From Subject of Change to Agent of Change — Women and IT in Brazil

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ABSTRACT
Brazil has one of South America's largest information technology (IT) communities. One hundred million people voted electronically for President and congress in 2004, and 97 percent of all income tax declarations are submitted via the Internet. Over 20,000 students graduate every year in computer science alone, and two of the federal government's four industrial priorities are related to IT — software and semiconductors. Though women represent 60 percent of the country's college graduates, less than 5 percent choose Computer Science as a major. Programs to foster gender equality have little intersection with the national digital inclusion program. This paper points out actions that may be considered to allow Brazilian women to become full citizens of the information society. These actions concern formal and informal means of education, and on visibility and advocacy.

Categories and Subject Descriptors
K.4.2 [**Computers and Society**]: Social Issues

General Terms
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IT, women, Brazil

1. INTRODUCTION
Brazil is a country of contrasts, ranging from geophysical to socio-cultural aspects. In winter, snow in the South coexists with the equatorial Amazon rainforest in the North. The same kinds of contrasts apply to its inhabitants, socially and technologically: they range from the very rich to the very poor, from the educated to the illiterate, from those who have access to state-of-the-art IT facilities to people who live in far-off villages without electricity. Nevertheless, in spite of being the fifth largest country in the world in surface, all of its 180 million inhabitants are united by a single language — Portuguese. This is a major facilitator in conducting education initiatives and in organizing social programs.

Given the wide scope of socioeconomic profiles, generalizations are dangerous. Any analysis of women and IT in Brazil has to keep these contrasts in mind. At a first glance, the scenario is not so favorable. Indeed, as in almost every other country in the world, the number of computer science (CS) women graduates is decreasing. Girls seem to be shunning training in this technology, favoring other domains, e.g., social and biological sciences. Statistics and overall observations show a widening of the gender divide in IT enrollment and job distribution.

On the other hand, if one considers in isolation the progress of Brazilian IT and that of women in Brazil, the situation is positive. The lot of women has improved continuously in terms of job offers, access to education, changes in legislation and equality of rights. At the same time, the country has progressed considerably in all aspects concerning IT, and is considered to be one of the world's leaders in many such aspects, such as systems for banking automation or electronic vote processes. A study published in 2005 [13], using the same methodology of the National Survey of Information Technology in U.S. Higher Education, shows that there is just a three-year IT gap between North American and Brazilian universities. Thus, conditions for de facto empowerment exist, but actions must be taken to achieve it.

According to Abbath and Ireland [2], women's empowerment is interpreted in different ways in the literature. For some, it constitutes a process of social mobilization around concerns such as divorce or property, while for others it refers to a change in women's state of mind. This paper uses the notion of emancipation in this second context. Liberty and equality awarded by law must be followed by liberty to participate in decisions at all levels — and this requires building a new mentality and a change in image.

This paper discusses some of these issues, and suggests directions that may be taken to change the scenario in the long term. These directions stress the importance of formal and informal education, not only for young women but also their families and teachers, and the role of the pervasiveness of radio and TV in Brazilian homes in helping to bring about this change.

The rest of this paper is organized as follows. Section 2 gives a brief historical background of the education of women in Brazil. Section 3 presents recent studies and statistics concerning Brazilian women in the sciences and IT. Section 4 uses the two

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preceding sections as the basis to propose actions to be taken. Section 5 concludes the paper.

2. BRIEF HISTORICAL BACKGROUND

This section discusses the evolution of the education of women in Brazil, which helps to understand the present situation concerning their participation in the Information Society. Though kept from formal schooling for almost 300 years, already in the first half of the 20th century Brazilian women had gained an impressive set of rights, ahead of many European and Latin American countries, recovering lost ground.

