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Investigating Gender Issues in an Undergraduate Computing Program

Abstract: *It is possible to see that still today, since computing is considered a demanding and difficult science to understand, it is mostly dominated by men. This reflects the culture that considers women unfit to handle complex tasks. Also, it is possible to observe that the entry of social minorities in the area programs, such as women, is declining. This article describes a survey conducted to explore gender issues in an undergraduate course in Computer Science. The survey mapped out the path of female students to investigate their motivations, difficulties, facilities and expectations regarding the program. Based on interviews, a qualitative analysis indicated the need for actions to discuss gender issues and encourage women's participation in Computer Sciences.*
Key words: *gender, social minorities, computing, university.*

Introduction

It is not possible to deal with issues involving human technological development without considering the social

values that permeate and influence technology, as well as the opposite. Technological development and social development are closely related. It is important to note that technology is not developed without the interference of society, and the opposite is also true (LangdomWINNER, 1986).

For this reason, it is necessary to understand the relationships between technology and the various appropriations that society makes of it, as well as to understand that hierarchical and value issues are embedded in the use, development and creation, or modification of technology According to Álvaro VIEIRA PINTO (2003), it is necessary to think about technology considering aspects of the community and the society in which it is inserted. Is is also necessary to deal with those who are included in technology training environments.

In an exercise to expand the technology to values, culture and gender, it is possible to see that today, computing, being a science considered demanding and difficult to understand, is mostly dominated by men and, why not, often directed to them. We live at a time when the computing area increasingly suffers a loss of incoming students and it is possible to observe that the entry of social minorities and women is also declining.

Several research projects and class initiatives have collaborated to analyzing this phenomenon (WIT, 2012; Silvia Amélia BIM, 2011; Leanne CODER, Joshua L. ROSENBLOOM, Ronald A. ASH, Brandon R. DUPONT, 2009; IEEE, 2007; 2008; Marília Abrahão AMARAL, BIM, Clodis BOSCARIOLI, Cristiano MACIEL, 2015; Juan José RODRIGUEZ, Nadia Puchaslki KOZIEVITCH; BIM, Mariangela Gomes de Oliviera SETTI; Maria Claudia Figueiredo Pereira EMER; AMARAL, 2016) and to thinking of ways to consider feminist issues in the computing area (Shaowen BARDZELL, 2010; Jeffrey BARDZELL, 2011). The present research intends to map the path of incoming female students in an undergraduate program in Information Systems (Bacharelado em Sistemas de Informação – BSI) of a Brazilian public university, analyzing what are their motivations, difficulties, facilities and expectations with respect to both academic and professional future work.

This work aims to map the path of incoming students in the first class of the Bachelor of Information Systems (BSI) program from a Brazilian public university, analyzing what are their motivations, difficulties, facilities and expectations, both in terms of academic performance and as future professionals. To this end, interviews were conducted with the students who enrolled in this class and completed the program.

Thus, the research considers gender issues in computing, in a real context, allowing for the analysis to be focused on the social product, i.e., the ways in which the

roles are performed on the daily routine of the BSI program students.

This document is organized as follows: Section 2 presents the studies that relate gender and computing, as well as women's participation in this area; the third section deals with the scenario of the BSI program, including quantitative data on the entry, stay and performance of students in the program, especially first semester students; Section 4 deals with the steps followed to map the trajectory of the students in the program; Section 5 presents results and discussions, showing an initial view of gender issues in that program; finally, Section 6 presents some thoughts on the challenge of promoting programs in computing that enhance women's participation.

Gender and Computing

Repertoires of a gender biased culture are internalized by individuals and, in some cases, end up shaping their identities. In society in general, these alleged differences are used to rationalize the imbalance of power and the division of labor at home and in the work place.

Although gender categories are represented within the culture as a natural expression of innate sex differences (for example, women are sweet and delicate, while men are strong), they are, in fact, socially and culturally constructed, and permeate other areas, aside from biology (Janet ABATTE, 2012; Judith BUTLER, 2006; Iris Marion YOUNG, 2005). These categories of gender are not fixed, but must be constantly updated through the actions and interactions of individuals and, in the process, can be modified, enhanced, or discontinued (Janet ABBATE, 2012).

