

Women in Computing Education: A Western or a Global Problem? Lessons from India

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Abstract

In the United States and Western Europe, the percentage of women earning a bachelor's degrees in computer science and computer engineering (CS/CE) has been low for over two decades. Contrary to the situation in the West, there has been a significant increase in the number of women pursuing a bachelor's degree in CS/CE in several developing countries. This chapter addresses how participation of women in computing education varies in developing countries from those in developed countries. It presents a case study of India which shows that in India the image of computing is of a women-friendly field as it offers lucrative jobs, high salaries, professional careers, safe office working environments, and economic independence. Yet, women remain marginalized due to patriarchal values prevalent in India. Nonetheless, this case study shows that computing and gender are constructed more diversely than assumed in Western research.

Keywords: India, computer science in India, confidence in mathematics, geek mythology, Indian female students, Patriarchy, underrepresentation of women

Introduction

Graduation trends in the last 25 years show that majors in computing related fields have had low popularity among female students in the United States and Europe. For instance, in 2015, U.S. women earned a mere 18% (9,209) of bachelor's degrees in computer science (CS), which is less than (14,431) of what they earned in 1985 (National Science Board, 2018). Similarly, in Europe women represented 16.7% of total graduates in information communication technology (ICT) in 2016 (European Commission, 2018). Low participation of women in computing education has been a pressing problem in Western countries. Gender diversity in computing is imperative as it will increase the skilled labor force pool, enrich innovation, and foster social justice. Most importantly, there is high demand of people with computing skills. The number of ICT specialists in the European Union grew by 36.1% from 2007 to 2017, over 10 times as high as the increase (3.2%) for total employment (Eurostat, 2018). Employment of computing related occupations in the U.S. is projected to grow 13% from 2016

to 2026, which is faster than the average for all occupations. These occupations are projected to add about 557,100 new jobs (US. Department of Labor, 2017). Often such growing needs are met by foreign skilled workers mostly from Asian countries. It is, therefore, no surprise that a number of governmental and corporate initiatives exist in the United States and in Europe to empower students with the computing skills to thrive in a global economy.

Women's underrepresentation in computer science and computer engineering (CS/CE) education has been scrutinized from many angles during the last two decades (Ahuja, 2002; Cohoon & Aspray, 2006; Singh et al, 2007; Beyer, 2015; Aspray, 2016). Scholars have identified a range of factors that may be divided into three themes. First, objective conditions including the small proportion of women among CS/CE faculty and student populations, differential treatment by male peers and economic impediments that limit access to ICT and/or competent preparatory education (Varma, 2002a; Katz et al, 2003; Kahle & Schmidt, 2004; Lang, 2010; Good, Rattan & Dweck, 2012; Beyer, 2016). Second, women's subjective evaluations of their self-efficacy leads to alienation and a pervasive sense of not belonging (Margolis & Fisher, 2002; Hyde, et al, 2008; Varma, 2010; Quesenberry & Trauth, 2012; Beyer, 2014). Third, gendered socialization and masculine culture that affect women's affinity for CS/CE study (Larsen & Stubbs, 2005; Varma, 2007; Papastergiou, 2008; Cheryan, 2011).

In contrast, women in many developing countries have increased their presence in CS/CE (Shashaani & Khalili, 2001; Adam et al, 2003; Lee, 2003; Fan & Li, 2004; Lagesen, 2008). A study conducted by the author in India shows that CS/CE is a popular major among women. Recent enrollment data show that women constitute approximately 40% of students in CS/CE at undergraduate level, 65% at master level and 50% at doctorate level. During the 2016 fiscal year, approximately 81,3000 male and 79,2000 female students graduated from CS/CE disciplines (Statista, 2018). This is despite the fact that Indian women socially have fewer rights and opportunities in comparison to the United States and Europe. Despite economic and social advantages in the United States and Europe, women in India seem to have levels of success in computing education that appears to somewhat surpass those of American and European women.

This chapter presents a case study of women in CS/CE education at undergraduate level in Indian institutions of higher education. Enrollment data shows that the CS/CE field appears to be a "women-friendly" field in India. The question of importance is: How is it that women in India have managed to outperform their peers in Western countries in studying CS/CE? This chapter argues that gender remains an important concept, even though CS/CE does not appear to be a male dominated field in India. It shows a contradiction since female students seem to be empowered with a degree in CS/CE, yet they remain sidelined within Indian social structure. At the same time, it questions the Western portrayal of CS/CE as a masculine field mostly due to a low number of women. An analysis of the Indian context for CS/CE and cultural/social meaning of gender in India provides a better understanding of the reconstruction of gender and CS/CE.