Brazil was officially discovered by the Portuguese in 1500. According to the Post Office History Service, the first woman to be taught to read in Brazil was Madalena Caramuru[1], the daughter of a Portuguese adventurer and a native Brazilian of the Tupinambá tribe — one of the most widespread Indian nations in the country at the time. Tupinambás did not accept the fact that men and women should be educated differently, and were perhaps at the origin of the first women's rights movement in Brazil, demanding, in the mid-16th century, equal instruction for women and men. The Jesuits, responsible for the first schools, thought this was "a very original idea," and tried to obtain permission from the Portuguese court to create alphabetization courses for women. This request was denied — by a woman, the Portuguese queen at the time — who considered this a dangerous precedent. What would have happened had she agreed? One can only wonder, but for almost 250 years afterwards women were denied formal education.

Nevertheless, one must remember that illiteracy was the norm among men as well. Any discussion of early education initiatives in Brazil must take into account the fact that the country was a colony of Portugal until 1822, and that, up to 1808, the establishment of colleges was forbidden by law. Anyone who wanted to go to a university had to cross the Atlantic to study in Portugal. Obviously, only the very rich could afford such a trip, and furthermore just men were sent abroad[2]. Education was (if at all) conducted at home, though boys were allowed to frequent schools founded by religious orders.

The year 1808 is a turning point in Brazilian history. The Portuguese court moved to Brazil, fleeing the Napoleonic invasion of Europe. It was only then that higher education institutions were permitted, e.g., the first school of medicine, in 1808. This late beginning must be contrasted with the Spanish and British colonies in the Americas, where universities were implanted as early as the 16th century (in San Domingo in 1538, and in Peru in 1551).

Given this scenario, one can consider it as a victory that the first Brazilian public elementary schools for women appeared in 1827 (5 years after independence from Portugal, though 260 years after the Tupinambá request), and that teachers colleges that accepted women students were created in 1867. On the other hand, women had to wait until 1884 to be accepted to study medicine in a university. The first woman doctor graduated in 1888.

[1] There are records of her writing letters in 1561.

[2] For instance, only 112 Brazilians graduated from the Medicine School of Coimbra (Portugal) in the entire 18th century!

Notwithstanding these limited education opportunities, a few pioneers should be mentioned. The first Brazilian text to appear on the rights of women to instruction and work was written by Dionísia Augusta (1810-1875), who under the pseudonym Nísia Floresta became one of Brazil's early feminists. This text was inspired by Mary Wollestonecraft's "A Vindication of the Rights of Women," adapting it to the Brazilian scenario. The first edition, written in 1832 when the author was only 22, was symptomatically entitled "On the Rights of Women and the Injustice of Men," and is considered by many to be the founding text of Brazilian feminism. Up until 1839 it was to see three editions in different Brazilian cities, thousands of miles apart.

Though artistic endeavors were not frowned upon, women painters and sculptors were only allowed in the Brazilian Academy of Arts in 1892, provided they frequented separate classrooms. However, Academy buildings were not prepared for such segregation, and thus women refrained from registering for co-ed courses that involved nude models [18]. Musicians fared even worse, as witnessed by the pioneer composer Chiquinha Gonzaga (1847-1935), whose life is a constant fight against ethnic and gender discrimination. She was behind the first copyright legislation to protect music and literary work in Brazil, in the beginning of the 20th century.

As mentioned by Castro [5], the country's economy had a remarkable development in the 20th century, while education, though improving very rapidly, did not do so at the same pace. With the end of the First World War, nevertheless, things started to change and emancipation movements prospered in all the major cities. Women poets, painters, musicians and sculptors became socially acceptable, as well as biologists, doctors and lawyers. The first two women engineers graduated in 1919, and already in 1924, there was a woman professor in an engineering school.

Among the early 20th century pioneers one must single out the name of Bertha Lutz (1894-1976). Having gone to France to study biology, she returned to Brazil to found the basis of national feminism, organizing the first feminist conference in 1919. Though a successful scientist, she decided to study law. She became a lawyer at the age of 40 to help the fight for women's rights. She was the first woman to be allowed employment in the public service (in 1919, at the National Museum), and helped write the draft for the Brazilian Constitutional revision of 1932 (prepared by a committee of 23 people, two of whom were women).

