COMPUTING SELF-EFFICACY AMONG WOMEN IN INDIA

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This paper presents findings regarding self-efficacy, which has been seen as an important variable for women's academic performance and perseverance, from in-depth interviews with 60 female undergraduate students majoring in computer science (CS) in 2007–2008 in India. It shows that CS is viewed as a woman-friendly field, as it offers lucrative jobs, professional careers, safe working environments, flexible working hours, and independence. Verbal persuasion from family members provided additional support to pursue CS education. Though they did not have early exposure to a computer at home or in school, female students' school preparation in mathematics facilitated their academic performance. Their peers' desires to join and succeed in the CS field further enhanced their confidence. The findings suggest that self-efficacy, computing, and gender are constructed more diversely than generally accepted in the American research.

KEY WORDS: digital divide, computer literacy, geek mythology, Indian higher education, mathematics competency, self-efficacy

1. INTRODUCTION

Low participation of women in computer science (CS) education is a pressing problem in the United States. During the past two decades, the share of bachelor's degrees awarded to women increased in almost all major science and engineering (S&E) fields, except in CS. From 1985 through 2005, the proportion of CS bachelor's degrees awarded to women dropped from 37% to 22% (National Science Board, 2010). Since the early 1990s, literature on the gender gap in computing education in the United States has grown (Ahuja, 2002; Cohoon and Aspray, 2006; Singh et al., 2007). Scholars have demonstrated possible factors ranging from socialization to structural factors for women's low participation in CS, including issues related to self-efficacy—the belief an individual has about his or her ability to perform a particular task (Bandura, 1977). Once in the program, female students underestimated their abilities and comfort level with their choice of CS study due to the masculine culture (Margolis and Fisher, 2002) and their inability to keep up with the rigorous curricula requirements (Varma, 2007a, 2007b). Often, these students ended up leaving for those fields that were more socially accepting of them and in which they felt they could succeed.

In contrast, women in India have increased their presence in CS education in most nationally accredited institutes and universities, except at the Indian Institutes of Technology or IIT (Parikh and Sukhatme, 2004). According to the latest statistics available from the Government of India (2004-05), in 2003 women received 32% of the bachelor's

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of engineering degrees and 55% of the bachelor's of science degrees awarded in CS; the participation of women in engineering was negligible until the mid-1980s. It should be noted that the CS curriculum in many accredited institutions of higher learning in India is similar to the United States; Indian departments rely on American curricula and standards and use American textbooks.

India is largely, what Mukhopadhyay and Seymour (1994) have called, a patrifocal society. In the patrifocal system, women are subordinated to the welfare of the family. Inheritance is patrilineal; all property is vested in, exercised through, and transferred from fathers to sons. Residency is patrilocal; girls are under their parents while they are unmarried and shift residency and allegiance to their husband's family after marriage. Upon marriage, men compound the family wealth by bringing dowry, whereas women diminish the family wealth by taking away the dowry. Family controls the selection of grooms/brides, as well as the marriage arrangements. Family lineage is patrilineal, or passed through the sons, who have specific ceremonial roles including funeral rites for the parents. The appropriate female behavior stresses adaptability to new environments or different conditions, obedience to family rules and authority, fondness for simplicity and home life, and sexual abstinence until marriage. If the daughter has an affair, the family's honor and public position is lost. At the political level, the Indian constitution provides for equality in education to all Indians, irrespective of caste, religion, and gender. However, the patrifocality affects Indian women's access to education in S&E at the social level. Female representation in S&E is low, despite the fact that over the years there has been a steady rise in the proportion of women entering universities (Indian National Science Academy, 2004), and women have been increasing their presence in CS since 1990.

Considering the patrifocal social milieu in India, historical exclusion of women in S&E, and the ideology and practice of scientific discourse, the question of importance is: How do Indian female students in CS enroll, learn, and accomplish in institutions of higher learning? This paper addresses the question: Why are women in India attracted to CS education at the undergraduate level, and how do they handle it once in the program? In particular, it examines Indian women's self-efficacy beliefs in computing.

Bandura, who coined the term "academic self-efficacy," suggested that task involvement and persistence are greater when an individual is confident of his/her ability to successfully complete a task (1977). The larger theoretical framework of self-efficacy is the social cognitive theory, which postulates that human behavior is continually under reciprocal influence from cognitive factors and environmental conditions. Accordingly, self-efficacy perceptions and beliefs about CS will influence whether students feel they should pursue and continue the study, how much effort they should apply to related activities, how they should persist if their education becomes more demanding and difficult, and their expectations for their overall performance. This paper, therefore, examines students' self-efficacy on several factors: early computer exposure, both at home and in schools; academic preparation for the study at the university level; encouragement from teachers, family, and friends for a computer-related career; effort expended on university courses; and the gendered perception of computing abilities.