For a long time, the low percentage of women in the science field was attributed to the existing natural differences between men and women; however, the increase in female participation in certain professions shows that the source of the problem is not linked to the nature of each professional (Clevi Elena RAPKIEWICZ, 1998). Inequalities between the sexes with regard to the ability to produce knowledge are built over time, starting in the family and at school.

The separation between "boys' things" and "girls' things" occurs in childhood, when the computer is in the son's room, even if the daughter also has interest in technology (Allan FISHER and Jane MARGOLIS, 2002). This kind of separation is noticeable even in high school. Student computers, according to some researchers, are generally more used by boys and, much of the time, for electronic games. The girls end up using them only when they are really needed. Although society usually considers this kind of children's

behavior natural, it is worth remembering that in childhood the boys receive toys such as pet toys, vehicles, military toys, sports equipment and educational materials, while girls usually get toys like dolls, dollhouses and housewares from their parents (Alison NASH, 1993).

In a research conducted in a nursery school (Ellen SPERTUS, 1991), children between 3 and 5 years old were asked if they considered the computer something for a girl, something for a boy or something for both. Among the children who responded that the computer is something for girls, most were male. That means, in fact, that female children carry with them the cultural belief that technology is not something created for them since their childhood (SPERTUS, 1991).

According to another survey, conducted by ACM (Association for Computing Machinery), girls are less interested in computing than boys, largely because they associate it with typing, maths and boredom. Moreover, not only girls, but also boys, have the image that whoever studies computing is "a person passionate about computers, living and breathing the computing world in front of the computer 24 hours a day, 7 days a week" (Jane MARGOLIS and Allan FISHER, 2002).

However, although that is the image prematurely formed, in interviews to authors Jane Margolis and Allan Fisher for the preparation of the book *Unlocking the Clubhouse*, 69% of female and 32% of male Computer Science students at Carnegie Mellon University claimed they do not fit that profile. The male students interviewed confessed that they spent much of their childhood playing games on computers or learning to program, either with help from parents or through books, while the female students said they did not want to spend their free time studying. Still at the university, this difference existed: outside the classroom, male students sought to learn other things about computers, while female students wanted to devote their time to other activities.

In the same way, in a study done in France and published in "Les femmes. Contours et Caractères", it is pointed out that, concerning leisure, there are twice as many men as women using computers in their free time (RAPKIWICZ, 1998). Aside from the Geek image, the popular belief that "computing is most appropriate for men" (Alex HACHÉ, 2011) and that "women should not be so smart" (MARGOLIS and FISHER, 2002), women do not want to feel alone in the middle of a class full of men. According to a survey by digital magazine *Computer Weekly* in July 2012, 52% of the women claimed that the area of technology is less attractive to girls because of concerns about being the only girl on the team, since culturally the area of computing is predominantly male.

However, even though women are not as socially driven as men to participate in scientific and computational

activities, their family responsibilities should also be considered, since these responsibilities prevent them from traveling on business and, therefore, this factor affects their roles at work and the progression of their careers (Sue BLACK et al., 2005).

Today we live at a time when the computing area increasingly suffers the loss of incoming students and, if the inflow of social minorities and women is observed, it is also declining. Several research projects and class initiatives have collaborated to analyzing this phenomenon WIT (2012), Bim (2011), Coder, Rosenbloom, Ash, Dupont (2009), IEEE (2007; 2008) and to thinking about ways to consider feminist issues in the computing area Bardzell (2010) e Bardzell e Bardzell (2011). Thus, an investigation with BSI program students was carried out to understand the public perception about women in the computing area and then, to investigate actions to foster women's participation in this program.

