GENDER MATTERS In science education:
A CRITICAL SYNTHESIS OF THE LITERATURE

1h4Girls in STEM

Online event
April 28, 2023

Lucy Avraamidou
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L.Avraamidou@rug.nl

- WHO ARE YOU?
- USE 3 WORDS THE BEST DESCRIBE YOURSELF

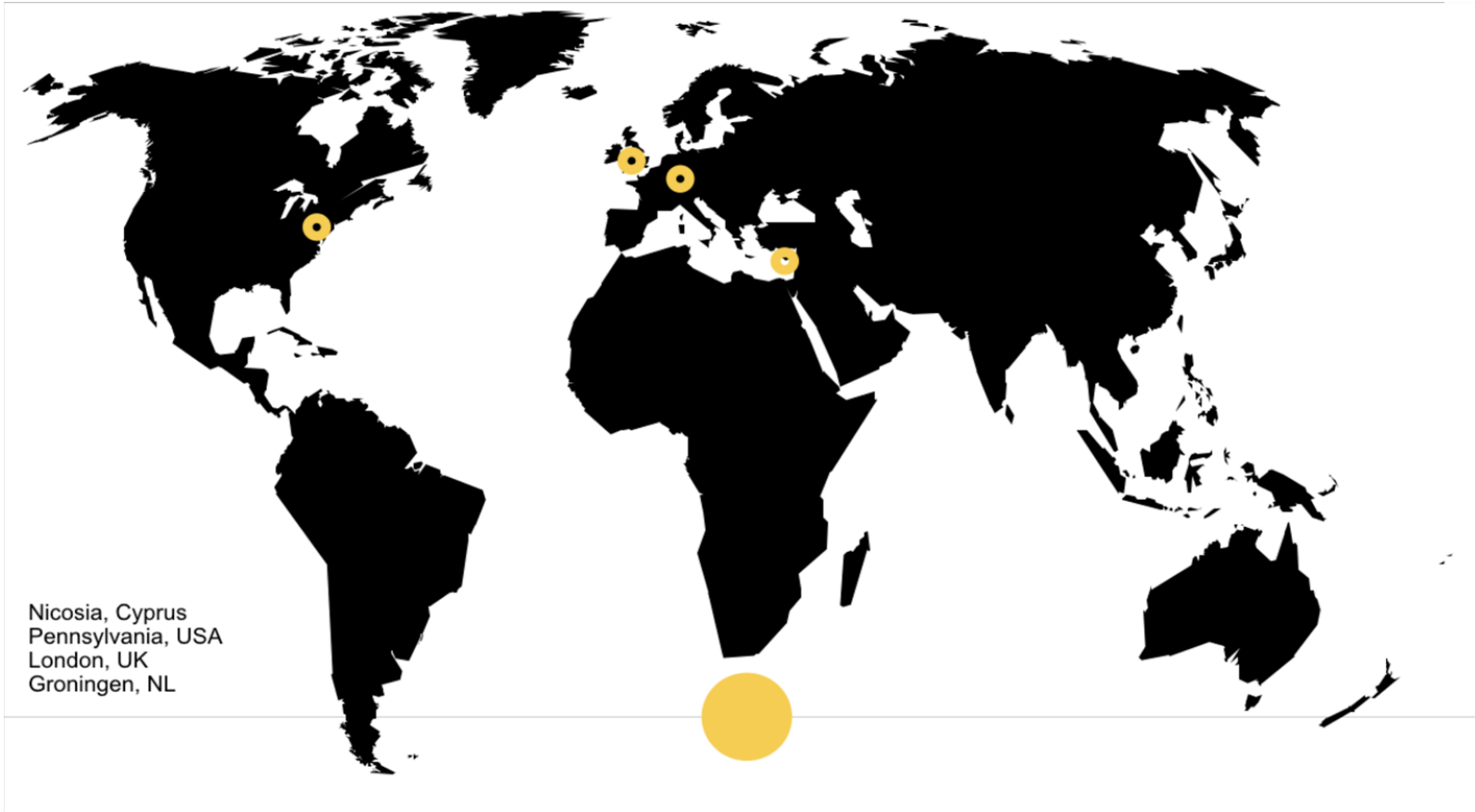
Lucy Avraamidou
back to the gym at 1002m #RadicalSelfCare

