Chapter 3
Paradox of Empowerment and Marginalization

Women in Computer Science in India

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Despite various initiatives by the National Science Foundation, information technology (IT) companies like Google and Microsoft, and nonprofit organizations such as the National Center of Women in Information Technology to achieve gender equality in computer science (CS), the proportion of women studying CS remains low in the USA. Since 2000, the share of CS bachelor’s degrees awarded to women has declined by 10%. In 2013, women earned only 18% of bachelor’s degrees in CS (National Science Board 2016). The same is the case in Europe where women represent around 17% of total graduates in CS (Ansip 2014).

The dearth of women in CS in the USA and Europe, however, can be contrasted with the situation in non-Western countries. Studies conducted in Iran (Shashaani and Khalili 2001), Hong Kong (Lee 2003), Mauritius (Adams et al. 2003), Taiwan (Fan and Li 2005), and Malaysia (Lagesen 2008) show that CS is a popular major among women. Despite no special initiatives undertaken by the Indian government, IT companies, or nonprofit organizations to encourage women’s enrollment in CS, there are a large numbers of women studying CS in India (Varma 2009, 2010, 2011). Since India’s independence in 1947, women’s participation in higher education has been growing. In 1950, women accounted for just about 10% of all students in higher education, yet, by the year 2011, women accounted for 44% of students enrolled in higher education (Frehill and Cohoon 2015). Enrollment data shows that women constituted 42% of students in CS and computer engineering at undergraduate level, 67% at master level, and 53% at doctoral level (Government of India 2012/2013).

Does this imply that CS is a “women-friendly” field in India? Based on in-depth interviews with female CS students in India, this paper illustrates the prevalence of gender issues in CS, despite the high presence of women. It reveals a paradox and
argues that female students seem to be empowered with a degree in CS and yet they remain marginalized within the Indian social setup.

3.1 Theoretical Framework

In the last two decades, the scholarly literature specifically on women in CS in the West has grown (Ahuja 2002; Cohoon and Aspray 2006; Singh et al. 2007). Overall, existing research has identified a number of factors that contribute to the relative paucity of women in CS in the USA and Europe.

It has been argued that there is a subtle gender-based socialization, which shapes the expectations of parents, teachers, and the students themselves that CS is more suited for men than for women (Varma 2002; Beyer et al. 2004). A number of studies have focused on the objective conditions, namely, the digital divide, the small proportion of women among CS faculty, gendered recruitment techniques and pedagogy, and the harassment of female students by their male peers (Katz et al. 2003; Varma 2007a). Another set of studies have highlighted how women’s subjective evaluations of their self-efficacy lead to alienation and a feeling of not fitting in, which makes the study of CS unappealing (Irani 2004; Varma et al. 2006; Grant et al. 2009). Most importantly, several studies show the CS field as dominated by the “geek” culture—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, being myopically focused on them to the point of obsession, and being antisocial—from which women distance themselves (Kvande and Rasmussen 1989; Rasmussen and Hænès 1991; Stepulevage and Plumeridge 1998; Margolis and Fisher 2003; Varma 2007b).

There are four main feminist theories that have addressed the question of women in IT. Reconfiguration feminist theory emerged in the early 1980s when gender was not considered an analytical category in the social analysis of technical developments. For instance, Cynthia Cockburn (1983) showed how men have used new technologies to assert their dominance over women. Using the example of the printing industry, she illustrated that men defined themselves as skilled compositors since they were responsible for hot metal composition, which has to be lifted (about 50 lbs) in printing. They protected their gender positions by claiming that compositors had to be men since women could not lift large weights. Further, they defined women as incapable of dealing with printing technology and did not permit composition work done by women to be printed. As a result, the gains of technological innovation were unevenly distributed, giving men more access to technical jobs and higher pay than women. Moreover, much contemporary scholarly research has shown that women have been excluded from the computing field and how such exclusions have contributed to the dynamic between CS and masculinity (Peterson 2007).

Cyber feminist theory focuses on the specific area of cyber culture and gender. It is based on the assumption that cyberspace and the Internet are inherently democratic
spaces, open to everyone and devoid of gender. In the world of IT, women can be liberated by breaking out of restrictions imposed on them through long history of masculine domination. For instance, Sadie Plant (1997) addresses the male as “1” and female as “0”. She sees an emerging world of women and IT set against the old world of patriarchy. She celebrates new cyber technologies as central in the fundamental shift in power from men to women and shows the inclusion of women in the World Wide Web, Internet, and other net-based communication technologies.

Cyborg feminist theory is neither positive nor negative about IT. Instead, it views IT as both an opportunity and a threat. For instance, Donna Haraway (1991) defines the cyborg as a cybernetic organism, a hybrid of machine and organism, a creature of social reality, as well as a creature of fiction. She argues against naturalism (all phenomena can be justified in terms of natural causes) and essentialism (all entities of the same kind possess a common set of characteristics), since these see innate differences between men and women, which are used as an explanation for why there are so few women in IT. Further, she proposes taking into account race and class to show complexities and contradictions in the relationship between gender and IT. She seeks to create coalitions based on affinity instead of identity since IT comprises extensions of the human body.

Finally, technofeminist theory seeks to find a balance between pessimistic ideas about gender and IT on the one hand and utopian ideals on the other hand. It sees IT as an opportunity for women to further their progress in the technological arena. For instance, Judy Wajcman (2004) sees IT as both a source for and a consequence of gender relations. She sees men as ill prepared for a postmodern future and women as ideally suited to the new technoculture. She regards women as more skilled communicators than men in the occupations that rely on information. She contends, however, that technologies are gendered in both their design and use, and women will not find computer technology liberating to them until they start designing it.