Investigation Process in the BSI Program

The BSI Program began in the first half of 2009, when the number of incoming female students represented approximately 16%, but this figure did not remain constant and did not exceed this initial percentage. Until the first semester of 2014, approximately 550 students enrolled in the program and are distributed in terms of situation, as shown in **Table 1**.[1] Based on this data, it can be observed that female students represent 15.71% of the total regular students of the program and with respect to the dropout rate, from the 199 dropout students, 82.91% are male, while 17,08% are female.

[1] The picture set in Table 1 does not require a student to take more than one situation concomitantly.It is worth noting that the reference to "They changed program" and "Transfer" mention the people who left the BSI program.

The first class, registered in 2009, was composed of 48 students, nine female, accounting for 18.75%, and 39 male, representing 81.25% of the total. In the following entries, the number of female students ranged from 5% to 15%, so the first group showed the most significant number of female incoming students. For this reason, and since these students have already graduated, the focus of this analysis is going to be on this class. From nine freshmen female students in 2009, four left the program, three of them in the first period, and they dropped out or did not reach the average score in Computer Science disciplines, notably in the Programming Fundamentals I, Algorithms I and Logic for Computing disciplines. The fourth student dropped out halfway through the program. It was not an objective of this research to investigate the reasons that caused these students to drop out.

It is important to point out that among the five female students who remained, all graduated with grades above the average coefficient of their class, which is 0.6212. From the 18 male students remaining in the first group, 77.78%

Table 1 - Overall ratio of the BSI program students by situation in 2014

	Women	%	Men	%	Total
Regulars	41	14.85	235	84.78	276
Dropouts, Dropouts without studying[2], Changed program, Transfer, Stopped Out, Exchange Student Clearance	47	16.55	237	83.45	284
Total	88	15.71	472	84.28	560

[2] They gave up without attending any class.

have a coefficient above average. In addition, of the seven largest coefficients of the class, five belong to the female students.

As in other programs in Exact Sciences, the first semester is an often insurmountable obstacle (Eduardo Rosalém MARCELINO; Marta Costa ROSATELLI, 2008; Mariangela Gomes SETTI; José Carlos CIFUENTES, 2009). In the case of BSI, the disciplines that have higher failure or abandonment rates are those belonging to the area of computing, cited above, followed by Differential and Integral Calculus I.

Methodology

To map the path followed by the students in the BSI program, the following steps were taken:

- Gathering data on incoming and retention of students (male and female) of all classes in the program;
- Selection of one class of the program, considered representative, for the completion of the research;
- Gathering data on the performance of the selected class;
- Preparation of questions for conducting interviews with the students of the selected class;
- Completion of interviews with all the students of the selected class;
- Qualitative analysis of the data obtained from the interviews.

The selected class was considered representative for two reasons: having the largest number of incoming female students and including students who have completed the program of Information Systems.

The data gathering instrument used for the interview was a script whose questions were divided into four categories:

- Information before joining the program (four questions);
- Information during the program (13 questions);
- Information after finishing the program (three questions);

- Information after a year of graduation (five questions).

Altogether, 25 questions were developed, of which four were objective and the rest were subjective.

In the first category of the script questions, responses were obtained on age, public or private high school, if the female student had any contact with computing concepts in high school, and what was the reason for choosing the BSI program.

Questions relating to the second category, "during the program", were: 1) What subjects did you like to attend? For what reasons? 2) What are the most difficult subjects in the program for you? For what reasons? 3) Did you face a problem of discrimination related to gender in your program? 4) Do you think there are disciplines "more focused on girls" and disciplines "more focused on boys" in your program? Why? 5) Does your Program Conclusion Paper involve these disciplines you said you have an affinity with? In what sense? 6) Have you ever done any extracurricular activity? (Internship, research assistantship, participation in the Community Extension Programs).

In the third category, "information during the program", the questions led to reflections such as: 1) Do you already work or do you want to work in computing? 2) How do you assess the role of women working in computing? 3) How is your relationship with your work team (on internship or in registered work activities in the computing area)?

