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# Differences in STEM Gender Disparity Between India and the United States

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**Abstract**

Turning standard narratives of technology and gender in the developing world upside down, India sees much less gender disparity in computing education than the United States. Based on qualitative research to explore this phenomenon, we draw preliminary conclusions that women in India feel pushed by their parents to go into computer science for socio-economic reasons, and that compared with the United States, sex-based differentiation in schools is muted in India. If confirmed, these conclusions raise complex questions about the relationship of gender, technology, and development that challenge some HCI efforts for gender equality or socio-economic development.

**Author Keywords**

Gender equity; STEM education; India; cross-cultural.

**ACM Classification Keywords**

K.3.2 [Computer and Information science education]

**Introduction**

In the United States, there is widespread concern about disproportionately low interest from girls and women in STEM fields - science, technology, engineering, and math. The problem is salient in computer science, where, for example, in 2012 women only accounted for 21% of undergraduate computer science majors (OECD, 2014).

**Male-to-Female Ratio in Computer Science Education in India and the United States**

	India	U.S.A.
<b>Women with CS degree</b>	45%	21%
<b>Female population</b>	47.7%	50.8%
<b>Male-to-Female Ratio in CS graduate education</b>	1.2:1.0	4.2:1.0

Table 1: Statistical comparison of the percentage of women in CS education and population in India and the U.S.

Sources: Percentage of women in computer science (OECD 2014; All India Survey on Higher Education, 2015). Population data (U.S. Census Bureau, 2015; (Census of India n.d.)

Curiously, this phenomenon is not nearly as stark in countries such as India, where women are well-represented in computer science: 45% of computer science undergraduates were women in 2013 (All India Survey On Higher Education, 2015).

What is striking about this difference, as we cross borders from the United States to India, is that it occurs in spite of gender-equity contexts that go in the opposite direction. The United States is among the world’s leading countries in terms of gender equality in general, and education specifically: It is ranked 1<sup>st</sup> by the World Economic Forum’s (2014) Gender Parity Rankings for Educational Attainment. India on the other hand was ranked 103<sup>rd</sup>, despite recent progress.

The phenomenon thus turns standard narratives of technology and gender upside down. In this preliminary paper, we explore possible underlying causes for this phenomenon based on qualitative interviews with young women from the United States and India who majored in STEM and non-STEM fields as undergraduate students. Our tentative conclusions raise complex questions about gender, technology, and development and potentially challenge HCI work in relevant areas.

**Related Work**

Studies have sought to understand why women’s representation in computer science is so low in the United States. There is consensus that the causes are socio-cultural factors as opposed to biology or genetics. The reasons for this view are compelling: There are considerable swings in representation over time, and there are significant differences across countries (Hill et al., 2010; Andreescu et al., 2008).

Several articles note the influence of background stereotypes. STEM subjects are seen as masculine while the arts and the humanities are perceived as feminine. Women and girls may therefore experience stereotype threat (Spencer et. al, 1999). Girls consistently assess their mathematical ability to be lower than boys of equal capability (Correll S. J., 2001). Over time, that assessment can lead to “disidentification,” where individuals lose aspirations for fields they are stereotyped against (Nosek et al., 2009; Good et al., 2008). The other effect acts through men and boys where a dominant “geek culture” may alienate anyone who feels anything less than ardor for the subject (Margolis & Fisher, 2002).

Findings from the United States contrast with what is known about women in India, who do not perceive computer science to be a masculine field but simply a path to socio-economic success (Varma & Kapur, 2015). Indeed, women studying computer science in India report high confidence about their academic performance (Escueta, Saxena, & Aggarwal, 2013). One study associates this gender-neutrality with family-centered cultures (Venkatesh, 2015).

All of these studies confirm that women’s representation in computer science is greater in India than in the United States, and they provide intermediate explanations for why this might be. However, existing work falls short of arriving at ultimate causes and offering actionable recommendations. For example, why is it that Indian women do *not* perceive computer science to be a field for men, when evidence suggests many American women do?

In our study, we take a closer look at the experiences and motivations of women in India and the United States, in an effort to understand the underlying causes of this surprising difference.

### **Methodology**

We conducted 20 semi-structured interviews of 45 to 75 minutes in length. The participants were chosen such that half (10) were Indian women who had attended university in India, and half (10) were American women who had attended college in the United States. Within each group, half (5) had majored in a STEM subject, and half had majored in a non-STEM subject. Most participants were master's students at the University of Michigan School of Information. All participants were from middle- or upper-middle class backgrounds and all had at least one parent with a college degree. All participants also had significant familiarity with STEM fields – either in their past experience or because of a future career interest.