Lucy Avraamidou
The power of air #lovescience

Lucy Avraamidou
across the border: "the light will stay on" ❤️

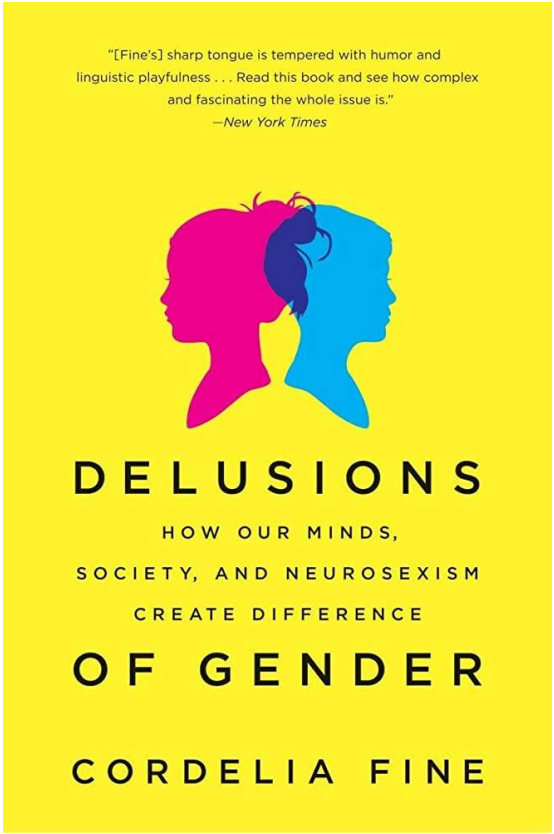
Lucy Avraamidou
hello Bologna, here we are: my amazing research team at #ESERA2019 ❤️

CENTRE FOR LEARNING & TEACHING


Nicosia, Cyprus
Pennsylvania, USA
London, UK
Groningen, NL

WIDEN AND DIVERSIFY STEM PARTICIPATION

our minds, society and neurosexism create gender differences



Pink is for girls, blue is for boys

physicist

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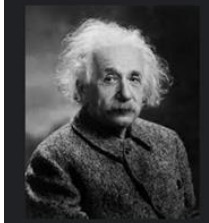
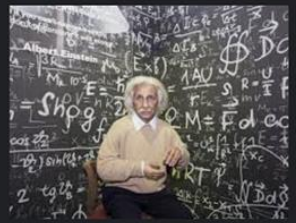
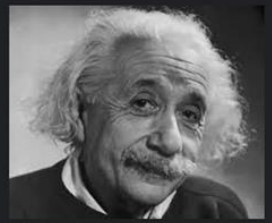
theoretical physics | physics scientist | cartoon | math | vertalen | nuclear | modern physics | theoretical physicist | math



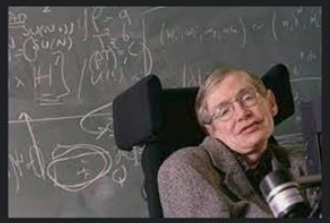
Physicist - Wikipedia
en.wikipedia.org



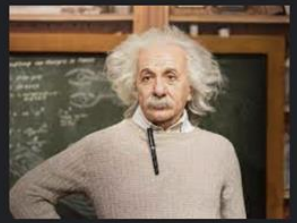
Physicist - Job role
careerswales.gov.wales



I (don't) look like a physicist. The m...
medium.com

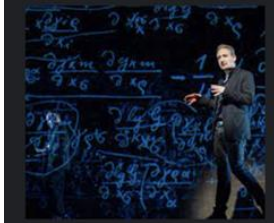


Israeli scientist may have proved Hawking's ...
timesofisrael.com



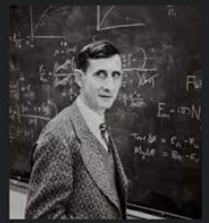
How To Become a Physicist (A Step by ...
owlguru.com

