFPA (Federal Institute of Pará).

Regarding the difference in gender and female participation, 4 articles were found, which belong to the institutions UnB (University of Brasília), CEFET (Federal Center for Technological Education) of Rio de Janeiro and UFAM (Federal University of Amazonas). The articles [18] and [3] present data on the gender difference in graduate studies in the areas of Computing and Exact Sciences at UnB. In [17], data is given that makes a comparative analysis between the student admission rate and the graduation rate of graduate students at UFAM. In addition to the articles, in the mapping of the literature, a Master's dissertation was selected, [19], which addresses the topic of gender in postgraduate engineering in Brazil.

The article [20], published by the IFSP (Federal Institute of São Paulo), presents profiles of students in technical, undergraduate and postgraduate courses in the area of Computing. This work includes the major difficulties mentioned by the students on the courses and also the differences in race/ethnicity between them. In [21], the authors are from institutions INPE (National Institute for Space Research) and UNICAMP (Universidade Estadual de Campinas). This work deals with the inclusion of women in graduate studies and their main motivations for taking courses in the various areas of INPE, including Computing.

3.4. RQ4) What is the gender distribution by year and by graduate programs at UnB?

As shown in Table 1, 375 works were collected, of which 28 are Doctoral theses, 206 are academic Master's dissertations and the remaining 141 belong to the professional Master's program, from the Department of Computer Science at UnB. Among the 375 works, 51 of these were written by women and 324 by men, that is, only 13.6% of the graduates from the three graduate programs of the Department of Computer Science are women and 85.4% are men. Analyzing the distribution of papers defended by year, it can be seen in Figure 3a that the highest number of women graduated in graduate studies in computing at UnB was in 2012, in which 9 women's defenses in this department, followed by the years 2018 with 7, and 2015, 2016 and 2019 with 6. Thus, it is noted that the years with the greatest gender diversity among graduates in graduate courses were 2012, with 39.13% female graduates, 2006 with 33.33% and 2009 with 28%. Therefore, it is noted that over the years there has been an increase in graduate students, but gender diversity is unstable, as there is no significant increase or decrease in the number of women in graduate school.

Of the 206 documents related to the academic Master's, only 32 are by women and 174 by men, that is, 15.5% of those who defended their theses in the academic Master's are female, and 84.5% are male, as shown in Figure 2a. The academic Master's degree is the oldest postgraduate

