Encouraging Women to Pursue a Computer Science Career in the Context of a Third World Country

Ludymila Lobo de Aguiar Gomes
Fundação Getúlio Vargas
Manaus, Brazil
lobo.ludymila@gmail.com

José Reginaldo Hughes Carvalho
Institute of Computing
Federal University of Amazonas
Manaus, Brazil
reginaldo@icomp.ufam.edu.br

Tanara Lauschner
Institute of Computing
Federal University of Amazonas
Manaus, Brazil
tanara@icomp.ufam.edu.br

Fabiola G. Nakamura
Institute of Computing
Federal University of Amazonas
Manaus, Brazil
fabiola@icomp.ufam.edu.br

Rosiane de Freitas
Institute of Computing
Federal University of Amazonas
Manaus, Brazil
rosiane@icomp.ufam.edu.br

***Abstract*—This innovative practice full paper presents a set of engaging actions aimed to encourage women to pursue a Computer Science career in a city of a third world country (Manaus, Brazil). Despite worldwide efforts to promote gender equality, typically, women account for less than 30% of the workforce in technological areas. In third world countries, the situation is much more unbalanced. Poor educational and economic conditions, allied with a chauvinism culture contaminated by sexism and stereotypes, are strong forces that repel the young girls from IT areas. As a result, the percentage of women in local Computer Science majors is lower than expected. The authors detail a program to involve girls from all school levels in computer science career, which is indeed the adaptation of a national program, combined with indigenous elements. The mentioned adaptation was a key success factor to catch the attention of students and local educators. Some activities that are included in this program are lectures at scientific, technological and gender discussion events, realization of dynamics in schools for the dissemination of computational thinking in children and young students, training students to take part in programming contests and develop knowledge into real computational applications. These actions resulted in highlights achieved in programming contests and prizes obtained through application development, and have provided a more conducive academic environment to discuss issues related to the female gender in science and technology fields. Besides the fundamentals of the program, the authors present the results of the last three initiatives, which happened in conjunction with local events, and the promising opportunities perceived in Computer Science major of a local university.**

***Index Terms*—gender equality; diversity politics, STEM education; women inclusion and leadership.**

I. Introduction

Statistically, the percentage of women in computing-related careers are dramatically lower when compared to men. The situation is worse when one realizes that this is one of the lowest difference rates among all professions [1]. Recent studies tried to explain the different reasons for these scenarios. Some point out sexism and negativism as the main reason to repel women from technological areas [2]. Sexism, predominantly an active factor performed by their male counterpart, discourages women either to adopt or to continue in the sector. Gender-based bullying may explain the reason young girls abandon STEM (Science, Technology, Engineering, and Mathematics) careers. Negativism, on its hand, refers disfavor aspects of culture and social habits, such as childhood activities, or social expectations, that pushes the girls away from the tech area, as biological factors cannot be assigned as the cause. Based on discussions in technology blogs, Medeiros and Borges [3] indicate that negative stereotypes are a primary reason to repel women from STEM careers.

Sales at al. [4] raise another aspect that discourages freshman girls is the degree of inhibition when questioning their professors. The study's research sample found that 61% of girls felt into the much-inhibited class, in contrast to the 29% of the total sample. Furthermore, 37% of men (among all men) had any sort of previous with programming language or logic, in contrast to 17% of women (among all women). This situation contributed to a higher degree of difficulty faced by girls in the first years of computer science majors.

The lack of encouragement during girls childhood and adolescence to play with games and toys that stimulate logic and/or programming experience is also pointed out as a factor that influences this initial difficulty. A study [5] concludes that just recently, in the era of personal computers, the access to them became predominantly among men. Probably, due to the marketing that, at the time, targeted men by associating the technological universe with the male audience. The side effect of that marketing strategy was a disinterest in most women. Therefore, this study also indicates that the absence of any technological background prior to the computer science major was a detrimental factor.

The literature proposes several approaches to address the gender imbalance in the computer science career [6]. Examples of initiatives may be found in Academia, Industry and

978-1-5386-1174-6/18/$31.00 ©2018 IEEE

Government institutions [1]. The vast and open discussions about the gender equality subject, aligned with the definition of policies to counterbalance the scenarios, are part of the existing initiatives [2].

