Accessibility of Computer Science: A Reflection for Faculty Members

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Over the past twenty years, the student population in Computer Science departments has become increasingly male, and the number of women among faculty members has remained quite small. Thus, many academic Computer Science Departments are almost exclusively male environments.

These notes are meant to be a contribution to dialog on the implications of this fact for premier departments.

Some of the quotations are drawn from documents at ETH and the University of Maryland, because I have first-hand experience at both institutions, but the observations and conclusions are more broadly applicable.

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Version 1: June 1999

1 Picture Yourself:

You are male, almost 20 years old, naive but bright. You choose to major in Computer Science, and on your first day at the university you walk into your first class and find a large room full of excited newcomers – and all but a handful of them are female.

You might begin to wonder

*http://www.cs.umd.edu/users/oleary/

- Why aren't more males interested in this subject?
- Aren't males good at Computer Science?
- Should you change majors?

You persevere, though, but midsemester you still have doubts.

- "Everyone" else seems to have a lot more experience than you do; at least it seems that they understand the subject better.
- The one time you got the courage to answer a question that the assistant asked, some of the females in the course seemed to resent it.
- None of the projects have been very motivating, although many of the females seem to really enjoy them.
- Many of the females have formed study groups, but you aren't invited to join. The other males seem equally isolated but afraid to be seen as banding together.
- You haven't seen any male faculty members or assistants in the department, so you wonder if you have any future in the subject.

After the end of the semester, you take the exam, but don't do very well. This magnifies your earlier doubts.

Will you continue to study Computer Science?

2 Unrealistic?

Yes, this scenario is totally unrealistic, but reverse the genders and you begin to understand how Computer Science can look to female students.

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> *"Your mind is like a parachute. It only works if it is open."*
> *Anthony J. D'Angelo*

3 Are women less talented in Computer Science?

- "In 1986 in the former GDR, 50% of Computer Science students were women (after an incredible 80% in 1972 in TU Dresden). Since then, this has declined to approximately 10%." [1, p.6]
- The percentage of women among recipients of U.S. bachelor's degrees in Computer Science was 37% in 1984, but only 28% in 1994 [2]. The percentage has dropped further since then, even though more than half of all bachelor's degrees are awarded to women.
- If women were able to do Computer Science in the 1980's, surely they are qualified now, but they are making other choices.
- Women (on average) outscore men on the verbal portion of the SAT exam, used for college entrance in the United States. Skills measured by this exam are at least as important as mathematical ones in many areas of computer science research today, including visualization, artificial intelligence, computational linguistics, language and compiler design, human-computer interaction, etc.

  Males (on average) outscore women on the mathematical portion of the SAT exam, but the gap seems to be narrowing [3] and once math experience is factored out of studies comparing male and female math ability, most of the difference disappears [4].
- From the "prehistory" of computers (Ada Lovelace) through its early history and up to the present, women have made fundamental and unique contributions to Computer Science [5].

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"In fact, most work with computers involves manipulation of information and communication with people, which relies as much on verbal and interpersonal skills as on mathematical abilities."
V. Clarke

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"[I]t is not true that girls are no good at computing or that they are not interested in computing, but it is true that both men and women believe that girls are no good at computing and believe that they do

not like computing. Such beliefs are self-perpetuating, and difficult, but not impossible, to change."
V. Clarke

References/Resources[1]

4 Do women "think" differently about technical subjects like Computer Science?

That is an interesting biologic and sociologic question, but whether the answer is "yes" or "no" really has little impact on the fact that women are underrepresented in Computer Science.

- If they do think differently, "[W]omen may bring with them specific skills and approaches that actually enhance the field of computing." J. Cottrell [1]
- If they don't, there can be no argument that they have less aptitude than men.

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"The real problem is not whether machines think but whether men do."
B. F. Skinner

References/Resources[2]

5 So why do so few women enter the Computer Science program?

- Most have little or no exposure to it in their pre-university studies, and they find little recreational software that appeals to them. Therefore, they never seriously consider the major unless they are encouraged by a relative or friend in the field or by an outreach program run by a university.