This new constitution decreed, among other things, that women and men should receive the same salary for equivalent work, and that pregnant women could not be fired because of their pregnancy. Also thanks to this constitution, women acquired the right to vote in 1932, before many other countries in Latin America and Europe (e.g., France in 1944). The first congresswoman (a medical doctor) was elected in 1933. The eldest woman who then registered to vote was 99 years old, and lived in a small village in the Brazilian hinterland. This is remarkable not only because of her age, but also because it indicates that the need for participation and emancipation was not restricted to large urban settlements.

In spite of this early start, between 1933 and 2003, only 143 women were elected for the national congress, as opposed to 6619 men. Nowadays, political parties must include at least 30 percent

women as candidates in any election, but women electors (the majority in the country) still seem to prefer voting for men — only eight percent of the 594 seats in congress are occupied by women.

3. THE PRESENT SITUATION

In the first decade of the 21st century, if one looks at the participation of women in Brazilian education and economy, it is hard to recognize the social and cultural conditioning of the past. The liberation movement of the sixties took force in Brazil in the seventies, with changes in law, and, even more important, gradually modifying the image of women and their role in society. Nowadays, in a population of almost 180 million people, of whom 51 percent are women, they constitute 43 percent of the country's workforce (as compared with only 32 percent in the seventies). However, only 9 percent of the CEOs of Brazil's 500 top revenue companies are women. Furthermore, their presence in the IT student population (and thus in the job market) is slowly decreasing.

The scenario of diminishing participation of women in IT is repeated all over the world, but in Brazil there are some puzzling differences. First, the percentage of women university graduates is increasing every year, and now surpasses the percentage of men. In many scientific fields, especially in biology-related ones, there are more women graduates. Hence, one can no longer detect the cultural barriers erected in the past. Second, Brazil stands favorably in comparison with several IT-sophisticated countries (such as the U.S., Germany or Canada) in terms of percentage of women in university faculty, and more specifically faculty of CS graduate courses. Thus, there exist role models to follow. Finally, the government has been promoting for some time several initiatives to decrease the gender divide, though directed to social issues, in particular health and safety.

This section gives an overview of the present education situation of women and IT in Brazil, backing up these remarks with statistics and data, trying to answer two questions:

1. What is the scenario of the education of women, and their participation in IT research and development?
2. What government initiatives in IT can be taken advantage of?

3.1 Education of Women and IT

The situation of the education of women in Brazil is extremely positive. A report published in 2005 by the ministry of Education [10] (based on the 2003 education census) shows that from 1996 to 2004, there was an increase of 102 percent in the number of women who chose to pursue academic careers (compared to an increase of 67.9 percent in the number of men). By the same token, while in 1996 there were 8.5 percent more women enrolled in universities than men, in 2003 there were 12.8 percent more women.

Following the same trends, 97 percent of all children between ages 7 and 14 are in school, with girls being the majority from high school onwards. In average, women study more than men (7 years, against 6.8 years for men). Moreover, 57 percent of the roughly 3.8 million to enter the university every year are women. Due to the higher drop-out rate among males, women comprise 61 percent of university graduates.

Many other indicators are equally positive. Women teachers are prevalent in elementary and secondary education: 43 percent of the country's 270,000 university teachers and 35 percent of all graduate course teachers are female. The number of women enrolled in science and engineering courses has also risen in the last 20 years. For instance, they are already the majority in mathematics, medicine and biology [10]. For example, in medical courses there are two women for every man. In some engineering branches (e.g., chemical or food engineering), they are approximately 40 percent of the students.

Partially responsible for this trend is the positive outlook the population has concerning the social benefits of science. A study on the public's perception of science conducted in four countries — Brazil, Argentina, Uruguay and Spain — shows that Brazilians as a whole have a more positive attitude than the other nationalities towards the benefits of science and technology, and the merits of pursuing scientific careers [25]. Thus, participation in science is seen as positive.