These theories start from the assumption that CS and the world of IT is male dominated. However, rather than being a universal assumption, this is an Anglo-Saxon and Eurocentric portrayal of CS. In contrast, women’s participation in CS in India is relatively high in terms of the enrollment data, as mentioned earlier. This chapter raises the question of how useful and applicable these theories are for understanding women’s position in CS in India. The chapter argues that an analysis of the Indian context for CS and the cultural/social meaning of gender in India allows for a fuller reconstruction of gender and CS.

3.2 Method

This chapter is based on in-depth interviews that were conducted by the author with 60 female undergraduates majoring in CS in India in 2007 and 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 technical institutes and two universities that granted 4-year bachelors’ degrees in CS. One campus is the top
national technical institute, and the other is a well-known regional technical 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.

Interviews were recorded, transcribed, and inserted in the NVivo program for data analysis. Two independent coders coded the same data to ensure reliability. Typically, students gave multiple answers; thus, two tables were created—primary/first response and how often a response occurred. 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 that concept exhibited itself. The Institutional Review Board at the author’s institution, which granted the permission to collect primary data, requires that the names of sites and subjects are not disclosed.

The interview guide comprised questions dealing with demographic information, early schooling, IT resources in schools/at homes, family support for education, precollege career aspirations, the CS program at their institution, and CS gender-specific issues. The following five (and demographic questions) questions posed to female students formed the basis for this paper:

- Are careers with a CS degree attractive to women? If yes, how? If no, why not?
- Why do you think there are so few women that study CS in your program?
- What attracts men to study CS in your program?
- Do women encounter obstacles that men do not in your CS program? If yes, can you give some examples?
- Do any incidents come to mind that are related to being a woman in your CS program? If yes, could you elaborate?

### 3.3 Findings

Since this is a qualitative study, findings are reported with interview excerpts to highlight the complexity of concepts and by frequency to show their strength.
3.3.1 Demographic Information

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 specifing 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 was of the middle caste, with one-quarter belonging to a 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; these students enrolled themselves in CS.

3.4 Attraction of a CS Degree for Women in India

In response to the question whether careers with a CS degree were attractive to women, all students enthusiastically said "yes" and gave various reasons for it, which were characterized into three categories. The majority of students (84% total response, 54% first response) identified high-paying job opportunities with a CS degree. The next category mentioned by the students (73% total response, 34% first response) was the good work environment that a CS job provided. The remaining students (39% total response, 12% first response) pointed out social and psychological benefits such as independence, self-esteem, and social status as making CS degrees attractive to women.

A large majority of students claimed that a CS degree would provide many prospects within the job market. They explained that because computers and computer resources are a growing part of many different fields, employment opportunities could be found in multiple sectors, fields, and locations. Students, mostly from technical institutes, also looked forward to the jobs in big multinational companies. They also believed that a CS degree increased the likelihood of beginning a career immediately after finishing their degree, as well as improved career security. In addition to finding jobs, students reported expectations that IT jobs come with a higher salary compared to other fields. High pay certainly added to the attractiveness of a CS degree since it was perceived to offer women a better standard of living.
and a better future for themselves and their families. The following interview excerpts illustrate these three aspects—employability, security, and social status:

CS is more attractive than other branches of engineering because it gives you job security. You are bound to get a job in a big software company. You even have a prospect to get a job in a multinational company [and] thus travel abroad (National Technical Institute).

Because it pays a lot. This is the most important thing in women’s minds... We have not earned much thus [we are] not valued. With a CS degree, we can earn a lot and be more valuable, more respected everywhere (Regional Technical Institute).

If I had opted for BSC, then I will only get a teaching job in a private school with 3,000 or 4,000 rupees per month... with a B-tech in CS, I can work in a private company and get at least 25,000 per month (Predominantly Sikh University).

In our country, CS and electronics are supposed to be the top most branches. Plus, you have more options open after four years in terms of high-paying job, working in big companies and going abroad. Other branches are limited to some extent (Historically Muslim University).

The second group of students described a comfortable work environment of CS jobs as an important factor as to why a CS degree was so attractive. They elaborated that they considered CS jobs as generally desk jobs, in which an employee worked in a secure office. Some students added that they would have air conditioning and get to drink coffee, further detailing the expected level of comfort that women would receive in these work settings. In addition, they would not have to travel often, work in a construction field or in a factory, have on-site visits, or work in dangerous places. Also, they would have regular daily hours instead of the random time structures associated with medicine. For these reasons, students believe that parents are much more pliable in consenting to women’s desires to maintain employment. Some students even said that CS jobs are family friendly, meaning that they earned familial support or approval. The following interview excerpts are examples from the “good working environment” category:

If you go into any other field like mechanical or chemical, you will be employed in a factory and do the physical labor... Even in medicine, you will be standing the whole day and work long hours. In CS, you are sitting in your office, which is a safe environment; still you contribute a lot to the society (National Technical Institute).

You don’t have to travel a lot. Your family will not like you to do a job, which involves traveling even if you are interested in it. They don’t like you going out in the sun, spending the whole day in the field and talking to field workers. With a CS job, you sit in a room, in air-condition room and program something or debug something (Regional Technical Institute).

With CS job, you can balance your home life and work life. It is not possible in many other engineering branches because of off-site work, travel, unusual hours, etc. (Predominantly Sikh University).