The contribution of this paper is twofold. Firstly, the authors presented a new program aimed to promote the inclusion of women in computer-related careers. Secondly, the work details the realization and results of a set of engaging activities contextualized to the reality of a third world country. The authors believe that both combined define a sound strategy to others scenarios.

The remainder of this paper is organized as follows. Section II overviews of the theory of student involvement in general, and a few initiatives of women engagement. The proposed program is described in Section III, while Section IV details its implementation. Section IV discusses the results and future actions. Finally, Section V concludes the paper.

II. Engaging Programs Background

This section presents the educational theories and similar initiatives that supported the proposed program.

A. Engaging Activities Fundamentals

Austin, in [7], developed his Student Involvement Theory stating that "it directs attention away from subject matter and technique and toward the motivation and behavior of the student". Tinto [8] mentions five aspects that might be addressed by an education institution to increase the success rate of students, with particular attention to the aspect of strong involvement in a variety of learning activities. In [9] the authors defined the concept of Vortexes as a cyclic activity interconnected with others vortexes to promote the engagement of numerous students.

These three works, although directed to higher education, have in common the principle that students' engagement is achieved, or rather, induced, by a set of interconnected activities. This same principle is applied in the present work, where the involvement of female youth in computer science and related careers is addressed by a collection of interconnected activities, detailed in Section III.

B. Related Initiatives

It is notorious, a worldwide movement to attract women's attention to STEM areas. Both industry, academic works and studies try to explain the unbalanced presence of men and women on these fields of work. The main Scientific Societies created sectors or chapters with the objective of promoting actions to deal with these scenarios. Examples include the ACM-W (ACMW supporting, celebrating and advocating for Women in Computing) [10], IEEE-W (IEEE Women in Engineering (WIE)) [11] e NCWIT (National Center for Women Information Technology) [12]. The most important scientific conference specially created around this subject is the Grace Hopper Celebration of Women in Computing [13].

Brazilian Computing Society (SBC) created the "Meninas Digitais" (Digital Girls, in free translation) program [14]. The program has the objective to promote the Computer related careers among the elementary to high school students, focusing on motivating girls to pursue a computer-related major. This program is responsible for several activities and projects, including Meninas Digitais, the project, MD-MT and elas++ [14]. The SBC also created the Women In Technology (WIT) as part of its most important anual conference. It is relevant to notice that SBC-WIT is today the most prominent STEM conference in the theme of gender equality in Brazil and is in its twelfth edition.

For the Latin American, one has the Latin American Women in Computing Congress (LAWCC), a satellite event of CLEI (the Latin American Computing Conference). Although recently created, LAWCC growths at each new edition.

III. The Proposed Engaging Program

The Cunhantã Digital Program encourages in Amazonas this growing worldwide movement involving actions for greater involvement of women in science and technology areas. The program, based on its countrywide counterpart Meninas Digitais (Section II.B), was a consequence of successful activities of engaging women in the North region of Brazil like Scientific and technological programming contests, mobile application development, or participation in the SciTechGirls project [15]. To promote a positive brand association among the Amazonians, strongly influenced by indigenous culture, the authors changed the word Meninas by Cunhantã, the word for girl in Tupi, a Brazilian indigenous language. Besides the name, visual materials also incorporate indigenous aspects. It is interesting to recall that the history of the Amazon region is intrinsically attached to the women influence. The Spanish explorer Francisco de Orellana reported his combat against a tribe of women warriors, naming the river as the River of the Amazon (as in the Greek mythology). Figure 1 shows the Cunhantã Digital (top) and Meninas Digitais (bottom) logos.

Fig. 1. Cunhantã Digital (top) and Meninas Digitais (bottom) logos.

Three types of outreach and awareness actions following the principle of involving activities are found the present program:

a) Short term motivational action: Aiming to reach numerous youth students and their educators, either in specific events or opportunistically using time slots in other events. Examples of this class of actions are:

- Promoting events with a focus on science and technology;
- Realizing events for educators, in the theme of gender;

- Promoting lectures by coordinators and students who are part of Cunhantã Digital, to publicize the actions and invite new students to participate;
- Supporting other local initiatives that also aim to encourage women in technological areas;
- Organizing informal meetings and meetups, open to the public, for conversations on gender issues.

