

## Does being human influence science and technology?

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### Abstract

This article addresses two major questions about women and science. Firstly, the commentary looks at the ways science and technology are discussed and represented all around us in society. Secondly, I ask whether this matters. The defining issue is therefore whether or not being human affects the type of science and technology that is conducted and valued within our society. By addressing these questions in science communication, we can add much to the debate about gender diversity and affirmative action being portrayed in our media and culture.

### Keywords

Participation and science governance; Representations of science and technology; Women in science

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Pay and role disparity between men and women has been a topical issue for over fifty years, and yet little progress has been made. The problem is particularly apparent in Science, Technology, Engineering and Mathematics (STEM) subjects, with a gradual decline in the numbers of women continuing into further and higher qualifications, and ultimately into the workplace — the so-called 'leaky pipeline' [Perkins, 2013]. While women do progress in biological science and medical fields, there is still a disparity in managerial or professorial roles [Rapaport, 2015]. In the physical sciences, there appears to be a dearth of women, with only 9% of engineers in the UK being female [EngineeringUK, 2017]. So what is going on, and why should we care?

### Are women part of mankind?

As a science geek growing up in the 1980s, I wasn't aware of the cultural idea that women who did STEM were considered to be strange [Fara, 2013]. Science was just another interest which went into the melting pot of childhood experiences. I have since learnt that this was in fact the tail-end of the gender-neutral movement [Oksman, 2016], and indeed I attempted to live my life by the idiom, "To boldly go, where no *one* has gone before". It wasn't until my late childhood that I realised that this was a 'politically-correct' adaptation of the original 1960s Star Trek catchphrase, which urged us "To boldly go, where no *man* has gone before". It is a subtle word change, but a whole new world of meaning for a little girl with big hopes.

Of course, I have since been thrown out of my utopia and metaphorically crashed into the societal expectations waiting for both myself and my two children (a girl and a boy). Gender roles, expectations, and futures are reinforced in society through multiple interactions every day. Right from day one, girls are given pink dolls and soft teddies, and boys are given loud cars and construction tools. Going against the grain takes exceptional tenacity and strength of character, or perhaps a blinkered view of social norms. This is why we still consider it unusual for men to become nurses or nannies, or women to become mechanics or soldiers.

### **Is STEM socially acceptable for women?**

Humans are social creatures, and more than anything, most of us want to fit in. It is therefore common sense that the things which we see others doing around us, are the things which we want to copy or be part of. The psychologist Albert Bandura termed this 'social cognitive theory' (previously social learning theory) [Bandura, 1976; Bandura, 1977]. This explains how an individual's learning is not only related to their personal capabilities and experiences, but also by observing others; this can be through social interactions, life experiences, or outside media influences [Bandura, 2001; Bandura, 2004]. In other words, an individual might not do something just because they are good at it; they will also observe the outcome of the behaviour and how others react to it socially [Fogg-Rogers, Sardo and Boushel, 2017].

I therefore argue that if we wish to influence whether it is considered socially acceptable for women to take part in STEM, we need to change the representation of STEM, scientists, and engineers in all aspects of society. This is no mean feat. It includes our use of language, the images we use in public engagement, and the presenters who discuss science in our media or events.

Fundamentally, if girls don't see women being received positively in STEM roles, then they will never think that STEM is a 'normal' thing for women to do. Indeed, including a diverse mix of activity leaders in STEM public engagement has a proven impact to reduce this 'stereotype threat'. Female aspirations and grades increase if they are offered successful female role models [Marx and Roman, 2002; Shapiro and Williams, 2012], while male aspirations are not reduced [Lockwood, 2006]. The same applies to Black and Minority Ethnic (BME) students, coined as 'the Obama effect' [Marx, Ko and Friedman, 2009].

### **Should we socially engineer society?**

This is why we purposively recruited women into our project Robots vs Animals, in order to provide a 50/50 gender balance in science communication event presenters [Fogg-Rogers, Sardo and Boushel, 2015; Fogg-Rogers, Sardo and Boushel, 2017]. Women only made up 30% of the engineering laboratory workforce we collaborated with - whilst this is actually a high proportion in engineering, it would have meant we had three women out of ten presenters. We therefore specifically targeted some women to join the project and rejected some men who were keen to join. While some of the male staff did support this approach, others were against the idea of 'affirmative action', as evidenced by these quotes.

*Employing women just for the sake of employing women and making their numbers up — I think it actually undermines and devalues the participation of women in such events. The quality is in the scientist regardless of gender. (Engineer 15, Research Supervisor, Male)*

*Maybe constantly throwing girls at them in engineering isn't actually working and maybe there's another way to do it. . . I do feel sometimes there could be more encouragement, positive encouragement, for boys to be doing it as well where I think boys can miss out because it's just assumed that that's what they're going to do.  
(Engineer 8, ECE, Male)*

It is an issue which has again recently made the news, with Google firing a male staff member who wrote a memo declaring there to be biological differences in men and women's capabilities and success in STEM [Redden and Davis, 2017]. Many would agree with the memo's author, which is why resistance to socially engineering our society is so strong. Indeed, few would disagree that women are designed to bear babies and that men tend to be physically stronger. However, in 2017, I would argue that this need not be all that defines us. It is why there is a difference between the terms 'equality', where all are considered equal and are treated as such, and 'equity', where some people are given extra help according to their needs [Dawson, 2014].