A census conducted by CNPq (the Brazilian National Research Council; see www.cnpq.br) in 2004 shows moreover that women have already surpassed men among the young researchers (53 percent women among those aged 24-30). This proportion, however, changes with age — there are 45.9 percent women in the age group 35-54, and 30 percent in the group aged 55-64. This seems to indicate that younger generations are bridging the gender divide. Seven out of CNPq's nine National Young Scientist Awards in 2003 and all of CNPq's six national scientific awards for graduate and undergraduate students in 2004 went to women.

However, as in several other countries, the largest concentration of women scientists occurs in the social sciences and in the so-called "soft" areas such as nutrition, psychology or medicine, whereas men predominate in "hard" areas, especially mechanical or electrical engineering (73 percent male students).

What is, however, the situation in IT? In this area, Brazil has a different situation from other countries. The number of women enrolled is decreasing, as everywhere else, contrasting with the fact that the first programmers were women [3]. However, unlike other countries, there has been no decrease in the number of students enrolled in CS or engineering courses. Recent studies such as reports from UCLA's Higher Education Research Institute show that the numbers for U.S. student enrollment in engineering and in computer science are dropping. According to Vegso [23], "the percentage of incoming undergraduates indicating that they would major in CS declined by over 60 percent between the fall of 2000 and 2004, and is now 70 percent lower than its peak in the early 1980s."

The U.S. National Science Board has stressed there is a decrease in the number of those pursuing careers in science and engineering, whereas the number of jobs that demands qualification in these areas is increasing. This has in turn prompted several campaigns in major U.S. universities to encourage young people to consider IT and engineering careers. Moreover, since statistical studies in the U.S. show that these areas are "predominantly white male" [23], several of these campaigns are now considering affirmative action efforts to attract women. Thus, the drop of interest in student enrollment has had the positive side effect of spurring an increase in gender equity educational efforts.

In Brazil, enrollments in CS are stable. The local software industry is expanding considerably (e.g., 7 percent growth alone between 2003 and 2004 [20]). Thus, there is market demand for CS graduates, not only for outsourcing, as in many other countries, but also to support the national software industry. This demand has been answered by an increase in the number of courses. As in other countries, female participation is decreasing. In the eighties it was common to see 30 to 40 percent of women enrolled in undergraduate CS courses. Twenty years later, though there are ten times more CS courses and almost 50 times more students enrolled than in the eighties, there has been a marked decrease in female participation[3].

A similar phenomenon is seen at the graduate level. Women faculty in CS graduate programs have reached an average of 20 percent, a very positive number, reflecting the relatively high proportion of undergraduates at the end of the eighties. Moreover, female Ph.D. CS students are also relatively well represented, corresponding to an average of 20 percent of the country's CS Ph.D. students. However, the number of female candidates for Ph.D. degrees has been dropping, a byproduct of the decline of interest at the undergraduate level.

Though perceiving a demand for more qualified personnel in IT, the government has not yet seen the need for articulating initiatives for women in such programs. The Brazilian Academy of Sciences and several scientific societies are actively promoting the involvement of children in scientific activities to attract them earlier to these careers. As a consequence, many budding initiatives have appeared since 2003, such as science summer camps and new teaching projects. Nevertheless, the emphasis is on fundamental sciences (e.g., physics and mathematics) and the role of IT is not being stressed other than providing infrastructure or educational software. In other words, the need for early engagement in IT is not mentioned.

Given all these dry numerical facts on enrollments and trends, what kind of qualitative analyses can be made for the Brazilian IT gender divide? Here, it must be stressed that the first women's studies program was created in 1980 in Rio de Janeiro [21], with other centers appearing since. In 1991, the Rio center promoted a meeting to analyze the situation of women in the sciences. This meeting discussed several issues, such as discrimination aspects due to predominantly masculine institutional structures and lack of programs to stimulate the inclusion of women. Four major topics were debated by working groups.