Most people in India say that the women should not do physical work. So, families don’t like women to go out and do physical work. This is not the case with the CS jobs because they involve mental work. So, families don’t create barriers for women to work in the software industry (Historically Muslim University).
Family and social controls are complex social tools that make freedom difficult for many Indian women. A CS job was perceived to provide women with independence and the freedom to dictate how they want to live their lives, at least to some degree. One of the strong appeals of the CS program was that students felt that it ensured that they would find a job immediately after finishing their degree and thereby help them to evade marriage and their parents’ plans. In addition, they felt that CS jobs would provide them with the attributes of a respected job and self-confidence, attributes that are out of reach for many women. Some of the students even claimed that by holding jobs in CS, women would be helping to elevate the status and dispel negative perceptions of women throughout the country. Others said that a job in CS would allow them to exercise their minds regularly, with critical and analytical analysis that will prove that they have the ability to be rationally minded, similar to their male counterparts. According to them, the ability to perform the technical and logical parts of the job also increased women’s standing in society at large. Below are female students’ voices on the “social benefits” that they believe they will experience following a degree in CS:

CS courses are very logical. It is not like chemistry where you have to memorize symbols and formulas. It is also not like biology where you have to memorize technical words and definitions. In CS, you have to think why this is happening? Why not this way? Why not that way? So, it helps to change the image of girls that they cannot think and they can only memorize subjects. (National Technical Institute)

Actually CS is a technical field. So, doing well in it tells the whole world that you are intelligent, you are analytical, you are technically very strong. You end up feeling good about yourself, about your abilities. You start developing confidence. You become a different person. (Regional Technical Institute)

CS jobs come with a lot of prestige not only for you, but for the entire family. Neighbor starts praising you because they think you have a sharp brain to figure out how to make [a] computer work... This gives you a lot of respect, builds a lot of confidence in you. (Predominantly Sikh University)

Ma’am, you don’t know how hard it is for women to live in India. We have to get approval to do what we want to do. CS will make life rather easy for us. It will give us freedom to be on our own feet... It will give us a good package job, which will allow us to do what we would like to do. (Historically Muslim University)

### 3.4.1 Status of Women in CS in India

The students were asked to reflect on the status of Indian women in CS, often understood as a male-dominated field. Students’ responses were characterized into three categories. The collective answer of the majority of students (68%) acknowledged the existence of a gender gap, developed from a mixture of social biases and structural obstacles. However, students were not uniform in their interpretation of the situation. Indeed, the remaining students (32%) asserted that there was not a significant gender gap. They cited either other programs with worse ratios, the belief that CS was actually a positive fit for women, or that the ratio in the program was near
parity. They also stated that the numbers of women in their CS program were growing so that any gendered imbalances were narrowing. Below are some interview excerpts that refute uneven representation of women in CS:

Ma'am, it is other way around. You find more females in CS than in other fields of engineering. (National Technical Institute)

The number of girls in CS is increasing. If you look at other branches such as mechanical and civil, the numbers of girls is much less. (Regional Technical Institute)

I don't think you are right. We have fifty/fifty ratio. So, your question will not apply here. There are many girls in our class. The toppers are girls. (Predominantly Sikh University)

It is not true that number of women is low in CS. Actually, it is more compared with many other fields here. If you go to physics or mathematics, you will hardly find any female. True, we are low compared with biology where most women tend to go. But, it is changing in CS. (Historically Muslim University)

The most frequently given explanation as to why fewer women went into CS came from students (77% total response, 45% first response) who felt that social/cultural standards and perceptions prevented many girls from entering technical fields. The most popular response was that many Indians envisioned technical fields, especially engineering as being male-oriented fields. Along the same lines, students referenced the social perception that girls were supposed to go into feminine fields such as medicine, biology, commerce, arts, or social studies. Some of them described the perception that women did not belong in college at all. This belief went hand in hand with the idea that women's first priority was marriage and raising a family. They stated that families pressure them not only to marry after 12th class (17–18 years old) but also to stay close to home. They further gave examples of their friends whose degree in CS created hardship because families then had a more difficult time matching their daughters to "proper" grooms. Below are some interview excerpts showing the "social bias" women face in contemporary India:

This is because of the conception in high school that only boys go into engineering and girls go into medical, humanities or commerce. So, girls do not pick the engineering stream when they finish high school [ninth to tenth schooling] and go to intermediate [eleventh to twelfth schooling]. Even if they want to pick the engineering stream, parents will not let them because they think that boys have better aptitude for technical things than girls. (National Technical Institute)

In India, family plays a big role. Without their support, girls can't do anything. From the very beginning, from childhood, the parents keep paying their attention toward the boys. They think boys must study. They will not take no if boys do not want to study. But, they don't think that girls must study. They think it will be good if girls study but they are not worried like they are for boys. So, girls themselves believe they do not need to study or work hard... And CS demands you to be very good in study and work hard. (Regional Technical Institute)

Ma'am, I am somewhat shy to say this. But my parents are concerned that if I study a lot I will have a problem in getting married. They will have to find a boy who is more educated than me. Because I am studying CS, they are worried that they will not find an engineer groom. We belong to the business community and not many boys study engineering... My parents will not allow me to do [master of technology] because it would mean even more problem in getting me married. (Predominantly Sikh University)
There is a perception that women should be excluded from higher education because their final destiny is marriage and raising kids. The four walls of the house is just their destiny. So, many people are still living in the old world. (Historically Muslim University)

The remaining students (48% total response, 23% first response) pointed out that a reason why so few women were in CS was because they lacked support in one form or another, including motivation or encouragement on one side and opportunities or financial backing on the other. Some of these students explained that without the resources to afford proper coaching to help students do well on the entrance exam, any students would have a hard time. The following interview excerpts display “structural obstacles” which women experience to succeed:

