Women in Information Technology: A Case Study of Undergraduate Students in a Minority-Serving Institution

Roli Varma
University of New Mexico

The issue of underrepresentation of women in information technology (IT) is of national interest due to the rapid growth of IT in recent years, the impact of IT on growth and productivity, the shortage of IT workers, and the gender equity in IT. Scholarly research has pointed its finger at bias in early socialization, math anxiety, masculinity of computers, the scarcity of role models, and women's preference for relational work. A study of students majoring in computer science and computer engineering in a minority-serving university found some additional factors such as tension between demands imposed by IT curricula and students' family and work responsibilities.

The use of information technology (IT) has brought profound changes to society at a very fast and unprecedented pace. Since 1995, IT has contributed, directly or indirectly, between 33% and 50% of the acceleration of productivity to the national economy (Federal Reserve Board, 2000). IT has also contributed to the country's structural shift to a service economy (Castells, 1996). In the past five decades, growth in services has exceeded growth in every other industrial sector—manufacturing, construction, mining, and agriculture. IT has contributed to growth in demand for labor as well as an overall skill upgrade in the workplace (Berman, Bound, & Griliches, 1994). The Bureau of Labor (2000) projected that between 1998 and 2008 the number of IT-related jobs would grow by more than 100%, exceeding an overall job growth of 14%.

The demand for IT workers has outstripped the supply. In 1997 and 1998, the Information Technology Association of America (1997, 1998), a trade association representing 11,000 companies, reported a large shortage of IT workers. The U.S. Department of Commerce (1997) issued a similar warning. The shortage of IT workers has resulted in Congress adopting legislation to increase the number of temporary H-1B visas that can be awarded annually to foreign skilled workers from 65,000 to 115,000 for 1999 and 2000. Last year, Congress increased the limit to 195,000 for each of the next 3 years. Almost half of all H-1B visas go for computer-related or electrical engineering positions (National Science Foundation, 2000, p. 3/27).

With the expected shortage of candidates from the traditional source of labor, the White male population, advocates of America's global leadership in IT have turned toward women and minorities. These advocates have formed an alliance with those who have long pointed out gender and ethnic discrimination in science and engineering. However, women who make up 51% of the U.S. population and 46% of the U.S. labor force constitute only 28% of computer and mathematical scientists (National Science Foundation, 2000, p. 3/11). Trends in the IT pipeline show that the number of female IT workers will not be much larger in the foreseeable future unless concerted efforts are made to attract and retain women in IT education. For instance, women's share of baccalaureates in computer science began to drop off sharply from more than 15,000 in 1987 down to about 6,500 by the mid 1990s, where it has stabilized (National Science Foundation, 2000, p. 4/26). This is surprising because IT work remains one of the best prospects for women in terms of salary, career path, rewarding office-based environment, and

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intellectually stimulating work. Moreover, many women already use computers for word processing, information, communication, and access to the Internet and thus are not alien to IT. They could be using computers to solve mathematical problems, do computer programming, design systems, or invent new technology (Coley, Cradler, & Engel, 1997).

In this article, I address why women who have the potential to succeed in the study of IT-related disciplines shy away from an IT education. I find that women face many barriers such as limited access to IT resources and education, family and peers' negative attitudes toward a career with an IT degree, cultural stereotyping about computers as a male preoccupation, perceptions of an IT career as dull and only for smart boys, and a lack of role models or mentors. In a minority-serving institution of higher learning, however, women face some additional barriers such as the poor match between the challenges posed by the IT curricula and the students' family and work responsibilities.

Methodology

The article is based on a study conducted at the University of New Mexico (UNM), a doctoral-extensive and a minority/Hispanic-serving institution. UNM grants undergraduate degrees in the key IT-related fields—computer science and computer engineering. There is general agreement that these two fields produce the core of the IT workforce—computer scientists, computer engineers, systems analysts, and programmers. Over the period 1988 to 1996, jobs for computer systems analysts grew much faster (158%) than jobs for computer programmers (9.8%). A temporary increase in the number of computer programmers in 1997 was mostly due to the temporary demand created by the Y2K problem (Freeman & Aspray, 1999, p. 35). Traditionally, students pick up technical skills for the core IT jobs in computer science and computer engineering fields.