The first question concerned the relatively small percentage of Brazilian women in the sciences. The reasons pointed out were lack of knowledge about the importance of science and lack of role models. Here, one must go back to the CNPq census mentioned earlier in this paper that shows that since then, there has been an increase of women among the young generation of researchers.

[3] In 2003, there were 650 courses offering CS-related undergraduate degrees (roughly 4.6 percent of the total number of courses in the country), 100,000 students enrolled (2.5 percent of country total) and 20,000 graduates (4 percent of the year's total).

The second issue concerned mechanisms to stimulate women to pursue scientific careers. Recommendations included the use of means of communication and emphasizing education at the elementary school level, teaching science early in life. The third working group considered difficulties in these careers, divided into external and internal factors. External complicating factors included the rigidity of the scientific community, allied to the discrimination suffered since colonial times (see section 2), that imposed the view of the superiority of men. It was pointed out, for instance, that women have to wait longer than men to be elected to the Brazilian Academy of Sciences, where men predominate. Internal difficulties included the fact that in Brazil, women have been conditioned by centuries of cultural conditioning to be responsible for taking care of the family. This is complicated by the lack of support infrastructure to working women. Furthermore, self-discrimination was also cited as an internal obstacle.

Finally, the last group discussed personal difficulties at home. Some of the difficulties mentioned were competition with the husband when both were scientists. Also, it was noted that often single women scientists at higher echelons discriminate against married colleagues.

Another study reported by Tabak [21] found that high school girls in Rio in 1994/1995 tended to choose "feminine" careers (e.g., in social sciences). Other testimonies of successful women scientists differed in their experiences and the factors that influenced their careers. Most acknowledge the influence of parents, and sometimes spouses [21]. Some say they are victims of the gender divide, while others, though acknowledging that women in science and engineering are a minority group, state that they do not feel women scientists are discriminated against in Brazil [27].

Last but not least, Brazil has a special ministry dedicated to women (Secretaria Especial de Políticas para as Mulheres - Special Secretariat for Policies for Women, SEPM, http://www.presidencia.gov.br/spmulheres/). Given all the problems faced by women, most actions of this ministry concentrate in social and health initiatives. However, due to the growing concern in the scientific community about the need for more women in science, this ministry has allied itself with the ministries of Education and Science and Technology to announce funding for projects to encourage studies about the participation of women in the sciences. The request for proposals for these projects was launched in July 2005.

3.2 Government IT Initiatives

Is the Brazilian IT scenario favorable to women? IT education, research and development have been considered strategic in Brazil since the mid-sixties. The first CS graduate course appeared in 1968, the first undergraduate course in 1969, and both had women teachers at an early stage. The telecommunications and the CS areas evolved separately, under distinct national policies that nevertheless prioritized the development of national know-how. In telecommunications, special attention and care were paid to the implementation of infrastructure and to the creation of a national telecommunications research center, a very successful initiative that led to the generation of various technologies, especially in fiber optics and commutation.

The privatization at the end of the nineties prompted the emergence of several new services, especially in the area of wireless technology. This has created an expanding job market in IT, with several startups developing software to be run on cell phones (e.g., utilities, games). In particular, the e-entertainment industry is attracting hundreds of young graduates. This is a positive factor, since computer games have been one of the means to attract youngsters to computer science. However, most games are directed towards masculine audiences. Not only does this present a well known deterrent for girls who might be otherwise interested in IT, but in the long run it keeps them away from this booming job market.

In computer science, the national policy was to create a strong national industry. For almost 20 years, there was a multiplication of firms to manufacture equipment and software – first minicomputers in the seventies/eighties and then PCs from the mid-eighties onwards. The protection and growth of the local industry was enforced by government control over importation of computer goods and services. One main financing source was banks. An unexpected byproduct was the early national effort in banking automation, which in the beginning of the 21st century has made the country third in the world in Internet banking.