It is because parents spend lots of money for boys and they spend very little money for girls. Getting into [National Technical Institute] requires a lot of coaching in good schools, a lot of financial support from the parents, which is mostly kept for boys. Then there should be mental or emotional support and families need to provide that also to boys. Most families think that girls do not need mental or emotional support since they know how to adjust. Since families are supporting mostly boys, you see more boys going into CS. (National Technical Institute)

Parents would not send their daughters to good private schools and good coaching centers because they are expensive. They think that it is more important to spend money for girls’ marriage than for girls’ studies. (Regional Technical Institute)

Well, I really had to convince my parents to allow me to study CS. They were not keen because they are keeping money to spend on my marriage and they did not want to accumulate new expense. (Predominantly Sikh University)

Well, thinking of Indian people is not so much developed. They don’t think that girls should study to get a job. They think that girls should study enough to get married and nothing more... Girls must obey parents. They do not have any money of their own. So, when they think of their future they have to consider resources which parents will be willing to give to them. (Historically Muslim University)

3.4.2 Attraction of Indian Men to CS

In response to the question what attracts men to CS, the students from all institutions described a combination of push and pull factors that helped propel men in the direction of engineering in general and CS in particular. In general, students from all institutions reported answers in comparable numbers, showing that the reasons for men’s success are relatively agreed upon by female students across the country. It should be noted that what students characterized as push and pull factors are not opposite to each other; instead they are two sides of the same coin, namely, the culture of masculine dominance.

The large majority of students (82% total response, 63% first response) said that motivations for men to enter CS came from the pull factors that the field offered. They believed that the field of CS allows for a high-earning potential, which is a major concern for many men, especially considering that they are supposed to be the family providers. Some students went so far as to say that their male peers did
not care so much for CS in itself as they did for the high salary they could earn with a CS degree. Other students felt that CS is seen as a "boom field" for men with a lot of job opportunities both in India and abroad. In addition, some students stated that men have natural predilections toward engineering, technical gadgetry, and computers. A couple of students suggested that men enter the CS field because it was developed by men, for men, and is continually dominated by men. Below are some interview excerpts, which show the “pull of CS” for men:

The contention is that men go for engineering. Within engineering, CS is the top-notch branch so they opt for that... With a CS degree, they will get a good job with high pay, for sure. So men prefer CS over let's say chemical, civil or mechanical engineering. They go to other fields if they are not accepted in CS. (National Technical Institute)

Ma'am, boys think they are good with technical stuff. They think they can manipulate computers. They think they are brainy. They feel superior among friends and family if they are in the prestigious field of CS. (Regional Technical Institute)

Boys opt for CS to make money. There is a perception that with a CS degree, one can work for a big multinational company. One can make a lot of money by getting a good job package. (Predominantly Sikh University)

Because men have a superior position in the society, they want to dominate everything that is new and powerful. This is the case with computers. We are living in the computer age. The whole of India is changing with computers and they have to take over that field as well. (Historically Muslim University)

The remaining students (53% total response, 37% first response) identified the push factors toward CS. According to them, the Indian social context pushes men to be financial providers by being in a technical field. The students generalized that the cultural norm is that men must earn income for their family. Families, therefore, raise their sons with the idea that technical fields are the appropriate pathway for them to take in schools and colleges. This social perception is sustained by financial assistance to men in the form of good private schools and top coaching centers. In addition, there is constant encouragement from family, teachers, and community for men to prioritize technical fields. Interestingly, while both men and women might experience the “pull factors” of CS, such as status and higher salaries, the following interview excerpts describe the “push for CS” that only male students enjoy:

If a guy says that he wants to study humanities or English he would get opposition from his parents. But if a girl says that she wants to study humanities or English, parents will welcome that. So, parents push their sons to study CS but they do not push when it comes to daughters. (National Technical Institute)

Basically men have always been encouraged to study engineering to be on their own feet. They are pushed to study CS to earn high income, provide for family, and make parents proud. (Regional Technical Institute)

Well, men don't have to prove themselves that they are good with computers. Parents, relatives, friends, and schools give computers to them. It does not matter whether they want them or not. (Predominantly Sikh University)

They are told to study CS by parents, friends, and teachers. It is because everyone expects men to earn money and the CS field is where one can earn good money. Women are told to settle down, get married, and raise children so they join CS after men have saturated the field. (Historically Muslim University)
3.4.3 Obstacles Encountered by Women in CS

When asked to describe the obstacles women encounter in their CS program, the students illuminated a range of impediments that showcase the uphill struggle women face on both societal and familial levels. Many connections are presented between the different obstacles that the students reported, such as the linkage between the problematic social perceptions ubiquitous to Indian culture, the dearth of support women receive, and the family restrictions or pressures women must contend with before entering college or the workforce.

A large majority of students (62% total response, 47% first response) labeled a structural restriction at some level as a hurdle women had to deal with to do well in CS and get a job. These students mentioned the difficulties for female students caused by colleges or the hostels that women reside at while attending college. Because of curfews imposed on women at the hostels, or times at which women were no longer allowed to work in the laboratories, female students had a more difficult time completing group projects, especially when trying to work with their male peers. These students further reported that employers queried women about whether they had permission to work from their parents or husbands, whether they would be able to travel, and what the women’s marriage plans were. According to them, these types of questions were never asked of male applicants. Interview excerpts below show “structural restrictions,” which women face to do well in CS studies and join the workforce:

I will give you a simple example. Recently, I did a project for which I needed some things that were not available in the close by market. It was not easy for me to go to the other market and return to hostel on time. So, I had to get hold of guys and request them to do a favor for me. They have no problem getting anything from anywhere... What comes naturally for boys, girls have to struggle for the same things, even for such small things. (National Technical Institute)