[1] 20
[2] 21

- The media has quite clearly projected the image of computer scientist as hacker: single minded, socially inept, obsessed with his work. This is not a particularly appealing professional goal [1].

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"The predominant themes of recreational computer games are war, battles, crimes, destruction, and traditionally male-oriented sports and hobbies [14]. Thus, it is not surprising that boys use computers in courses and summer camps both earlier and more often than do girls.
A. Pearl, M. E. Pollack, E. Riskin, B. Thomas, E. Wolf, and A. Wu

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"I asked ten friends of mine, all girls and women of color, to paint a picture for me of the person who came to mind when I said the words 'computer scientist.' Nine out of ten said he *was* white.*"*
C. Edwards

References/Resources[3]

6 Why do so many of these women leave the Computer Science program?

A lack of self-confidence seems to be typical of women in their high school and college years.

> "Self-confidence regarding mathematics appears to be the most distinguishing characteristic separating collegiate men and women. There are clear indications that at every level, from middle school to the doctorate, women generally are less confident in their mathematical abilities than men. Successful women report receiving encouragement and assurance of their abilities at several critical junctions from parents and instructor." D. J. Lewis [1]

[3] 22

The situation is similar in Computer Science [2]. Since many women lack confidence in their decision to enter the program, it is easy to change their minds, especially if they encounter bias in their teachers and colleagues and see a less "chilly environment" in another subject area.

If a Computer Science department wants to retain its women students, then this lack of confidence is a fact to be recognized, and the faculty would need to follow the guidance of the Hippocratic oath: "First, do no harm."

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"[T]he actions often are not intended to be discriminatory; the people who convey biased attitudes toward women may be well-intentioned. Nevertheless, the effect of their behavior is to undermine the professional image of women held by their colleagues and the women themselves."
A. Pearl, M. E. Pollack, E. Riskin, B. Thomas, E. Wolf, and A. Wu

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"Singly, these behaviors probably have little effect. But when they occur again and again, they give a powerful message to women: they are not as worthwhile as men nor are they expected to participate fully in class, in college, or in life at large."
B. R. Sandler

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"The unequal treatment of women who come to MIT makes it more difficult for them to succeed, causes them to be accorded less recognition when they do, and contributes so substantially to a poor quality of life that these women can actually become negative role models for younger women, [wrote the tenured women of the Faculty of Science in a report to the Dean of Science]. In short, they said, they were so miserable that any young woman looking up at them would think, 'Why would I want that?'"
Boston Globe*, 21 March 1999, p. A01*

References/Resources[4]

[4] 23

7 What makes the environment chilly?

Each woman reacts differently, but some may be made uneasy by conditions such as these:

- few women assistants and faculty members to serve as role models [1,2].
- reduced access to study groups [1,9].
- programming projects designed for male interests [3].
- devaluing of women's contributions, especially attributing them to male colleagues [2,4].
- friction between women coping by being "one of the boys" in work habits, socialization, and competitiveness, and those seeking an alternative path [5,10].
- hostile attitude from a few male students [4].
- expectation of instructor that she will do poorly [6,7] and negative feedback from instructors [8, p.51].
- classes that overwhelmingly use male language ("the user ... he", or "suppose that your wife...") and gender-stereotyped examples [4].

Each is just a little issue, but the cumulative effect can be overwhelming.

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"However, the lack of social and professional connections available to most women in academic science and engineering departments, in concert with overt and covert gender bias as well as differences in socialization, creates special and unique problems for women."
H. Etzkowitz, C. Kemelgor, M. Neuschatz, B. Uzzi

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"I have always believed that contemporary gender discrimination within universities is part reality and part perception. True, but I now understand that reality is by far the greater part of the balance."
Charles M. Vest, president of MIT

References/Resources[5]

[5] 24

8 But the instructor's attitude can't make the female student fail, can it?

Studies show that students live up to the instructor's expectations, unconsciously trying to prove the expectations correct [1].