2. METHOD

The paper is based on in-depth interviews that were conducted by the author with 60 female undergraduates majoring in CS in 2007-2008. The technique of in-depth interviews was selected because there is little detailed information on women studying CS in India. The study took place in two engineering institutes and two universities that granted four-year undergraduate degrees in CS. One campus was the top national engineering institute and the other was a well-known regional engineering institute. To ensure that minorities in India were included, one university was historically Muslim and the other was predominantly Sikh. Random sampling was used to select 15 subjects who were in their second and later years of studies at each institution. Once approached, all students participated in the study. The interviews were structured in the sense that only certain issues were covered, and they were also unstructured in the sense that they resembled private conversations with the subjects. Such a combination allowed subjects to express themselves in depth, while the author could maintain control over the topics and explore interesting leads. Each interview lasted anywhere from less than an hour to an hour and a half. The interview questions which formed the basis for this paper are outlined in the Appendix.

Interviews were recorded, transcribed, and inserted in the Nvivo program for data analysis. Two independent coders coded the same data to ensure reliability. Once all interviews were coded, the author analyzed the data for possible relationships between concepts and variations in the patterns observed. Attention was paid to the number and types of properties, noting not only how many subjects exhibited a concept, but also how often it emerged and how it exhibited itself. The Institutional Review Board (IRB) at the University of New Mexico, which granted the permission to collect primary data, requires that the names of sites and subjects cannot be disclosed. Below, findings are reported with interview excerpts to highlight the complexity of concepts and by frequency to show their strength.

All of the students interviewed were young, unmarried women between the ages of 19 and 22. They were in their second to fourth year of CS studies. Other than being a full-time student, none of these students held a job while attending their university. Almost all of them characterized their family background as middle class, with many specifying that they fit into an upper-middle-class category. Their depiction is reflective of the occupations of the students' parents, especially their fathers, who were professionally employed. Another indicator was that 40% of the sample had both parents working. Although the study took place in a predominantly Sikh and a historically Muslim university, almost 75% of students were born to Hindu families. Of the Hindu students, a majority were of the middle caste, with one-quarter belonging to high caste. Prior to attending a university, most students attended private schools and the rest attended central government schools. All these schools had English as a medium of instruction. These students were admitted in their current institutions based on their score in the institute's entrance exam or central/state board exam. Once admitted, they were allowed to choose their field of studies based on the marks they received in the exam.

3. FINDINGS FROM THE INDIAN CASE STUDY

3.1 Exposure to Computers

General computer usage prior to joining universities is an important variable in self-efficacy. Students were more confident in their CS abilities if they had access to computers at home and had spent some time using them as tools (Compeau and Higgins, 1999). Furthermore, the manner in which students use computers influences their computing abilities.

Few students (5 out of 60) reported having a computer in their home as a child; if a computer was brought into the home, it was when they were in the secondary schools (high school, consisting of 9th to 10th grades, and intermediate college, consisting of 11th to 12th grades). A little over half of the students (32 out of 60) had personal access to a computer, either in their high school years (15 out of 60) or in their intermediate college years (17 out of 60). The remaining 23 students had no access until they went to a university (Table 1). Of those who had access to a computer, nearly everyone used it to browse the web, chat with their friends or relatives, check email accounts, listen to music, and play games. Some used a computer to do school work or other kinds of work by using word processing, power points, and paint. Most students occasionally used computers in cyber cafés, which are easily available and inexpensive, though some used them at friends' or relatives' places.

TABLE 1: Exposure to computers at home

Subjects from	Comments
Top national institute	"When I was in the 9th or 10th grade, my parents bought a computer. But I did not work with it a lot because school kept me busy. If I used it, it was at a very minimal level." "My dad had a computer in his office, but not at home. There was no computer at home while I was growing up."
Regional well-known institute	"No ma'am. I did not have a computer at home. I used to go to the cyber café to do assignments, projects, and search for things." "My father used a computer for his office work. But it was out of my reach. But it created more curiosity in me."
Historically Muslim university	"When I was in the 7th or 8th [grade], one of my close relatives bought a computer, and we used to go to his place to play on it or watch movies." "No one in my family knew about computers to have one at home."
Predominantly Sikh university	"No. I got a computer in the 2nd year of my B-tech. Since my mother and father are working, they have computers in their offices. So they did not need one at home. When I joined a course for computer languages, my teacher just advised me to get one. And we got a computer a year back." "My father bought an old computer when I was in the 9th [grade]. But I did not do anything complicated on a computer, just played games."