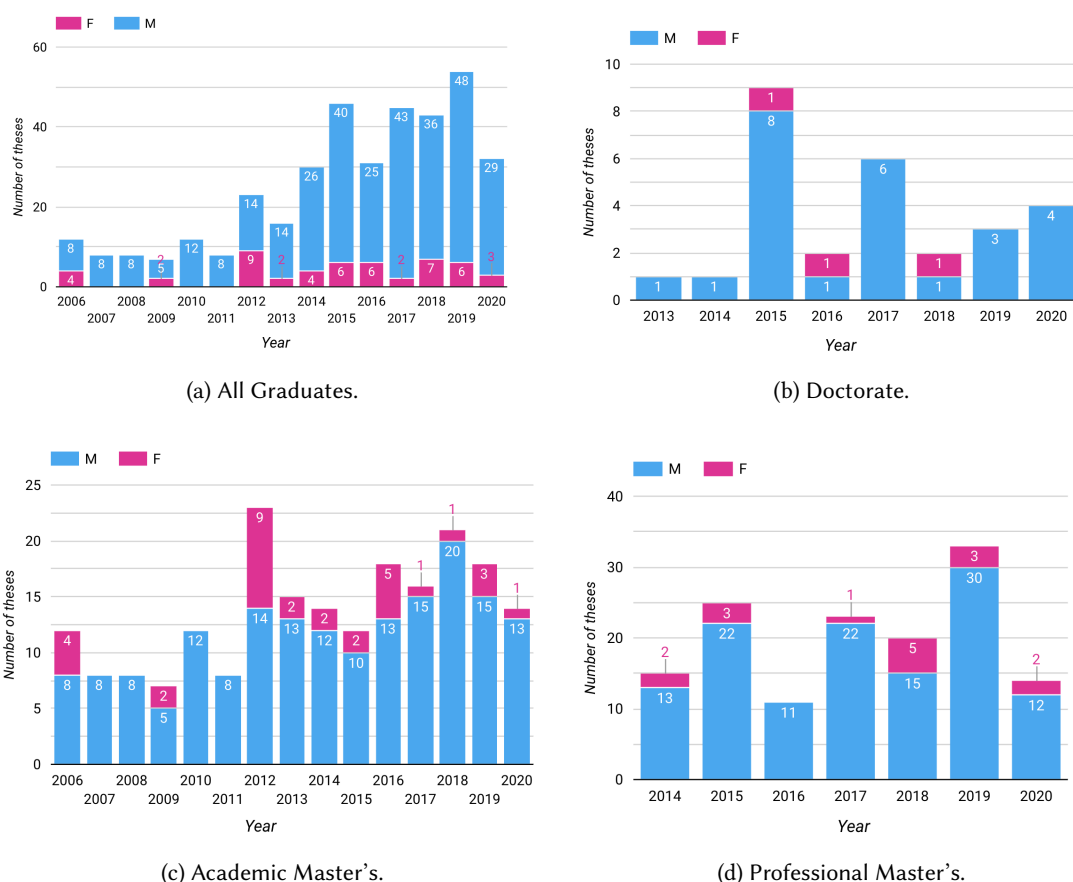


Figure 3: Gender x Year.

course at the Department of Computer Science at UnB, having theses defended since 2006, as shown in Figure 3c. It is important to note that the first year found is one of the years that presented the most women, that is, 4 of its graduates, exceeded only by the year 2012 with 9 women. However, similar to the distribution of works per year of all three courses, the academic Master's degree also shows variable gender diversity over time.

In the professional Master's degree, 141 works were found, of which 16 were defended by women and 125 by men, that is, 11.3% only are female while 88.7% are male (as shown in Figure 2b). In addition, as may be observed in Figure 3d, the highest number of graduates in any year was 5 in 2018. The variation in the number of women over the years is also maintained in this course, with the largest percentage of women (25%) in 2018.

The Ph.D program has the least gender diversity among all three programs, as shown by the fact that, of the 28 students who received a doctorate in Computing at UnB, only 3 were women, that is, only 10.7% of all Ph.D. graduates is female (see Figure 2c). Unfortunately, as not many women graduate from undergraduate and Master's degrees, consequently there will be few women studying for a doctorate in the area of Computing. The three women who received

