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The STEM paradox: Factors affecting diversity in STEM fields

ACAT 2019

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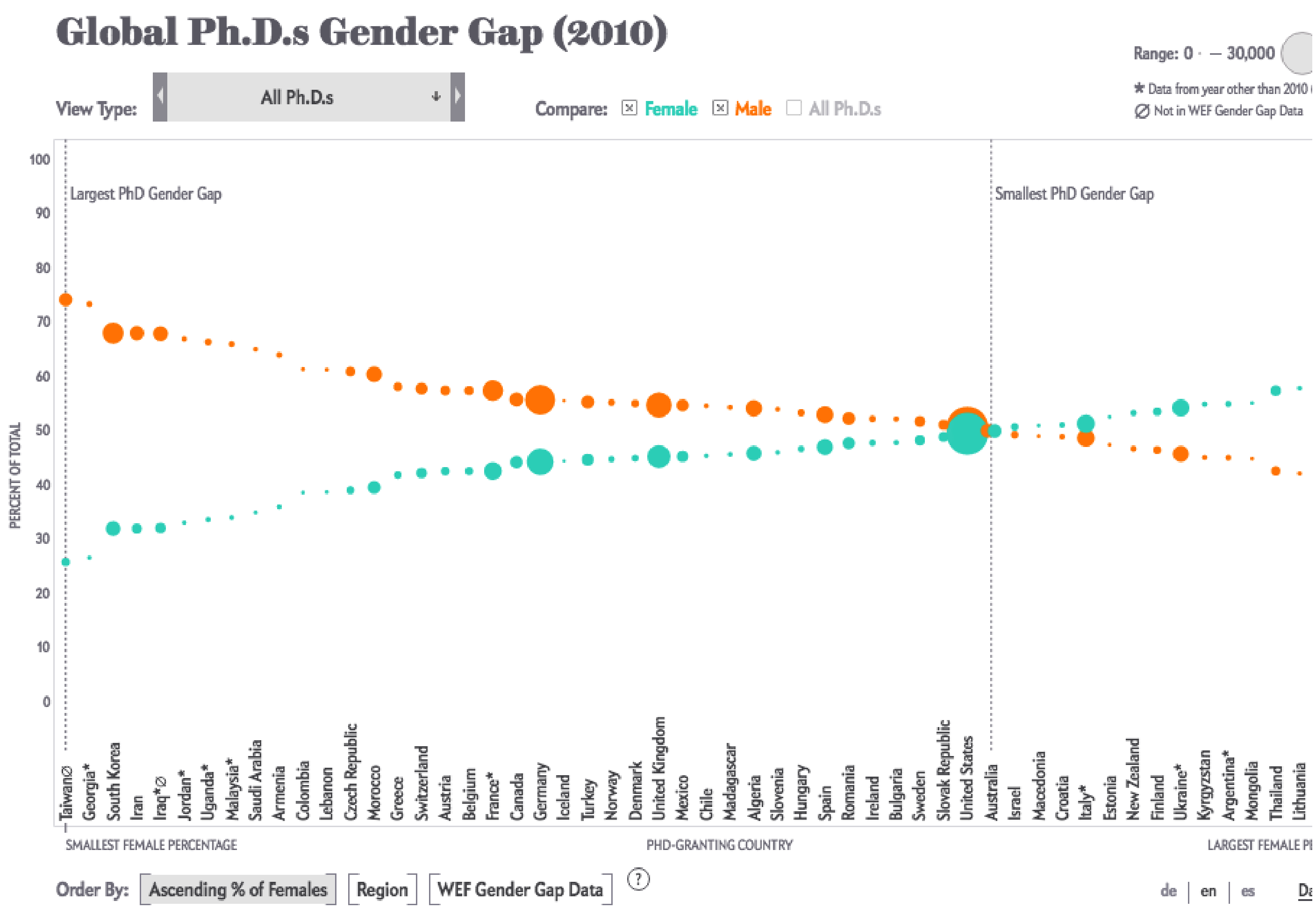
Diversity in STEM fields

