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Why I Chose Computer Science? Women in India

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ABSTRACT

In many developed countries like the United States, the percentage of women earning a bachelor's degree in computer science (CS) is relatively low. In contrast, in many developing countries like India there has been a significant increase in the number of women pursuing a bachelor's degree in CS. This is despite the prevalence of patriarchy in India. This paper uncovers why women in India are attracted to CS education. It is based on 60 in-depth interviews conducted with female students majoring in CS at four institutions of higher education in India in 2007-08. The findings suggest that Indian women perceive CS as a woman-friendly field.

Keywords

Digital divide, confidence in math, gender in computing.

INTRODUCTION

In the United States, the percentage of women earning a bachelor's degree in computer science (CS) has declined since 1985. For instance, women received 37% of CS degrees in 1985 which dropped by 15 points in 2005 when women earned only 22% of bachelors' degrees in CS (National Science Foundation, 2008). Alarmingly, the proportion of women who thought they might major in CS has fallen from 4.1% in 1982 to 0.3% in 2005 (Vegso, 2005). Many reasons have been proposed for such a gendered gap. Socialization theorists show that while boys are raised to be in a science and engineering (S&E) including computing field, girls are brought up to be in traditional fields such as arts, humanities, and social sciences (Frenkel, 1990; Spertus, 1991; Trauth, 2002; Margolis and Fisher, 2002; Varma, 2002). Structural theorists highlight institutional barriers such as access to computers and information technology resources both at home and in schools which lead to gender differences in specific uses of computers (Gorriz and Medina, 2000; Cooper and Weaver, 2003; Kennedy, Wellman and Klement, 2003; Beyer, Rynes and Haller, 2004; Creamer, Burger and Meszaros 2004; McCoy and Heafner, 2004). A number of scholars argue that women's subjective evaluations of their self-efficacy in mathematics and CS lead to alienation and a pervasive sense of not belonging, which renders CS study unappealing or even intolerable (Vetter, 1990; Seymour and Hewitt, 1997; Margolis and Fisher, 2002; Varma, Prasad and Kapur, 2006).

In India, female representation in S&E has been low, despite the fact, over the years, that there has been a steady rise in the proportion of women entering universities (Indian National Science Academy, 2004). Since the 1980s, scholars have begun to study Indian women in S&E fields. Most studies show flatter career paths, prejudices, lack of infrastructural support, dual burden for Indian women scientists and engineers (Gurnani and Sheth, 1984; Chakravarthy, 1986; Krishnaraj, 1991; Jaiswal, 1993; Subrahmanyan, 1998; Gupta and Sharma, 2002). In recent years, however, there has been an increase in women's enrollment in S&E fields including computing.

Separate data on women in CS in India are not available; instead, CS data are included within information technology (IT) data. Nonetheless, most indicators suggest that there has been a significant increase in the number of women pursuing a bachelor's degree in the IT-related fields including CS in India (Basant and Rani, 2004). For instance, women constituted 21% of the total 650,000 IT workers in 2003 when compared to 15% in 2001 (NASSCOM, 2003). The enrollment of women in engineering is still low although it has increased from 7.6% in 1989−1990 to 16.2% in 1999−2000 (Parikh and Sukhatme, 2004). In 2003 women received 32% of bachelor's of engineering degrees awarded in CS and 55% of bachelor's of science degrees awarded in CS (Government of India, 2004-05).

The noted increase in women's choosing CS is despite the fact that patriarchy—a system of male dominance legitimized within the family and the society through superior rights, privileges, authority, and power—is very strong in India. Patriarchy leads both men and women to internalize their respective positions within society and to define their role vis-à-vis the other sex (Basu, 1992). Basically, Indian tradition dictates that a woman is subject to her father while she is unmarried, subject to her husband after her marriage, and subject to her sons if she is a widow. Family lineage is passed through the sons, who have specific ceremonial roles including funeral rites for parents. Most importantly, all property is vested in, exercised through, and transferred through patrilineal descent. A male is considered a sound investment that will compound the family wealth, whereas a female is considered a liability who consumes wealth without adding to it. The dowry that must be provided with each daughter upon her marriage places an enormous economic burden on families. Furthermore, there is a fear of loss of honor *(izzat)*; the daughter may have an affair and thus bring a bad name to the family. If the honor of a family's woman is lost, the family's entire public position is considered lost, which leads to the early marriages of daughters. A result of the system of patriarchy is a strong preference for sons over daughters in India (Rajan, Mishra and Vimala, 1996). It is therefore no surprise that India's existing sex ratio (the number of females per 1,000 males) is 933 females per 1,000 males (Census of India, 2001).