Physicist: Occupations in Alberta - alis
alis.alberta.ca



Physicist Brian Greene: 'Factual i...
theguardian.com

A Quantum Physicist Recommends The 'Ru...
forbes.com



Freeman Dyson, legendary...
nationalgeographic.com

Brookhaven Physicist Robert Palm...
bnl.gov

3,983 Physicist Stock Photos, Pictur...
istockphoto.com

From theoretical physicist to data scientist | by ...
towardsdatascience.com

https://www.youtube.com/watch?v=yND9hDpPwYA

MODESTUM
EURASIA Journal of Mathematics, Science and Technology Education, 2021, 17(7), em1983
ISSN:1305-8223 (online)
OPEN ACCESS
Research Paper
https://doi.org/10.29333/ejmste/10991

Life-Experiences of Female Students in Physics: The Outsiders Within

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[1] University of Groningen, NETHERLANDS

Received 13 April 2021 • Accepted 10 June 2021

Abstract
The purpose of this multiple case study was to examine the kinds of experiences that were critical to the physics trajectories of four purposefully selected undergraduate female physics students in central Europe. The data were collected through individual semi-structured interviews and were analyzed following an inductive approach and a combination of open and in-vivo coding. The findings showed that: (a) all participants experienced a lack of sense of belonging in physics because of stereotypes and biases about the role of women in physics, which were evident both in classroom discourses and lack of recognition by their instructors and their male peers; (b) the intersection of gender and physics identity served as a barrier to the participants' perceived recognition (by others) as competent physics persons as well as their sense of belonging in physics; and, (c) all participants pointed to the lack of role-models and specifically women of color in academia.

Keywords: physics education, life-history, gender, case study

Physics ABOUT BROWSE PRESS COLLECTIONS Search articles

OPINION

More than Just a Woman Physicist

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Institute for Science Education and Communication, University of Groningen, Groningen, Netherlands

July 22, 2021 • *Physics* 14, 75

Approaches that consider the intersection of multiple social and personal identities are urgently needed to understand why women are underrepresented in physics.

AP/Carrie Cato

Physics needs diversity policies that account for each person's unique identities and experiences.

EDUCATIONAL MEDIA INTERNATIONAL
2022, VOL. 59, NO. 2, 150–171
https://doi.org/10.1080/09523987.2022.2101205

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The lonely heroine: portrayal of women scientists in films

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ABSTRACT
Popular films can influence the public's image of women scientists and (re)shape social stereotypes. In this study, we examined how women scientists were portrayed in films in the context of fourth-wave feminism. Twelve characters of women scientists in eight films were analysed using sociological film interpretation across the following categories: occupation, socio-political theme, and time frame. The findings showed that most characters were portrayed as competent, diligent, and typically as experts in their fields. The most prevalent stereotype across the films was the *lonely heroine*. Overall, the findings suggest an improvement in the representation of women scientists in films and provide a set of implications about how women scientists' portrayal in films may contribute to addressing gender science stereotypes. Beyond seeing women in scientific fields represented, it is important that their portrayal is positive, diverse, and intersectional and does not reinforce stereotypes of either dominant or overly feminine women.

KEYWORDS
Gender science stereotypes; science and media; Science Communication; Gender; feminism

RESEARCH ARTICLE
JRST | WILEY

"I am a young immigrant woman doing physics and on top of that I am Muslim": Identities, intersections, and negotiations

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Abstract
Framed within intersectionality and using science identity as a unit of analysis, in this single case study I explore the barriers, difficulties, and conflicts that Amina, a young Muslim woman, immigrant in Western Europe confronted throughout her trajectory in physics and the ways in which her multiple identities intersected. The main sources of data consisted of three long biographical interviews, which were analyzed through a constant comparative method. The analysis of the data provided insights into how intra-personal, interpersonal, sociocultural factors, alongside a myriad of experiences nurtured Amina's intersectional identities and what this may mean for Muslim women's participation in physics. The findings are summarized in two main assertions: (a) Amina was confronted with various barriers across her journey in physics with the intersection of religion and gender being the major barrier to her perceived recognition due to cultural expectations, sociopolitical factors, and negative stereotypes and (b) Amina's social class, religion, gender performance, and ethnic status positioned her as Other in various places throughout her trajectory in physics, and consequently hindered her sense of belonging. These findings suggest the urgency and importance of (a) examining the intersection of science identity with other