Yes. I stay in a hostel. So, I cannot go for night help. I must finish everything between 7 and 8 pm... These are hostel rules. But, boys have no problem in getting these extra things. There are no hostel restrictions for them. So, they end up getting more knowledge because of such opportunities is automatically given to them. (Regional Technical Institute)

Yes, ma’am. Companies prefer boys for job because they can take a job anywhere. But for girls they are not sure if we can relocate ourselves or whether we will remain with the company once we get married. They ask questions to find out these things but they do not ask boys such questions during placement. We have to convince them that our parents are different and they will allow us to work away from home or that we do not wish to get married for another 4-5 years. (Predominantly Sikh University)

Ma’am, lots of obstacles for women. Like in job placement, unless you are extremely good, companies will not hire you. They think we will get married and quit the job. So, they will hire guys even if they are average and girls only if they are exceptional. (Historically Muslim University)

Over half of the students (52% total response, 36% first response) presented evidence that the obstacles women encountered came from gendered societal perceptions about who should go into technical fields. These answers illuminated the
deeply rooted social beliefs that engineering was a male-oriented subject and that women were not right for the field. Another aspect of the social attitudes that presented hindrances for girls were the ideas that women were not supposed to go for post-11th and post-12th class education and that their role was to become wives and stay-at-home mothers. Students from all institutions brought up these beliefs, some saying that they deeply affected how parents and teachers treated girls, and even stating that many women internalize these ideas. These biases reflect authority figures’ priority toward men over women, such as teachers who showed heightened interest in the education of male students or parents who chose to spend money only on their sons’ education. Below are some interview excerpts, which show the persistence of Indian “gendered technical education”:

When we had a workshop in the first semester, we were supposed to chop a piece of metal and then file it. No girl was allowed to use the machine. Teacher said that physically it will be better if boys use the machine and girls watch them how they are doing it. Such things always come up for girls. (National Technical Institute)

People think that girls can’t do CS because they do not have technical mind or engineering is for men only, engineering is men’s job. I think this perception is the biggest obstacle. (Regional Technical University)

Yeah. Society believes that women are not better than men in technical education. This is a common assumption, which everyone makes, because of which many women believe that they are not better than men... God has made us equal. We both have brains. But the common assumption is that men are better. So, this kind of thinking makes life very hard for a woman. (Predominantly Sikh University)

Yes, definitely. All rules are made by men for themselves. So they have set a lot of restrictions on women. It has made Indian society rather a male-dominated society. For example, men must work and women must stay at home. Men must study and women must get married. Men must go for technical lines and women must go for arts lines. Men must have freedom to do what they like and women must get permission to do what they would like to do. These are obstacles which women face most of the times. (Historically Muslim University)

Some students (34% total response, 17% first response) explained that women were often forced to make compromises within the family, putting their desires aside to go along with parental decisions. Family pressures certainly present a major obstacle that women have to overcome to enter the field of CS, backed constantly by a context of social attitudes that compel girls to heed their parents’ word. The following interview excerpts show the “family constraints” that prevent women from moving ahead in their own desires:

So many of my friends were as good as me, but parents did not want to spend any extra money on their daughters so they can join coaching, which they did for their sons. (National Technical Institute)

Yes, ma’am. There are often obstacles. I want to go for higher studies after this degree. But, my family is not allowing me to go outside [this city]. They feel insecure. For my brother, they allowed him to go abroad. For him, they do not feel insecure. Still, my family is better because they allowed me to study here. Many friends of mine were not allowed to go into professional college because they were girls. (Regional Technical Institute)
I think I am somewhat privileged. My parents are educated and open-minded. But not everyone is lucky like me. Many of my friends are treated from their childhood they must learn household works so that they can get married. They go to school to get a good match. If you are not educated up to high school or so you will not find a good match. This is very partial, very biased. Parents are educating their daughters so they can find a good husband. Boys do not get education so they can get good wives. (Predominantly Sikh University)

Society places lot of restrictions on girls. Like most of my friends have already been married. Parents get worried if girls do not get married by 20 or 21. But for boys it is okay. They can get married late. So, there is a pressure on me also. And every time I have to argue with my parents to let me study. (Historically Muslim University)

3.4.4 Incidents Related to Being a Woman in CS

When asked to describe specific incidents that are related to being a woman in their CS program, a small minority of students (17%) had nothing to say. They simply stated, “No,” “Nothing,” or “I don’t think so.” The overwhelming majority of women (83%), however, reported a wide range of different incidents that they faced because of their gender. These incidents ranged from what may be construed as trivial teasing to outright bias toward male students. Although most incidents were specific to the CS program and occurred on the campus, some pertained to family and education.