Indian Women and Computing Education

In 1947, India declared independence from the British emerging as economically and technically underdeveloped in relation to the West. Since then, India has sought to catch up to scientific and technological advances made in the West with its industrialization policies. However, until 1990 India had controlled its industrialization with licenses and regulations. In

1991, India implemented economic liberalization reforms to provide favorable business environments to national and multi-national corporations. The Indian government has made the ICT industry a viable option to strengthen its national economy and emerge as a “soft-power,” a term coined by Joseph Nye of the Harvard University. The Indian ICT sector has grown tremendously. According to one estimate, in 1986–1987, there were only 6,800 IT workers in India (Basant & Rani, 2004); Currently, ICT industry is creating over 3.7 million jobs per year (Statista, 2018). The ICT industry is expected to provide quality employment to a large number of qualified people in the coming years. Indian people especially women are well aware of bright futures with CS/CE education.

Gender Socialization

Socially, women have had fewer opportunities in every country. The stereotype that a “woman’s place is in the home” has assigned their social role. Consequently, formal education for girls was secondary to that for boys. In the last 100 years, western countries have moved towards an egalitarian form of social organization. This is not to deny that subtle gender biases in socialization, lack of encouragement for girls to pursue science and engineering (S&E) fields and gender stereotypes do not exist. In India, patriarchy—a system of male dominance legitimized within the family and the society through superior rights, privileges, authority and power—is prevalent (Sarshar, 2010). Basically, Indian tradition holds that a woman’s place is under her father while she is unmarried, under her husband after her marriage, and under her sons if she is a widow. Most importantly, all property is vested in, exercised through, and transferred through patrilineal descent. A male is considered a sound investment, who will compound the family wealth, whereas a female is considered a liability who will consume the wealth in the form of dowry on her marriage (Varma, 2002b). Because chastity is a must for the woman’s marriage, families control all aspects of their daughters’ lives. In such a social system, girls grow up with multiple restrictions. Though both boys and girls attend school, the experience of the two radically differ. Girls attend schools with the knowledge that ultimately their proper place is going to be in the home to fulfill domestic duties, while boys attend schools so they can become the provider for their families. It is, therefore, no surprise that female students view education as a means of obtaining greater strength to stand the Indian social system, which is not friendly to them.

Early Exposure

It is believed that if female students have early access to and better use of computers at home and in schools, they are likely to pursue CS/CE major at the university level. Since India has a huge agrarian sector, a digital divide is seen mostly between rural and urban India, rather than along gender lines. Even among a large section of the English-knowing urban population, female students face a digital divide at home and in schools (Varma, 2010). This is mostly because family members yet to see the importance of purchasing or renting a computer at home, which is rather expensive even for the middle class. Schools do have computers, which are typically situated in the laboratory. In fact, a computer course is introduced during sixth grade in schools, which follow the National Council of Education and Training (NCERT) curriculum. However, schools lack a strong telecommunication infrastructure with adequate

reliable bandwidth for Internet connection. Furthermore, electricity remains unreliable with fluctuations in voltage and frequency. Though such economic barriers apply to all students, there are social and cultural barriers that relate only to female students. It is common for teachers to direct or encourage male students to use computers and female students to watch male students' activities. Parents and relatives tend to keep an eye over female students' use of the Internet to make sure they are not on a "wrong path."

Confidence in Mathematics

A certain level of "mathematical sophistication" is seen as necessary for a CS/CE major (ACM & IEEE Computer Society, 2005). Historically, lack of proficiency in mathematics has been seen as a constant obstacle to deal with in the underrepresentation of women in S&E in the United States and Europe. Even though mathematics scores show no gap between boys and girls (Hyde, et al, 2008), it has been found that women tend to lack confidence in their mathematical skills when compared to men (Margolis & Fisher, 2002). Due to the introduction of computing as a subject in schools, female students in India have an early exposure to the field. Most importantly, they are confident about their mathematical training and thus believe in their ability to do well in CS/CE at the university level (Varma, 2011). Typically, female students are rarely concerned about their ability to do challenging computing and mathematical work either in absolute sense or relative to male students. Academically, female students compare rather well with their male peers. There is a general belief that gender is not the main factor in determining who does well in CS/CE courses. This is not to deny that more opportunities are available to men than women, causing some men to perform better than women. It is, therefore, no surprise that once female students join CS/CE, they seldom change their major to something else.

