Girls & STEM: Making it Happen

Sylvia Martinez
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Twitter: @smartinez
sylviamartinez.com

"When our schools become more gender-fair, education will improve for all our students – boys as well as girls – because **excellence in education** cannot be achieved without **equity in education**."

– *How Schools Shortchange Girls (AAUW)*

National Girls Collaborative Project

ngcproject.org/exemplary-practices-overview

- Engaging Girls in STEM
- Access & Equity
- Collaboration
- Evaluation & Assessment

All resources: sylviamartinez.com/stem-girls

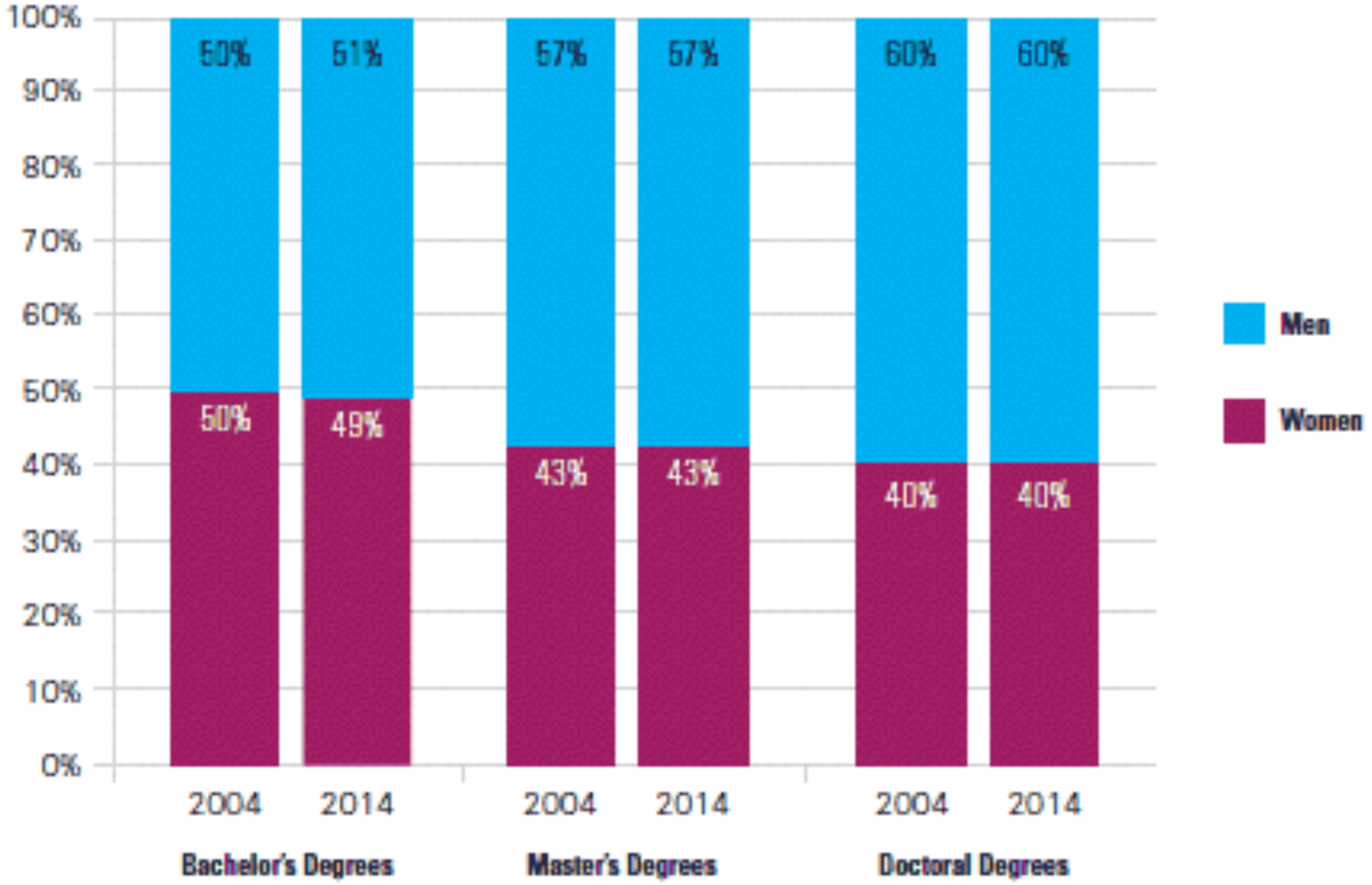
"The maker movement provides multiple entry points to engage and interest girls and other nontraditional users of computer science."

bit.ly/intelgirlsintech

Sobering Statistics about Women and STEM Jobs

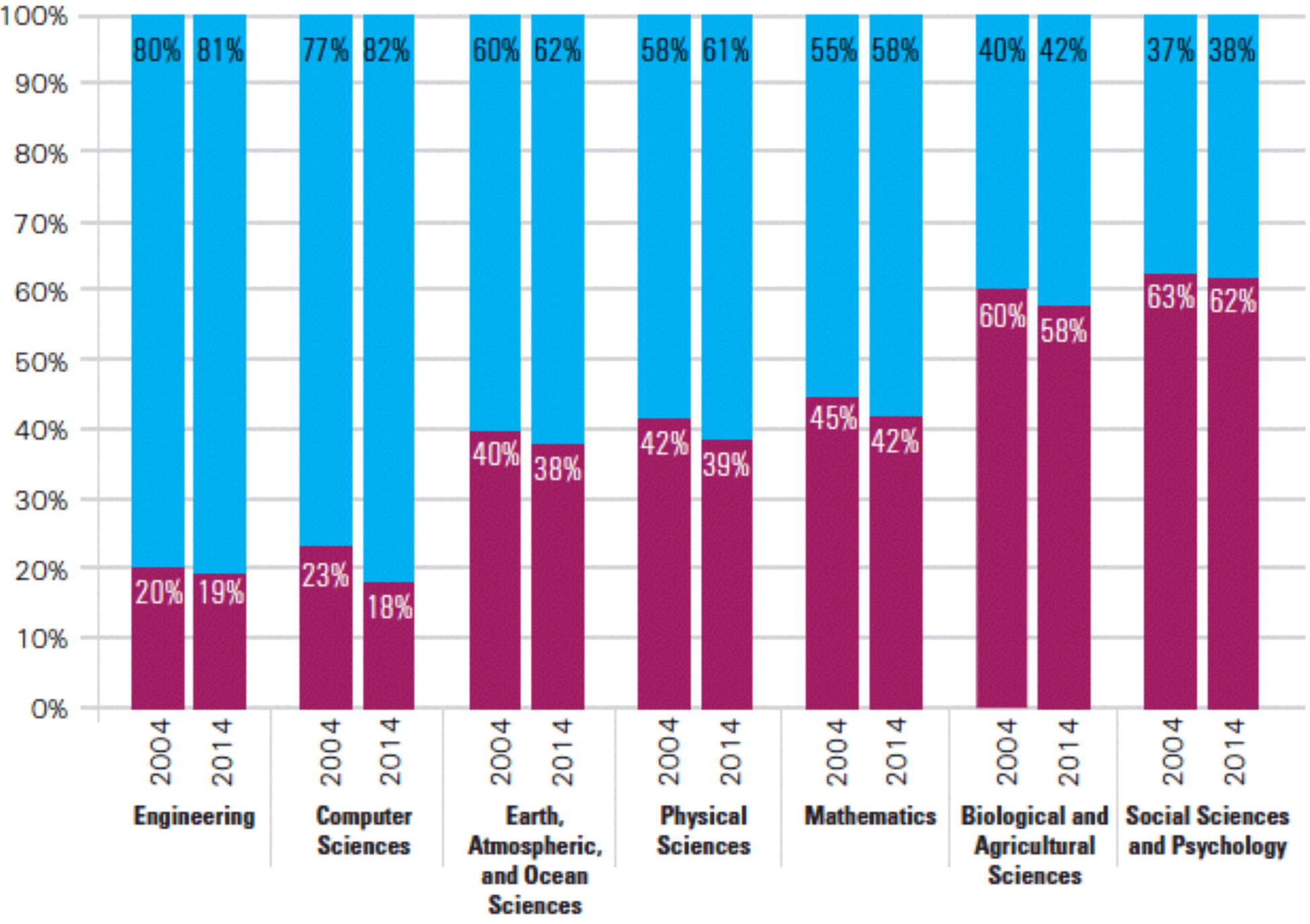
- "Women have seen no employment growth in STEM jobs since 2000" - Forbes.
- Women leave STEM jobs at a significantly higher rate then men - often citing gender issues