- Introduction
- Gaps
    - Gender, Physics, Computer Science, Engineering
- The STEM Paradox or Gender Equality Paradox
- Other Potential Barriers
- Possible Solutions
- Q&A

Diversity in STEM fields

- Underrepresentation of women in math-intensive fields
  - Women obtain more than half of U.S. undergraduate degrees in biology, chemistry, and mathematics, yet they earn less than 20% of computer science, engineering, and physics undergraduate degrees (NSF, 2014)
  - math-capable women disproportionately choose nonmath fields during adolescence (Ceci et al., 2009)
  - women's and men's preferences are constrained and expanded by cultural factors (Cheryan et al., 2017)

Diversity in STEM fields



Diversity in STEM fields

	Percentage of Physics Faculty Members who are Women				
		2002	2006	2010	2014
Rank					
	Full Professor	5	6	8	10
	Associate Professor	11	14	15	18
	Assistant Prof	16	17	22	23
	Instructor/Adjunct	16	19	21	23
	Other Ranks	15	12	18	20
Highest Degree Offered					
	Ph.D.	7	10	12	14
	Master's	13	15	15	18
	Bachelor's	14	15	17	20
Overall		10	12	14	16

Diversity in STEM fields

Race and Ethnicity of Physics U.S. PhDs, Classes 2014-16 (3-year average)		
	Number	Percent of all PhDs.
White	843	46
Asian American	57	3
Hispanic American	38	2
African American	16	1
Other US citizens	12	1
Non US citizens	861	47
Total	1827	100

Diversity in STEM fields

	S&E as a % of Non-S&E Degrees in 2010	
Countries	Men	Women
South Korea	84%	36%
Iran	62%	40%
Austria	136%	80%
Belgium	170%	98%
Bulgaria	103%	94%
Finland	185%	73%
France	279%	166%
Germany	115%	58%
Italy	180%	112%
Switzerland	108%	62%
United Kingdom	181%	110%
United States	197%	89%

Diversity in STEM fields

- Why is it important to focus on diversity and inclusion?
  - Talent
    - New majority
  - Economics
    - Globalization
  - Innovation & Creativity
    - Thinking differently
    - Diversity powers innovation