If a professor makes a sexist joke, a female student might well find it so disturbing that she is unable to listen to the rest of the lecture [2]. Suggestive pictures used in lectures on image processing are similarly distracting to the women listeners and convey the message that the lecturer caters to the males only. For example, it is amazing that the "Lena" pin-up image is still used as an example in courses and published as a test image in journals today [3]

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> *"Dealing with prejudice can drain a person's energy and motivation. After an oral exam in an honors university physics course, my professor said, 'You know, you are a girl, but you are good.' My reaction: why continue in a field where the established scientists will expect incompetence from any woman? It is easier to break into a field where people will judge me first on my merits."*
> *D. P. O'Leary*

References/Resources[6]

9 Where do prejudices come from?

> Professor Alpha had previous female students. He found them too quiet, and they had too little background. Two of them dropped out. And his daughter and sister have no talent in Computer Science.

Would you like to have your potential judged on the basis of your brother's skills?

Or on the basis of the weakest student in your class in high school (gymnasium)?

Unfortunately, children as young as three years old have been shown to have formed restricting gender stereotypes (for example, that girls cannot be doctors [1]), so it is unlikely that any of us are free of them. We need to be aware of the tendency and compensate for it.

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[6] 25

A man and his son are in an auto accident. The man dies, and the son is rushed to the hospital for surgery. In the operating room, the doctor says, "I can't do the operation; this is my son!" How is this possible?

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"Aristotle maintained that women have fewer teeth than men; although he was twice married, it never occurred to him to verify this statement by examining his wives' mouths."
Bertrand Russell

References/Resources[7]

10 Why should I care about whether women are comfortable in the Computer Science program at my university?

Premier departments are making efforts to increase the participation of women. For example, in the early 1990's when the percentage of women undergraduate Computer Science majors at MIT dropped to 20%, this became a source of concern. In many departments, the percentage is far lower; e.g., 6% at ETH in 1999, according to the *Sommer 1999 Semesterprogramm.*

As the number of males entering college decreases (due to decreased birthrates), it will become even more difficult for industry to fill their technical positions unless talented women successfully complete degree programs.

Can a country compete in a global economy when half of its talented citizens find it difficult to receive technical training?

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" 'Alle Dienststellen haben in ihrem Bereich die Gleichstellung zu verwirklichen.' Mit diesem Grundsatz hat der Schweizerische Bundesrat 1991 die 'Weisung über die Verbesserung der Vertretung und der beruflichen Stellung des weibliche Personals in der allgemeinen

[7] 26

Bundesverwaltung' erlassen. Gleichstellung an der ETH Zürich bedeutet grundsätzlich, dass die Chancengleichheit von Frauen und Männern sichergestellt ist."

"All departments have to achieve equality within their area." With this principle the Swiss Federal Council legislated the direction of the improvement of the representation of female personnel in the federal government. Equality at the ETH means that the equality of opportunity of men and women is secured."
http://www.equal.ethz.ch/scg/scg.html

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"It is the goal of the University of Maryland System to assure that women and minorities are equitably represented among the student body, faculty, staff, and administration of the institutions constituting the System, so that the System reflects the diversity of the State's population."
132.0 VI-1.00-Policy on Affirmative Action and Equal Opportunity,
Bylaws of the Board of Regents, University of Maryland http://umdacc.umd.edu/policies

References/Resources[8]

11 Finding a mentor

Often faculty feel most comfortable with students who are younger images of themselves: the same gender, race, and nationality.

Some "faculty men may see women as being different from themselves, less intellectually able, less committed and dedicated, or simply inappropriate for academic careers" [1]

Some faculty members even refuse to consider hiring a female assistant.