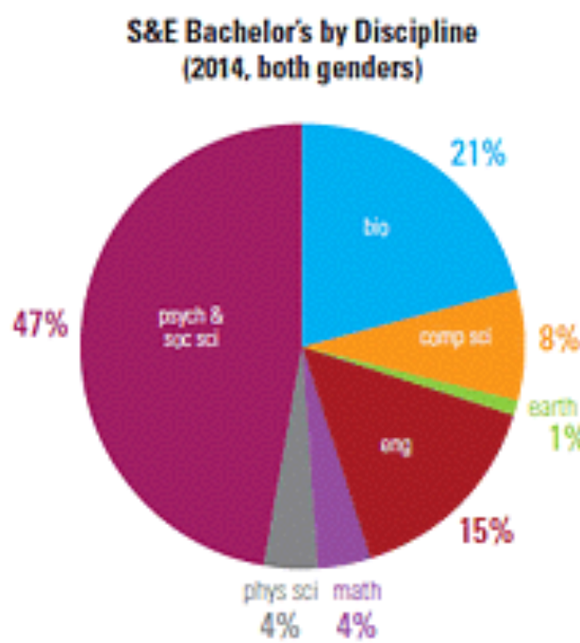
Gender Distribution of Science and Engineering Degrees by Level (2004, 2014)



Note: Analysis is based on Clearinghouse degree records with field of study reported, which represent approximately 87 percent of all degrees reported to IPEDS. Percentages may not sum to 100 percent because of rounding. Professional degrees excluded. Detailed data tables for all 11 years can be downloaded from the NSC Research Center website at http://nscresearchcenter.org/wp-content/uploads/Snapshot_15_S-E_Degrees_Data_Tables_2013-14.xlsx.

Gender Distribution of Bachelor's Degrees in Science and Engineering Disciplines (2004, 2014)





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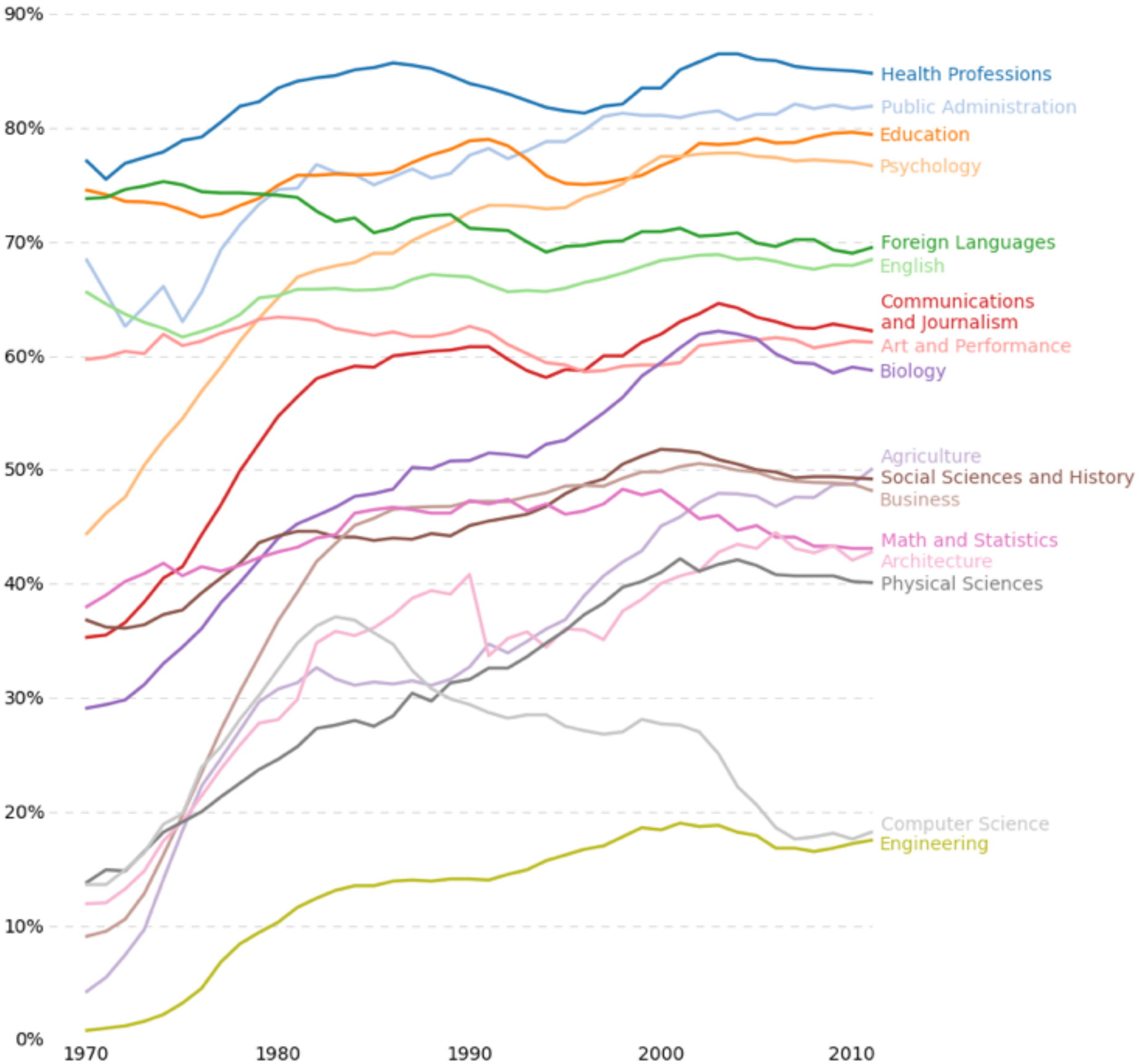
Percentage of Bachelor's degrees conferred to women in the U.S.A., by major (1970-2012)