This paper studies women in CS education in India. In particular, it focuses on how they developed interest in CS despite the dominance of patriarchy. It is a part of a larger study which investigated the two research problems: (1) Why are women in India attracted to CS education? (2) Does attraction to (or rejection of) CS study vary differentially between India and the United States? A cross-national comparison is likely to provide a better understanding of the issues women face in CS education in both countries.

METHODOLOGY

In 2004–2005, primary qualitative data were gathered in the United States through in-depth interviews with 150 students, divided into groups of 30 (15 females and 15 males) belonging to one of the following five major ethnic/racial groups: White, Afro-American, Hispanic, Asian American, and Native American. These students were attending seven campuses that granted four-year undergraduate degrees in CS and/or CE and were designated as Minority-Serving Institutions. In 2007–2008, a similar study was carried out in India. In-depth interviews were conducted with 60 female undergraduates majoring in CS. The interview questions used were the same as in the United States study though some new questions were added to address the Indian situation. The study took place on four campuses that granted four-year undergraduate degrees in CS. To ensure a broad representative sample, main minorities in India are included in the study. One campus was historically Muslim and the other was predominantly Sikh. Random sampling was used to select 15 subjects who were in their second and more years of studies from each campus. None of the students declined to participate in the study. To ensure that data collection is consistent with the earlier study in the United States, the author conducted all interviews. These interviews were recorded, subsequently transcribed, and inserted in the Nvivo program for analysis. Two independent coders (different from the U.S. study) coded the same data to ensure reliability and validity.

FINDINGS

Developing Interest

To find out how women in India developed early interest in computers, a series of related questions were asked, including: How did you become interested in computers? When did you become interested? What interested you? Who interested you? Where did you become interested? What people in your life influenced your decision to study CS? How did they influence you? Responses to such questions show that there exist numerous reasons why young women in India become interested in CS in general. Further, the students' interest in CS surfaced at different periods of their education.

A small number of the students reported having a computer in their home or easy access to computers prior to grade eighth. These students developed personal curiosity in computing based on informal interaction and exploration. Another major factor in the development of interest in CS was whether or not students were offered computer classes in their high schools (9^{th} and 10^{th} grades). It seems some of the high schools which students attended had some degree of computer facilities, although many of these students complained that the computer laboratories were poor.

Another factor leading to interest in CS involves those young women who had a parent, sibling or cousin who owned a computer or studied in an engineering field themselves. For many of the students, parental support was a strong motivating factor in their entrance into CS. Especially influential were fathers and older brothers who helped the students by relating personal experiences or by telling them that computing was a promising field for women. Male family members described CS as "good for girls" because it required only mental strength not physical, and because they could work at a desk.

For many of the students, as they entered Plus Two College (11th and 12th grades), they were asked to choose between the optional fields of medical or non-medical (engineering). Their distaste for the medical stream led them to their choice to take the non-medical stream. Also significant to many Indian women's decisions was that when they were admitted to university for undergraduate studies, students were allowed to choose their field of studies based on the rank they received in the entrance exam. Students pointed toward their entrance based on a ranking system in which only "toppers" enjoyed the ability to choose their field of entry. These students referred to that rank as their reason for entering CS. They selected CS as their major based on a pragmatic assessment of the field. Reasons such as strong possibilities for future employment, the ubiquitous presence of computers in occupational settings and the ability of a student to be on the cutting-edge of modern technology were presented. Also, a few women commented upon how a degree in CS allows for some independence in their life.

Experiencing Digital Divide

To understand early exposure to computers, a number of questions were asked: When you were growing up, did you or your family have and use computers? If yes, how many computers? Who used them? What did you use them for? If not, did you have access to computers? Describe the computer resources that were available for you to use while you were in elementary school? Describe the computer resources that were available for you to use while you were in high school?

Whereas in the United States, children engage computers in the household from an early age, young women in India had a different experience. Fewer than ten students in this sample reported having a computer in their house prior to high school. Those that did stated that they used the computer mostly for basic purposes such as playing games and using software like Microsoft Word. A small minority explained that they may have had computers in the house, but that they were solely used by the parents or older siblings for work purposes. Once in high school, another five students reported that they acquired a computer at home. However, a majority of students still maintained that they only utilized computers for basic purposes that now included the internet, watching videos, playing games, and for homework. Prior to attending university, very few students claimed that they used computers for more advanced purposes like programming. This number is greatly influenced by the students' environmental factors such as a person in the household who intentionally taught the young women programming or roles played by the school and private coaching.

