Strategies for improving diversity in STEM

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Relevant papers:

- S. Ceci and W. Williams, Sex Differences in Math-Intensive Fields, Current Directions in Psychological Science **19**(5), 272-279 (2010).
- M.-T. Wang, J. Eccles, and S. Kenny, Not Lack of Ability but More Choice: Individual and Gender Differences in Choice of Careers in Science, Technology, Engineering, and Mathematics, Psychological Science **24**(5), 770-775 (2013).

There are generally 4 main reasons cited to explain the underrepresentation of women in math intensive STEM fields:

1. Ability: girls are more likely to have balanced math and verbal skills whereas boys are more likely to have better math skills than verbal skills
    - Consequently, when choosing a career, girls have more choices – they can go into a field which requires math proficiency, but can also go in a field which requires good communication skills
2. Career preference:
    - Girls tend to prefer careers which involve interaction with other people. They also tend to select careers that are 'altruistic', i.e., have the potential to impact the lives of other people in positive ways
    - Boys are more likely than girls to prefer careers which involve working with machines and which do not necessarily involve interaction with other people
3. Life choice
    - Women are more likely to consider careers which provide a balance between life and work – they are thinking about starting a family and raising children, and careers which require intensive work around the time when they are 30 (e.g., academic careers where the pressure to get grants and publish is high during the tenure process) are not necessarily seen as appealing.
    - Men do not seem to have these kinds of concerns
4. Gender bias
    - Many studies have shown that there is gender bias when it comes to encouraging children/teenagers to pursue STEM careers
        i. For example, middle-school/high-school teachers tend to encourage boys more – they pick boys more often to answer questions, and spend more time attending to their questions. This is independent of the gender of the teacher.
        ii. Other studies in elementary school (95% of teachers are female) related to math anxiety show that kids pick up on the math anxiety of the teachers and it affects

girls disproportionately more – they are more likely to develop a belief that math is difficult and they cannot do it.

iii. Even parents seem to encourage their boys more: for example, a study by Kevin Crowley (LRDC Pitt) shows that in the context of a museum exhibit, parents spend three to four times more time answering science related questions posed by their boys than their girls.

The following things were discussed about these different points:

1. and 2. If girls have more choice than boys, and can choose between math intensive or communication intensive fields, why don't they choose STEM fields? We should think about increasing awareness of the improved career opportunities in math-intensive STEM fields, both in terms of job finding, remuneration and job security.
    - Also, widespread misconceptions seem to exist about STEM careers not involving interaction with other people. In virtually every STEM field people work collaboratively in teams, nobody does research on their own anymore. In nearly all math-intensive fields ability to work in a team and good communication skills are essential. Since girls are more likely to prefer careers which involve working with other people, this aspect of the career can be highlighted
    - It is important to raise awareness about what a scientist **does** and what doing science entails – for example engaging in outreach, participating at science fairs, developing a working relationship with schools; keep in mind that kids often rule out careers as early as middle-school (they may have a good idea of what they want to do, but they can have an idea of what they don't want to do).
        - Making the point of how working in a particular field can actually benefit society can make the field more appealing to women
    - The approach of challenging misconceptions has worked very well for CMU
        - In 1995, only 5% of computer science majors were women
        - CMU conducted studies and found that many students who were not majoring in computer science thought that 'doing' computer science basically means hacking
        - They worked to change the image of the major as something which can help human beings and which involves working with other people
        - In 10 years, the percentage increased from 5% to 40%

3. It is unclear why they issue of life balance is more prevalent for math-intensive STEM careers. For example, the same issue can easily come up in social science positions, for example academic, where women are the majority. The same problems related to need for getting grants and publishing arises for women in tenure track positions there as well.

    - Ming-Te mentioned that more recent research is finding inconclusive results related to this and it appears that the issue of finding life-work plays a minor role in deterring women from choosing STEM careers.

4. Gender bias: multiple studies have found that women seeking STEM positions are less likely to be hired than men with the same qualifications, and if hired would be paid less.