Preference for CS/CE

Typically, enrollment in institutions of higher education in India is on the basis of the scores students receive in state and/or national entrance exams. Technical fields are typically seen as suited for men, while women are expected to study feminine fields such as medicine, commerce, arts, or social studies. Now CS/CE has emerged as the highest pursued major for those who do not wish to pursue medical or social sciences track. CS/CE is preferred by and for women mostly for three reasons: economic benefits, suitable work environment, and social advantages (Varma, 2015a, 2015b). Economic benefits for a woman with a CS/CE degree appear to be much higher than with a degree in other fields. Not only will women have high-paying job opportunities with a CS/CE degree, they could get employment in multiple sectors, fields and locations, including in large national and multinational companies. Due to the remarkable growth in the ICT sector, they could take a job soon after graduation. Undoubtedly, high paying jobs offer women a better standard of living for themselves and their families. Such economic benefits tend to alleviate concerns their families have about marriage and dowry. In addition to potential for job opportunities with a CS/CE degree, women will be working mostly in offices and laboratories rather than male dominated shop floors or construction sites. CS/CE jobs are seen as white-collar positions at a desk in a secure indoor office, with air conditioning. It should be noted that female toilets are not easily available on outdoor jobs. Furthermore, computing

jobs tend to have flexible regular daily hours, rather than arbitrary hours and locations associated with medicine, which have been historically considered a suitable profession for women. Finally, there has been tremendous appreciation for women with a CS/CE degree inside and outside institutions of higher education. Women eventually enjoy a higher social status due to their ability to perform technical tasks, which results in women accessing greater autonomy and self-confidence. For all these reasons, female students have strong support from parents, family members, friends and community for their CS/CE study. In fact, families put pressure on young women to enter into computing.

Image of Computing People

In the Western countries, the prominent image of people in computing is of geeks (Margolis & Fisher, 2002; Wajcman, 2004; Varma, 2007). Traditionally, geeks are seen as eccentric people who are obsessed with computers, fall in love with computers with their first exposure, overly smart in breaking codes, knowledgeable in the inner workings of computers, and socially awkward. Geeks have become more acceptable over a period of time, yet the association with geeks remains derogatory and thus not desired by women in the West. Contrary to the West, the image of people in computing is positive in India. They are considered dedicated, hard working, intelligent, meticulous, and smart people (Varma, 2015a). These people score very high in mathematics and sciences, while being very detail-oriented which are both needed in CS/CE. They are an inspiration for others, so it is considered pleasant to be around them. Most importantly, they are socially and culturally active like anyone else. Basically, they are role models for young male and female students. Male students' attraction to CS/CE has little to do with the geek culture, instead male students are pulled towards CS/CE because it offers many high paying job opportunities inside and outside of India. In India, parents raise their sons to pursue fields which have high income potential since they must financially support their families.

Gender Issues

Does the above mean that female students do not experience any obstacles in pursuing CS/CE degree? In the Indian patriarchal social system, a man is the head of the family who controls a woman's education, mobility, labor participation, reproduction, and sexuality (Sarshar, 2010). Patriarchy results in a strong preference for sons over daughters. As a result, female students experience problematic social perceptions, the dearth of financial support, and the family restrictions due to their gender (Varma, 2016). They receive less support than their male siblings in the form of financial assistance and encouragement for higher education. A family considers the sons' role as staying home to provide for the family, whereas girls are expected to leave home after marriage to raise a family. Teachers have greater expectations in the education of male than female students; thus, women have to work harder and perform better to achieve the same acclaim. Because of their gender, female students face curfews at their hostels and at home (typically 8 PM). Furthermore, male and female students cannot enter each other's hostels or homes before curfew time. Consequently, the system has created a gendered restriction that curtails a female students' ability to stay in laboratories longer to complete group projects and network with male peers. It also gives male students an edge in

regards to hard assignments and group work. During job placements on campus, it is common for employers to ask whether female students have their parents' permission to work, as well as their marriage plans. Because women are not expected to travel alone, female students could not travel for a possible internship, additional training, and job interviews. In other words, female students are forced to make compromises in regards to family in educational institutions, and in seeking employment.