Once in high school accessibility of and direct training in computers increased substantially. Many students described having some type of computer facilities in their high school. However, students' attitudes toward the computer resources varied. Most of the students who commented upon the usage of the computers in school said that the machines were used for basic purposes only. This pattern seems to have developed for two reasons: poor quality/inadequacy of computers and a lack of availability or instruction of advanced skills. Availability, or lack there-of, was a constant theme for many of the questioned students who explained that while their schools might have had computer facilities on the premise, a small number of machines, inadequate or broken machines, high student to computer ratios, long wait lines, and access only to certain rankings created an imbalance in who was actually using the computers.

Some students reported that their high schools had good computer facilities. Usually, this corresponded with those students who were given an option in the 11th and 12th grades to take computer or engineering focused coursework. In general, these students were given direct instruction in computers and were given priority access to the school's facilities. Students who completed optional education of this type expressed much higher rates of competence than their peers and were much more likely to report a positive level of preparation for their college studies.

Where high schools were unsuccessful though, private coaching filled in the gap for some students. The private coaching provided ample space to develop the necessary pre-college experience and training in CS to help the students feel prepared upon entering the university. These students were much more likely to report positively that they were prepared for college.

Training in Mathematics

Since the Indian women students were not exposed to computers early on, the question of importance is whether they felt prepared for CS study upon entering a university. Students were asked: Did high school classes prepare you well to study computer science at the university level? If yes, how were you well prepared? If no, how were you lacking in preparation? Their responses were cross checked with two questions: What was your best subject in high school? What was your worst subject in high school?

Students' responses show that prior to attending a university the computer based experiences of young Indian women vary. Of the 60 students queried from all four colleges, 27 stated that they entered their university studies prepared, 26 claimed a lack of training, and seven said that they were somewhat prepared. To add complexity, only about half of the students

claimed basic computer proficiency, about one-sixth claimed advanced proficiency, and the remaining one-third referenced little to no computer skills at all. How then did these students proceed into CS majors, some at very prestigious universities?

What can be surmised from the interview data is that while a clear digital divide existed for many with regard to the access and instruction in computer technology, a strong background in mathematics has allowed for these students integration into the CS field. At least one-quarter of the students explicitly reported that regardless of their training in computers, their proficiency in mathematics based on high school instruction was critical to their ability to proceed into CS. Compounding upon this data, when asked their best subject in high school a large majority of students (75%) included mathematics amongst their answers. Comparatively, the two subjects of chemistry and physics put together were only the favorites of one-quarter of the group. A strong knowledge of mathematics was an aspect of the private coaching that most of the students took in the two years prior to the standardized entrance test that determined their ranking and college placement.

DISCUSSION

The Indian educational system is rigid, requiring advanced mathematics courses in high school; the American educational system is flexible, giving students a choice when it comes to studying advanced mathematics. Mathematics, among other things, teaches students logical and rational thinking which are required in CS education. For a long time, women's under-representation in S&E fields in higher education in the United States was explained in terms of their poor preparation and proficiency in mathematics when measured against their male peers. When the gap between female and male students' scores in mathematics narrowed beginning in the early 1990s, it was proposed that compared to men, women lacked confidence in their mathematical skills. Beginning around the year 2000, media outlets and others have increasingly decried the poor preparation of American students (including women) in mathematics as compared to students in India and China (e.g., February 12, 2006 cover page of *Time Magazine)*. This case study has shown that women in India feel better prepared for CS education due to a solid grounding in mathematics. It means improvements to math education at K-12 levels are necessary, especially for women in the United States.

At the university level, the flexibility available to students in the United States gives them the option of changing their field of study midway through college and to graduate with a degree in the new field. Such choices either do not exist or are rare in the Indian educational system. If one is not succeeding in the pursuit of a CS degree in India, one is likely to work harder to address the problems instead of switching to another discipline. Most importantly, women in India do not want to change their major from CS to some other field because they view CS as a woman-friendly field.

In addition to the educational/institutional factors, there are social/cultural factors influencing why significantly more women in India prefer CS. Indian women want to learn about computers and do not wish to be left behind. Furthermore, there are many high-level job opportunities in IT-related fields that require a degree in CS and which provide excellent opportunities for women to become socially and economically independent. Rather than field based, CS work is office based where women feel secure.

CONCLUSION

Women in India demonstrate that computing is not gendered as it has been framed in the United States. The gender imbalance in the United States seems to be specific to the country; it is not a universal phenomenon as it has been presented in the scholarly literature. Women in India are enrolling in CS despite all odds placed against them.

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