    - For example a Yale study gave identical resumes to labs looking for a lab manager position, with the exception of the name (in one case male, in another female). They found that females were less likely to be called back and if hired, would have a starting salary around $4,000 lower than males (males' salary was around $30,000, women's around $26,000).
        - No difference between female and male
    - Proposals for getting time on the Hubble space telescope are less likely to go to women (however, the effect is small)
    - This bias is very subtle: both men and women exhibit this bias, and they are unaware that they are doing so
        - For example, in the Hubble space telescope case, Meg Urry from Yale who is aware that there is a gender bias actually led the Hubble proposal review committee and made a lot of efforts to include women in the committee and listened carefully to the deliberations of each panel – she did not hear anything that struck her as discrimination
    - So if this bias is so subtle what can we do to guard against it?
        - One faculty from the Biology mentioned that in a recent biology faculty search, they would prime the faculty on the search committee by looking at women prominent in the field before evaluating applications

It was also discussed that in math intensive fields, women have a tendency to judge their performance by harsher standards than men, which can lead to them leaving a major. For example, in computer science people have compared the performance of females who left the major with males who stayed and found better performance for the females. It is important to remind students what their grades actually mean, for example, a grade of 70 can be seen as really low by a student, but if the exam average was 60 (note, exam averages below 70 should be avoided), that's not true. We should not assume that students know how to evaluate their own performance.

- For example, Eillen Pollock wrote an opinion piece in the New York Times in which she said that in her undergraduate career she worked with a faculty member on a thesis and at some point told him that she wanted to go to MIT and study theoretical physics. The faculty member said things like "you know, doing that is really difficult" and she took it to mean that she couldn't do it. She ended up pursuing an English career.
- Later, she went and talked to the faculty member and asked him what he thought about the thesis. He said it was the best thesis he had ever had a student write with him. Eileen replied "Why didn't you tell me this then?"
- It is important to praise students when they do good work, they may be unable to realize it otherwise. Remember that this can increase their self-efficacy and can lead to improved chances of pursuing STEM careers.

One important thing to keep in mind is that self-efficacy plays an important role in pursuing a career despite difficulties. Self-efficacy is the belief that one can overcome adversity. Studies have found that positive self-efficacy is more correlated with persistence in a field than actual performance. In other words, the belief that "you can do it" is more important than how you actually do.

- In this regard, countering common beliefs about math intensive fields that one needs to be "smart" to be successful is important. Numerous studies have found that there is no such thing as talent (in any field) and that exceptional performance is always associated with intense work.
- Studies by Carol Dweck have found that convincing students that intelligence is malleable (like a muscle – you need to exercise your brain in order for it to grow and learn) instead of fixed (you are intelligent or not) can go a long way in motivating them to be persistent and use effective study strategies.
    - Dweck found that the belief that being good at math is innate accounts for gender differences between middle-school girls and boys in math performance: only among the students who believed that math is a gift (i.e., math ability is innate) there was a gender gap in performance. There was not difference for students who believed math ability can be developed.
- It was discussed that even in a college class, one should spend some time convincing students that intelligence can be developed – have students read a short article on cognitive science results which shows that learning entails making new neural connections which actually 'grows' your brain, discuss the article and give an assignment to convince one of their friends who is having trouble in a science course (physics, math, chemistry etc.) of this fact. They can be successful if they work hard – learning is just like working out – you do it every day, but don't strain yourself and your brain will grow.
    - Also, the experiments of Josef Polgar with teaching his daughters to play chess – he wanted to prove that anybody can become a world class performer if they work at it, and this is exactly what happened. All three of his daughters reached international grand master status and some of them have beaten famous chess players. Judit Polgar was the first woman in the history of chess to beat Kasparov. She is by far the best women player to ever play the game.
- When praising students it is important to praise their effort NOT intelligence to reinforce the message that effort is what correlates with performance and there is no such thing as innate ability.

It was also discussed that the sense of belonging is also important. In math intensive STEM fields, women are underrepresented and it can be interpreted (by students) that the lack of women in a field is due to a lack of innate ability (women just aren't as good at math as men), and this is why it is important to challenge the assumption of innate ability.

In life-sciences however, there are more women than men. It was also pointed out that in other countries there is no gender gap in math intensive fields. For example, in Iran, the percentage of females pursuing physics BS and PhDs is larger than men. Similarly in Asian countries there is no underrepresentation of women in math-intensive fields.

- The problem is cultural
- Important to challenge commonly held assumptions about ability – messages about what women are good at and what men are good at abound popular media

There is also gender bias in teaching evaluations: women generally receive lower teaching evaluations than men:

- When students are shown profiles of faculty in the context of teaching a course, they evaluate the profiles with female names lower than the profiles with male names.