Due to its proximity with national laboratories (e.g., Sandia and Los Alamos laboratories), private industry (e.g., Intel), and the state government, IT education at UNM offers excellent job and career opportunities for New Mexico residents, especially women. Only 25% of the undergraduate students enrolled in computer science and computer engineering at UNM are women, but the majority of these women are minorities (60%). The average age of undergraduate students majoring in computer science and computer engineering is a relatively high 26 years old. Most of these students are from New Mexico. Many tend to hold a part-time position to support their studies. Many women students are single mothers, having 1 to 4 children. New Mexico ranks near the bottom among all 50 states in terms of per capita median household income, the percentage of people living below the poverty level, and the percentage of college students from low-income families.

With the goal of understanding what makes women and minority students attach to or detach from these IT-related fields, the technique of ethnographic interviews was used. This method studies the topic from the subject's point of view rather than from the expert's. In-depth interviews were conducted with 40 subjects majoring in computer science and computer engineering at UNM. This sample included 34 undergraduate female and male students and another 6 students who have switched from IT to a different program. Most of those who switched went into information systems offered by the Anderson School of Management at UNM. All students came from different ethnic backgrounds, such as White (7 women and 4 men), Hispanic (7 women and 4 men), Native American (4 women and 3 men), Asian (4 women and 4 men), and African American (3 men). This cross-gender and cross-cultural sample was designed to provide a better understanding of the issues related to the lack of participation by women and minorities in IT-related disciplines and careers.

The interviews were based on both structured and unstructured formats. They were structured in the sense that certain issues were covered; they were unstructured in the sense that they more closely resembled a private conversation with the subjects. Such a combination allowed subjects to express themselves in depth while the interviewer maintained a certain control over the topics and was able to probe interesting leads. These interviews lasted anywhere from 45 minutes to almost 2 hours. Every interview was audiotaped. After the interviews were transcribed verbatim, the Nudist software program was used for qualitative analysis. The data were coded for all issues that have any bearing on students' attachment to IT, preference for any other major, and detachment from IT. They were also sorted by ethnicity, gender, and IT fields.

Why So Few Women in IT?

Much of the scholarly work related to the gender gap in IT has been based on a broader issue of the

underrepresentation of women in science and engineering. Recently, Margolis and Fisher (2002) studied the gender gap in computer science at the undergraduate level at Carnegie Mellon University (CMU). Based on their findings, CMU's remedies and special programs have led to an increase in enrollment of women majoring in computer science from 8% in 1995 to 37% in 1999, to 42% in 2002 (http://www.cs.cmu.edu/~gendergap). Their study, however, is limited by its representation of underrepresented minority groups; of 97 computer science students interviewed, 3 were female African Americans, 6 were male African Americans, and 5 were male Hispanics. Perhaps this is because CMU is a private university, ranked overall among the top 10 universities in the United States, with a computer science department regularly ranking among the top five in the country. Researchers have found that disparities by social class and race/ethnicity are strongly related to pipeline progress in science and engineering–related disciplines (Clewell, Anderson, & Thorpe, 1992; Oakes, 1990). Experiences of women majoring in computer science and computer engineering at UNM revealed a strong intersection of gender and class.