Data source: nces.ed.gov/programs/digest/2013menu_tables.asp
Author: Randy Olson (randalolson.com / @randal_olson)
Note: Some majors are missing because the historical data is not available for them

Table 2 Uptake of STEM by All and Female Students at ISCED Levels 5 & 6 - 2010

	Women % of All Students (1)	All Students in Science & Engineering as % of All Students (2)	Female Science & Engineering students as % of All Female Students (3)
Finland	53.8	35.1	16.1
Germany	51.3	30.7	15.8
Ireland	52.4	27.6	14.7
Sweden	59.4	25.3	14.2
France	55.0	25.6	14.1
Austria	53.1	25.7	13.9
European Union (27 countries)	55.4	25.0	13.6
Czech Republic	56.8	25.3	13.1
United Kingdom	56.6	23.0	12.2
Poland	59.2	21.2	11.8
Denmark	**58.1**	**18.7**	**11.2**
Switzerland	49.2	22.9	10.6
Norway	60.8	16.4	8.5
Belgium	55.2	17.7	8.0
Netherlands	51.8	14.5	5.1

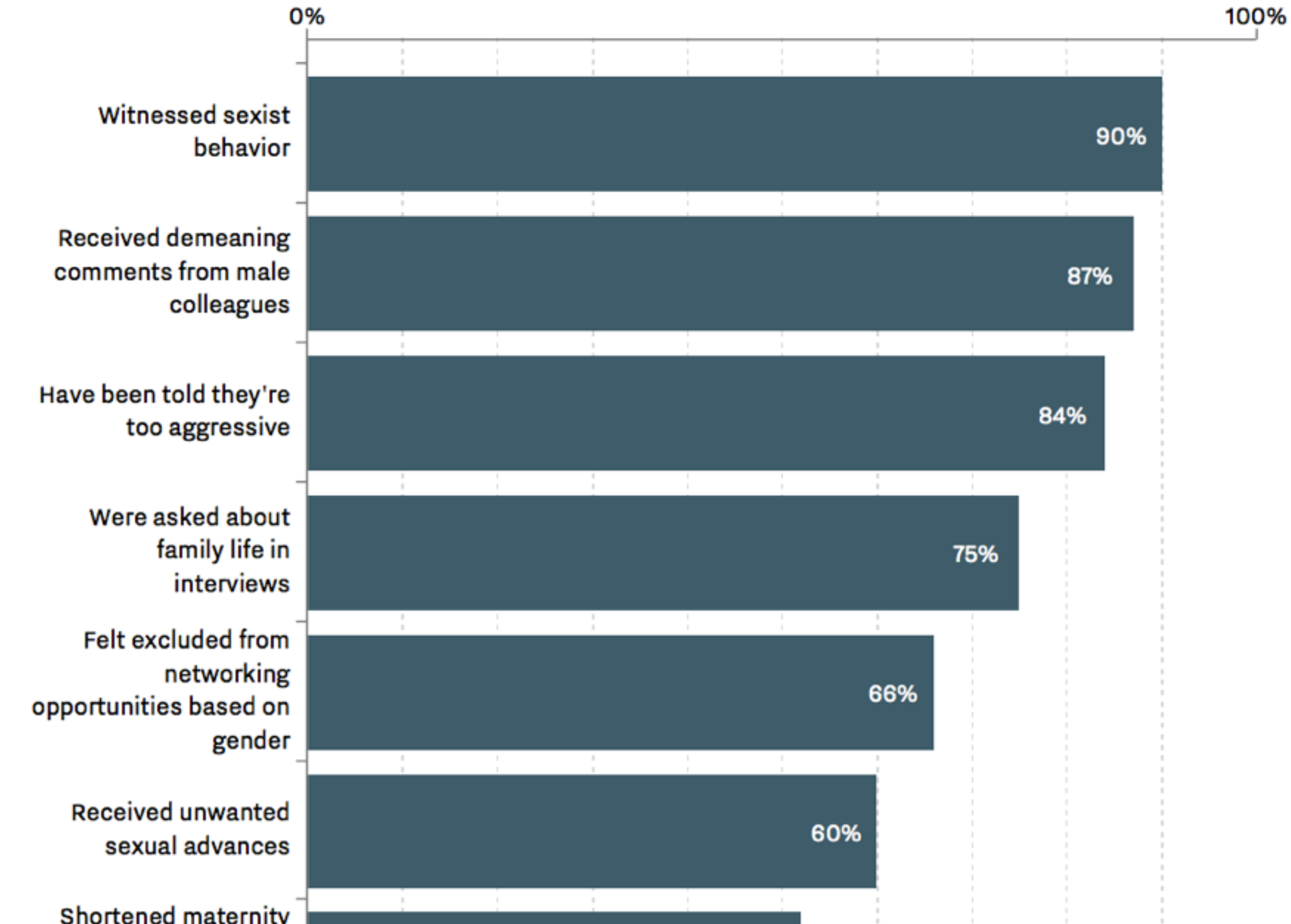
Source: Eurostat
(1) Women among students in ISCED 5-6 - as % of the total students at these levels
(2) Students at ISCED levels 5-6 enrolled in the following fields: science, mathematics, computing, engineering, manufacturing, construction - as % of all students
(3) Female students at ISCED levels 5-6 enrolled in the following fields: science, mathematics and computing; engineering, manufacturing and construction - as % of all female students

Securing Australia's Future STEM: Country Comparisons - Australian Council of Learned Academies