Schools are important institutions for exposing students to a computer, irrespective of caste, class, gender, religion, and geographic location. Access to a computer in schools can enable students to acquire systematic computer experience and skills which otherwise may not be available to them (Adya and Kaiser, 2005).

Approximately one-third of the students (19 out of 60) either reported no computer facilities in their secondary schools or felt that there may have been computers but they did not use them. The remaining students (41 out of 60) agreed that their secondary schools had some type of computer facilities but disagreed on their quality and accessibility (Table 2). Low computer-to-student ratio, a lack of advanced software or applications, and electricity fluctuations led almost half of the students (19 out of 41) to rate their secondary schools' computer resources as basic or minimal. Another half of the students (18 out of 41) stated that their secondary schools had adequate or sufficient computer resources, such as a more equitable computer-to-student ratio, the presence of some advanced computing programs, or computer classes in which students were able to interact on a weekly basis with the computer. Yet many of these students complained that Internet access was either lacking or slow, and frequent power cuts limited use. Only a very small group of students (4 out of 41) praised computer resources in their secondary schools. These students reported taking a computer-oriented focus and had access to computers on a daily basis in computer labs that included advanced software or programs and Internet access.

TABLE 2: Computer resources in schools

Subjects from	Comments
Top national institute	"Our school had some computers. Our computer teachers had computers. But we were not allowed to use, just watch. Teachers said that students misuse computers."
	"Sorry. I did not see any computer in my school."
Regional well-known institute	"We had those things that were essential for our computer studies. Like Windows, Office, Pentium 4, etc. It is just that we did not have many, so a bunch of us had to share."
	"The computer resources? They were not good. We had PCs, but they were not working. Mine was a central government school and still it did not have working PCs."
Historically Muslim university	"In my school, computers were not for everyone. They were just for 11th and 12th [grade] students who opted for computer option."
	"We had a computer lab, a very basic computer lab. No Internet access. Basic software."
Predominantly Sikh university	"We were very happy when our school acquired five computers. It looked really good compared to those schools which had none." "We had a practical every week for 45 minutes. So 5 to 6 of us were grouped to
	use the computer. We used to open MS Word and go for options, power point, etc. We prayed for power not to go off during practical."

3.2 Pre-University Academic Preparation

An important factor of students' self-efficacy is how well their schools prepare them for CS study at the university level. Prior academic background, namely, in problem solving skills and the ability to persist in challenging situations, is generally considered a vital prerequisite for the coursework (Grant et al., 2009).

A little over half of the students (32 out of 60) claimed that their secondary schools did not prepare them well for the study of CS at the university level, about one-third of the students (21 out of 60) felt partially prepared, and the remaining 6 students believed they were fully prepared (Table 3). Students who blamed their secondary schools for not academically preparing them qualified their responses by pointing out that they were not actually trained in CS itself. Either their secondary schools did not offer computer classes, or if they did, these classes were poorly offered and did not facilitate a strong handling of the subject matter. Yet most of these students believed that their education in

TABLE 3: Pre-university academic training for computer science studies

Subjects from	Comments
Top national institute	"I didn't even touch a computer before I came here, and I have done very well so far. How is it possible? If you have good backing in math, you can learn a lot on your own." "In terms of general knowledge about computers, yes, they did. But they did not teach any programming, so I was not prepared. But I was prepared in math, thus ready for any engineering subject."
Regional well-known institute	"No. Actually the level is quite high here. High school and college studies are not at very high levels. So students who are interested in engineering have to do some extra coaching. This is what I did, took coaching in math and physics." "There are things about the computer they teach you in high school that they don't teach you here. So if you do not opt for the computer in high school, you miss out on some basics which professors here consider too trivial for them to teach."
Historically Muslim university	"I had taken the computer option in the 12th [grade]. It helped me a lot. Some of my classmates didn't even know how to turn on a computer when they began the program. They had a tough time." "I never studied computers in my high school or in college. But some of my classmates are pretty well versed than I am because they studied languages back in college. So they have a stronger background than me. My high school, my college gave me courage and taught me math to become bolder."
Predominantly Sikh university	"Not exactly. Back in school, I took general subjects such as physics, chemistry, mathematics, economics, etc. CS is an entirely different subject. So I had to join a coaching institution to learn computers before coming here." "They prepared me in basic subjects like math and physics. That knowledge is helping me a lot to understand computer science now."