And in the final category, which aimed to collect the data after one year of graduation, the questions aimed to extract information about the performance in the labor market in the computing area, if the expectations that students had when finishing the programs are being achieved, for how long each of them is at her current work / company, how many companies have they worked for after their graduation and if they believe that there has been progress in their career during this first year after graduating.

Results and Discussions

The interviews were conducted with the five female students who graduated in the first class. The age of the participants ranges from 21 to 28. Three female students attended high school in a private institution and two in a public institution, one of which attended adult education. The students had no contact with any computing concept during high school.

It was possible to observe that the students were solicitous during the activity and that they realized the need to have more knowledge on gender issues and social minorities in computing. In addition, they also noted that, besides the

need for action that can provide the increase in female students entering the BSI program, it is necessary to develop activities so that they remain on the program until the end.

As mentioned in section four, the five female students who entered the first class of the Information Systems undergraduate program and that successfully finished it were interviewed in relation to four moments: (i) before joining the program, which was called motivation; (ii) during the program; (iii) after the program; and (iv) after one year of graduating. The following is a discussion of the answers given by these students.

Motivation

Three of the five respondents entered the BSI program before reaching the age of 18. Coincidentally, these students had attended high school in private schools. The other two students started the program at ages 19 and 24, coming from public schools, the latter having attended an adult education course.

Even though they come from schools with different profiles, none of them had contact with computing concepts in school. However, most of them were influenced by examples of people close to them who work in the computing area. The following reports express the reasons for the students to choose the Information Systems program:

> *Because of the labor market and because my husband took the course here.* – A1

> *A friend of mine had taken this course at the Federal University and since my father works with IT, he always said it was an area with plenty of opportunities in the labor market.* – A2

> *I wanted to study accounting,* […]*, then my friend said that she would study BSI,* [...] *My friend's father is a system analyst and said the market should be good. But I did not even know what it was.* – A3

It is possible to identify that the respondents were predominantly influenced by male examples. In addition, it is interesting to note that the main motivation of these students, to study BSI, was the favorable labor market.

During the program

The students were asked about the subjects they liked during the program. Contrary to what one might expect, they were most interested in computer-based disciplines. The following statements cite these disciplines:

> *Analysis and Software Engineering (I and II) are the areas that I like a lot. Programming* (Fundamentals and

> Algorithm) *was very cool, although super hard, but after it 'sank in', it was super cool.* [...] *I liked distributed systems a lot, that was the coolest subject I did.* [...] *We (me and A2) did a methodology work also in the social line, as well as in Interaction Design. And now our Program Completion Paper also follows this line.* – A1
>
> *Programming (Fundamentals and Algorithm) was very cool, although super hard, but then it 'sank in', it was super cool. I also liked distributed systems and enjoyed Interaction Design. I liked the project and leaving the classroom. I liked helping people. I have done social projects since methodology, along with A1.* – A2
>
> *It was the part of logic, graphs, discrete mathematics, theoretical computer science. This is the area that I wanted to follow, but within the company there is not much to do with it. I liked networks. What made me in stick with this program were the logical disciplines, programming fundamentals and algorithms. Here I began to see that everything has programming in it. It is very nice to see things working. And the programming logic is something out of sight. When we learn it, we can put this logic in everything.* – A3
>
> *I liked the programming disciplines the most. I get along very well with this subject. For me, it is very easy to understand and to develop the proposals. I liked Data Structure.* – A4
>
> *Calculus, discrete mathematics, economics, because they involve mathematics.* [...] *Oral and written communication, people management, marketing, computing and society, projects management, informatics law, opportunity management (this especially because of the great teacher with whom I studied the subject)* [...]. *Analysis, systems design and software engineering were the subjects with which I most identified myself from the computing specific subjects. Let's say that it would be the area I would like to follow if I was going to work with computing.* – A5

The testimonials of students A1, A2, A3 and A4 explicitly state that the programming disciplines are among the most interesting to them. All of them agree that they are difficult subjects; however, after understanding the concepts, it is the charm of the area. The discovery that it is possible to create – "It's really cool to see things working." (A3) – is a motivation to stay the program. Students A1 and A2 go beyond the interest in technology itself and realize the importance of the social responsibility that the area has, developing social projects during the program. Student A5 also demonstrates the ability to apply various concepts with which she had contact throughout the program, when reporting her interest in both

mathematics based subjects, and for more applied disciplines.