After CS/CE Degree

The above shows that female students have an affinity toward CS/CE education as it leads to better occupations. They select a CS/CE major after going through competitive admission to institutions of higher education, then they seek to finish required courses and training. The attainment of a CS/CE career is the final outcome of their preference. However, their CS/CE career preference is affected substantially by the constraints imposed by parents and society (Varma, 2010). After completing their CS/CE degrees, female students typically take a job in the ICT sector. Entering directly into the workforce appeals to them due to the available opportunity and company representatives coming to campus to recruit students as soon as they graduate. Women think their earnings will reduce the financial burden of their families for their marriage; in India, a person commonly spends one-fifth of the total wealth accumulated on the wedding. Increasingly, women with employment potential are viewed as desirable marriage partners. It should be noted that in India, girls are in tremendous pressure to get married as soon as they finish their undergraduate degree. By taking a job, they end up having some financial independence thus are able to avoid the pressure from parents for marriage. Some female students do opt for graduate education. Interestingly, there is a preference to do a master's in business administration (MBA), as it would result into a higher pay scale than with a CS/CE degree (Varma & Kapur, 2010). These female students prefer to take managerial or financial positions within the ICT sector rather than being computer scientists or computer engineers. Unlike having a job, Indian women in graduate schools are seen as passing time until they find a suitable marriage partner.

Conclusions

Much scholarly research in the West has shown how women have been excluded from the computing and other technology fields, as well as how such exclusion has given these fields masculine characteristics. It has been argued that stereotypes of masculine/geek images in computing results in fewer females enrolling in CS/CE. Those who do join the program begin to question their position in the field and typically leave before completing the degree. Even though in the West women are underrepresented in computing, this is not the case in India. Enrollment trends by gender show a decline in the number of women in the CS/CE fields in the United States and Europe, and an increase in India. Many women in the western countries avoid computing and prefer other vocations; in contrast, computing is a magnet for women and their families in India.

Indian women see CS/CE degrees as potential for providing them with bright futures. They are attracted to CS/CE mostly due to the strong possibilities for future employment and the potential of high paying jobs. Living in the patriarchal milieu, Indian women desire financial independence from families to avoid any future social restrictions. With a high-paying job in the ICT sector, they look forward to standing on their own feet instead of being homemakers and even after marriage they anticipate a high social status by supplementing the household income. Furthermore, they view ICT-related jobs as rather

safe for themselves. For Indian women, being indoors in an office in front of a computer and interacting with a small number of professionals, means they are protected from the outsiders. Physical safety is a very important consideration for parents to let their daughters work outside of home. Parents seek for their daughters to be protected from sexual assaults which is seen as a threat at construction sites and in factories. In contrast, to western women working indoors in an office is considered normal and, thus, there is little excitement for it. Sitting in front of a computer and being confined to a desk does not go well with their desire to interact with people. The fields of biology, psychology, and social sciences are seen as people-oriented fields and, thus, desired by women in the United States and Europe.

The reasons CS/CE is viewed as well-suited for women is not in contradiction with the Indian social context. Parents favor CS/CE in lieu of engineering because it assimilates with their perception of the type of work girls should be allowed to do. Parents typically do not approve of other engineering fields since girls would be outside and involved in physical activities, which they consider unsafe for women. Without parental permission, girls could not have enrolled to study CS/CE. In fact, their preference to CS/CE is closely linked with the family preference to CS/CE. Although this suggests a gendered construction of CS/CE, albeit different from the United States and Europe, it should be noted that women themselves view the field as giving them independence from the social obligations imposed on women in India. The possibility of women going against their families' wishes for them to get married is impossible without the economic security attained through a well-paying job, which is what a CS/CE degree can provide. It should also be noted that there is little special provision for women in higher education by the Indian government.

To sum up, masculinity and gender issues are prevalent in western and non-western countries, but in different forms. The gender imbalance in western countries seems to be specific to their social context; it is not a universal phenomenon as it has been presented in scholarly literature. Indian experience shows that gender is divisive in CS/CE, not because of the nature of the field but mostly because of the Indian patriarchal system. Even with the gendered treatment of women by family members and society as a whole, women do not doubt appropriateness of CS/CE major for them.

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Discussion Questions

1. How do high school classes prepare Indian girls to do well to study CS/CE at the university level?
2. Why do female students in India not consider changing their major from CS/CE to something else?
3. What is the typical perception of the computing field in India and in the Western countries?
4. How are people in the computing field perceived in India in comparison to perception in the Western countries? What are their characteristics?
5. Are careers with a computing degree attractive to women in India and the United States?
6. What are similarities/differences between women in India and the United States with respect to attitudes/beliefs towards careers with a computing degree?
7. Why do you think there are so few women that study CS in the West?
8. What attracts men to study CS/CE in the Western countries?
9. Do women encounter obstacles that men do not in the CS/CE programs? Give some examples?
10. Why do Indian female students not want to pursue CS/CE after attaining their undergraduate degree?

Author Biography

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