mathematics was strong, and thus helpful, in engaging in CS. Students who felt partially prepared specified that their secondary schools offered some training in CS, along with strong grounding work in mathematics. Those students who thought they were fully prepared credited strong training in computers and mathematics in secondary schools. Many of these students had taken the non-medical option in the 11th and 12th grades, and thus knew they would be pursuing some sort of engineering degree. Many students, whether they assessed themselves to be little, partially, or fully prepared, received additional training from private tutoring or coaching in general subjects such as mathematics, physics, and chemistry before joining a university. Though students differed in their characterization of pre-university academic preparations for CS study from little to full, nearly all of them credited their strong training in mathematics.

Student responses toward secondary school academic preparation for the study of CS at the university level were double-checked against their best and worst subjects in the secondary schools. Some students listed multiple subjects as their best subject. An overwhelming majority answered mathematics (46 out of 60), followed by science (17 out of 60). Even among the 10 students who gave more than one subject as their best, 8 listed mathematics. Of the 6 students who claimed that they were good in all subjects, 4 went on to highlight mathematics. Computers as a subject received a very small showing as students' best subject (2 out of 60). None of the students listed multiple subjects as their worst subject. Social studies was the most frequent response, with over one-third of the students (24 out of 60) falling into this group. Languages ranked second as the worst subject of the students (17 out of 60), who especially found Hindi or their regional languages to be a problem. Lastly, the subject of sciences, especially chemistry, was reported as the worst subject by nearly one-quarter of the students (13 out of 60). Six students stated that they had no worst subject.

3.3 Verbal Persuasion

Information on self-efficacy is frequently distributed through verbal persuasion. Encouragement from family members, teachers, and friends to take CS coursework at a university can assist students to seek development of their computer skills (Simpson, 2003). It can further reinforce the notion that they are, or can become, a competent computer scientist or computer engineer.

Over one-third of the students (23 out of 60) believed either that no one influenced them to go into the CS field or that they were self-driven to enter it. Even when self-motivation was a major factor in their choice, some students still mentioned that family and friends supported their decision to study CS. The remaining students (37 out of 60) identified many people who influenced them to enter the field (Table 4). The majority of students credited their family members, not limited to, but mostly male family members, including fathers, brothers, cousins, and uncles. These male figures valued education and saw CS as a positive field of study for women. Often, they had some experience with engineering or computers. Interestingly, a small sample of students was influenced by friends (who were mentioned four times) and teachers (who were mentioned three times).

TABLE 4: Role models for computer science studies

Subjects from	Comments
Top national institute	"My older brother. He is an engineer, but he did his engineering in mechanical. He told me that I should go for CS. I can really do it. He was very inspiring." "No one inspired me for CS. I felt computers were ruling the world. So if I wanted to stay on the top, I needed to do CS."
Regional well-known institute	"No, I was not influenced. My parents tried to influence me to become a doctor because both of them are doctors. But they stopped influencing me once they realized that I have an aptitude for math, and not for biology." "My parents. They said that there is a wider scope in computers."
Historically Muslim university	"My uncle. He gathered all the information regarding CS. He told me that I should go for CS because it is a growing field. I was so thrilled that he went out of his way to collect the information." "No one. I am the first person in my family to go in engineering."
Predominantly Sikh university	"My parents. My father felt that computer science is a good field for girls. It is not the going out to the field kind of job. It is a comfortably sitting in a room, having coffee, and working kind of job." "No one in particular. But the IT industry influenced me. There are various opportunities in this field."

Continued support from family members can allow self-efficacy appraisal (Simpson, 2003). They can provide an emotional support, generate a supportive atmosphere, and reduce stressful situations, which can positively affect students' self-efficacy.

A large majority of the students (51 out of 60) reported that everyone was supportive of their study of CS; only a small number of students (9 out of 60) described their family members either as unsupportive or somewhat ambivalent about the study of CS (Table 5). Students used such language as "glad," "happy," "pleased,", "satisfied," "lucky," "fortunate," and "proud" to explain that the people in their lives were positive about the decision to go into the CS field and to study it at a university. A small group of students even detailed their experience by saying that originally their parents wanted them to go into a different field, but once they were in the program and doing well, most parents seemed to come around and be encouraging. Those students who felt that their family members were unsupportive and ambivalent about the CS program gave such reasons as their parents were unknowledgeable about computers, they did not know the opportunities available with a CS degree, or they wanted the student to enter a different field of study.