To begin, one-quarter of students (26%) mentioned activities that fit into the category of biased treatment, mostly from teachers. Students described a range of biases that showed professors having unequal expectations of male and female students with the result being that women had to work harder and perform better to achieve the same acclaim. Biased or preferential treatment also took the form of teachers singling out female students for questioning or reprimand. Below are some interview excerpts on “teaching-related incidents”:

In our training program, there were two girls and a bunch of boys. All of us gave our bio-data to the trainer. He looked at boys’ bio-data and took them. He did not conduct any interviews. But when it came to us, he interviewed us. He wanted to see if we have the knowledge and we are mentally prepared for the training. (National Technical Institute)

In my second semester when I entered into the practical exam, I was very nervous. But to my amazement, professor did not ask me any question about the subject. Instead, he was asking stuff like what does my father do and how many siblings I have. These questions had nothing to do with the practical. He has his mind set that girls cannot do engineering, and he did not hide his mind. I was pretty hurt at that moment. Then he said that I could go. I got really frustrated. I asked him to ask me questions on the practical. Then he asked me one question, which I was able to answer. I got pretty good marks. Now I am having fun telling this, but at that time it really hurt me that girls cannot do engineering. (Regional Technical Institute)

Actually, there is a difference between boys and girls. Our teachers will give things first to boys or will make boys group leaders. We only get things if there are extras. We only become group leaders if there are no boys left. (Predominantly Sikh University)
In the first semester, we had a workshop. We were divided into groups for practical. I was the only girl in the practical group. So, I got picked out a lot. It was not in a very bad way. It was more like too many questions were directed toward me. It seemed to me that they wanted to prove that I am wrong and they could say that I am not supposed to do it like that. It was not very disturbing, but it was not pleasant either. (Historically Muslim University)

The next set of incidents narrated by the students (21%) centered on gendered restrictions either from curfews in the hostels in which they lived, from being excluded from male hostels, or from being prohibited from going out at night by themselves. A gendered restriction was created by the fact that male and female students could not enter each other’s hostels, thus curtailing the female students’ abilities to network with their male peers. This was an issue because the male hostels are seen as impromptu networking sites. It also gave the male students an edge with regard to complicated assignments and group work. Travel for possible internship, additional training, and job interviews was also a problem for women; it is more socially acceptable for a man to travel alone than for a woman. Below are some interview excerpts on “hostel-/travel-related incidents”:

There is one thing that comes all the time. Because sometimes we have to do assignments in groups, it is hard to find students. Generally, boys do not like to form groups with girls. I have many friends who are boys. But when it comes to doing an assignment, they do not include me. It is mostly because I can’t go to their hostels or they can’t come to my hostel. So, we have to work in the labs and not many students like to stay in the labs throughout the night. (National Technical Institute)

Because I am a female, I get less exposure compared to boys. They can go out in the evening and meet other people. Going out is not a risky thing for them. But, I can’t do the same. It is a risky thing for me... So, they end up learning a lot more because they have more people to interact with and share knowledge with them. We miss out on such opportunities. (Regional Technical University)

Generally the problems with the girls are they can’t move in the evening. Even our hostels they are closed after 6:30 pm. In summer it is around 8 pm. So, we are bounded. The boys are not bounded at all. If they want to go out of the hostel they can go. (Predominantly Sikh University)

My parents require me to be home as soon as classes are over. So, I can only work with others in between classes, which no one likes to do. (Historically Muslim University)

Another set of incidents narrated by students (18%) was specific to home and family. These students explained that they received less support than their male siblings regardless of that support came in the form of financial assistance or emotional encouragement for higher education. This was mostly because sons are seen as providers for the family, whereas girls are expected to leave home after marriage. Some students explained that parents and relatives also feel that women should not waste too much of their time with a technical education when the ultimate goal for them is to get married and raise a family. Below are some interview excerpts on “family-/home-related incidents”:

Most of my male friends discuss their future plans with their parents, whether they should go for higher education or work. If higher education, whether they should do it in CS or in business. When I discuss my future plans with my parents, they say you should get married after your study, and then you should do anything you like. Marriage is not a variable in my
male friends' future, but it is in mine. My parents supported me in my study. But, now they are not supporting me to go abroad for a PhD. They want me to settle down first. So, I want to take a job to enjoy my life. (National Technical Institute)

Because I am a girl, my parents were not keen on spending money for me on coaching when I was in 11th and 12th standards. They did not hesitate to spend 50,000 rupees for my brother. It is same with my other friends. Parents think girls will leave home after marriage so there is no point to spend extra money on them. Generally, girls are equally intelligent as boys, but parents are not prepared for that. (Regional Technical Institute)

I am the only child of my parents. My dad wants me to be independent. He wants me to be ambitious. But, then he did not let me go to [X university] because he did not want me to be alone in a new city. [X university] is much better than this one. (Predominantly Sikh University)

One classmate of mine had to drop out in the second semester due to the pressure from her parents. She wanted to study but now she is getting married. She is learning cooking and going to beauty parlors. Her parents say that she can study after marriage also, but it rarely happens. Many of my friends want to study but they are under pressure from their parents to get married. I know some will not be able to further their dreams. (Historically Muslim University)

Finally, some students (15%) reported incidences of "teasing" – a euphemism for street sexual harassment or molestation of women by men. Students referred to it as a common occurrence, and one even stated that it could be unbearable. The harassment happened both on and outside the campus. Students noted that on their way to campus, they had to go through a "tunnel" of staring, rude comments, and sometimes even touching. On campus, the harassment usually came from male peers and was something the women tried to ignore. Below are some interview excerpts on "teasing-related incidents":

Well, students tease a lot. They try to touch. (National Technical Institute)

I take a bus to come to the college. I always get teased. People will stare at me, look at me from top to bottom, whistle at me, say something cheap in my ears, and sometimes even touch me. I can't say this to my parents because they will stop my education. (Regional Technical Institute)

I hate being teased. If I tell my parents that boys tease me, they will say then why are you going to university? Are you going to get touched? I do not tolerate teasing, but I can't do anything about them. (Predominantly Sikh University)

Ma'am there is a lot of teasing. It is not on the campus or in the department. It is outside. But to come to campus, you have to travel outside. I cannot repeat the words that I hear from men... I am not a Muslim, but feel like wearing a burka to avoid being teased. (Historically Muslim University)

3.5 Discussion

All four feminist theories – reconfiguration, cyber, cyborg, and technofeminism – differ with regard to the reasons behind, and solutions for, the gendered nature of IT but agree in seeing computing as a masculine field, an area that is dominated by men
and, thus, inclined to keep women out, unless some steps are taken by women and for women. How CS became a masculine field in the USA and Europe is beyond the scope of this paper. It should be noted, however, that with the IT revolution in the USA and Europe, the social context of CS changed. In the 1980s, CS was constructed as a field suited for a small minority of geeks/hackers, who are different from other CS students yet dominate its culture. American and European women, living in a postmodern society, make their personal choices as they want and according to how they want to be perceived by others. They have many choices available to them. If they select CS, they will belong to a field constructed for geeks/hackers and perceived as being antisocial. This does not appeal to many women in the USA and Europe.