The STEM Paradox

In Iran, 70% of university graduates in STEM are women

In UAE, Oman, Saudi Arabia, 60% are women

In Sweden, 34% and in USA 19% of engineers are female

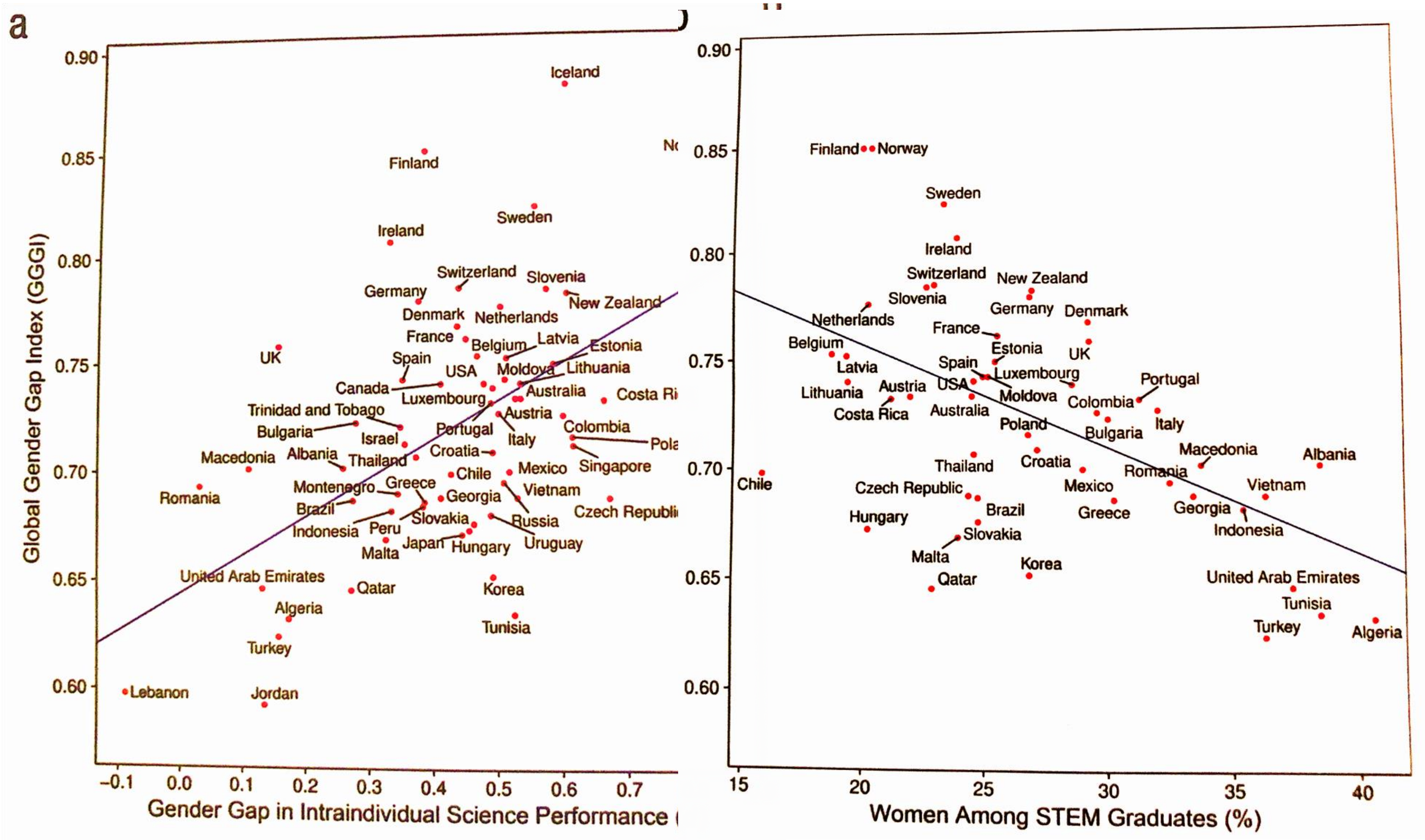
The STEM Paradox: Why are Muslim-Majority countries producing so many female engineers?

- Professions are chosen for women
- Performance drives the fields, rather than interest
- Equalizing workforce participation between genders would produce 47% economic growth in the Middle East (McKinsey, *Women in the Workplace*)

Gender Equality Paradox

- **Gender Equality Paradox**: Countries with greater gender equality have a lower percentage of female STEM graduates (Stoet & Geary, 2018)
  - The more gender equality, the fewer women in STEM
  - 18% U.S. computer-science college degrees go to women (27% take AP exam)
    - welfare support, making choice of highly paid STEM jobs less attractive
    - high level of social security make personal preferences more apparent

Diversity in STEM fields



Gender Equality Paradox

- 475,000 adolescents across 67 countries (Stoet & Geary, 2018)
    - The Global Gender Gap report (World Economic Forum)
    - Overall Life Satisfaction (UN Development Program)
    - PISA (math, science literacy and reading comprehension)
- Achievement in STEM subjects similar for both genders
- **Intraindividual** strength: Boys are often better in science relative to their overall academic average
    - Boys' intraindividual strength in science is larger than girls'
    - Girls have higher ability in non-STEM subjects (e.g., reading)
- Girls had lower **interest** in science subjects
    - In UK, 29% of STEM graduates are female, whereas 48% might be expected to take science subjects based on science ability