3.4 Persistence

Difficulty in the CS program is often related with CS anxiety, which has been noted as having a negative impact on students' self-efficacy. If students feel they cannot succeed in the CS program, they will try to avoid disappointing results of their efforts by finding alternatives (Cohoon, 2006).

TABLE 5: Family support for computer science studies

Subjects from	Comments
Top national institute	"They did not want me to do CS in the first place. They wanted me to become a doctor instead. But once I made my choice, they have been very supportive. Now they tell me that it is great that I followed my dreams." "This is my final year. I already have a job. So my parents are very happy that I chose CS."
Regional well-known institute	"They are very happy with it. They know I have a bright future. IT technology is growing day by day." "Studying in this institute and doing CS means a lot to them. You are respected, and it is kind of a sure thing that if you do well in this subject, you will definitely get a good job."
Historically Muslim university	"They are very happy. They never thought that their daughter would get into a technical stream. So they are very proud of me." "They are supportive. They think it is a good choice. One can get a job in a big company."
Predominantly Sikh university	"My parents are not computer literate. I won't say they are bad in education, but they are computer illiterate. So they say that everybody is doing CS these days. So it must be okay. Also, I am teaching them how to use a computer. They are thrilled about it." "My family initially was a little apprehensive. They wanted me to do commerce. But now they are fine."

An overwhelming majority of students (54 out of 60) had not entertained the idea of changing their major from CS to something else; only a few students (6 out of 60) had considered altering their major during their first year (Table 6). Many students explained that it did not cross their minds to switch to something else because of the benefit, opportunity, and independence they could gain from a degree in CS. A few students who contemplated the idea of switching had entered the program without any previous computer knowledge and thus found the CS coursework daunting at first. They also expressed that they were happy they had remained in the CS program and that after the first year they were much more confident about their abilities.

Observations of the successes (or failures) of fellow students provide standards against which students can compare their own performance. This offers another criterion for self-efficacy appraisal (Varma, 2007b).

A large majority of the students (48 out of 60) reported not knowing anyone who changed majors or dropped out of their respective CS programs. Only some students (7 out of 60) did know someone who had dropped out or switched majors, and the remaining students (5 out of 60) had heard of some students that had switched or dropped out, but they did not personally know of any such situation (Table 7). Students across the board explained that the goal for many students was to get accepted to the CS program, so leaving it was often looked at as a step backward. Most students who knew someone who had switched came from the regional universities. Four students seem to have switched to

TABLE 6: Considering to leave computer science studies

Subjects from	Comments
Top national institute	"In my first year, I wanted to change to electrical engineering. I was having a hard time because I did not have any background in computer and programming. But not after the first year. Once I got the grip of CS, I never thought about changing it." "I am pretty happy. I will not change that."
Regional well-known institute	"Not at all. I know that CS is difficult and hectic because I am in this branch. I do not know about other branches. But at this place nothing is easy. All branches have their own problems. So it is better to stick with CS than face new problems. Plus with CS, I can find a good job easily and earn for myself." "How can you think of changing your study when you are halfway through?"
Historically Muslim university	"I already changed my studies from biotech to CS because it has a great scope. I don't want to change anymore." "I am very satisfied with this program. I am doing well. Hence, I do not want to change it."
Predominantly Sikh university	"No. Computers are so important in today's world. Why would I change it?" "Maybe in the first year, I thought of it. I felt my background in computer was zero and I will not be able to do the degree. But by the 3rd semester of 2nd year, I found CS interesting. So not anymore."

electronics due to the demanding workload and intensity of the CS program. Two students dropped out of the program to get married, and one left to join the Air Force.

Finally, student self-efficacy is likely to be influenced by whether they have a clear understanding of what a CS career is all about (Varma, 2007a). Though students may not have adequate CS career knowledge in primary, middle, and secondary schools, knowledge is likely to increase at the university.