Limited Access to the Computer

Over the past 20 years, computers and other forms of IT have been widely diffused both at home and in the K-12 educational system. Almost 98% of all schools have at least 1 microcomputer for instructional use, and about 80% have 15 or more. The average ratio is approximately 10 to 11 students per computer (National Science Foundation, 2000, pp. 9/21-9/23). However, students differ in their access to computer technology and in their use of computers. Students attending high-poverty and high-minority schools have less access to computer technology. Limited availability of computers at school is further offset by their availability at home. For instance, in 1998, 47% of White Americans owned a home computer compared to 23% of African Americans and 22% of Hispanics (National Science Foundation, 2000, p. 9/36). Socioeconomic status (parental occupation, education, and income) accounts for a substantial amount of the differences in exposure to IT. Similarly, women are slightly more likely than men to have experience in word processing and more likely to use a computer in their language or social science courses. Women are less likely than men to have experience in computer literacy, using computers to solve mathematical problems, and taking courses in computer programming (Coley et al., 1997).

The problem of limited access to computers in schools and at home and the differential use of the technology is serious because it contributes to unequal participation in IT. Accordingly, I studied how students perceived IT resources available during their precollege education as well as access and use of computers at home.

Many students interviewed did not have a computer at home or in their elementary and middle schools. This is partially because these students came from low-income families in a poor state. Another reason is that when these students were in elementary and middle schools, the use of computers had not been as widely dispersed. Their high schools mostly had computers outside the classrooms (e.g., library or instructional room), and few were taught computing classes. Female students indicated that more boys than girls in high school were at the computer corner and that boys assumed it was their territory.

There was a variation on students' access and exposure to computers along ethnic lines. White male students, and to some extent White female students, were exposed to computers at an earlier age than non-White students. For instance, a few White students reported having an older computer at home, which was generally kept in the boy's room. Asian students also had a computer at home, which was kept either in the family room or in the study. Hispanic, African American, and Native American students rarely had a computer available for personal use at home.

Still, most male students had played with video games before coming to UNM and felt comfortable initially around computers. This was not the case with female students in all categories except Asian. Generally, female students depended on others, usually a man, to show them how to tinker with a computer; male students explored computers with less guidance. Asian female students, however, were more active in exploring how to tinker with the machine.

Below are some interview excerpts that show that many students did not have early access to a computer in order to be involved in the creation and control of computing technology. If they did have access, women generally used the computer less for exploration and knowledge compared to men:

> Actually [the computer] did not come into the house until about high school. Back then, there

> wasn't Windows; it was sort of like, just DOS. I played video games, but that was probably it. (White male student)
>
> We had one family computer when I was in the middle school. Now we have three computers in the house. (Asian male student)
>
> I think [the computer] was more or less for my dad at first. Soon, it was used by my younger brother, mostly to play games. Sometimes, he showed me a video game or two on it. (White female student)
>
> We used [computers] a lot for reports, writing a lot of reports. In high school again, writing reports and that is mainly what we used them for. (Hispanic female student)

Subtle Biases in Early Socialization

There has been a long history of scholars showing social, cultural, and psychological factors that result in girls' unwillingness to major in science and engineering (Betz & Fitzgerald, 1987; Hass & Perrucci, 1984). Science and engineering careers and masculinity are so deeply embedded in raising children at home and school education that children have little difficulty internalizing that science and engineering are for boys only. Unlike in the past, parents and teachers seldom assert openly that women cannot or should not aspire to become scientists or engineers because they are naturally incapable of engaging in scientific and engineering activities. There is, however, a subtle gender-based socialization, which results in shaping expectations of parents, teachers, and students themselves that science, engineering, mathematics, and computers are for boys. For instance, at home, boys consistently receive more praise for their science and mathematics learning than girls do. Mathematics and science teachers make more eye contact with boys and challenge them to find the correct answer more than they do with girls in their classes (Tobin, Kahle, & Fraser, 1990). Furthermore, teachers seldom redirect if girls are clustered around the art in the classroom. Even media depicts women to be mostly interested in fashion and household works than in science and engineering careers. When media do show successful women, they are portrayed as lawyers or doctors, not as scientists or engineers (Thom, Thompson, & Hoy, 2001). Educational television shows such as *Bill Nye the Science Guy* and *Mr. Wizard* help to transmit this message to girls about their place within science and engineering. Children are growing up with computers, yet computer games are seldom designed with girls' interests in mind (Cassell & Jenkins, 1998).