Government industrial policies generated great demand for IT experts, and thus creation of many CS courses. In the eighties, women's enrollment climbed to 40 percent in the better universities. As a consequence, the percentage of women in related jobs was also relatively high. The closed national market was opened in the nineties. At the same time, all levels of the Brazilian government (municipal, state, federal) created a series of initiatives in IT because of its longstanding recognition of the importance of IT literacy and its role in fostering the progress of a country. Its innovative programs involved funding for education, increase in the interaction between university and enterprises and support for small enterprises.

As mentioned by Takahashi [22], one of these initiatives, the National Research Network (RNP) played a crucial role, setting up Internet services for academia and especially assembling a model for open Internet services in the country. Because of this, by 2000 Brazil was already the 12th country in the world in terms of registered Internet domains, and around 37 percent of its GNP passed through electronic transactions. Official IT programs have boosted the country's software production and created a large market for these products in the country itself. This contrasts with the situation of countries cited together with Brazil when one talks about IT growth and manpower, India and China, where the emphasis has been on outsourcing [24]. Furthermore, in 2003 the federal government defined that two out of its four industrial priorities were to be directly related to IT — software and semiconductors.

A consequence of these programs and actions has been a shortage of people trained in highly specialized fields. This prompted initiatives to attract more people to CS careers. Education efforts have resulted in considerable funding being allotted to e-learning and distance education. Government support of free software development has also spurred interest in the young generation — 97 percent of the developers are aged 19 to 22. Symptomatically, 89 percent of free software users are males [19].

A special initiative of the Ministry of Science and Technology in 1999 was the institution of a task force of over 150 experts to analyze and propose directions to boost the Information Society Program in Brazil, whose results appeared in the Brazilian Information Society Initiative's so-called Green Book [22]. The Book covers a wide range of subjects, discussing the need for policies and programs to make all Brazilians full citizens of the information society. Among its directions, four can be singled out since they reflect major goals as well as the experts' perception of IT priorities:

- The need for digital alphabetization at all levels, via curriculum updates for all areas, not only CS;
- The need to educate experts to fill the demands of the IT market, but also those of areas such as health or transportation, where more than a superficial IT knowledge is needed;
- The need to create computer networks linking schools to exploit distance learning;
- The need to promote the creation of virtual laboratories for multidisciplinary research, supporting the work of experts who are geographically dispersed.

These goals are discussed at length in the Green Book, which suggests several actions to attain them. However, out of 195 pages, only a few paragraphs mention the need to include minorities, among whom women are mentioned. This shows an awareness of the problem, but does not place it in its proper perspective.

4. PROPOSED ACTIONS

Digital inclusion has become a major concern in the country, where a large portion of the population is still IT-illiterate. Thus, any mention of an "IT gender divide" meets with little resonance, since the country is worried about the IT divide itself, regardless of gender. Moreover, as shown in the previous section, there was remarkable progress for Brazilian women in the 20th century in terms of education, social standing and overall status. Scientific careers are desirable, and there is no lack of IT job opportunities. In spite of the progress attained, there are still differences felt at several levels concerning employment and placement opportunities. If the IT divide affects men, it should affect women even more, since they are historically and socially the "weaker link." These reasonable assumptions need more statistical studies.

Thus, effective initiatives must be preceded by comprehensive studies on the participation of women in IT. As mentioned in section 3.1, it was only in 2005 that the government launched an official call for projects to elicit reliable data concerning the participation of women in the sciences. There is, furthermore, a dearth of studies on education of women in IT, and most information on such issues must be mined from the general education census such as the ones reported in INEP [10] or Litto [13]. These studies, however, do not present any fine-grained distinction that would allow focused initiatives.

By the same token, it must be stressed that the data reported in this paper originate in a study conducted by the author that was restricted to CS departments and courses. Other IT-related careers (e.g., in telecommunications or some branches of electrical engineering) were not considered in this study, since in most cases available data are grouped under the "engineering" label,

without the necessary refinement. Moreover, many universities and colleges have CS-related courses but do not offer CS degrees and therefore could not be included, for lack of information. Such is the case, for instance, with mechanical engineering departments that specialize in robotics, or electrical engineering research groups that work in microelectronics or signal processing. Degrees offered in these cases receive the label "Mechanical (or Electrical) Engineering," and thus it is impossible to detect, from census reports, the closeness of their relationships with IT. This alone shows that there is a need for a more comprehensive view of the Brazilian IT student population.