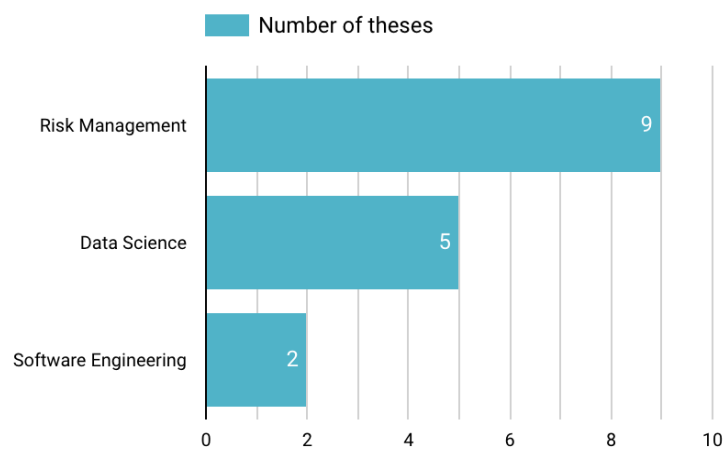


Figure 4: Professional Master's Research Area

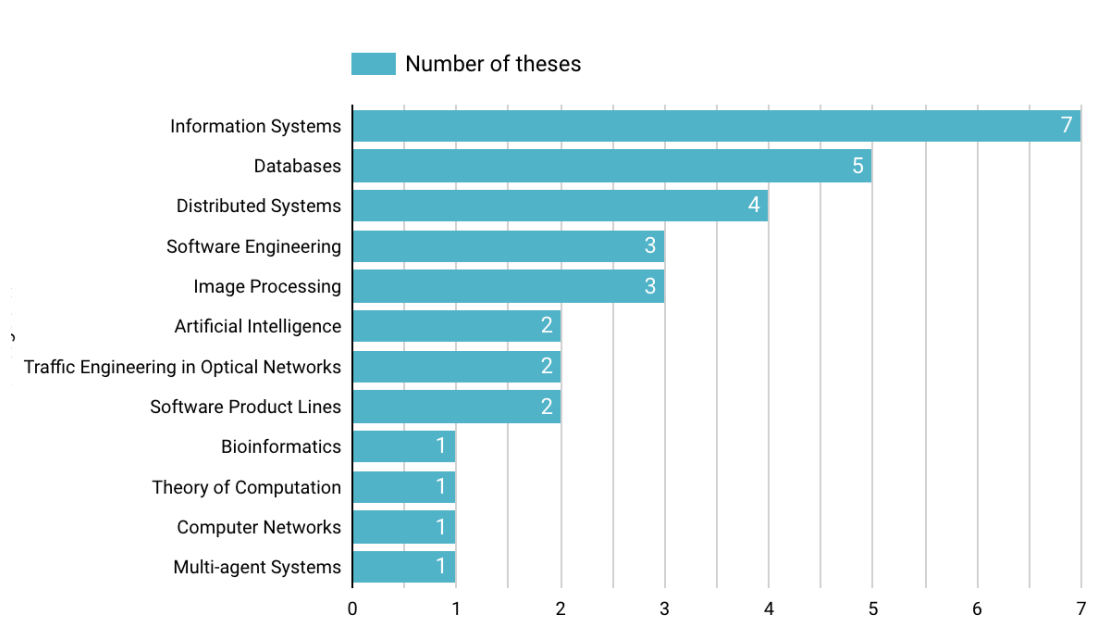
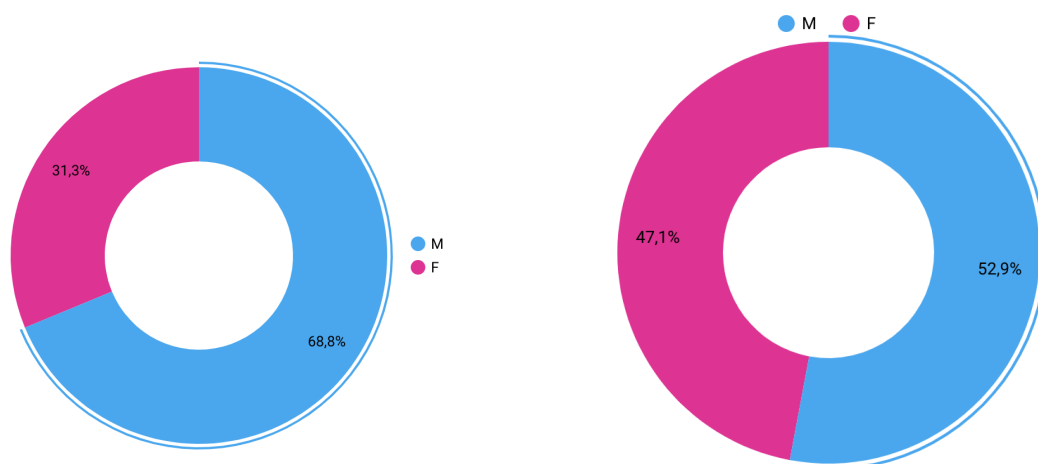


Figure 5: Academic Master's Research Area

Ph.D. degrees from the Department of Computer Science at UnB are spread over the years 2015, 2016 and 2018, as can be seen in Figure 3b.



(a) Gender Difference between Advisors in Total.