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RESEARCH ARTICLE
JRST | WILEY

Identities in/out of physics and the politics of recognition

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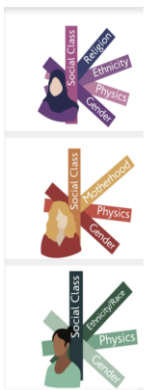
Abstract
Framed within intersectionality, this multiple case study explores women's participation in physics through the construct of physics identity and with a focus on recognition. The study is drawn upon an empirical life-history exploration of three women: a native to Northwestern Europe, late-career white woman and two immigrant women to Northwestern Europe, one is an undergraduate student of color, and the other, an early career Muslim woman. The data for this study were collected through multiple, semistructured, interviews in a period of 2 years, which were analyzed using a constant comparative method. Collectively, the three life-histories tell stories of otherness, persistence, hope, and failure and they elucidate the kinds of identities that are deemed "in-place" and "out-of-place" in physics. They showcase how the three women authored multiple identities that simply co-existed for them, while for others were seen as conflicting and caused misrecognition. The findings point to four main insights: (a) recognition is neither linear nor binary and it comes in many different forms that range from explicit encouragement to no opposition; (b) it is drawn upon various sources including ones in the early years of life: family, school teachers, university instructor, students, and social community; (c) it is culture-dependent and as such, it is influenced by factors on multiple levels, including cultural and gender



GST International Journal of Gender, Science and Technology
http://genderandset.open.ac.uk

Selected papers presented at the 5th Network Gender & STEM Conference, 29–30 July 2021, in Sydney, Australia