Upon completion of their CS degree, most students (39 out of 60) planned on joining the workforce; only some students (8 out of 60) desired to move directly into a graduate program, and the remaining students (13 out of 60) were undecided between pursuing a job or higher education (Table 8). Students who expressed their desire to join the workforce were confident about receiving placement into good information technology (IT) companies. Entering directly into the workforce was appealing to them due to the frequent job placement campus visits by company recruiters. They thought of employment as a positive step that would open up alternative paths for them in the future. Also, many of these students expressed that finding stable and respected employment would help to alleviate concerns their families had about marriage. The general perception was that women with a strong education and employment potential were becoming more and more desirable for marriage partners due to their ability to add income to the household. Students who expressed their desire to move directly into a graduate program felt it

TABLE 7: Fellow student retention in computer science

Subjects from	Comments
Top national institute	"No. I do not know anyone who moved to a different field. All of us finish CS degree. There is no culture of finishing halfway. There is a culture of going all the way in four years." "There is the option of changing. If students find hard, they can change to an easier program. But it is very rare. CS is very interesting."
Regional well-known institute	"CS is a branch that once you get in, you don't change to something else, no matter how hard it is. In fact, it is a privilege to be in this field. So people want to stay in it. They do not want to change it." "I do not know anyone who has changed the major. I do know of students who are not happy. But it has nothing to do with CS. It has to do with [this institute]."
Historically Muslim university	"CS is better than everything else. Students know this. So they are coming to CS from other branches. They are not going from CS to something else." "People are not leaving. They are coming to CS."
Predominantly Sikh university	"Not before graduation. But after graduation, students go for management or finance." "I know of one girl in my class who left the university after the first semester because she got married. That is the only case I know of. Otherwise I have seen girls getting into CS, not leaving CS."

would allow them even more opportunity than their peers, as well as a broader range of possible employment, and at a higher level or pay scale. However, most students hoped to pursue a graduate degree in business. They felt that a master's of business administration (MBA) would measure well alongside their CS bachelor's and would make them attractive candidates for managerial or finance positions within the IT sector. Very few students thought of pursuing a master's degree in CS. They had a passion for CS and felt it was important to acquire deeper knowledge in the field. Students who were not sure whether they would join the workforce or a graduate program cited two specific factors as highly influential on their decision: job placement and college admissions. The strength of their placement and whether or not they were admitted to the university that they wanted to attend were both significant factors in determining their final choices.

With regard to their plans for marriage, as Table 9 shows, a majority of the students (38 out of 60) reported that they planned on getting married sometime in the future, but most (34 out of 38) also stated that they had no desire to give up their hard-earned independence once married. They considered their degrees and ability to work in a well-respected field to be precious. Only some students (4 out of 38) expressed that their desire to work after marriage would be based on a number of factors, an important one being the input of their future husband and in-laws. Over one-third of the students (22 out of 60) explained that they were not contemplating marriage, either at that time, or for the future. For them, independence was a high priority, one that would be maintained through work, further education, or maybe even travel abroad.

TABLE 8: Future plans after graduation

Subjects from	Comments
Top national institute	"I want to study more. But I don't think it will be possible because my mother would want me to get married as soon as possible. So I will go for a job. If I have a job, I do not have to get married. If I get admitted with a scholarship, I will choose to study over a job." "After I graduate from here, I want to study for a couple of years. But I do not want to continue with the technical stream. I will opt for higher studies in management or finance because it is a short cut to lead a team."
Regional well-known institute	"Now I will go for a job. But after I have saved some money I will do an MBA. Scope with a CS degree is quite limited. Companies pay you more money with management responsibilities than just doing technical work." "Definitely job. I am looking forward to getting a good job in a good company. I want to acquire working experience and earn for myself. My parents have been putting a lot of money into my education. With a job, I can give them back some of their money."
Historically Muslim university	"Actually, I am from a poor family so I am looking for placement these days. My parents think my dowry will go down if I am working." "I am trying to get into the job market so I can be on my own feet. [God] forbid if I have to leave my parents' home to stand on my own feet. I am confident that with a job I can do that."
Predominantly Sikh university	"For me, study is primary. So my first choice is to do a master of technology so I can go for a teaching job." "If I continue to study, my parents will insist that I get married. They think it is hard to find a groom for a highly educated girl. So I see myself working after graduation. Working women are in great demand for marriage."

3.5 Gender

The relationship between gender and self-efficacy has been a frequent focus of research (Galpin et al., 2003). Studies show that male students tend to be more confident than female students in CS in the United States. Students' gender role stereotyping is seen as partially responsible for differences in confidence.