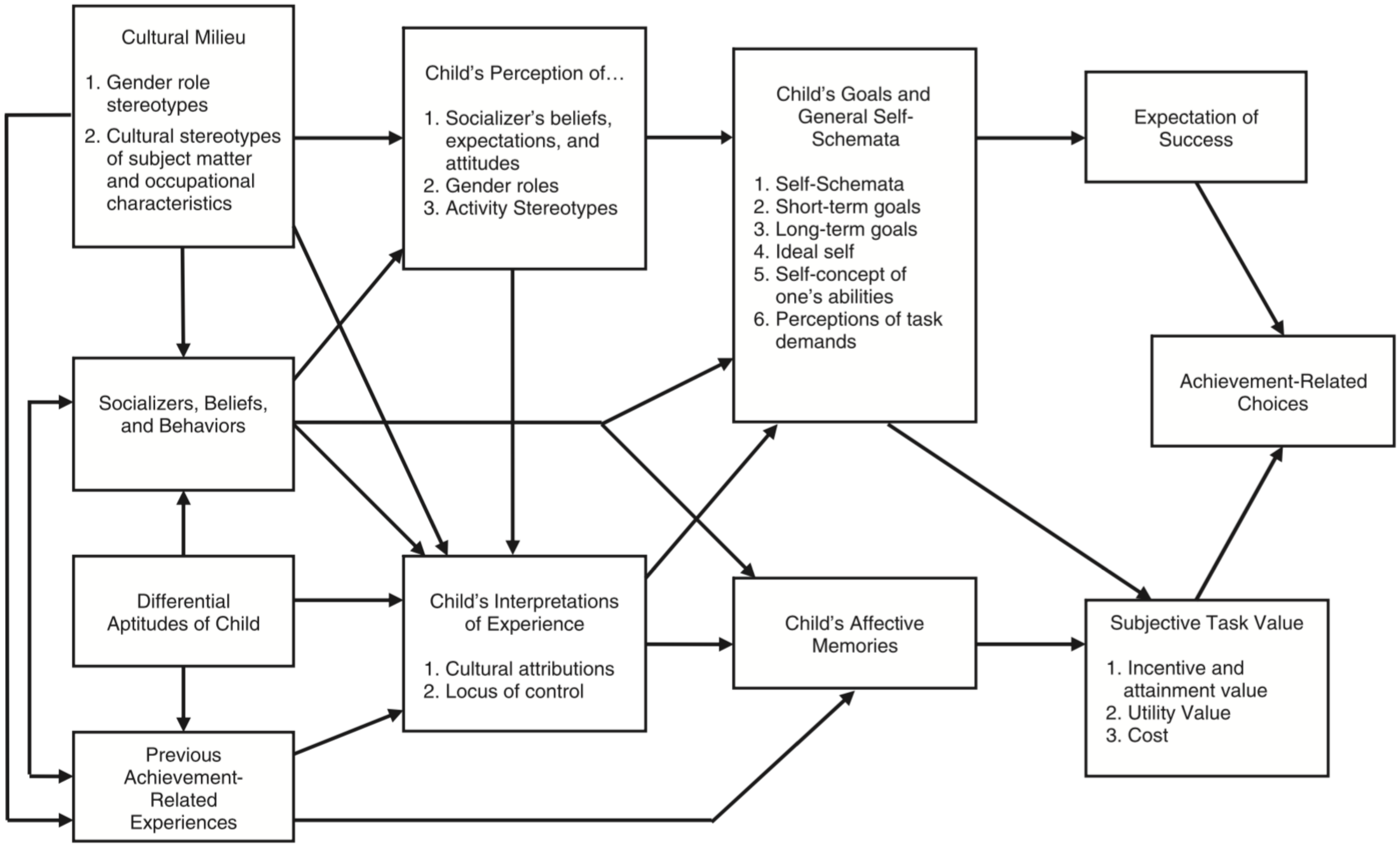
Other Possible Factors

- Unconscious biases push girls away from STEM
- Parents think science is harder and less interesting for their daughters which predict career choices
- Women get less credit than men for the same math performance
- Women are less likely to get hired or chair dissertations
- Less pay
- Women of color face even greater challenges as racial and gender biases intersect