(b) Gender Difference between Female Student Advisors.

Figure 6: Gender Difference between Advisors.

3.5. RQ5) What areas of research did women pursue in graduate school?

To answer this research question, it is necessary to analyze the Figures 4 and 5, which show the distribution of postgraduate women by research area.

Figure 4 shows that the greatest preference of women in the Professional Master's is in the area of Risk Management, with 9 women. Then came the Data Science area with 4 women. In the Academic Master's course, the graph in Figure 5 shows that the four areas that have most women graduates are Information Systems, Databases, Distributed Systems and Software Engineering, with 7, 5, 4, 3 women, respectively.

In the doctorate, as stated earlier, only 3 women graduated at this level, and these three women specialized in different areas, these being Information Systems, Computational Theory and Bioinformatics.

3.6. RQ6) Do graduate program female students generally choose female supervisors?

The graduate programs analyzed have 48 professors, of which 33 are men (68.8%) and 15 are women (31.3%) (see Figure 6a). As can be seen, the percentage of female professors is higher than the percentage of women graduates. Of the 375 papers defended, 206 have a male professor as their advisor and 169 a female professor. Thus, 45.1% of the supervisors of work are women, which means that the female teachers supervised more work than the male supervisors.

Filtering only the female students and analyzing their professors, it is possible to notice, according to Figure 6b, that the percentage of female and male professors does not change much, with only 2% more for men. However, only 31.3% of professors are women, which means that female professors mentored more women.

4. Conclusion

As presented in this article, Brazil has been working hard on research on the gender difference in Computing courses, but the focus has largely been on undergraduate and other educational levels, with less study of the postgraduate level. Most publications present data in which they debate the gender difference, but there is nothing that addresses initiatives to encourage the inclusion of women. Therefore, it is possible to conclude that women in graduate studies in the area of Computing is not a subject of much interest to researchers, considering that among the 203 articles collected in the mapping, only 12 match the educational level in question. In addition, in the mapping carried out, it was noted that there has been no increase in output, and in several years no publication on this topic was found.

At UnB, graduate courses in Computing have low gender diversity, the year with the highest number of female graduates being 2012, with 39% in the "Program A" course. In addition, in some years, in the three courses, no women were found among the students. Therefore, the discussion on the subject is very important, as there are many publications on women at other levels of education, as noted in the mapping carried out, but there are no studies in postgraduate studies. At this level, the presence of female students is very low, as seen in the Department of Computer Science at UnB.

Finally, it is possible to conclude that the low gender diversity in Computing is a problem that is perpetuated in postgraduate studies in a very expressive way, and it is necessary to research more on the subject so that this gap can be discussed in society and, perhaps, public policies can be created to change this global scenario. The road to increasing gender diversity is long and several actions must be initiated in the present so that we can have a better future.

References

- [1] M. M. Maia, Limites de gênero e presença feminina nos cursos superiores brasileiros do campo da computação, *cadernos pagu* (2016) 223–244.
- [2] D. Nunes, Educação superior em computação, estatísticas 2017, *Sociedade Brasileira de Computação-SBC 1* (2019).
- [3] T. K. M. Nunes, A. P. Araujo, M. Holanda, Mulheres na pós-graduação nas áreas de exatas: Um estudo de caso na universidade de Brasília, in: *Anais do XIV Women in Information Technology*, SBC, 2020, pp. 244–248.
- [4] M. Holanda, A. Araujo, Pós-graduação em computação na universidade de Brasília: Um grande desafio na diversidade de gênero, in: *Anais do XIII Women in Information Technology*, SBC, Porto Alegre, RS, Brasil, 2019, pp. 169–173. URL: <https://sol.sbc.org.br/index.php/wit/article/view/6731>. doi:10.5753/wit.2019.6731.
- [5] Elsevier, Gender report 2020: The researcher journey through a gender lens, 2020. URL: https://www.elsevier.com/__data/assets/pdf_file/0011/1083971/Elsevier-gender-report-2020.pdf.
- [6] B. Kitchenham, O. P. Brereton, D. Budgen, M. Turner, J. Bailey, S. Linkman, Systematic literature reviews in software engineering—a systematic literature review, *Information and software technology* 51 (2009) 7–15.