The Program Completion Papers of all the students confirm their affinity with the subjects mentioned in the statements. They could relate the issues they considered most interesting throughout the program in this final work.

In addition to the required academic activities, all students had extra experiences such as internships, scientific research, voluntary participation and community extension program.

Although having satisfactory performances during the course, the students had to face situations of gender discrimination. They signaled that such attitudes came from male faculty members and from recruitment professionals. When asked about this question (Did you face any problem of discrimination related to gender in your program?), all were unanimous in saying that gender discrimination exists and has been experienced by them, as shown in the following reports:

> *Yes.* – A1 and A2
>
> *Yes. In the internship I also had problems. In a job interview, the guy was super ignorant and the only thing he did not say was that girls cannot enter the infrastructure area. One teacher used to say that a woman does not have the ability to do this program.* – A3
>
> *Not to me directly, but in the room in general and when we entered the program we had sexist teachers who said the girls would not go ahead on the program*. – A4
>
> *There was no direct discrimination. But one day I signed up for an internship job in IT that required a driver's license. It may be a lack of self confidence, but I was sure that I would NEVER get called – a woman in IT and driving (laughing).* – A5

It is worrying to note, especially in the A5 student report, that the indirect comments made in the classroom generate lack of self-confidence in female students, even if they have a higher performance than that of the male students.

Only in the first half of 2013 there was an activity to discuss gender issues and to encourage greater participation of women in computing. One of the reports expressed the importance of this type of activity: "We were already very unmotivated and this event gave us a shake, motivated us." – A3 However, although gender discrimination was present throughout the course, no female student believes that there are subjects which focus specifically on female or male students.

Even though the students had a good performance in the program, with experience in internships, research assistantship and extension, when asked about whether the

program had met their expectations, the average of the responses was 3.6 on a scale of 1 to 5, in which 1 means it met very little of their expectations and 5 means it totally met their expectations. Regarding the motivation for the program, the average of the answers is much lower: 2.8 on the same scale (1 little motivated and 5 very motivated). It is interesting to note that in the answers to the question about the difficulties, the students say they did not face many difficulties (average 2.2). In addition, all are satisfied with the professional opportunities that the program offers (average 4).

In view of these results, it is important to investigate the reasons why the students feel little motivation even being satisfied with the professional opportunities.

After the program

Soon after the end of the course, four of the five students said they work in the computing area. One of them was not working at the moment, but reported that she would start an internship in the computing area soon.

The students were asked about the role of women in the work context. The responses concerned the communicative ability of women as a differential, as shown in the following statement, shared by three students:

> *The man communicates less than the woman, so in mixed teams the communication flows better*. – A1, A2, A3

> *In addition, the planning ability is also highlighted as a female differential: "I think we have a differential when sharing activities, because we can stop, think and better divide the activities"*. – A4

Unlike previous statements, student A5, based on her professional experience, does not perceive differences between men and women:

> *I could repeat the common statement that says that women are more communicative, organized, etc. However, in the experience I have had in internships until today, I did not feel a significant difference that shows something very different that happened because of the female influence*. – A5

Finally, the testimonial of the students on their relationship with other co-workers revealed that the experiences are positive. Most of them worked or works with predominantly male teams and have always been respected as women and as professionals. The social life, however, is sometimes compromised by the fact that women's issues are not always popular with men and vice versa.

Some female students have experience working in mixed teams and the reports are also positive. In general, the

students say there is a sense of balance in teams that have men and women.

After a year of graduation

After a year of graduation, all students are working in computing, two of them for nine months in the current company and three of them for one year at the same company. Only one of the students has worked in two companies, the others worked in a single company since their graduation.