Other Factors

- Women hold primary responsibility for taking care of the home and children
- Visuospatial & verbal abilities
- Gender differences in distributions & variances
- Gender differences in career development choices
- Family, neighborhood, peer, & school influences
- Stereotype threat: well-known stereotype is made salient
- Training studies
- Achievement related choices

Achievement Related Choices



Eccles (1994)

- Stereotype Threat, Role Models & Career Choices (Cherney & Campbell, 2011)
  - 548 U.S. boys & girls from single-sex and coeducational high-schools
  - Stereotype Threat (ST): well-known stereotype is made salient
  - Increased self-esteem and achievement motive in SS schools
  - Career choices, Role models, and Stereotype Reactance

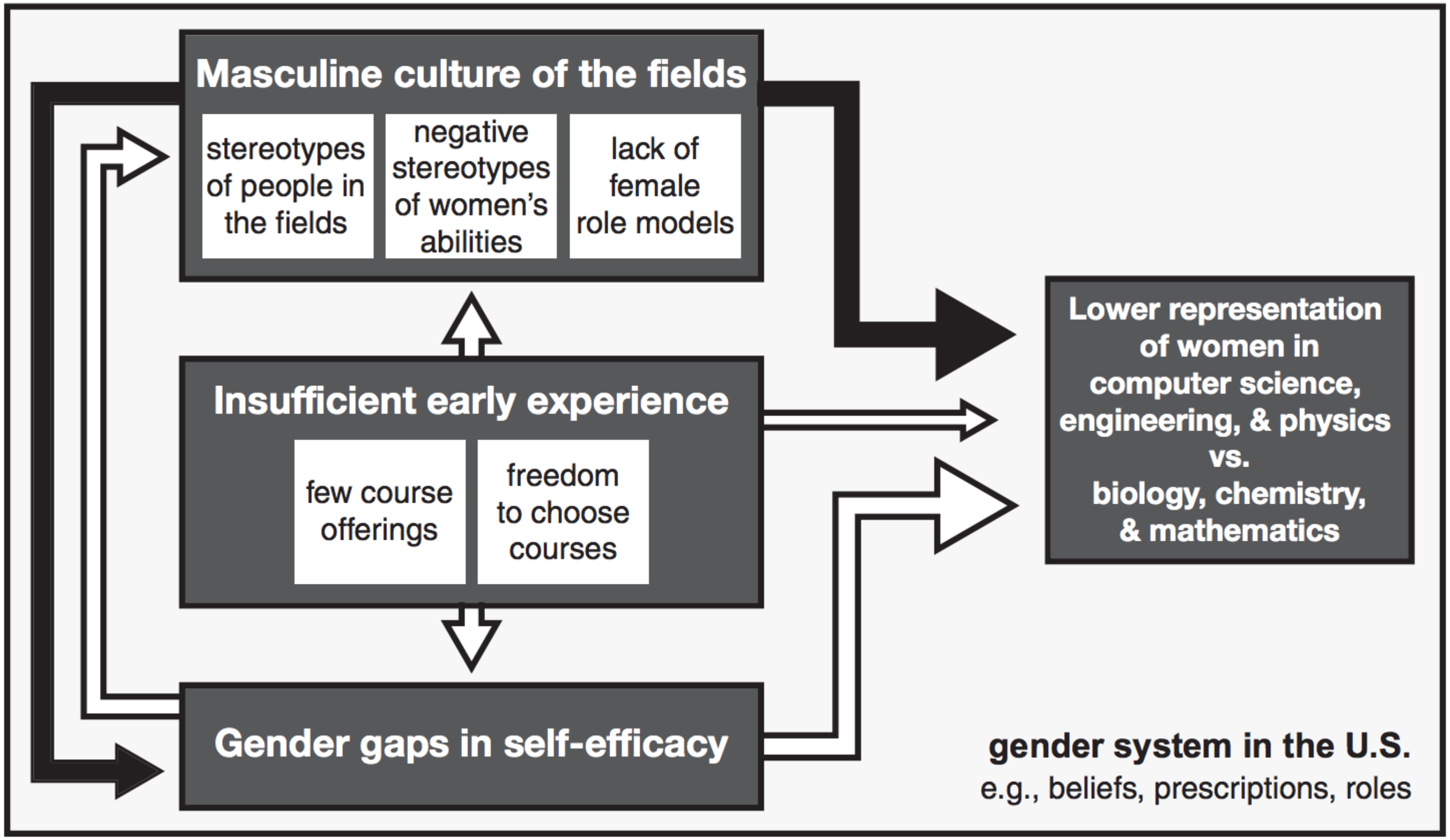
Career Choices

Career Choices	Coeducational Schools		Single-Sex Schools		Overall
	Boys	Girls	Boys	Girls	
Health Sciences	20.8%	35.8%	20.8%	32.3%	28.8%
Social Sciences	1.9%	15.3%	5.9%	11.8%	9.6%
Physical Sciences	21.7%	***9.5%***	20.8%	***9.6%***	14.0%
No Sciences	55.7%	39.4%	52.5%	46.5%	47.6%

Gender Balancing

- Why are some STEM fields more gender balanced than others? (Cheryan, Ziegler, Montoya, & Jiang, 2017)
  - Disaggregated STEM fields
    - Computer Science, Engineering, Physics
    - Biology, Chemistry, Mathematics

Diversity in STEM fields



Gender Balancing

- Factors that influence physics, engineering, computer science