Because gender socialization plays a key role in the choice of a profession, I explored how students inherit the gender imbalance about IT at home and schools. I found, as research on women in science and engineering has shown, that women differed from men on environmental factors such as family values, social expectations, teachers' role, and media portrayal.

Most women interviewed did not view themselves as becoming computer scientists or computer engineers while growing up. In high school, it was mostly male students who were at the computer. Teachers identified them as computer experts and thus reinforced the men's identification with computers. High school teachers or mentors seldom directed female students into computing and related activities as much as they did with the men. UNM computer science and computer engineering departments also did not make any effort to reach high school graduates, especially women, to expose them to the potentials of an IT education. It is therefore no surprise that many women initially hesitated in selecting their majors in computer science or computer engineering. These fields within science and engineering appeared somewhat unfamiliar to them.

Male students were also somewhat ignorant about computer science or computer engineering, but they did believe that risk taking is an essential element of higher education. Asian women did not reveal any hesitation with their decision to major in these two fields and thus appeared to be more willing to be risk takers than other women. This is mostly because Asian women associated computer science and computer engineering with employability, high-paying jobs, and a natural choice for those with strong backgrounds in mathematics and science.

The following interview excerpts show that the underrepresentation of women in IT-related fields at the undergraduate level is at least in part inherited from the bias in early socialization both at home and in the school system:

> Well, I guess machines, programming, things like that, came naturally to me. I have been mechanically inclined. . . . I was always very interested in computers. But, in the last few

> years, I became intensely interested in them. (White male student)
>
> In my junior high, we had a computer room. The only reason that you could go into that computer room was if you were taking a computer class. They had started some remedial training. . . . When I asked my teacher for the computer class, he simply said that class will not be good for me because it was on programming. (White female student)
>
> My counselor had advised me to do accounting. When I asked him about engineering, he simply said that he was trying to place me on a career path where I would be successful. (Native American female student)
>
> I got interested in computers because I made a bet with my dad. He told me that I could not do computer science, and I told him I could. (Hispanic female student)
>
> My parents were keen on me studying computer science because it is so growing right now. If you don't know computers, that means you are way behind. (Asian female student)

The Masculine Environment

Instead of blaming women for their socialization, some scholars find gender-based distortions in the fields of computing. It is argued that the educational culture of computer science and computer engineering, as well as stereotypes, conveys that computers are for strong men who wish to have a close encounter with powerful machinery. Success in the computer science field is strongly associated with the histories and behavior of the "boy wonder icon." Seymour and Hewitt (1997) noted that the male model of computing assumes that students must have a fascination with the machine quite early on in life. The general picture is that the successful computer scientist or computer engineer is a White male nerd/hacker, super smart, and a geek. He sits in front of the computer all day and sleeps near it. His socialization is limited to talking about computers all the time. He has no other identity than being a computer scientist. Margolis and Fisher (2002) showed that the stereotypes of "geek mythology" discourage women from opting for a major in computer science. It has been suggested that women are entering other information science programs in greater percentages than computer science and computer-engineering programs because the former, like medicine and law, are perceived as more people oriented (Freeman & Aspray, 1999).

Because computer science and computer-engineering enterprises seem to be dominated by a unified masculinity, I sought to separate the accurate perceptions from the stereotypes about computing and examine how this deters women's and minorities' involvement in IT education. I found that the image of computer science or computer-engineering fields and people in them is indeed of White male, geek, and antisocial. Yet, most of the students interviewed, both men and women, viewed themselves as different from the stereotypes.