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"Die ETH Zürich versteht sich ihren Mitarbeiterinnen und Mitarbeitern gegenüber als verantwortungsbewusste Arbeitgeberin mit fortschrittlichen Anstellungs- und Arbeitsbedingungen. ... Sie duldet keine Diskriminierung ihrer Angehörigen aufgrund von Geschlecht oder

[8] 27

sozialer, ethnischer und religiöser Herkunft. Die ETH Zürich will den Anteil an Frauen in allen Bereichen von Forschung, Lehre und Verwaltung erhöhen."
Leitbild der ETH Zürich 1996

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"In its relationship with staff, the ETH Zurich conceives itself to be a responsible employer committed to observing up-to-date employment practices and working conditions. ... No discrimination among its members is permitted on the basis of sex or social, ethnic or religious origin. The ETH Zurich wants to increase the proportion of women in all fields of research, teaching and administration."
Leitbild der ETH Zürich 1996

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"The University of Maryland, College Park, affirms its commitments to a policy of eliminating discrimination on the basis of race, color, creed, sex, sexual orientation, marital status, personal appearance, age, national origin, political affiliation, physical or mental disability, or on the basis of the exercise of rights secured by the First Amendment of the United States Constitution."
University of Maryland Human Relations Code

References/Resources[9]

12 Are women judged fairly?

Surprisingly, the answer is no!

Research shows that there is pervasive bias against women in

- refereeing of papers [1,2]
- assessment of professional accomplishments [1]

[9] 28

- teaching evaluations [3]

Bias also comes into play in letters of recommendation. Accomplishments are often devalued or credited to male colleagues [4], and characteristics that are considered assets in males are considered faults in women:

- Mr. X is assertive; Ms. Y is pushy.
- Mr. X is persistent; Ms. Y is stubborn.
- Mr. X thinks creatively; Ms. Y is easily distracted by tangential ideas.

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In one study, first done in 1968 and then replicated in 1983, college students were asked to rate identical articles according to specific criteria. The authors' names attached to the articles were clearly male or female, but were reversed for each group of raters: what one group thought had been written by a male, the second group thought had been written by a female, and vice versa. Articles supposedly written by women were consistently ranked lower than when the very same articles were thought to have been written by a male [Goldberg 1968,Paludi et al 1985,Paludi et al 1983].

In a similar study, department chairs were asked to make hypothetical hiring decisions and to assign faculty rank on the basis of vita. For vitae with male names, chairs recommended the rank of associate professor; however, the identical vita with a female name merited only the rank of assistant professor [Fidell 1975].
E. Spertus

References/Resources[10]

13 The pregnancy issue

A U.S. army study found that "even when pregnancy leave is included, [enlisted women] take less time off than men, who lose it to sports and auto injuries and drug, alcohol and discipline problems [1]."

Similarly, a study of the hiring of scientists and technical staff at the (British?) National Health Service found that employers often assume

[10] 29

that all women will leave to have babies and that wastage due to pregnancy is greater than for any other reason. The pervasiveness of [this myth] was shown by the way in which they influenced practices at selection (for instance, only women were asked questions about marital status and dependent children). They also influenced notions of who can be a manager [2]."

It would be unthinkable in Switzerland to refuse to hire a Swiss male just because he had an obligation for military service. If a woman takes an eight week pregnancy leave once over the course of six years of graduate study, she is away from her work less than half the time that the Swiss male would be!

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"All men are caught in an inescapable network of mutuality."
Martin Luther King, Jr.

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"It would be naive to think that the problems plaguing mankind today can be solved with means and methods which were applied or seemed to work in the past."
Mikhail Gorbachev (1988)

References/Resources[11]

14 Status of women faculty

Women faculty members face a difficult balancing act. Administrators at MIT were convinced that they treated male and female faculty members equally, but data on office space and other resources proved them wrong. Here is part of what an MIT report has to say about the situation in 1999:

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"We believe that unequal treatment of women who come to MIT makes it more difficult for them to succeed, causes them to be accorded less recognition when they do, and contributes so substantially to a poor quality of life that these women can actually become negative role models for younger women... ....