  - Stereotypes of each field (negative about women’s abilities)
  - Income potential
  - Perceptions of work/family conflict
  - Perceptions of the value of STEM
  - Lack of (female, relatable) role models
  - Insufficient early experiences
  - Freedom to choose course offerings
  - Gender Gap in Early Educational Experiences
  - Gender Gap in Self-Efficacy

Possible Solutions

- Possible Solutions
  - Target girls for whom science and math are the best subjects and who enjoy it but still don't choose it (Stoet, & Geary, Psych Science, 2018)
  - Girls are more engaged when they're 'Doing Science' rather than 'Being Scientists'
  - Avoid using gender labels at very young age
  - Explain how doing science may save lives and help people
  - Make coding fun!
  - Promote self-efficacy, particularly in girls

Possible Solutions

- For Managers
  - Determine and understand need for diversity and inclusion in organization; dedicate resources
  - Establish diversity plans/goals and integrate into performance review and recruitment plan
  - Retention plan
  - Support a climate that values diversity, equity and inclusion and supports all members to thrive
  - Establish a culture of accountability and assessment
  - Pay equity

Conclusions

- Questions
  - Can we realistically expect more diversity in the physical sciences?
  - What barriers do you encounter?
  - What ideas and solutions would you implement?
  - How do we avoid unconscious bias and stereotyping?