Generally, male students interviewed indicated that they wanted to tinker with computers once they were exposed to them. They were hooked right away and decided to continue with computer activities for the rest of their lives. They perceived the computer as a buddy that would not talk back to them. They believed that women are not interested in computers the way they are. Female students, on the other hand, viewed computers serving higher societal goals in arts, commerce, communication, education, medicine, and politics. Their interest in computing evolved gradually, not instantly. Contrary to male students, women perceived computing as somewhat boring and lacking personal contact and communication. Female students were critical of the general impression that a computer scientist's life must be centered only on the computer. They did not want to be this single minded and, thus, differed from their male peers. Both female and male students felt that students with hacking abilities were idealized and known to everyone.

Students from different ethnic groups differed on the masculine image of IT. For instance, White women were not sure whether they truly belonged in IT fields. They felt the emphasis on computer programming made the field very narrow and limited their intellectual potential. Furthermore, they believed that by entering computing fields, they are being perceived as less feminine. Hispanic women saw the lack of fit between them and a computing culture mostly due to the perception, by peers and teachers, that their presence was due to diversity initiative and not due to academic achievements. Hispanic women felt disrespected because they were rather fashionable and thus considered less intelligent compared to other women. Asian women, on the other hand, were at ease with

both the computer and IT fields. They took to computing as a challenge as soon as they became familiar with the field and the department. Unlike male students who became involved in IT-related fields because of their intrinsic interest, Asian female students gave cultural reasons (e.g., family encouragement) and practical reasons (e.g., economic benefits). They believed that other than the very few women students enrolled in IT fields, attention to maleness or gender was unnecessary.

The following interview excerpts reveal how this male environment dominates IT fields:

> Computer science students walk around with engineering papers all the time. They usually hang out in the department, doing homework, staying up late, just to work on projects. (Asian male student)

> You talk more about computers than any other topic. Even the fun topic you make fun of is computers. So, usually you just talk about computers all the time. (Hispanic male student)

> Well you can easily tell who is doing a computer science major. They are usually males. You can find them at night, usually in the lab. They drink coffee. They are pretty hyper because of all the coffee in them. (White male student)

> Definitely don't have a life. Don't have a social life at all. . . . They just tend to want to work by themselves. (Hispanic female student)

> A typical computer science student is stressed out and overloaded. The ones who are successful really do not have social lives. (White female student)

> I think eventually computer science needs to change to be more like computer science and business, computer science and sciences, computer science and medicine. (Native American female student)

Confidence Gap in Mathematics and IT

A solid background in mathematics and science has been considered a prerequisite for high school students in taking science or engineering paths in college. It has been suggested that women lack preparation and proficiency in mathematics and science. They, therefore, remain precluded from the science and engineering fields (Snyder, Hoffman, & Geddes, 1997; Vetter, 1990). Previously, academic achievement tests such as the National Assessment of Educational Progress (NAEP) and the Scholastic Aptitude Test (SAT)[1] showed male high school students scoring higher than female students in mathematics and science. They also showed underrepresentation of women among the highest scores.

Since the early 1990s, however, the gap between female and male students' scores in mathematics and science has been narrowing. For instance, the 1996 NAEP results in science showed that men scored 152 and women scored 148, a very slight difference. Similarly, average mathematics scores for women and men for the same year was not significantly different (National Science Foundation, 1998, pp. 15-16). On the 1996 SAT, women's scores in mathematics were lower than men's scores (492 for women vs. 527 for men) (National Science Foundation, 1998, p. 25). This is mostly because a larger number of women than men from lower-income families choose to take college entrance tests; economic status accounts for a substantial amount of the differences in mathematics and science progress (Madigan, 1997).

Yet, studies reveal that women feel less prepared than other students in mathematics, science, and computing (Lundeberg, Fox, & Puncochar, 1994; Sax, 1995; Seymour & Hewitt, 1997). Both men and women believe that men are better than women in mathematics and computing (Margolis & Fisher, 2002; Valian, 1998). Therefore, I examined whether women entering UNM underestimate their abilities in mathematics and computing compared to men.