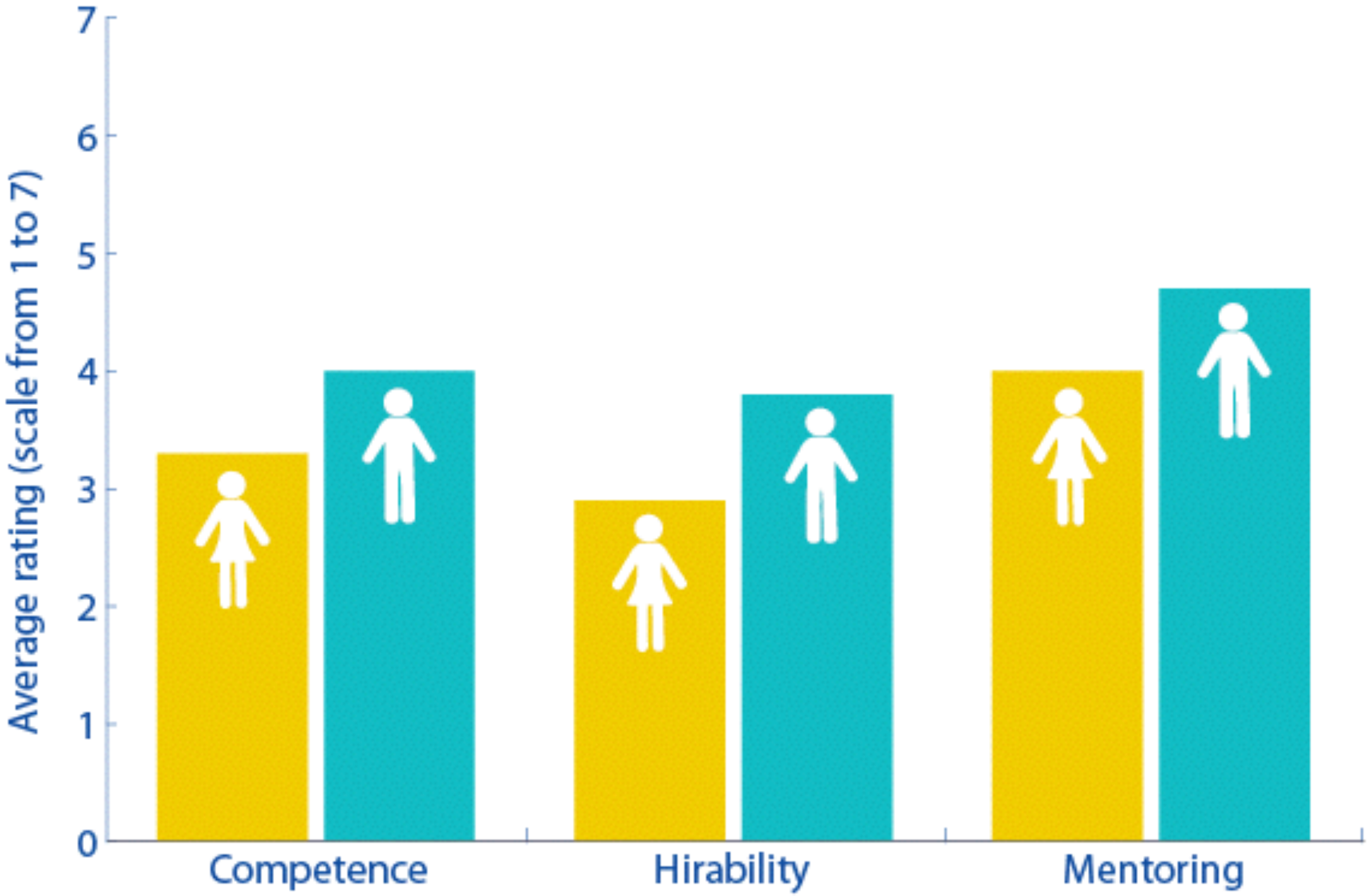
Common issues

- There are few women in STEM fields because there are few women in STEM fields
- Culture
- Economics
- Stereotypes
- Lack of encouragement
- Discrimination

Experiences of women at tech companies

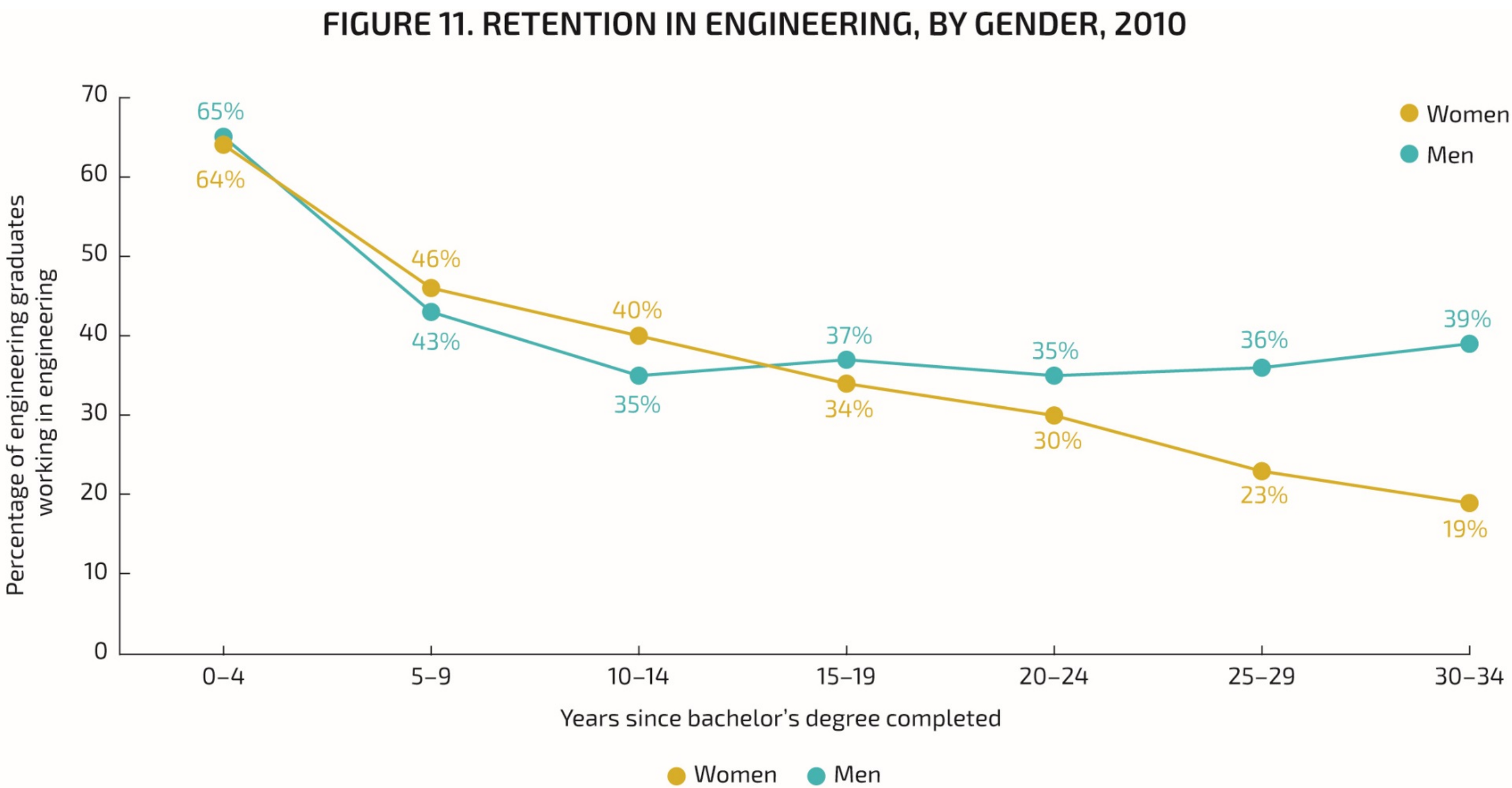


HOW EMPLOYERS RATE MALE AND FEMALE CANDIDATES WITH IDENTICAL RESUMES



Solving the Equation: The Variables for Women's Success in Engineering and Computing - American Association of University Women (AAUW)