b) Medium-term qualification action: To address the issue of lack of qualification, which is one of the social barriers that affect particularly women. The purpose of this action is to provide to the participants a skill on technology subjects. Example of this action includes:

- Organization of workshops and lectures in elementary and middle schools;
- Encouragement and preparation of students to participate in scientific and technological competitions (hackathons);
- Organization of groups of study about Computing courses with female students;
- Supporting students, including psychological assistance.

c) Continuous evangelization action: A common term to promote new technologies, the word evangelization has its root on the concept of good news. These actions have the objective to spread the word to parents, educators and the whole society that computer-related careers are very well suited to the women. Examples of these actions are:

- Dissemination of relevant information to women related to technology, such as news of scientific projects, businesses led by women or other prizes and achievements made by women in the scientific and technological field;
- Collection and analysis of data related to the participation of women in technology;
- Dissemination of technical information on these gender studies in scientific papers and conferences;
- Dissemination of the program and its principles and actions in various media vehicles, including social networks, television, newspapers, and radio.

Figure 2 summarizes the impact of each action class in promoting the engagement of women in computer science careers. They are classified into duration (short term, medium/long terms or continuous), size of the reached audience (small, medium, large), depth of technical information (little, some, much, none):

Type	Duration	Reach	Depth
(a)	short	medium	little
(b)	medium/large	small	some/much
(c)	continuous	large	depends

Fig. 2. The action class roles in promoting the engagement of women in computer science careers..

IV. Engagement Program Realization

This section details the actions realized in the course of two years, starting from the launching event:

A. Workshop Cunhantã Digital

The Cunhantã Digital Workshop had its first edition on August 21, 2015, whose objectives were to stimulate the participation of women from the Amazon region in areas of science and technology, to promote interaction between professional women and students, and stimulate the entry of women into undergraduate courses and careers. The event was held in Manaus. More than 200 people participated, mostly women students or professionals, representing 78% of the total. Men were also welcome in the event, who sought to find out more about this feminine problem and discuss gender issues in academia and companies. There were talks given by invited researchers, group dynamics, presentation of applications and cases of success of some outstanding students, and also a debate involving women from diverse segments, such as politics, industry, and academia.

B. I Fórum Cunhantã Digital

Based on the success of the Workshop, the 1st Forum was held from January 25 to 29, 2016, aimed at educators, to discuss and plan actions of activities to be carried out in elementary schools and secondary education, as well as university courses. The event had 174 participants, including educators from the state and municipal educational network, from the main universities of the capital Manaus, and from some other municipalities in Amazonas, such as Itacoatiara, Parintins, Benjamin Constant and Coari. It also had the presence of the Superintendent of a city's autarchy, the highest body for the management of the policies and incentives of the state's Industrial Complex, which demonstrates the prestige achieved by the Cunhantã Digital movement and its potential for strengthening of its actions.

C. Arduino Day

On March 31, 2018, in partnership with Makers Manaus and PyLadies, Cunhantã Digital held programming workshops for about 400 participants in Manaus. In this practical approach, members of Cunhantã Digital and PyLadies prepared activities for teaching Computer programming, and other 8 practical workshops related to Arduino platform, and others 14 lectures. The topics covered involved introductory classes, demonstration of Arduino projects and advanced and beginner tutorials, including tools for housing automation, digital games, machine learning, robotics and artificial intelligence.

D. International Women's Day at Icomp-UFAM

On March 8, 2018, to celebrate International Women's Day, Cunhantã Digital promoted a panel of messages, where students of Institute of Computing at UFAM (Federal University of Amazonas) could leave messages of encouragement for women, students, professors or other collaborators. A moderator coordinated the activity. It was also held an activity with the classes of freshmen of the courses of Computer Science, Computer Engineering and Software Engineering, totalizing 145 students, where 17% are women. Also, it was held a contest involving cryptography, where winners received prizes, but each girl received a toast to help with graduation.

E. BEPECO: Computing for Children

On November 18th, 2017, in partnership with Federal University of Amazonas, State University of Amazonas, UFAM Computing Extension Program (Pet Computação), Pense & Prog, Kodkós, SEJEL (Secretaria de Estado da Juventude, Esporte e Lazer), Prefecture of Manaus and SEDUC (Secretaria de Estado de Educação e Qualidade de Ensino) Cunhantã Digital held and event called BEPECO - Brincando de Pensamento Computacional (Playing with Computational Thinking, in free translation), holding activities for children from 4 to 17 years old. The event was held at UFAM Institute of Computing, and the activities were carried out to initiate logic and programming for children, including Scratch workshops, helping on how to building robots, creating digital drawings and a competition that involves physical activities and logical reasoning.