Interviews revealed that women do not avoid mathematics or have any anxiety about it. However, on average, male students held more positive attitudes toward mathematics than female students did. This was despite the fact that women indicated mathematics to be their strongest subject in high school. Similarly, male students believed they were more competent and interested in computing than female students. This was partially due to the fact that many women entered computer science or computer engineering with very little computer experience.

Nonetheless, women in different racial/ethnic groups differed on self-confidence, self-image, and self-reliance. For instance, Hispanic women were more independent and assertive in getting their IT education needs met whereas Asian women were more

confident about their mathematical skills and logical thinking. Both Asian and Hispanic women attributed their early achievements in mathematics and science to their parents, who had high expectations and were involved in their daughters' lives. Interestingly, Hispanic women stated that their mothers were their role models, whereas Asian women stated that their fathers were their role models. White women, on the other hand, were more likely to feel inadequate, as they compared themselves with their male peers who took less time to finish the coursework. Because they lacked the obsession with computers of male students, White female students constantly had more self-doubts around their success.

The following interview excerpts show that female students feel less prepared than male students in the coursework. This is despite the fact that female students were strong in mathematics and performed comparably well in computing courses:

> I don't know that much about computer science. I enjoy it and I am still learning, but I don't have a vast majority of knowledge that some of these other kids have. What keeps me going is a strong background in math, nothing else. (Asian female student)

> I think a lot about whether I am going to finish this degree or not, because I am always doubting myself. And that kind of discourages me. . . . I hope I can get through this. All of my classes have been going well. So that is what keeps me going. But, I keep having doubts in my head. (White female student)

> I don't let myself get intimidated like that. But, sometimes . . . I feel like that, maybe, I could not do a certain segment because I was a woman. (Hispanic female student)

> In some of our classes, I feel really intimidated about answering questions, because most of the guys know more in that field. . . . It is kind of hard for me to talk because I feel intimidated by the guys sometimes. (Native American female student)

Crises of Nontraditional Students

Computer science and computer engineering are hard and demanding technical fields. As students put it,

> It is going to take me 5 years to get through the engineering degree. And, for loads of people I have talked to, it seems to be more the norm than the exception. . . . It is not one of those typical degrees you go through in 4 years. . . . You can't fudge your way through engineering.

> Computer science is not a liberal arts major. It is a very tough, very rigorous degree. . . . I am not saying that the other degrees are pointless or useless, but they are nothing compared to computer science.

Many students majoring in computer science and computer engineering at UNM are often nontraditional. They did not join UNM immediately after high school. Instead, they worked to save money for education; some have continued to work part-time to support their studies. Their families seldom had money for their children's college education. The average age of UNM undergraduate graduation in computer science and computer engineering is 26 years. Some have young children, and many female students are single mothers. For these people to keep up with curricula requirements, as well as look after children, and keep part-time jobs is challenging. Student scholarships can be kept only if one maintains the course load to finish the program within 4 years with the required grades. The programs of computer science and computer engineering, however, are not sensitive to nontraditional students. As students describe the two fields,

> If you do not live for the school of engineering, then it is very hard to keep up with everybody else. If you have a family, or even have a part-time job, it is much harder. So, I kind of feel like, in order to succeed in engineering, you have to be single, not married, no boyfriend, no girlfriend, no job, no kids. Just school. Just live at the engineering building. (Hispanic male student)

> One time my little boy was sick, and I was having a really hard semester and I was having a really hard time with him. . . . I went to talk to a professor. I told him that I am a single mom and my little boy has been sick. And, I know that is not your problem, and he said that "you are right, it is not my problem." (Hispanic female student)

> Most of my friends that are in computer engineering and are doing well, would be at school

> from 8:00 in the morning and stay until 8:00, 9:00, 10:00 [p.m.], maybe even midnight, including the weekends. I really cannot put in that kind of time. I have a job and a kid at home. My mother is helping out with my kid, but still I could not put in a good 8 to 10 hours every day. (Native American female student)