In association with
NETWORK GENDER & STEM

Gender-Inclusive Instructional Practices in University Mathematics Classes

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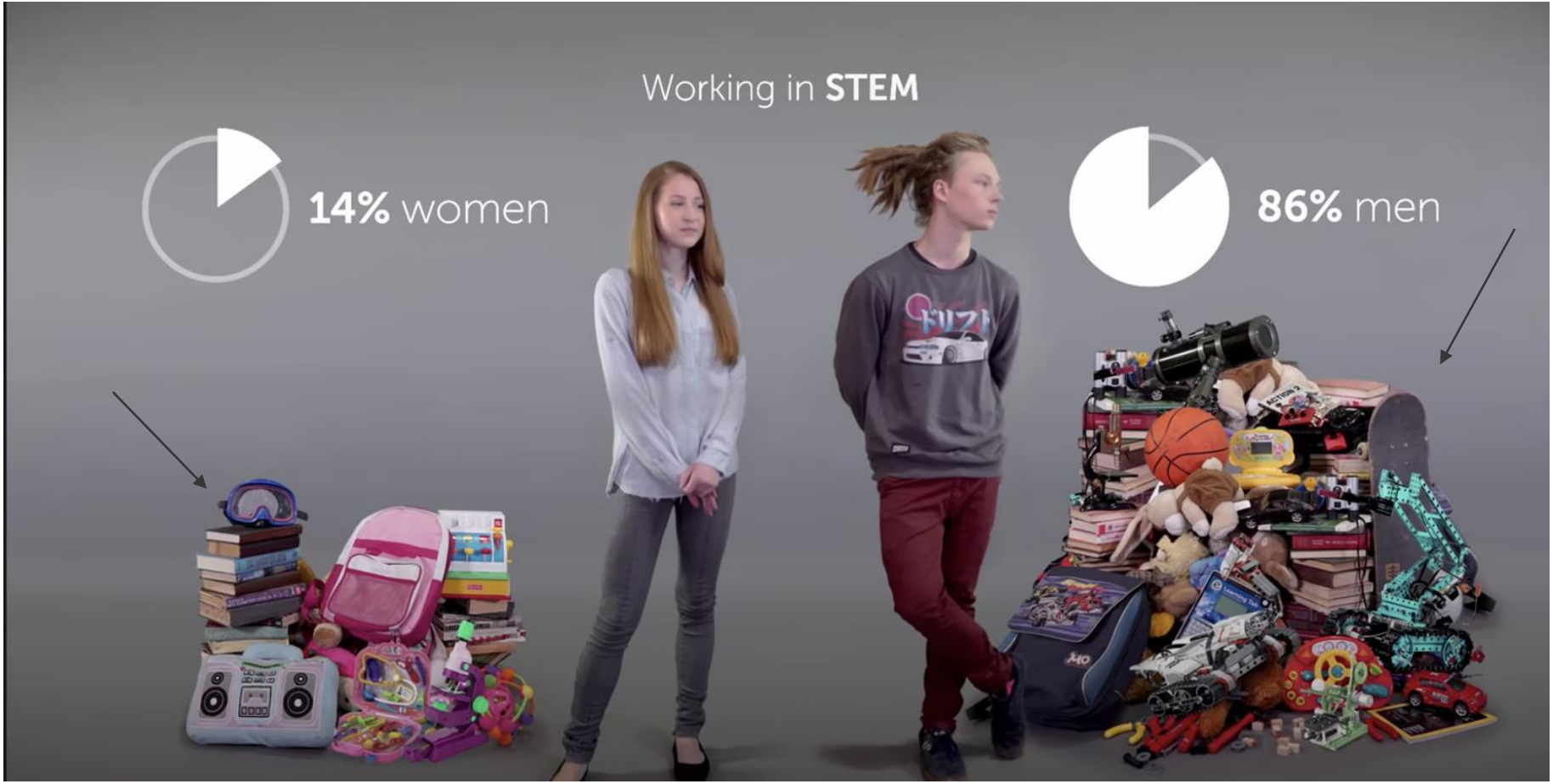
ABSTRACT
Women have been underrepresented in STEM fields around the world (UNESCO, 2018). Prior research identified some of the reasons for this gender disparity such as systemic barriers, lack of confidence, lack of female role models, and cultural and gendered science stereotypes. These issues have been framed in contemporary literature within the construct of STEM identity. Building upon this literature, our project explored the role of the university classroom in supporting the development of a strong STEM identity and specifically the view of self as a competent science person. The project consisted of two parts. In the first part student-led desktop and empirical research focused on generating evidence-based recommendations for how an introductory Calculus course could be redesigned to be more gender-inclusive. The second pertained to the evaluation of the redesigned Calculus course centered around two main indicators of success: (i) students' confidence as mathematics learners, and (ii) their intention to continue with STEM education. The project has scientific and practical implications as it contributes evidence towards understanding the kinds of activities that might support university students' STEM identity development and provides a set of concrete, evidence-based, gender-inclusive instructional practices.

- Who aspires to be a scientist?
- Who is seen/recognized as a competent physicis?
- Who has access to physics?
- What supports and what hinders participation in physics?
- **Who is allowed in science**?
- **What identities are deemed in/out of place in science?**

STEM RESEARCHERS WORLDWIDE



European Institute for Gender Equality, 2017

EUROPEAN STATISTICS

- The number of university students in STEM (science, mathematics, ICT) rose between 2003 and 2013
  - **The gap between women and men remained consistent throughout this period: women are 50–70% less likely to complete a master's degree in STEM subjects than their male counterparts**,
  - Twice as many STEM male graduates continue to STEM employment than female STEM graduates.
  - **Women** mainly graduated in health and welfare, humanities and arts, along with social sciences, business, and law
  - **Men** graduated in engineering, manufacturing, and construction-related fields, followed by technology, science, and math

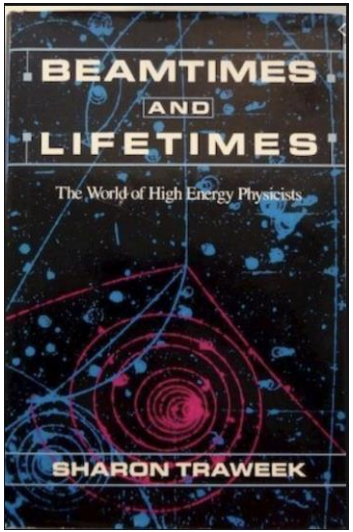
Eurostat, 2014

WHY IS THIS A PROBLEM?