Thank you

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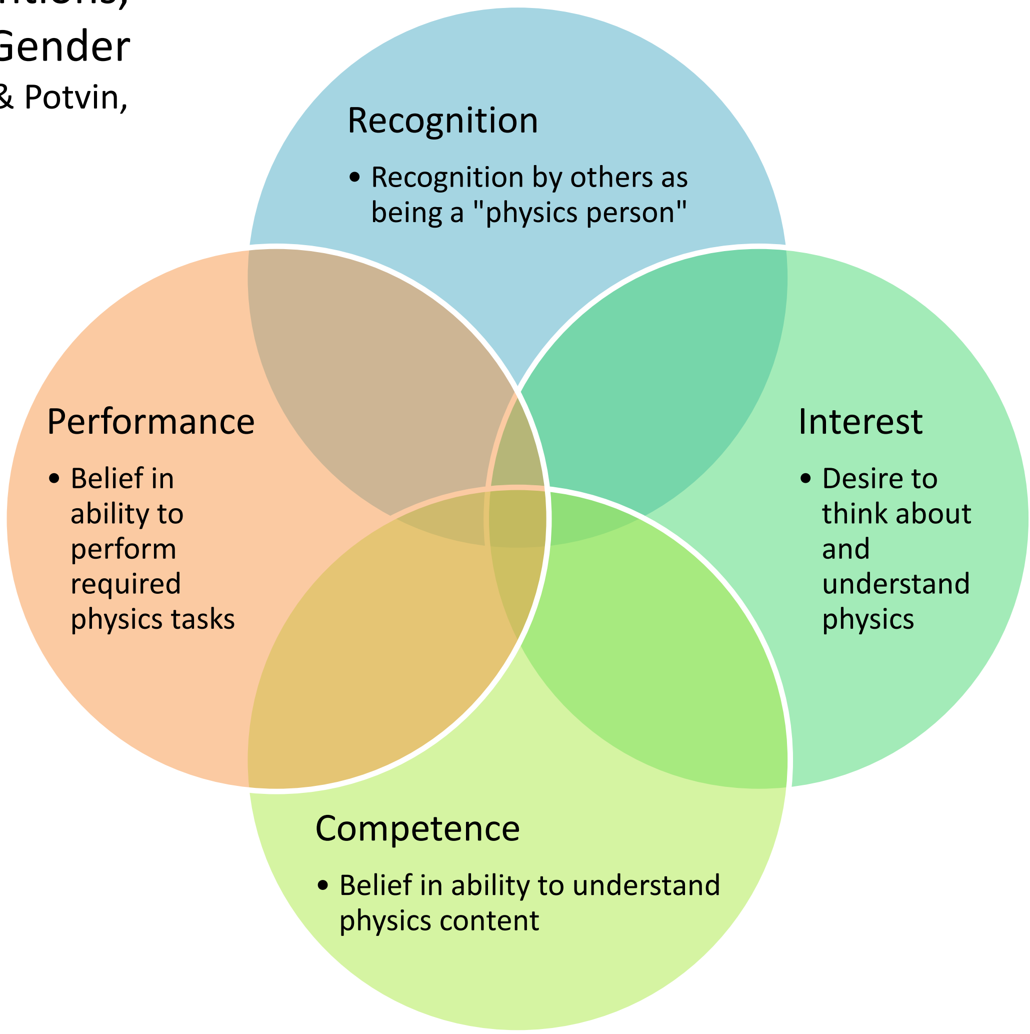
Physics Identity Framework

Career Intentions, Identity & Gender

(Lock, Hazari, & Potvin, 2013)



Physics Identity Framework

- Influence of students' physics & math identities on choices to pursue physics careers (Lock, Hazari, & Potvin, 2013)
  - 6772 surveys SaGE data (Sustainability and Gender in Engineering)
  - Males reported higher physics recognition and interest than females
  - Strategies aimed at improving female representation in physics should emphasize physics recognition and interest rather than performance/competence

Diversity in STEM fields

	Earned S&E doctoral degrees by sex and region 2010				
		Physical/Bio Sc	Math/CS	Engineering	Non-S&E
Male					
	South Korea	639	132	2124	3890
	iran	322	100	494	2008
	Austria	229	152	337	608
	Belgium	222	79	349	452
	Bulgaria	31	7	88	153
	Finland	119	65	266	285
	France	2652	768	1003	1811
	Germany	3621	1113	2126	6745
	Italy	1013	277	1280	1769
	Switzerland	529	136	339	1055
	UK	2385	1070	1995	3655
	US	6943	2343	5997	9770

Diversity in STEM fields

	Earned S&E doctoral degrees by sex and region 2010				
		Physical/Bio Sc	Math/CS	Engineering	Non-S&E
Female					
	South Korea	271	53	382	2487
	Iran	214	31	96	1095
	Austria	173	38	124	591
	Belgium	145	30	152	458
	Bulgaria	44	9	42	147
	Finland	118	24	108	541
	France	1979	231	376	1910
	Germany	2670	250	388	7305
	Italy	1230	160	679	2470
	Switzerland	342	18	99	991
	UK	1800	285	535	4040
	US	5667	812	1815	14986