This case study, on the other hand, has shown that CS is constructed differently in India. The CS culture in India consists of dedicated, hardworking, intelligent, meticulous, and smart students (men and women). Students interviewed did not say that the Indian male students are attracted to CS because of its geek/hacker image. In fact, students rarely mentioned the word geek. Students were fascinated by computer technology and spent long hours to figure out its inner working. Yet, they did not view CS people as obsessive to the extent of being antisocial, which is a widespread perception in the USA and Europe. CS people in India are not seen as lacking social skills.

As the present case study has shown, female students selected CS as their major based on a practical calculation of the field, namely:

1. Robust potential for employment in national IT companies as well as in multinational companies inside and outside India
2. The omnipresence of computers in non-IT industries
3. The high-pay scale compared to other jobs
4. The opportunity to be working on leading-edge technology
5. The use of mental, rather than manual strength
6. Working indoors at a desk in a less threatening environment, rather than outside in a construction site in an intimidating environment
7. Having the flexibility to work from home at any time

There was no disagreement among female students interviewed on the suitability of the CS field for women. This case study, therefore, adds important nuances to previous research about CS and CS cultures and to theories about the exclusion of women from these fields. It brings into light a range of characteristics, which attract women to CS in India, previously not associated with a CS degree and a CS job in the West. These characteristics constitute a picture distinctly different from the "geek" culture, described as distancing women from the CS field. The case study thus illustrates how CS can be constituted as a "women-friendly" field. The results can also be interpreted as providing an empirical example of what Plant (1997) describes as the emerging world of women and IT set against the old world of patriarchy. Women in India found that the CS degree could be empowering for them and contribute to a shift of power from men to women in the Indian society.
An important question is why women’s representation in CS has increased in recent years in India. One answer to this lies in India's rapid economic development and industrialization, which has led to changes in the traditional role of women. Although, following its independence from the British in 1947, India was underdeveloped in relation to the West, it sought to catch up with the scientific and technological advances made in the West by developing/acquiring modern technology and industrializing its economy. Before 1990, however, the Indian government controlled its modernization and industrialization with licenses and regulations. In 1991, the government changed its approach by implementing economic liberalization policies. Now, India provides a more favorable business environment for both national and global corporations (Varma 2009). The IT industry has become a key element in India’s attempts to fortify its national economy and develop as a "soft power" in the world. In this context, the Indian IT sector has grown tremendously. It is projected that the total number of IT workers will have grown to 3,750,000 by 2015–2016 (Aggarwal 2008a). Although it began as a demand for low-end skilled IT workers, the demand patterns of IT have changed in favor of high-end skilled workers, requiring CS or an equivalent degree, such as electrical engineering and mathematics (Aggarwal 2008b). The IT industry has, therefore, emerged as a place to provide quality employment to a large number of technical people. As the present study has shown, education in CS equates to high-paying quality jobs for both men and women. The attraction of CS for Indian women, however, is not limited to just their communication ability, as held by cyber feminist theory.

Since independence, Indian women have been getting education as expected by their parents, family members, and communities in large. This education, however, was seen as a means to learn social and home skills; it was not seen as a means to have a job unless there were pressing economic issues. Typically, women were expected to pursue medical and teaching career paths, and not engineering ones, which were seen as suited for men. The growth of IT jobs, however, has led to a greater acceptance of the idea of engineering careers for women. Of all the options open to women in modern India, IT seems to have taken over from medical and teaching careers. This is mostly because CS has been constructed as a field suited for women as this case study has shown; the same is not true, however, with other fields in engineering, where the presence of women remains low. The students interviewed compared CS with physics and other engineering fields to show the changing nature of CS for women. This case study, therefore, shows some support for feminist theories that point out an underrepresentation of women in science and engineering fields.

Typically, an early exposure to computers is considered an important factor in generating interest in CS among students (Adya and Kaiser 2005). Very few female students in this study, however, were exposed to a computer regularly before enrolling in their institutions of higher education. This shows that female students viewed the CS field as suited for women even without having much experience with computers. This study, therefore, does not provide support for the digital divide – the growing gap between men and women in terms of access to IT – as a reason for a lack of interest in CS. This does not mean, however, that the use of computers and
Internet access should not be equitable between men and women. My results show that female students found CS courses quite difficult initially, compared with their male peers, because of a lack of exposure to computers.

In addition, female students viewed many teachers to be inconsiderate of their lack of an adequate background in CS, and they could not get help from their male peers on group projects since they had to return to hostels/homes due to curfews. Despite such difficulties, these female students did not entertain the idea of leaving CS since they felt lucky to be in the CS field. This again strengthens the view that CS is viewed as the best field for women in India.