[11] 30

Each generation of young women, including those who are currently senior faculty, began by believing that gender discrimination was 'solved' in the previous generation and would not touch them. Gradually however, their eyes were opened to the realization that the playing field is not level after all, and that they had paid a high price both personally and professionally as a result.

Given the tiny number of women faculty and the fact that they are essentially irreplaceable, one would have assumed that all tenured women would be treated exceptionally well – pampered, overpaid, indulged. Instead, they proved to be underpaid, to have unequal access to the resources of MIT, to be excluded from any substantive power within the University. How did this surprising state of affairs come about?

First and foremost it is essential to set aside the issue of whether these women were badly treated because they were simply not good enough. It must be understood that for these particular women the opposite was undeniably true. Despite discrimination, most of these women achieved at an outstanding level within their professions. Forty percent of the tenured women faculty are members of the National Academy of Sciences and/or the American Academy of Arts and Sciences. Only people above the average MIT faculty could have succeeded at this level despite the many obstacles the senior women faculty encountered in their careers. Indeed, it should be almost obvious that the first women, the first blacks, the pioneers who break through despite enormous barriers must be exceptional. Once and for all we must recognize that the heart and soul of discrimination, the last refuge of the bigot, is to say that those who are discriminated against deserve it because they are less good."
Committee on Women Faculty in the School of Science

References/Resources[12]

15 What can be done at the faculty level?

- Shared governance and a high level of democracy is a strong asset in recruiting women faculty members.
- Hire female faculty. Until equity is achieved:
  - Actively recruit good women candidates; don't just wait for them to apply.

[12] 31

    - After they interview, stay in contact to let them know that you would welcome them as a colleague.
    - Be aware of biases that might appear in recommendation letters and try to avoid undervaluing a female candidate because of them.
    - If two candidates rank virtually the same, and if law permits, make the offer to the woman candidate first.

- Support qualified women as candidates for administrative positions such as department head, dean, and higher.
- Invite more female seminar speakers and longer term visitors and make them visible to students. By their presence, these visitors tell women students that they have a future, and they tell the male students that they are preparing for a career in which they need to deal with male and female peers.
- Support qualified women candidates for heading departments or divisions.

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"I think men have a hard time collaborating with women (in either research or general lab activities) until there are enough women around that they feel comfortable and have productive expectations of women colleagues.... When enough women are around, the fraternity atmosphere becomes a society, a community."
C. Sidner, AAAI fellow and a member of the research staff at Digital's Cambridge Research Laboratory

References/Resources[13]

16 What can be done in beginning courses?

- Accommodate a variety of different backgrounds. If the first course weeds out students who have little background in programming, then many talented students will be turned away, including a disproportionate percentage of women. If prior experience is assumed from entering students, then to remedy this loss there would need to be an institutional commitment. Offering a summer orientation course to introduce the necessary principles is one such example. One alternative would be to establish an alternate introductory course, for students with less background, that has more class meetings or a two-semester duration, and to provide more supervised hands-on experience as part of the curriculum.

[13] 32

- Communicate the broad applicability of Computer Science to life and societal issues. Medicine relies heavily on visualization. Biology uses pattern matching. Encryption and privacy are essential for banking and e-commerce. Numerical and statistical computations form the basis for data analysis in science, engineering, and the social sciences.
- Choose projects that make applications clear and that draw upon the students' previous experience. Some examples:
  - Discuss privacy and security issues with the class and have them program an encryption algorithm.
  - Program a code-breaking algorithm.
  - Write a simplified spreadsheet package.
  - To illustrate sorting and searching, write a spell-checker.
  - Write a program to reformat a paragraph to a given width.
  - Write a user-interface for an existing spell-checker.
  - Write a simplified "draw" program or mail-filter.