Thus, an important action recommended here is the **need for a comprehensive country-wide census** on women in IT. Moreover, numbers are useless without appropriate contextualization. Therefore, this census must come together with a **survey on the perceptions surrounding the problem**. As mentioned in the beginning of this section, the IT gender divide is not perceived as a special problem even by people who are concerned with the gender divide. Both the census and the survey are necessary to establish an objective basis to design appropriate campaigns that will concentrate money and human resources in initiatives that will influence the largest possible number of people.

A second observation concerns the role of parents and families in influencing careers and self-image, involving factors such as ability and academic achievement. Much has been said about the relationships between parental attitudes and activities on the one hand, and children's self-perceptions of motivation and development, as well as their perspectives of the world, on the other. Parents are also fundamental in shaping occupational aspirations, and the level of parent education is a very important factor in predicting children's achievement; e.g., see Davis-Kean & Sexton [7].

Parental influence, essential in the formative years, continues for a long time afterwards in countries like Brazil, where often children leave home only when they marry. Again due to cultural reasons whose origins lie in the country's history, males who live with their parents are subject to less parental control than their female siblings. In this perspective, it is not sufficient to work with the girls but also with the families. This is a much broader goal, and harder to attain.

Here, the nationwide demand for digital inclusion can be used as a lever to involve everyone in education campaigns whose goal is IT literacy, but whose byproduct may well be changing the perception of families and girls about information technology. Indeed, as mentioned by Sanders [17], there is often a misunderstanding about IT careers. Many students arrive at the university believing that they involve just meddling with hardware. Others think they require writing programs, and very few are aware of the breadth of choices available. These limited and erroneous views are a deterrent to women, given the perception that hardware is unfeminine and programming is boring, or that IT activities are not challenging enough.

Thus, a second action recommended here is the **informal education of entire families, with emphasis on parents**, calling attention to the advantages of IT jobs and the fact that they offer women a good opportunity.

The third point concerns the girls themselves. They must be attracted to IT careers, and encouraged to become leaders in the field. As remarked by Creamer, Burger & Mezaros [6], one of the challenges to be faced is how to show young women who enjoy using computers that this enjoyment can be the basis for career choices.

Here, two parallel directions must be taken: change CS curricula, making them more attractive to women; and promote visibility and advocacy actions, involving, among others, role models and integration of the efforts of parents, teachers and coaches. Interestingly enough, one third of the women in the country's workforce are teachers. This would augur well in terms of perspectives offered to careers and outlook in life, since these women can present good role models to the students. This, however, will involve training the teachers.

Therefore, the third action proposed is to provide the basis for **adequate training of girls and teachers**. One necessary direction requires rethinking the educational structure, and developing new kinds of content to be used in courses, e.g., courses that offer material on the Internet should be aware that girls use the Internet differently from boys (see Kennedy, Wellman & Klement [11]). These changes must start at an early stage, since, as stressed by Wigeld et al. [26], boys and girls' interest in mathematics and the sciences starts diverging once they enter adolescence.

Many initiatives have appeared recently concerning the need to attract students to computer science, regardless of gender issues. Such studies emphasize the need for a multidisciplinary approach (e.g., Mahmoud [14]), or involvement of students and teachers in the actual use of new technology products such as handheld computers and robots [1]. Preliminary work conducted by Randall, Price & Reichgelt [16], for instance, seems to indicate that curricula involving multidisciplinary applications will attract a higher percentage of women. Studies that concentrate on analyzing how education practices can affect gender balance consider moreover activities such as pair programming or collaborative learning (e.g., Bair & Cohoon [4]).