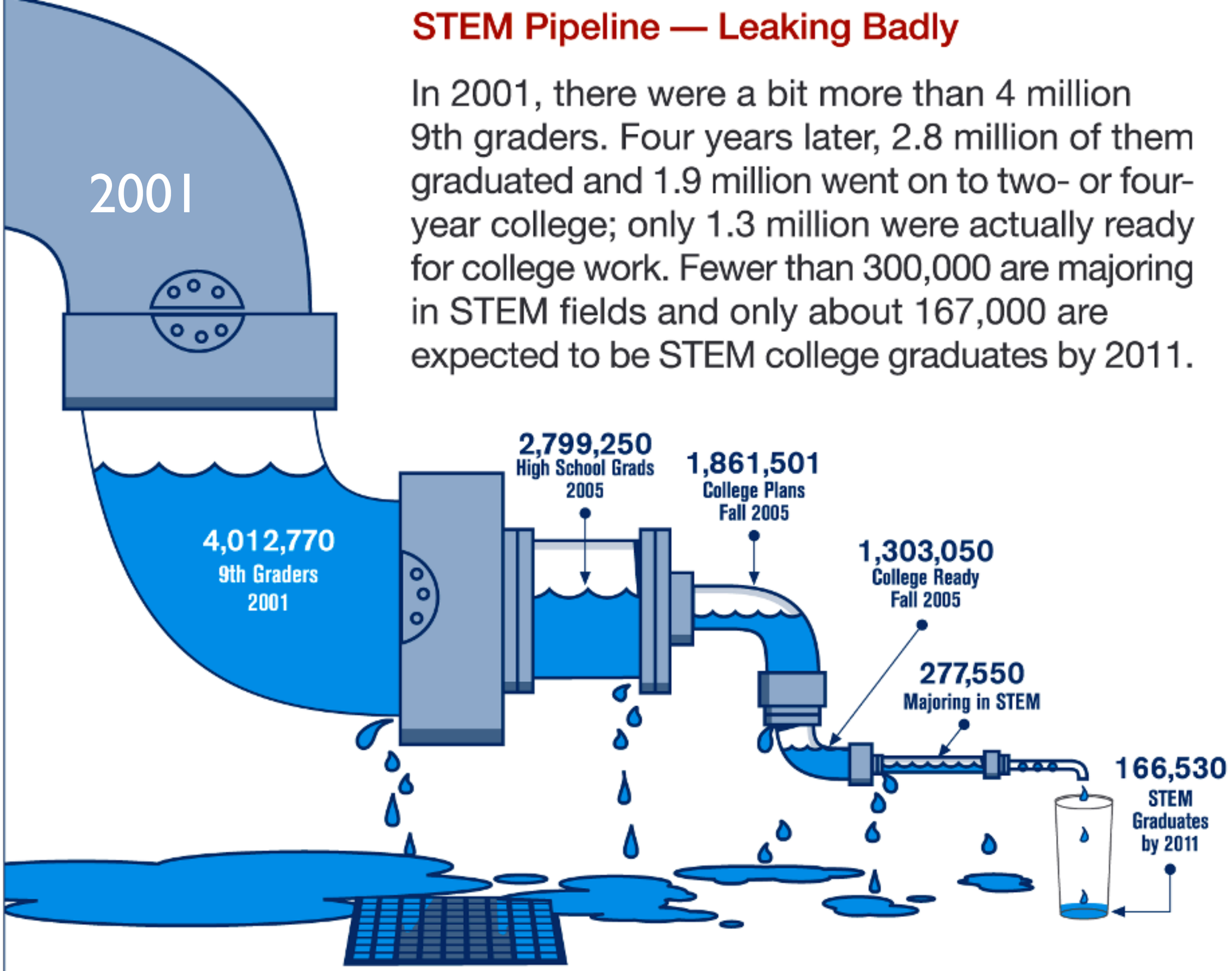
Leaky career bucket



Solving the Equation: The Variables for Women's Success in Engineering and Computing - American Association of University Women (AAUW)

STEM Pipeline — Leaking Badly

In 2001, there were a bit more than 4 million 9th graders. Four years later, 2.8 million of them graduated and 1.9 million went on to two- or four-year college; only 1.3 million were actually ready for college work. Fewer than 300,000 are majoring in STEM fields and only about 167,000 are expected to be STEM college graduates by 2011.



Source: NCES Digest of Education Statistics; Science & Engineering Indicators 2008

Although interest in STEM is high, few girls consider it their number one career choice, given competing opportunities and interests.
81% of STEM girls are interested in pursuing STEM career, but only 13% say it is their first choice.

- Girls in STEM are interested in many careers: Top four career categories: Medicine/ Health Care, Arts/Design, Entertainment, Social Science.
- 30% of STEM girls (vs. 35% non-STEM girls) are interested in being a stay-at-home mom.
- Girls want a career that they love and want to help people and make a difference in the world.
- Gender barriers persist; About half of all girls feel that STEM isn't a typical career path for girls. 57% of girls say that if they went into a STEM career, they'd have to work harder than a man just to be taken seriously.

Generation STEM: What girls say about Science, Technology, Engineering, and Math - Girl Scouts of the USA (2012) (Girls 14-17)

Females who have high math abilities are also more likely than males who have high math abilities to also have high verbal abilities, giving them more choices of majors/careers to pursue.

Maybe this is a reasonable choice!

Women's underrepresentation in science: Sociocultural and biological considerations. (2009)

Gender Inclusive Spaces

- Girls rate themselves less interested in computer science when in a "geeky" room
- Who belongs here? (Ask)
- Open doors (literally and figuratively)
- Better than gender neutral
- Who owns the space? Student owned doesn't mean exclusion of others
- Different communities, different solutions

Teacher bias

- Statistically, teachers give boys more opportunity to figure out the solution to a problem by themselves while telling the girls to follow the rules.
- Teachers are also more likely to accept questions from boys while telling girls to wait their turn.
- Teachers rate girls ability in math lower than boys, in spite of grades & test scores

Teacher Math Anxiety

- Elementary education majors have some of the highest levels of mathematics anxiety
- Math anxiety impacts student learning
- Female teachers' math anxiety disproportionally affects girls' math achievement
- 90% of elementary teachers are female

Beilock, Sian L., et al. "Female teachers' math anxiety affects girls' math achievement." *Proceedings of the National Academy of Sciences* 107.5 (2010): 1860-1863.

Gresham, Gina. "A study of mathematics anxiety in pre-service teachers." *Early Childhood Education Journal* 35.2 (2007): 181-188.