- [7] M. Holanda, A. Lima, A. Borges, K. Ketulhe, C. Koike, R. B. Oliveira, A. P. Araújo, Computing for girls in elementary school in brazil: A mapping of literature, in: Latin American Women in Computing Conference (LAWCC), 2021.
- [8] Proceedings LAWCC – clei, 2021. URL: <http://clei.org/lawcc>.
- [9] Proceedings WIT, 2021. URL: <http://sol.sbc.org.br/index.php/wit>.
- [10] Teses e dissertações, <https://www.bce.unb.br/bibliotecas-digitais/repositorio/teses-e-dissertacoes/>, 2022. Accessed: 2022-08-06.
- [11] E. S. Matos, M. J. dos Santos, J. M. Oliveira, A. C. C. Ferreira, E. F. Corlett, Professoras negras na pós-graduação em ciência da computação: uma proposta de pesquisa, in: Anais do X Women in Information Technology, SBC, 2016, pp. 83–86.
- [12] E. S. Matos, E. F. Corlett, A. C. C. Ferreira, J. M. O. dos Santos, Sobre a trajetória de professoras negras na pós-graduação em ciência da computação: alguns resultados preliminares, in: Anais do XI Women in Information Technology, SBC, 2017.
- [13] D. F. Cordeiro, A. S. Rocha, K. K. Cassiano, N. R. da Silva, Representativeness of women in postgraduate programs in computer science in brazil, in: Anais do XIV Women in Information Technology, SBC, 2020, pp. 110–119.
- [14] V. Dantas, R. Figueiredo, S. Medeiros, T. Costa, et al., Perfil profissional das egressas dos cursos de computação da universidade federal da paraíba-campus iv, in: Anais do XIII Women in Information Technology, SBC, 2019, pp. 79–88.
- [15] B. C. de Oliveira, C. Boscaroli, E. N. Pereira, G. M. de Souza, L. Torres, Egressas de ciência da computação da universidade estadual do oeste do paran : o que veio depois?, in: Anais do XI Women in Information Technology, SBC, 2017.
- [16] L. H. C. Nunes, J. R. Reis, C. M. Paxi ba, M. J. Ponte, M. W. Nascimento, R. P. Nascimento, Perfil dos egressos de computa o do interior da amaz nia no mercado de trabalho, in: Anais do XIV Women in Information Technology, SBC, 2020, pp. 254–258.
- [17] F. Nakamura, L. Lobo, R. de Freitas, T. Almeida, A. L. Machado, T. Lauschner, Participa o feminina em cursos de computa o: um estudo no instituto de computa o da universidade federal do Amazonas, in: Anais do XI Women in Information Technology, SBC, 2017.
- [18] M. Holanda, A. Araujo, P s-gradua o em computa o na universidade de bras lia: Um grande desafio na diversidade de g nero, in: Anais do XIII Women in Information Technology, SBC, 2019, pp. 169–173.
- [19] B. Freitas, Diferen as de G nero na Pesquisa e P s-Gradua o em Engenharia no Brasil, Ph.D. thesis, Disserta o de Mestrado apresentada ao Programa de P s-Gradua o em Tecnologia, Centro Federal de Educa o Tecnol gica Celso Suckow da Fonseca, CEFET/RJ, 2013.
- [20] T. Sousa, E. Silva, S. Oliveira, Perfis das estudantes dos cursos de inform tica do instituto federal de educa o, ci ncia e tecnologia de s o paulo (ifsp), campus bragan a paulista, in: Anais do XIII Women in Information Technology, SBC, 2019, pp. 144–148.
- [21] M. L. Moreira, L. Velho, P s-gradua o do instituto nacional de pesquisas espaciais numa perspectiva de g nero, cadernos pagu (2010) 279–308.