The three actions proposed so far — gathering data plus a survey of perceptions, informal education of families, and new education initiatives for girls and teachers — pass through the need to change the image of women in today's information society. This involves modifications both in self-image (how women see themselves) and in cultural stereotypes (how the society sees them). Here, it might help to check the origins of the term. According to the dictionary [15], the word "image" has been used in French since 1597 to denote "reproduction of something or someone." It entered into English, via old French, from the Latin "imagin, imago," meaning "reproduction or imitation of a form of a person or thing"; imagination, therefore, means to form images in the mind.

The question to ask is, therefore, *how to help people reshape and form new images in their minds*. This, in turn, requires investigating affective and emotional issues. Affective aspects influence and overlay cognitive ones. Thus, it is important to change the outlook girls have on science and on IT in particular. A result of the SIGIS report [8] is that image problems in IT are associated with the fact that there are relatively few women in the field, and thus poor visibility - i.e., lack of female role models. Stereotyping is another reason mentioned [9, 17] for women not

choosing computer-related careers. Other often-cited reasons are environmental and cultural factors, and women's different interests and computing experiences (e.g., see Lester & Brown [12]).

Emancipation and empowerment through image change involve issues such as:

- Building the level of self confidence. Many mechanisms have been proposed to do this, such as networking, support groups, or mentoring.
- Training and constructing the appropriate skills. This is the task of formal education at all levels.
- Revising gender stereotypes. Role models and positive reinforcement are examples of means to work in this dimension, as well as informal education of families.

Concrete means, in the Brazilian culture, for creating new "images" are:

- Organization of specific seminars during meetings with parents, taking advantage of parent associations, which exist for every elementary and secondary school; and
- Promotion of positive image enforcement, taking advantage of the penetration of radio and television.

The last item merits a special discussion. Results of a nationwide census in 2002 showed that 90 percent of the homes have at least one TV set, and that the average Brazilian spends three to four hours a day watching television. Consumer surveys also show that homes that do not yet have a refrigerator will have a TV set. In other words, people would rather spend money on this leisure commodity than in an appliance that preserves food. Also, almost all women are responsible for domestic tasks at home, and a high percentage of low-paid jobs are held by domestic workers (22 percent of all women employed, according to 2004 statistics). While performing these tasks, it is common for women to listen to the radio. Radio and TV are the communication vehicles favored by the government in, for instance, national vaccination or traffic security campaigns.

The fact that these media effectively reach all homes should be taken advantage of, to promote country-wide awareness of how women's lives can be enriched by the use of information technology. New images can be indeed formed in the mind by having them appear on TV or discussed on the radio.

5. CONCLUSIONS

This paper presented a brief overview of issues concerning Brazilian women in IT-related activities and efforts. Starting from a historical perspective of advances achieved, it showed that, even though there has been marked progress in past decades, especially concerning the rising level of education, there is still much to be done. Women, when mentioned, are grouped under the minority label, though they constitute 51 percent of the country's population.

There is a growing awareness, in Brazil, of the need to improve the lot of women, resulting in gender-oriented government social programs, such as in health issues. On the other hand, the relatively small participation of women in IT activities, especially in higher managerial positions, has not yet been perceived by the population as a case for concern. First of all, women have many more basic issues to face, such as improvement in legislation, work conditions or salary parity, and thus inclusion in IT is not necessarily a priority. Second, girls do not consider engineering or technological careers as worthwhile to pursue, either because of expected social behavior or because of self-image issues.

In order to change this scenario, a wide spectrum of initiatives has to be considered. A basic action proposed in the paper emphasizes the need for more reliable data on the problem, to conduct informed campaigns directed by facts and not by results of partial studies.

The paper stresses the importance of education, where it is not enough to engage girls but also their relatives. Technical training in IT should also be accompanied by informal education, presenting to families a new socio-cultural perception of women's role in society. In parallel, schools and universities should increase efforts in making their curricula more attractive, e.g., by providing cross-disciplinary education. Furthermore, visibility and advocacy actions can take advantage of the prominent role that radio and television play in Brazil.

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