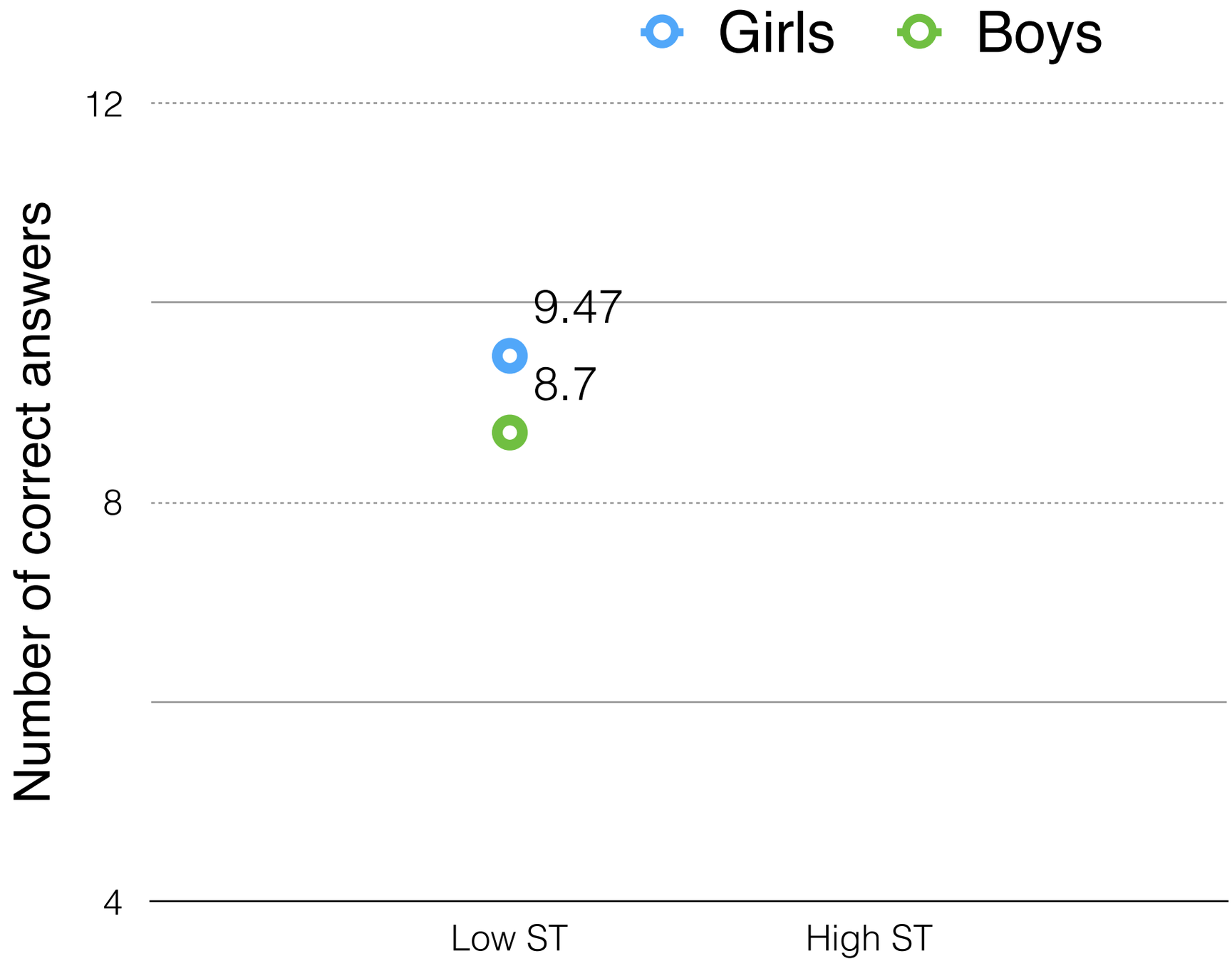

Math
is
hard!

Stereotype Threat

Is the threat (and resultant anxiety) of confirming a negative stereotype about one's group - including race, gender, and other identities.

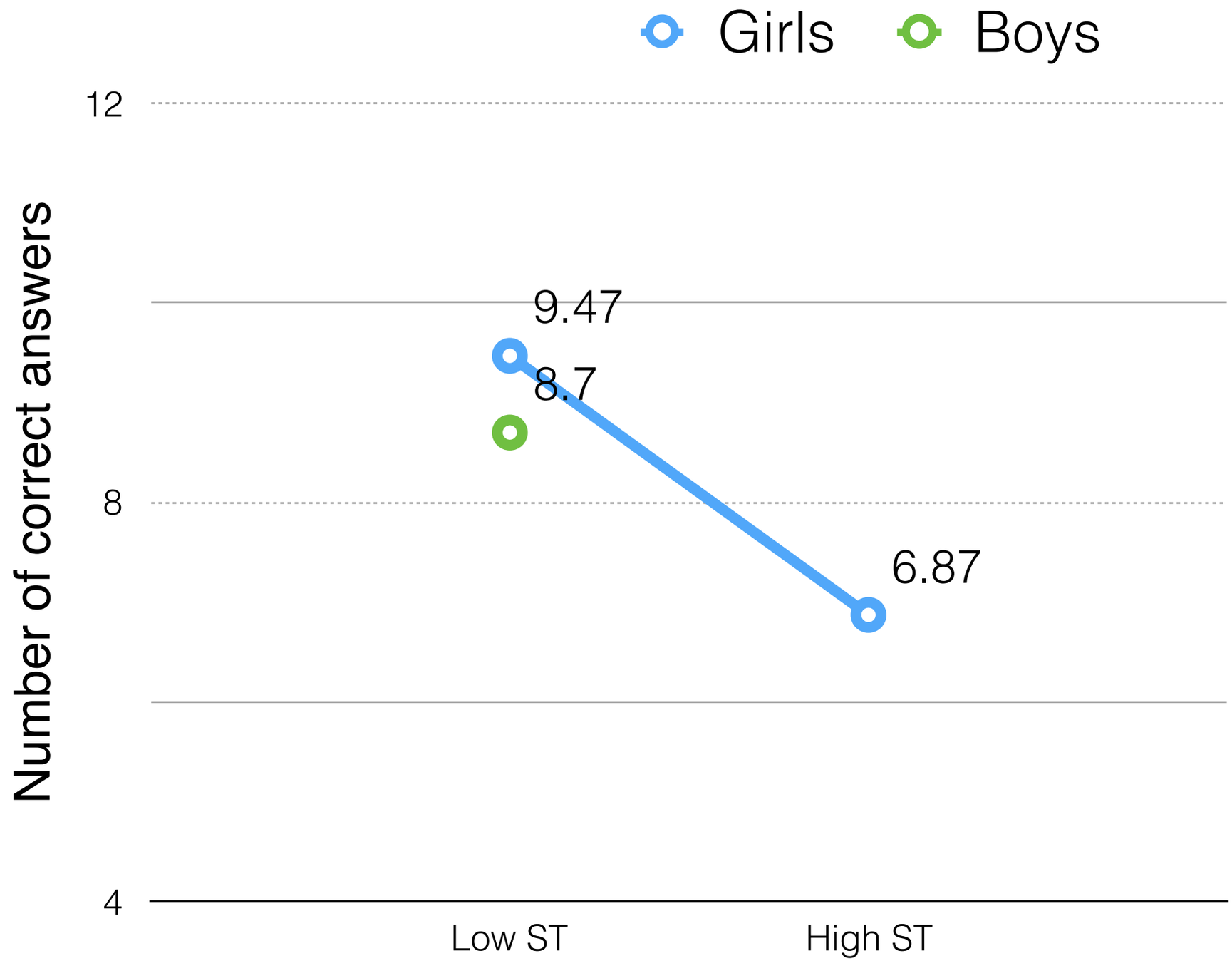
(**Steele & Aronson, 1995**)