Almost one-fourth of the students (14 out of 60) believed that they were, in fact, superior to their male colleagues in CS; over one-third (24 out of 60) ranked themselves as equal with their male peers in CS; and the remaining students (22 out of 60) considered their male classmates to be better than them at CS (Table 10). Generally, the students who thought they were either better or equal came from engineering institutes; most students who felt that the men in the CS program were stronger came from historically Muslim and predominantly Sikh universities. Interestingly, all groups of students did not think gender was a deciding factor in who could do well in CS. Instead, students pointed out that there are more opportunities available to men than to women, causing some men to perform better. According to students, if women had the same opportuni-

TABLE 9: Future career plans after marriage

Subjects from	Comments
Top national institute	"I see myself working after marriage. People will not seek a girl from [this institution] if they want her to stay home." "I will clear things before getting married. I do not want my degree to be wasted."
Regional well-known institute	"Men do not change their lives after marriage, so I do not see why women should change their lives. I plan to work after my marriage." "I think my parents will find someone who has same views as mine and will support my career."
Historically Muslim university	"If I did not want to work after my study, I would have done home economics." "Now days, women are working. It is a common thing that women manage both a job and family. So I will be doing the same thing, I will not be doing anything great."
Predominantly Sikh university	"Girls working in good companies are in great demand. Men prefer wives to work to supplement income. So I see myself working after marriage." "It is parents' dream that girls get married and settle down. I am sure they will find someone who will support my job. They are my parents and would not want to see me sitting at home unhappy."

ties, they would do even better than men. Access to extra outside coaching, later hours in laboratories, the ability to travel more freely, and a longer span of computer experience were some of the factors that students described as leading to an uneven playing field. Students further believed that with hard work, women could improve their performance and even become superior to the men.

4. DISCUSSION & CONCLUSION

Despite general increases in women's enrollment in S&E fields, their representation in CS is not approaching parity with men's in the United States. Gains accomplished by women in the CS field by the 1980s have diminished over the last two decades (National Science Board, 2010). Increasingly, underrepresentation of women is explained by showing the relationship between gender and self-efficacy. Variables that affect women's entry in CS courses are the perception of the field as overly technical and programming-based, the belief in the difficulty in combining a career in CS with having children and a family, and the stereotype of the existence of the male culture (Beyer et al., 2004). Female students who do join the CS field face issues of competency, identity, and legitimacy. Whereas male students rate themselves as more comfortable using computers and have high self-confidence, female students underplay their computing abilities and confidence (Margolis and Fisher, 2002). Women have a harder time constructing a positive identity for themselves within the CS cultural environment. They have to learn

TABLE 10: Gender and computer science abilities

Subjects from	Comments
Top national institute	"Yes I am equal to them. Only in sports, I am not equal to them. Of course, I am not the smartest person over here, and that is not because they are guys or I am a girl. There are many guys who are not as smart as me, and there are many guys who are at par with me. And there are other girls who are extremely smart." "In this place, males are the majority. So we have all types of male students, good, average, and mediocre. There aren't that many girls. Only the best girls are in this program. So we are definitely above them."
Regional well-known institute	"Earlier they used to be better than me. It was not because my classmates were males. It was because they were from big cities, they went to good schools, they had a sufficient amount of exposure of CS, they knew some languages, [and] they had played with computers a lot. So they had the ease which I did not. But this has gone down." "Actually, CS just requires your brain. Both men and women have equal brains. So this issue does not come up."
Historically Muslim university	"I think I am below them. It is because we have limitation of coming back to hostels by 8 pm, but they don't have such limitations. The world is more open for them. So I have to work harder to get to their level." "It depends from person to person. It does not relate to being a man or a woman. It is your ability. You can be better if you work hard. You can be worse if you don't work hard. I am better because I try my best."
Predominantly Sikh university	"No, I don't find myself as strong as them because I never had computers, but many guys had fooled with computers before coming here. So they do have an edge over us." "In our class, female students are doing better than male students. But I am not among those women. In our class, the topper is a girl; every time she tops. Actually, we are as good as boys."

to translate "male talk" with few female reference points to look to for determining individual status (Irani, 2004). The end result is that the CS field is viewed as not being woman-friendly in the United States; it is perceived as masculine by the sheer number of men in it and its male culture.

Feminist scholars in the West have gone one step further from the underrepresentation of women in CS and the issues which women face upon joining the field to show that computer and the computer-related fields have a gender. They show how men have used the computer to maintain their control over women and have excluded women from participation in it. Computer technology is seen as gendered both in its design and use (Wajcman, 2004). The environment of CS is dominated by geek culture. At the heart of geek culture is a set of idealized male norms, such as falling in love with computers with the first exposure, being extraordinarily well versed in the inner workings of computers, myopically focusing on them to the point of obsession, and being antisocial

(Turkle, 1984). Geeks possess traditional masculine characteristics such as a fascination with technology but lack traditional feminine characteristics such as social skills (Varma, 2007a). These male norms circulate in everyday life, projecting the male way as the only way to be and do CS.