**Does who we are affect how we see the world?**

So why should equity in STEM matter? This all comes down to your paradigmatic worldview. STEM has traditionally operated in a positivist paradigm, whereby science is the pursuit of a truth which exists outside of reality. Within this worldview, it really doesn't matter what sort of person the scientist or engineer is, as the truth will be found by whoever seeks it. However, social constructionists see the world differently, arguing that each person and society has a different perception of what is true according to our background, culture, and experiences. In this context, it really does matter what sort of person is in charge of doing the questioning and decision making.

Whilst I am not denying the existence of reality, I am arguing that increasing diversity in STEM is therefore a good thing for science! Broadening out the range of people who undertake STEM subjects means that we have a wider range of experiences and ideas to draw on, be that through gender, race, or social class (and indeed where they intersect). It means that scientists and engineers can ask questions which reflect their life experiences, and find solutions which will work for people like them.

An example of this would be research into the menstrual cycle and conditions such as endometriosis. This area of medical science is chronically underfunded and treatments are rare [Weckesser and Taylor, 2016], ostensibly because these complaints are viewed as 'women's problems' by (presumably) a gendered workforce funding or performing the research. Yet let us not forget that 50% of the population will have, does have, or has had periods!

'To err is human'; this idiom shows us that wherever humans are involved, there will be idiosyncratic changes according to who we are. Ranging from outright misogyny or racism to more subtle forms of unconscious bias [Easterly and Ricard, 2011], we are socialised to prefer our own 'in group' [Tajfel, 1974]. This means individuals favour people with whom they identify or are portrayed as the most powerful in our society, which in the West tends to be white middle-class men. It is why STEM would benefit from a more diverse workforce in order to assist the whole of humanity.

## Why should we care about gender diversity?

There are therefore several reasons for more action to be taken to improve gender diversity and parity in STEM. Firstly, there is a utilitarian argument; STEM careers urgently need more workers in order to secure the economic future of developed countries [Perkins, 2013]. If only 50% of the population are attracted to a profession, then there is a further 50% of the population which may prove to be a new recruitment pool. Marketing careers in STEM towards the qualities which appeal to women may improve recruitment and retention. There is some evidence for this, as girls respond positively when STEM careers are presented as creative, collaborative professions which are aimed at providing solutions for people and society [Adams et al., 2011; Diekman et al., 2011].

Recruitment is only part of the issue however, with retention of mid-career women being equally important. The key reason cited for why women leave engineering, in a study of 3700 graduate women engineers, was an unsupportive workplace culture [Singh et al., 2013]. Equitable workplace environments are therefore the second reason to increase gender diversity. If we accept that women have to face different challenges in life due to their biology and societal expectations, then workplaces should be able to accommodate these issues. Rather than expecting all employees to be the same, employers need to be able to cater for diversity within their workforce. Indeed, supportive leadership and peer mentoring networks have both been shown to be vital for providing social persuasion and vicarious experience to encourage women to stay in and develop their careers [Marra and Bogue, 2006; Shull and Weiner, 2002; Sonnert, Fox and Adkins, 2007; Xu and Martin, 2011].

The third reason is a democratic one. If women are not at the table, then 50% of the population is not represented in decision making for our society. Women bring different life experiences and new approaches to problems and solutions in STEM. Encouraging diversity in all its forms, including race and social class, means that we can deliver collaborative solutions which work for the majority of our society.

## You can't be what you can't see?

This article therefore strongly argues the case for more efforts to tackle gender diversity in STEM. The challenge is multi-faceted and complex, and therefore so should be the solutions. More work is needed with children, parents, and teachers, to tackle what is considered to be socially normative, including attempts to raise science capital [Archer et al., 2015] e.g. the Hypatia Project and Responsible Research and Innovation (<http://www.expecteverything.eu/hypatia/>). Pay disparity and employment rights also need to be tackled by employers, such as the Athena Swan project in higher education (<http://www.ecu.ac.uk/equality-charters/athena-swan/>).

However, the saying goes that 'it is the straw which broke the camel's back', and so it is the everyday 'microaggressions' [Sue, 2010, p. 5] which I believe can make the most difference. We are all responsible for reinforcing gender norms and behaviours, and so we can all make an effort to change our behaviours. This means calling out friends and family when they state what people can and can't do. It means using the pronoun 'she' instead of 'he' in stories or descriptions of professions. It means showing pictures of women as the active archetype, instead of a passive bystander. And it means using gender neutral language wherever possible. If we all work together, maybe we really can reach a future where we can 'boldly go where no one has gone before'.

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