The interviews were semi-structured with a protocol focused on family, educational background, personal characteristics, and professional experience with special attention to gender dynamics and academic experiences with STEM/non-STEM subjects. Toward the end of each interview, we also asked specific questions about gender discrimination.

### **Preliminary Results**

Below are preliminary findings from an informal analysis of the interviews.

**Commonalities:** There was strong agreement between women from India and the United States about the behavioral differences between girls/women and boys/men.

*Speaking Out in Public:* All of the women we interviewed -- whether they were from India or the United States – specifically expressed a “fear of being wrong” in public or among their peers. Many of the participants self-consciously expressed a sense of insecurity, lack of confidence, and self-doubt. Even participants who identified themselves as being confident in their technical abilities reported being very cautious about what they say out loud.

*Group Dynamics:* When asked if there were differences between working in groups with boys/men and girls/women, participants consistently reported that men were more assertive, and women were more considerate. Women in general were described as more organized, more emotional, and more thoughtful in group work. This is related to, but not the same as the point above about public expression: Women were described as being mindful of other people and their views. Men were described as being “childish” or “aggressive.”

**Differences:** Stark differences between what Indian women and American women reported occurred in discussions about family and school environment.

*Limited Career Choice in India:* Among families who send their children to university in India, engineering or medicine is the default expectation (both for men and women). Parents place great pressure on their children to study specific subjects for reasons of socio-economic prospects –career and marriage partners are a prime concern. For the most part, children feel they must comply. Partly as a result, there are well-worn pathways and institutional support for computing education in India. Most of our Indian participants did not consider other majors or career options.

Further reinforcing parental choice, curricula are rigid throughout secondary school and college, with little ability for students to choose among options, or to switch directions once they arrive.

*Discrimination in Schools:* Our Indian participants categorically denied experiencing gender discrimination in school. They acknowledged discrimination in other areas of life including in the family and in post-university professional environments, but not in formal education. In contrast, most American women reported experiencing some bias or discrimination at school. Studies confirm that subtle gender bias on part of U.S. teachers favors boys in STEM education as early as primary school (Moss-Racusin et al., 2012).

It is surprising is that this difference exists when India can be otherwise highly discriminatory toward women. For now, we have only speculations for why this might be: One is that Indian women may not take as much notice of gender discrimination as their American counterparts. This seems unlikely, however, because our Indian participants noted discrimination in non-school contexts. Another possibility is that formal education in India is largely desexualized through drab uniforms, strict disciplinary practices, and social norms that inhibit sexuality for minors. In contrast, American schools all but celebrate gender differentiation through an absence of dress codes and institutions such as school dances.

*Geek Culture:* Validating Verma & Kapur (2015), one response we heard only from our American participants was an association of computer science with nerds or geeks. Our American participants referred to a “bro” or “geek” culture in STEM fields, which they did not feel a part of. Indian women did not see the same

association. Despite male-female differences, Indian girls/women still felt that their participation was welcome in groups and their input was valued. Women who had experience working with both American and Indian men specifically noted this difference.

### **Implications for HCI**

These findings, if valid, have a number of implications for HCI projects, especially where the goal is either gender equality or socio-economic development in the developing world. First, our findings counter any narrative of monotonic forward progress. Advances in personal agency – girls’ right to choose their majors or career aspirations – may cause apparent regressions in gender equality in the technology field, as girls are understandably more likely to opt for other fields when confronted with discriminatory behavior. Second, while HCI-for-social-change projects tend toward behavioral nudges that have temporary effects on behavior, deeper causes of gender disparity may deserve closer scrutiny. Third, given the apparently non-discriminatory school environment in countries such as India, it may be unwise to rush to introduce digital technology, which some have found to have unintentional gender biases (Beckwith & Burnett, 2004; Huff, 2002).

### **Summary**

Qualitative interviews among Indian and American women with undergraduate degrees in STEM and non-STEM fields suggests that while women in both countries see some commonalities in their interactions with boys/men, there are also significant differences in educational contexts that could explain why women are proportionally represented in computer science in India, while highly under-represented in the United States. Women in both India and USA seem to experience similar internal struggles, but Indian girls report little

discrimination from figures of authority at school. American boys and men, meanwhile, seem to treat women differently compared with Indian boys and men, possibly due to heightened sexualization of the school context. Meanwhile, Indian girls face great parental pressure to go into STEM fields, while American girls do

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