Stereotype Threat



The effect of stereotype threat (ST) on math test scores (Obsorne 2007)

Stereotype Threat



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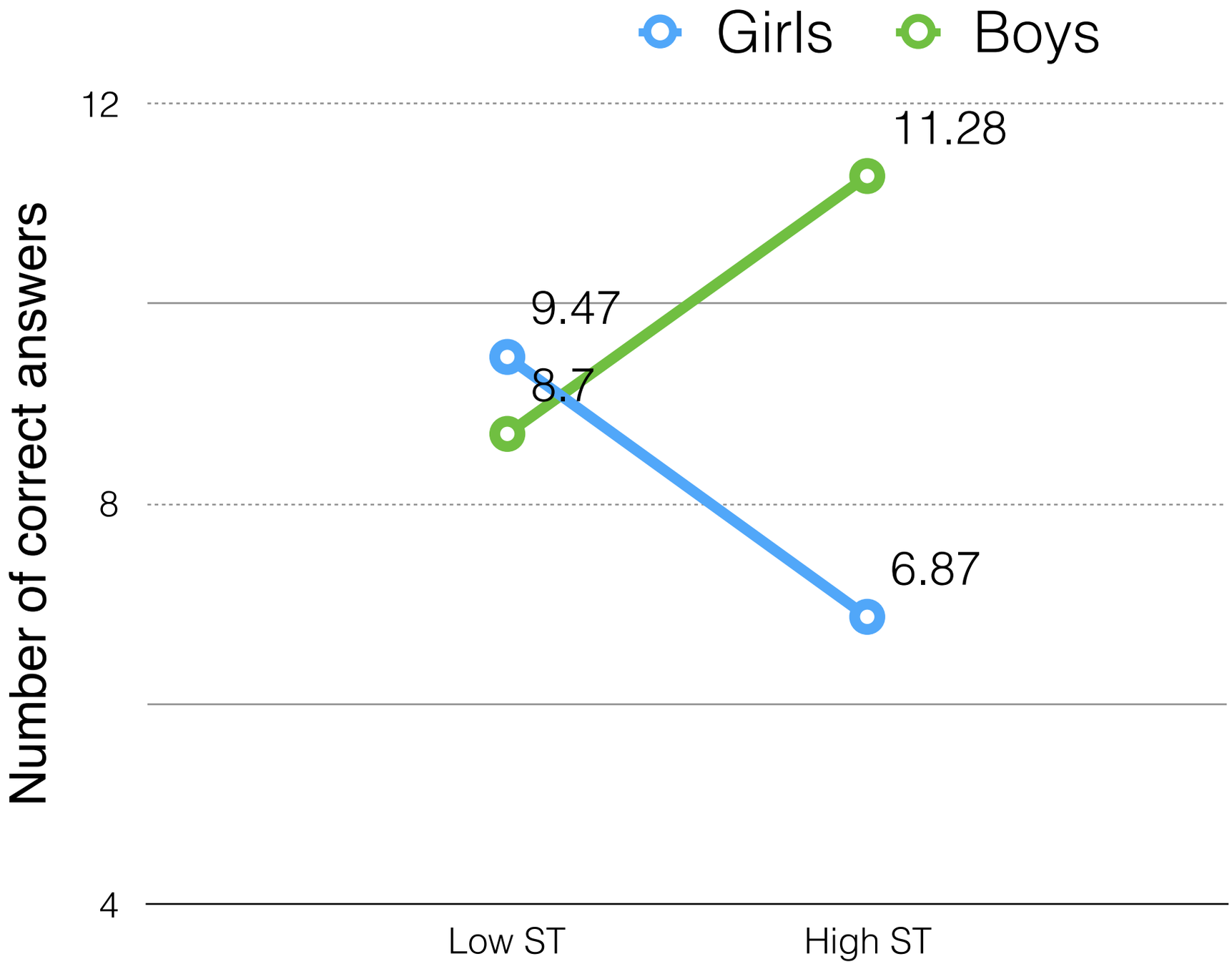

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Leaky pipeline + leaky bucket