> I am working full-time and going to school. Right now, the job I am in is also another male-dominated profession. And, I ask myself that same question with that whole area. And, some of it, I think, is because of hours. You have to spend 5 to 8 hours on a computer, and that does not go with [women's] family expectations. (White female student)

> Programming forces you to sit and keep going. It forces you to sit the whole night. It forces you to think from 10 different perspectives. It consumes tons and tons of hours. It eats up all the time. . . . I really do not know how students with kids keep up with it. (Asian female student)

Only 1 of the 6 students (4 women and 2 men) who have switched their majors from computer science and computer engineering to information systems gave the reason that she "does not belong in the [field]." Although she was not as interested in computer science as the men were, other students gave very practical reasons such as the difficulty in maintaining their college courses and balancing them with families and jobs.

What Can Be Done?

Interviews show that women are underrepresented in IT-related disciplines because of subconscious behavior that ends up promoting education and careers far more for men than for women. Furthermore, family commitments and work needs of women from low-income families create serious problems for them in keeping up with the curricula needs of computer science and computer engineering. Still, female students at UNM have been taking advantage of opportunities available in IT by pursuing education in computer science and computer engineering against all odds.

New Mexico and its precollege school system need to provide easy access to computers and various IT accessories to students, especially girls and minorities. Because IT-related fields are relatively new and New Mexico is a poor state, most high school students applying at UNM seldom have computers at home or parents/relatives who are computer scientists or computer engineers. In such cases, schoolteachers are the best source to encourage girls, exposing them to computers and teaching them in computing classes.

To reduce the gender imbalance, computer science and computer-engineering departments at UNM could initiate many administrative and educational policies. They could educate high school teachers in understanding that computer literacy is similar to English and mathematics. They could also train these teachers in what basic introductory courses in computing at the high school level should be included. Surfing the Internet and using office applications is not equivalent to becoming part of the technical computing field. UNM women faculty could lecture at local high schools and help expose girls to the concept of IT education as rewarding, along with offering ideas for career opportunities in IT. A field trip to Intel or other software companies could be planned so that high school students, especially girls, could observe IT professionals in an actual work setting.

Because UNM students declare their major in computer science or computer engineering in their second year, an introductory course could be introduced that would show the human dimension of computing and application of IT to a wide range of issues. This course could be taken as an elective. Such a course would be informative for all students and would satisfy many women who place computer science or computer engineering within a larger purpose. Most important, admission policies could clearly specify that no prior experience is required to enter the program. As the experience of nontraditional students demonstrates, women develop interest in computing over time.

To make the general environment more women friendly at UNM, faculty could be educated about the types of attributes that create the stereotypes about computer science and computer engineering. To deal with confidence crises of women, advisers could clarify that mathematics is necessary, but not the major factor in computer science or computer engineering education. They could convey that female students do not have to measure themselves against other students' performance. These departments could create a support system or instructional programs so students with varying levels of experience and time commitments could get the help they need. Faculty could make extra efforts to ensure that female students feel valued. Informal get-togethers or other departmental events could open channels of communication between

female students with one another, as well as with the graduate students and faculty. Both the computer science department and the computer engineering department have two female faculty members. Other than trying to recruit additional women faculty members, these female faculty members could take on an additional role in serving as mentors for female students.

With active recruitment policies, female high school graduates, as well as first-year UNM students, are likely to opt for a major in an IT-related field. By incorporating concerns of diverse student populations, computer science and computer engineering programs at UNM could attract a much broader audience.

Note

1. These tests have been criticized for not providing an accurate picture of students' academic progress and mathematics and verbal skills. Nonetheless, NAEP and SAT scores are considered a primary indicator of the state of mathematics and science education.

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Roli Varma is an associate professor of public administration at the University of New Mexico. She also teaches a Technology in Society course for the school of engineering. Her research interests and publications include restructuring of corporate R&D laboratories, the comparison between scientists working in industry and academia, engineering ethics, tenure and freedom in engineering, and women and minorities in information technology.