The students were asked if their expectations regarding the labor market while BSI's students were met. Only one student said no, but she did not justify her answer. The other four students said yes, their expectations were met, and reported that they got a well-paying job.

One of them, the A5 student, said:

> I realize that every day I can align my personal and professional expectations with the area I chose to follow. The most interesting is that working with technology offers me several possibilities, several segments and this makes me more delighted every day. It depends more on the professional self-realization in this context and on identifying what goals one wants to achieve and try to achieve them.

Regarding the perception of career development in this first year after graduation, a student replied that there was no progress in her career. The others said yes, they feel they have evolved in their careers during this first year. Student A5 said: "Yes, the knowledge acquired during this year has allowed me to participate in larger projects". Another said: "I felt a self-evolution within the company from the moment I stopped being a trainee to be hired. The responsibilities increased and I feel that I correspond well to this condition".

And a third, A4, mentioned that

> Both wage developments by being formed, as well as knowledge. On knowledge, I identify: 1) the opportunity to study subjects with which I have more affinities (books, internet, research etc.); 2) The ability to work in several areas, practical knowledge; 3) Engaging with different technologies; 4) Meeting different people, which for me adds other ways of looking at the world.

Final Considerations

When talking about the lack of women in science and engineering, the differences between the two sexes are brought to the discussion. Thus, much of the research in computing that relates to women focuses on sexual difference, in particular on the differences in behavior

between men and women, or on their different interests, as for example games for girls and games for boys.

However, when there are cultural problems in science and engineering that discriminate and do not allow the manifestation of femininity, then the issue becomes related to gender. The debate needs to move from discussing sex to discussing gender. Thus, the experiences of women in the computing area should be viewed in a way that allows for the community to pay attention to gender discrimination mechanisms in general.

The reports of the female students indicate a scenario that needs to be further explored. The lack of knowledge about the computing area is still a factor that may influence the choice of women regarding the higher education they want to follow. Even though the use of computing in people's everyday life is increasingly growing, most of them do not understand the purpose of choosing a career in technology as a profession.

However, even not knowing the area, examples of people satisfied with the profession in the computing area, both male and female, influence women in the process of choosing a higher education program. In the case of the interviewed female students, almost all examples are male. It is therefore necessary to share more examples, also including women, with female students in high school and it is also important because the choice of a profession often happens very early. In 2010, for example, the model of the Computer Engineer Barbie doll was chosen by popular vote after an intense worldwide campaign representing the area of Computing (Jim ISAAK, 2010). The initiative may seem irrelevant, but it is actually a way to show girls that being a Computer Engineer, or working in the computing area, is a very interesting activity and it is not necessary to give up their femininity for this.

Research in the games area also seeks to investigate the relationship between the gender of the characters and the interest of girls in technology programs (Kara A. BEHNKE, 2012). It is possible to identify in these different initiatives that examples are powerful strategies to stimulate the interest of girls in Computer Sciences. However, most girls have no contact with IT professionals in their social and family life. Therefore, it should be a commitment of universities and companies to bring them the reports of successful experiences from people who work in the computing area.

In addition to initiatives to attract more women to computer science programs, technology and computing, it is essential that the faculty be prepared to deal with diversity in the classroom. Unfortunately, there are still unprepared and uninformed teachers, who have speeches and attitudes that

disrespect and do not value the presence and contributions of women to computing. It is necessary to keep the interest of the female students throughout the program. And for this, it is necessary that all the teaching staff be trained to deal with these differences. The students were unanimous in saying that, both in the university context and in the labor market, it is possible to experience gender discrimination situations.

The scenario mapped in this study is similar to what happens in other countries like the United Kingdom, for example. A 2008 survey shows that, even though women are a minority in education and in the labor market, they can achieve better qualifications than men (E-SKILL UK, 2008). The participants of this research also had a better performance in the program than the male students. However, they still do not feel motivated for the program, although acknowledging that the job opportunities are very interesting. Thus, it is necessary to conduct more research, in order to find ways to keep the motivation of the female students before, during and after an undergraduate degree in computing.

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