Contrary to the American case, women in India are not excluded from computing. Enrollment trends by gender show an increase in the number of women in the CS field in India. Studies conducted in Iran (Shashaani and Khalili, 2001), Hong Kong (Lee, 2003), Mauritius (Adam et al. 2003), Taiwan (Fan and Li, 2004), and Malaysia (Lagesen, 2008) also show that CS is a popular major among women.

This case study has shown that despite the digital divide due to economic and social factors, CS has been constructed as a woman-friendly field in India. Female students selected CS as their major based on a pragmatic assessment of the field, namely, strong possibilities for future employment, high pay scale, the ubiquitous presence of computers in occupational settings, the ability of a student to be on the cutting-edge of modern technology, a field requiring mental rather than physical strength, and working indoors on a desk rather than outside in the field. Most importantly, they believed that a degree in CS would allow for some independence in women's lives. With a high-paying job in the IT sector, they looked forward to standing on their own feet instead of being housewives, and even after marriage they anticipated enjoying a high social status by supplementing the household income. It is therefore no surprise that dropping out or switching from what is considered a hot career for women was not a choice; instead, the goals of those female students who were not in CS was to perform well enough so as to move into it. There was no disagreement among female students on the suitability of computing for women.

Yet, some of the reasons CS is well suited for women are also tuned with the Indian social context. For instance, in CS women can remain indoors where they will be guarded rather than outdoors where there is potential for harm. Also, "mental tasks" associated with working in the office are acceptable, but "manual tasks" involving physical activities in construction sites are not. Although this suggests a gendered construction of CS, albeit different from the United States, it should not be forgotten that women themselves viewed 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, and this is what a CS degree would give them.

Nonetheless, the masculinity of the CS field and the computer is not practiced in India as it is framed in the United States. Indian women are interested in computing because it is a means for them to secure financial rewards, gain prestige, become career-oriented professionals, and attain an economically independent status. A lack of resources and opportunities seem to be the main issues which women must overcome to do well in CS in India. This shows that socioeconomic context must be taken into consideration to understand how gender interacts with CS. It means self-efficacy must be measured in a context-specific way, and strategies need to be designed accordingly. It also means women in computing cannot be viewed as a globally homogeneous group.

Finally, this case study implies that after graduation women will have wider opportunities to enter and succeed in the IT sector. Just because women are being educated and trained does not guarantee they will have equal access, opportunity, and satisfaction in their employment as men. A case study of women in the IT industry in India shows the prevalence of inequality between genders and the patriarchal power structure (D'Mallo, 2006). This suggests that the findings from the present case study are limited to female undergraduates who are in the program. It shows that the reason for women's attachment to CS is that they are vested in the field.

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APPENDIX: INTERVIEW QUESTIONS

- 1. When you were growing up, did you have a computer at home? If yes, did you use it? What did you use it for? If no, how did you have access to a computer?
- 2. Were computers available for you to use while you were in the secondary schools? If yes, did you make use of computers? What did you use them for? How easily were they available to you? Where were they located?
- 3. Did your secondary school classes prepare you well to study CS at the university level? If yes, how were you well prepared? If no, what was lacking in preparation?
- 4. What was your best subject in the secondary schools?
- 5. What was your worst subject in the secondary schools?
- 6. What people influenced your decisions to study CS? How did they influence you?
- 7. What does your family say about your choice to major in CS?
- 8. Have you considered changing your major from CS to something else? If yes, why? What would you have changed to?
- 9. Do you know any student who was pursuing CS but switched majors or dropped out? If yes, what reasons did they give you for doing so?
- 10. What do you want to do with your CS degree after graduation? Do you want to go for higher education or a job? If you get married, do you think that will change your job or study plan?
- 11. Do you consider yourself in CS as strong as male peers in the program, stronger than them, or not as strong as them?
- 12. Background questions: What is your age? What is your marital status? Do you have children? If yes, how many? What are your parents' occupations? How would you characterize your family's economic background in terms of upper class, middle class, lower class, or others? How do you characterize your religion? If Hindu, how do you characterize your caste in terms of upper, middle, lower, or others? Did you go to private or government secondary schools? What was the medium of instruction in your secondary schools? Do you have a job in addition to going to university? Are you a full-time or a part-time student? Typically, how many courses do you take in a semester?