- Europe is facing a shortage of scientists
- The lack of gender diversity limits workplace performance

A culture of no culture

Scientific practice requires an objective, rational, asocial, decontextualized researcher: a person immune from context, from culture



CULTURE OF SCIENCE

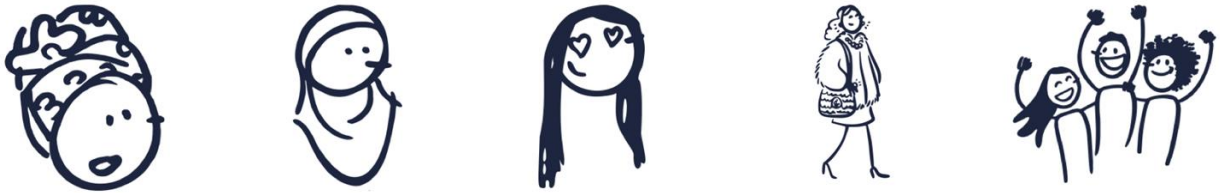
DEHUMANIZING

UNWELCOMING

MASCULINE

COMPETITIVE

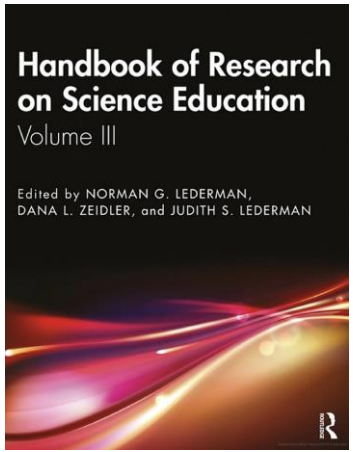
WHO IS LEFT OUT?



GENDER MATTERS

Building on the Past, Recognizing the Present, and Looking Toward the Future

Anna Danielsson, Lucy Avraamidou, and Allison Gonsalves



WHAT IS GENDER?

- Biological sex: m/f
- Gender as performance
  - Masculinity/femininity
  - Inclusive of transgender and non-binary individuals/performances

Understanding Gender Gaps

- Although **female students overall outperform male students** in school gender gaps in performance favoring male students have been found in a variety of physics learning contexts
- Women on average made up 60% of the students in the studied courses they only made up 40% of responses to instructor-posed questions in the classes
- Studies investigating cognitive ability as linked to women's and men's differential participation in science suggest that such gender differences are not a result of differences in absolute cognitive ability

STEREOTYPES AND BIAS

- In the Global North, children as young as **six years old subscribe to the stereotype of mathematics and science as male domains**
- There is substantial evidence suggesting that **stereotype threat** can impact career choice, retention and performance of women in science
- There is also research indicating that stereotypes and biases lead to **discriminatory practices** (e.g. hiring procedures)

Interest, self-efficacy, belonging

- Male and female students have different interests toward science studies and careers.
  - attributed to various factors ranging from cognitive to sociocognitive ones, such as self-efficacy, self-determination, and sense of belonging in science
- Female students have lower **self-efficacy** than male students in physics

HARASSMENT AND MICROAGGRESSIONS

- Several studies have identified sources of gendered discrimination in science, particularly in physics, astrophysics, and planetary science fields
  - SEXUAL OBJECTIFICATION
  - SEXIST LANGUAGE
  - SEXIST JOKES
  - DENIAL OF SEXISM

IDENTITY-BASED APPROACHES

- Gender as performance
- Femininity and (masculinity) science
- Masculinity and insiderness/outsiderness
- Science identity and belonginess
    - Emphasis on the environment and not on the self: **fixing the system and not the individual**
    - Attention to structural barriers (e.g. motherhood, single motherhood etc)
    - Attention to recognition: feedback by the environment