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Girls usually score better than boys on verbal tests, and boys have more difficulty than girls in learning to read. But schools do not take this as a reason for letting boys drop out of reading classes. Quite the reverse: most schools have remedial reading classes which are used predominantly by boys. Teachers put extra effort into teaching boys to read to make up for any deficiency, whether its origin is biological or social.
A. Kelly

17 What can be done throughout the curriculum?

In all courses:

- Establish an environment where it is easy to ask questions.
- Give students a glimpse of how their knowledge would be used in industry. Industry advisors tell U.S. academic Computer Science departments that the main skill that the students miss learning during their studies is the ability to interact well on team projects. Consider including some

assignments in which students, while acting relatively independently, can contribute to a larger project and see results that they could not have achieved by themselves.

- Use inclusive examples and language. For example, don't use artificial intelligence examples in which the men are active players and the women passive props. Use "he or she" when talking about the end-user, to emphasize that software should be designed for both males and females. Don't choose all of your examples from a narrow subject area (e.g., warfare). Aim for broader appeal.
- Don't water down the content of the course but make sure that your examples emphasize the wide usefulness of the principles. For example, a robot is fun to play with, but it will be even more appealing if students understand the relevance of robot research in advancing remote surgery, handling of hazardous wastes, space exploration, etc.
- Rewrite some abstract course assignments to develop the same skills and tools while including a specific interesting application. For example, assignments in numerical courses can be use data drawn from applications in medicine, transportation engineering, scheduling, etc.
- Grade assignments and written exams without looking at the students' names, so that the grader does not know the gender of the student.

Recruit more female students:

- Invite female students to visit your department a year or two before they need to decide where to attend university. Organize a day of demonstrations and tutorials.
- Make use of printed resources and web documents to encourage such students to choose computer science.
- Offer summer short courses to help talented female pre-college students bridge deficiencies in their background and develop confidence in their abilities in computer science and mathematics.

Efforts such as these require dedicated effort for some faculty members and graduate assistants. This should be recognized by a reduction of other duties and funding provisions (either within the institution or from outside sources) so that these programs are not run as an overload.

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"When Alexander the Great visited Diogenes and asked whether he could do anything for the famed teacher, Diogenes replied: 'Only stand out of my light.' Perhaps some day we shall know how to heighten creativity. Until then, one of the best things we can do for creative men and women is to stand out of their light."
J. W. Gardner

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"The whole art of teaching is only the art of awakening the natural curiosity of young minds for the purpose of satisfying it afterwards."
A. France

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"A teacher affects eternity; he can never tell where his influence stops."
Henry Adams, The Education of Henry Adams

References/Resources[14]

18 What can be done within graduate education?

- Faculty need to use their contacts at peer institutions to identify qualified female undergraduates and then actively recruit them.
- When you write a letter of recommendation for a woman, list her qualifications and accomplishments and then draft the letter pretending that you are discussing a male candidate. You may find that you write a very different (and more fair) letter using this approach.
- Success begets success – to the extent that current students are treated with fairness and encouragement, good male and female candidates will be likely to choose that department.

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[14] 34

"All women students and faculty interviewed reported that they joined it rather than a department at an other prestigious institution, because of their perception that it offered a collaborative, cooperative, and collegial milieu. They were attracted by the warm interpersonal interactions they had experienced when they interviewed and by a sense of personal concern for the candidate conveyed by faculty and students. ... Most had been disturbed by the demoralization of students at other departments where they had interviewed, having heard stories of exploitative advisors and anonymity in large research groups."
H. Etzkowitz, C. Kemelgor, M. Neuschatz, B. Uzzi

References/Resources[15]

19 Did you notice?

The suggestions above don't just improve the climate for women; they aim to improve it for men as well. Everyone should benefit as the environment becomes more equitable.

That is what accessibility is all about.

20 References:Are women less talented in Computer Science?

References for Section Are women less talented in Computer Science?[16]

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