Another key issue often used to explain CS being less attractive for female students in the USA and Europe is a lack of female role models, which reinforces the image that the CS field is not meant for women (Bonetta 2010). This case study shows that this was hardly an issue for Indian female students. They were attracted to the CS field despite not having any role models. This is not to suggest that female role models would not help to increase representation of women in CS. Instead, the female students were primarily concerned with a lack of computer resources and opportunities to do well in CS in India.

Yet, the relationship between gender and CS in India has its own complexity due to the “patrifocal” Indian social system. Under this patrifocal system, women are subordinated to family: inheritance is patrilineal, residency is patrilocal, family roles are differentiated on gender lines, marriage is controlled by family, and women are expected to practice chastity, domesticity, and obedience (Mukhopadhyay and Seymour 1994). Typically, children in India are not raised to be independent and self-sufficient; instead, they are supposed to depend completely on their family for their personality growth and career development while valuing family loyalty, integrity, and unity. Within such a framework of family values, male children are raised to be assertive and to see themselves as the provider for the family and for this reason tend to have family resources at their disposal. Female children, on the other hand, are viewed as a drain on family resources in respect to their marriage and are raised to be self-sacrificing, docile, and accommodating. Ultimately, parents’ decisions affect most aspects of their children’s life, including education, career choice, and mate selection.

The reasons why CS is viewed as well suited for women are not in contradiction with this Indian social context. Female students believed that a CS degree would make it possible for them to get a highly paid job, become independent, and feel respected. Yet, they could not have enrolled to study CS without their parents’ permission and their family’s approval. In fact, their preference for CS was closely linked with their family’s preference for the subject. Parents favor CS among engineering career paths because it fits well with their perception of the type of work girls should be allowed to do; parents do not approve of other engineering fields since girls would be on construction sites and involved in physical activities, which they consider unsafe for women. Even employers ask prospective female graduates whether they have permission from their parents to work. According to the female respondents, such questions are not posed to their male peers. This shows that feminist theories about gender and IT are still relevant in the Indian context, although the
basic premise, about CS as a male-dominated field, does not hold in India. Theories, such as cyborg and technofeminist theories, are useful and important in order to outline complexities and contradictions in the relationship between gender and IT.

Female students’ comments show that they are well aware of gender issues and are mostly pessimistic about women’s status in Indian society. Interestingly, most of their comments are defined by the wider society’s gender bias, since the Indian social system is constructed to favor men. This suggests that gender is divisive in CS, not because of the nature of the field but mostly because of the Indian patriarchal system. Even with the gendered treatment of female students by family members and society as a whole, they did not doubt the appropriateness of a CS major for them. In fact, they believed that with a CS major, their standing in the family and society as a whole will have moved upward. This study thus illustrates the importance of taking the social and cultural context into account when considering relationships between gender and IT. This means that some of the previously mentioned theories need to be used with care when adopted in a cultural setting different from the one they were developed in. One such example could be the technofeminist theory’s assumption that computer technology will not be liberating for women until they start designing it. The women in this study found that computer technology offered them a liberating potential, regardless of the designer behind it.

This case study has shown that the socioeconomic context must be taken into consideration to understand how gender interacts with CS education. Underrepresentation of women in CS education in the USA and Europe cannot be considered to be a global phenomenon; indeed, large numbers of women are opting for CS majors in India, and, of all the engineering related disciplines, CS is perceived to be the best field for Indian female students. This questions many theses including that CS is a masculine discipline. At the same time, this study shows the prevalence of gender issues.

3.6 Conclusion

Women representation in CS in India shows a complex paradox of empowerment and marginalization. At one level, CS appears to have emerged as a powerful tool to empower women. It allows them to strengthen their abilities and skills, which is much needed as India emerges as a knowledge society. It should be noted that the findings from the present case study, therefore, are limited to female students who are pursuing bachelors’ degrees in CS. However, with a CS degree, female students hope to overcome various social barriers, increase their employment choices, and improve their quality of life. They believe a CS degree will open up avenues that were previously unavailable to them. Traditionally, women have been excluded from the scientific and technical sphere, both deliberately and indirectly, due to their low level of education. CS education has opened up a window for women to the world beyond household boundaries. It is, therefore, no surprise that female students in this study viewed CS as a liberating major/profession. While CS education
creates many new opportunities, at the same time women are marginalized as they face enormous challenges if they are to do well in CS education and find employment. Family members do not encourage them to be independent and career oriented; instead, a woman's primary goal is seen to be starting a family by getting married. This value system contributes, consciously or unconsciously, to the unequal division of resources and support at home and in schools between girls and boys. This continues at institutions of higher education, since female students do not have a great amount of support both in terms of resources and access to laboratories due to home/hostel restrictions. Despite majoring in CS and thus being viewed as smart, competent, and intelligent, the Indian value system places women in a secondary position to men, and female students narrated several examples that showed biased treatment by teachers and double standards by parents.

Nonetheless, female students not only envisioned financial independence but also social freedom from rigid perceptions of the role of women with CS education. Instead of being forced into a marriage and/or having children, the female students believe they would be able to convince their families to allow them to pursue a different path. For them, the benefits accruing from a CS career, namely, a high social status and independence with a well-paid job, outweigh the short-term biased treatment from teachers and gendered restrictions at home and at the institutions of higher education. Economic independence facilitates freedom from the social obligations imposed on women. The possibility of women opposing their families' goals for them to get married is highly unlikely without the economic security achieved through a well-paid job. Finally, this case study shows female students' attachment to CS. They believe that after graduation, they will be able to enter the IT industry and enjoy the prevailing work environment. It should be noted, though, that just because women are being educated in CS does not guarantee they will have equal access, opportunity, and satisfaction in their employment as men—a further dynamic within this paradox of empowerment.

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