FEMININITY AS 'OTHER'

- Over the past 10 years, science education research has seen a large increase in studies adopting identity-based approaches
- Femininity has been constructed as incompatible with science identity, and hence those performing more feminine identities have been constructed as "other" in science
    - FEMININITY AS NOT BINARY
    - DIVERSITY WITHIN

Supporting science identity development

- Interventions to support the development of self-view
- Interventions to support recognition *by others* (managers, colleagues, teachers, parents, society)
- Opportunities to develop a sense of self as a scientists
- Interventions that address structural barriers (e.g. free access to museums)

LGTBQ+

- Lived experiences of queer individuals in STEM: unsafe and unwelcoming culture (Marosi, Avraamidou, Lopez-Lopez, in review)
    - Women and gay men are underrepresente: Heteropatriarchy, biases, harassment
    - Different experiences between gay and straight men
    - Most studies are carried out in the US

Intersectional approaches

- Intersection of gender with other identities
  - predominantly focused on race and gender: experiences of Black women and women of color.
  - a gap in knowledge when it comes to other types of identity intersections, for example, **ethnic identity, religious identity, social class, disability, and motherhood.**

FINDINGS

- at a structural level, gender has largely been approached through a **binary** approach: male/female, which is both limiting and problematic (i.e. exclusion of transgender, non-binary)
- data on gender are rarely reported through an **intersectional lens** to include race, socioeconomic status, first language acquisition, and immigration status
- how gender or other social categories influence research, the context, or the theoretical framework remains unexplored
- the knowledge base on the intersection of gender and subjects besides physics remains scarce.

PRACTICE

- No more programs to “crack the gender code” and to attract more women/gender diverse individuals in science are needed because the problem is not one of attracting them but one of **retaining** them in science.

- Need for **systemic programs** on how women are recognized by others; programs that seek to improve science learning and working environments from the school level to the professional, aiming to provide gender-inclusive spaces where everyone experiences recognition.

Moving forward

- **Teachers**: examine unconscious bias, expectations from female, male, non-binary students, and recognition (feedback),
- **Parents**: explicitly support children of all genders to engage with science, resist cultural expectations and misrepresentations
- **Researchers**: engage more thoroughly with intersectionality: beyond gender
- **Curriculum:** gender inclusive curricular/portrayal of scientists with diverse backgrounds/identities

Stop trying to fix women

7 FEBRUARY 2023 **COLUMN**

I want to share a story. The story is not my own but that of Amina, a 'woman in science'.

Amina told me her story a few years ago, as part of an investigation I was conducting into women's experiences in science. The story documents her journey to become a physicist, her passion for research, her persistence and failures.

The story also highlights another important issue: Amina is not just a woman physicist. Amina is also a Muslim, a Turkish migrant to the Netherlands, and a single mother.

Amina entered the tenure-track system with excitement and ambition. She was the only woman in her research lab. She was frequently confronted with the question 'How do you reconcile physics and religion?'

Amina used to work long hours at the lab and traveling for conferences, until she had her first child. As a single mother, she had to rely on day-care in order to attend meetings and events. 'Am I a bad mother?' she would often wonder.

> So, what do we do? We take short-sighted measures that aim to 'fix' women

In the year she decided to leave academia, she found herself trying to avoid being in a room alone with her manager. 'I didn't know what it was exactly… a combination of his look, words, and proximity that just didn't feel right.'

Amina's story is her own story, but is also not at exception. Women are stereotyped, they get cited fewer times than men, they face challenges in trying to get promoted, they are paid less than men, they are harassed in laboratories, they are lonely in rooms full of men.

So, what do we do? We take short-sighted measures that aim to 'fix' women: to make them more resilient and to enable them to navigate a broken system. Women do not need to get fixed.

Academia needs to be fixed through a systemic and multifaceted long-term plan, so as to become a welcoming and inclusive space for everyone, not in spite of identity differences and gender performances, but because of them.

Amina is not a woman in science; she is a scientist.

LUCY AVRAAMIDOU

https://ukrant.nl/stop-trying-to-fix-women