F. Google Women Techday

Google Women Techday is an event with speeches related to technology and entrepreneurship, in which 100% of the speakers were women. It also had practical programming workshops and panels with the themes "Women leading Communities" and "Women leading Business". In partnership with the Google Developer Group of the city, Cunhantã Digital assisted the event with development and design activities for the official website, with marketing activities to publicize the event and other activities related to the organization of the event, which had taken place on April 28, 2018, and had 400 subscribers, of which 67% were women. The alumni Ludymila Lobo was one of the organizers. The program's coordinator Rosiane de Freitas has participated as a speaker at the panel "Women leading Communities".

V. Results and Future Initiatives

Despite the short creation time, there have been some cases of success involving students participating in projects and actions of the Cunhantã Digital, including.

In The 2015 ACM-ICPC South America/Brazil programming contest, promoted by SBC and worldwide by ACM-ICPC [16] [17], a team from the Institute of Computing (IComp) of UFAM (Federal University of Amazonas), qualified for the Brazilian finals of the competition. And, being the best performance among the 08 (eight) teams formed only by women, in a total of more than 600 teams (with a great predominance of men). Also, some students individually excelled in various competitions and scientific events. The event featured three (3) unique editions of the International Women's Hackathon sponsored by Microsoft Research [18] between 2013 and 2014, culminating in the development of feminine applications: Mommy's BeneFIT, Make UPhi, What the Hack and How To Help.

In 2017, the students participating in Startup Weekend Women Manaus were awarded the 2nd place, developing the Tips Now application, to recommend gifts based on each user's profile. In the same year, the student Ludymila Lobo was selected to participate in Globo Hackathon, having been one of the 52 people chosen for the competition at national level. The selection criteria involved the professional curriculum, the portfolio of developed projects and telephone interviews.

As future initiatives, to develop the computational thinking, we intend to disseminate the maker culture, in three cities from northern Brazil. This action will define a new level of the proposed program, as it will build real chances for youth to evolve their lives with new opportunities in cities with few options of economic development, having one of the lowest human development index in Brazil. For this change, it is essential to involve the whole community: students, teachers and parents. Program researchers and students intend to enroll teachers, technicians and managers of 3 Integral-time public schools in the technical and vocational training courses along with 90 students. All students will be awarded with a Junior Science Initiation Scholarship. Basically, everyone will be immersed in a Maker Culture dynamic. The goal is to use this experience as a pilot to test and adjust the concept, program and methodology to spread to many others cities of Amazonas.

VI. Conclusions

The Cunhantã Digital Program has been very well-received by the Amazon community. A very positive impact has already been observed, involving educators, professionals and students around the theme of increasing female participation in courses and professions in the areas of science and technology, with special emphasis on the areas of Computing.

A channel of interaction between educators and program promoters and young students interested in the movement (mostly women, but also many men) has been maintained via Facebook social network [19].

As activities in progress, programming competitions have been held and actions involving the development of applications have been promoted [15]. As a next step, it is planned to hold the II Workshop and II Forum of the Cunhantã Digital program, as well as the realization of a cycle of lectures to be taught by university students and professionals in the area in secondary and elementary schools. There was also an invitation for the program to be presented at 7th Feira Norte do Estudante (North

Student Fair, in free translation), which usually receives more than ten thousand students from elementary and middle school, where students are given a chance to get to know the course they wish to choose, and where this is expected to motivate girls students to learn more about courses and careers of Computing and related areas, collaborating to increase the enrollment of girls in university courses in these areas. Those events were really useful for: i) Increasing our audience, making the brand Cunhanta Digital more popular among the community, which makes it more probable to be remembered and invited to other events and speeches; ii) Learning more about our audience, by collecting feedback and knowing how we can improve in the next events; iii) Generating more role models when students and alumni are in the spotlight of big events and competitions.

ACKNOWLEDGMENT

We thank our colleagues from the State University of Amazonas, who always helped to put in practice the actions organized by Cunhantã Digital movement.

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