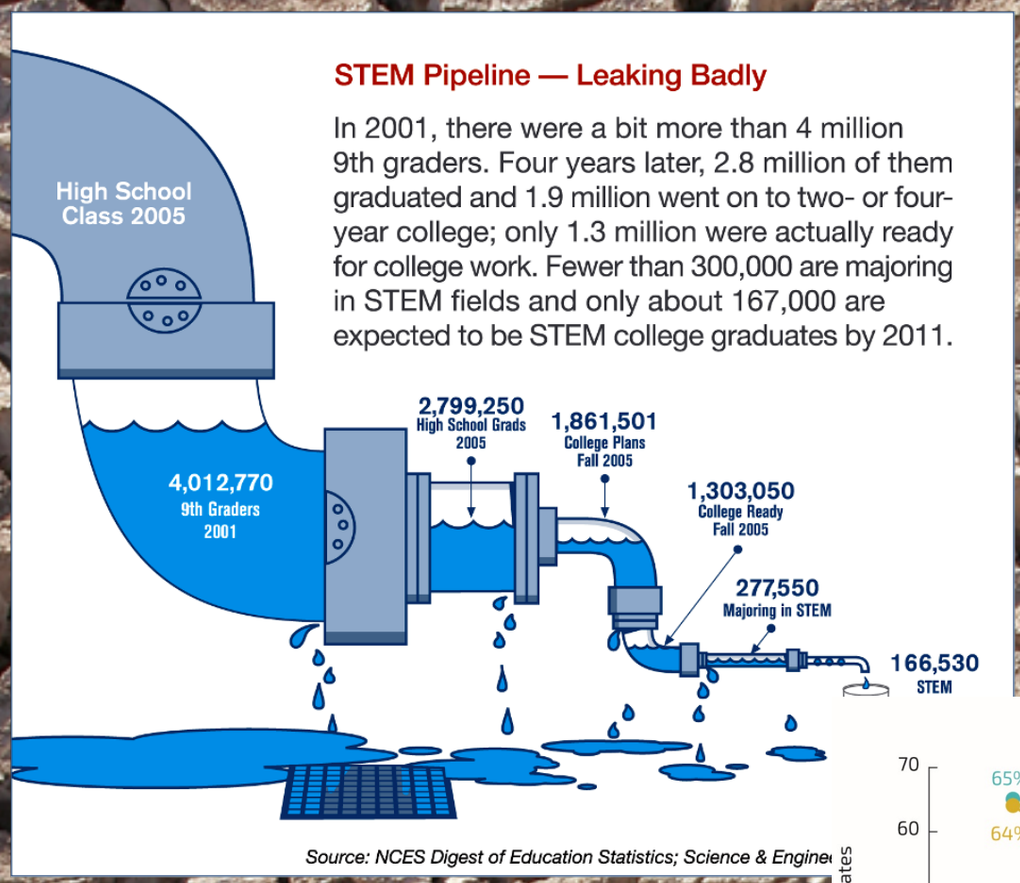
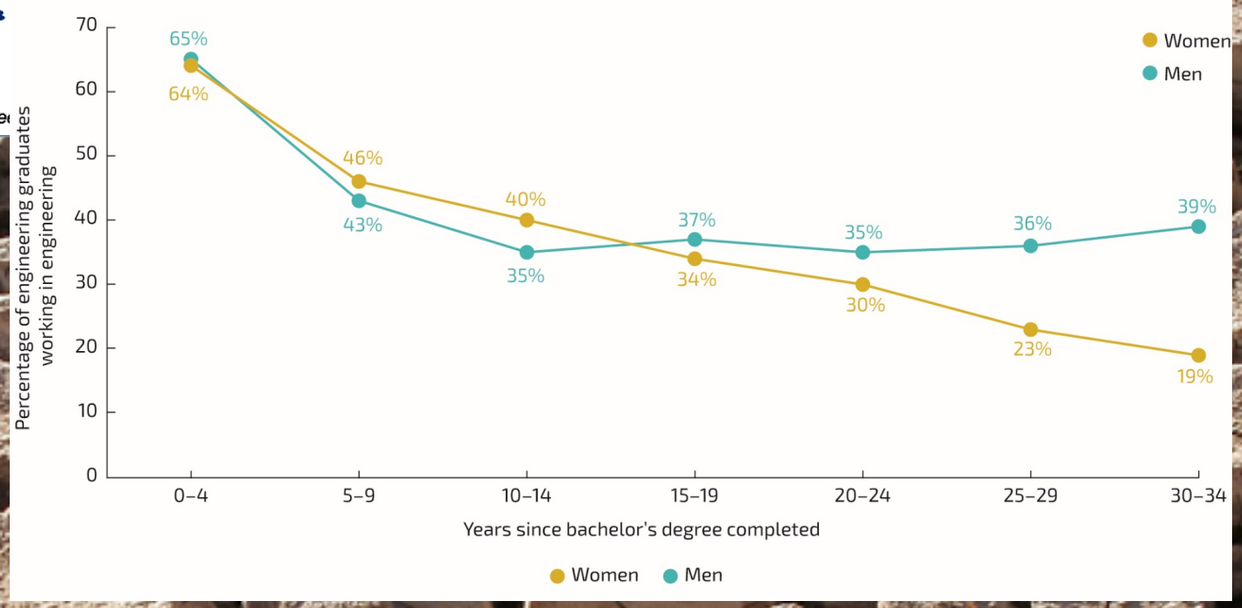


FIGURE 11. RETENTION IN ENGINEERING, BY GENDER, 2010



What can we do?

WHY ARE THERE STILL SO FEW WOMEN IN ENGINEERING AND COMPUTING?

#addwomen

AAUW
empowering women since 1881

THE HARVEY MUDD MODEL

1. Update introductory course
2. Expose students to early research opportunities
3. Introduce students to the community of female computer scientists

K-12 Version

1. Start coding & hands-on science in earlier grades. Include programming in all science classes. Introductory courses should accommodate non-hobbyists.
2. Make it real. Real tools, real problems, real science. Teach content in support of activities & making.
3. Connect to mentors, both peers and adults

Girls more likely to:

- Collaborate & strive for consensus
- Let others take credit / Take the blame
- Decline to compete for scarce materials
- Take on organizational roles
- Be compliant and adapt
- Look to the teacher for clues on how to behave or what to choose

4+3 Solutions

- Discuss stereotypes; similar to growth mindset
- Role models, peer mentors, & non-gendered examples
- Real world problems and projects that help others
- Gender-inclusive spaces
- *Address teacher anxiety and biases*
- *Tell kids the truth and let them help*
- *Change how STEM subjects are taught*

Problem Solving

- Dr. Seymour Papert defined two styles of problem solving: analytical and bricolage
- Bricolage - French for tinkering, using found objects, playfulness in creation
- Higher grades = more analytical
- Real world is both

Mastery Styles

Sherry Turkle

Hard Mastery **Academic & rigorous**

linear, rigid, abstract, solitary

Soft Mastery **Naive & lazy**

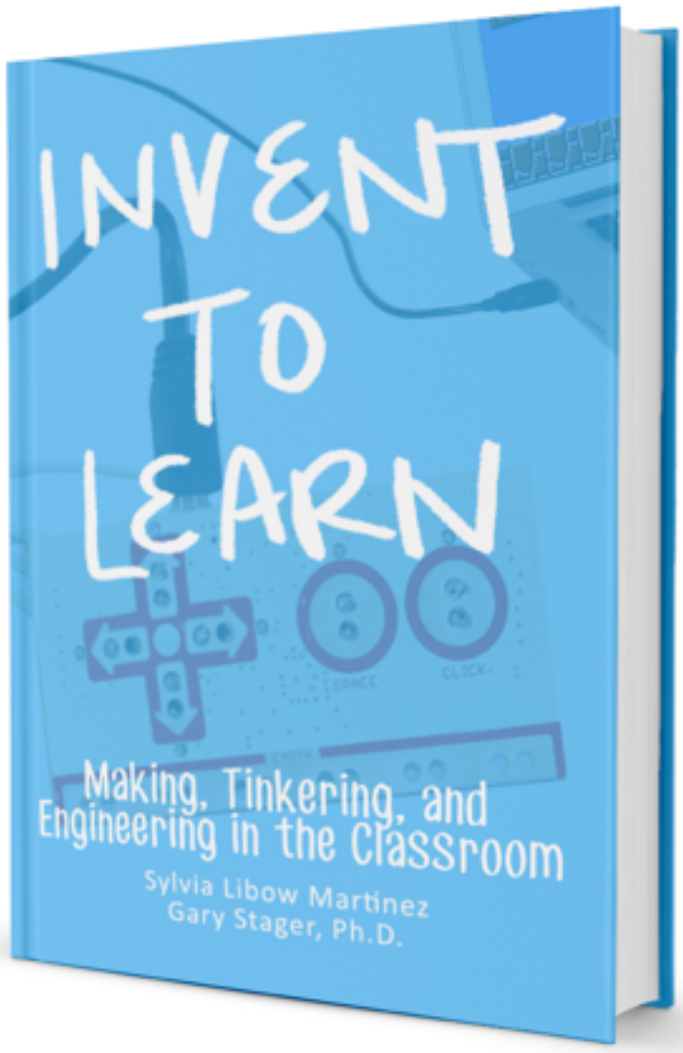
non-linear, messy, concrete, collaborative

"The bricoleur resembles the painter who stands back between brushstrokes, looks at the canvas, and only after this contemplation, decides what to do next." - Sherry Turkle

Invent To Learn:

Making, Tinkering, and Engineering in the Classroom

www.InventToLearn.com

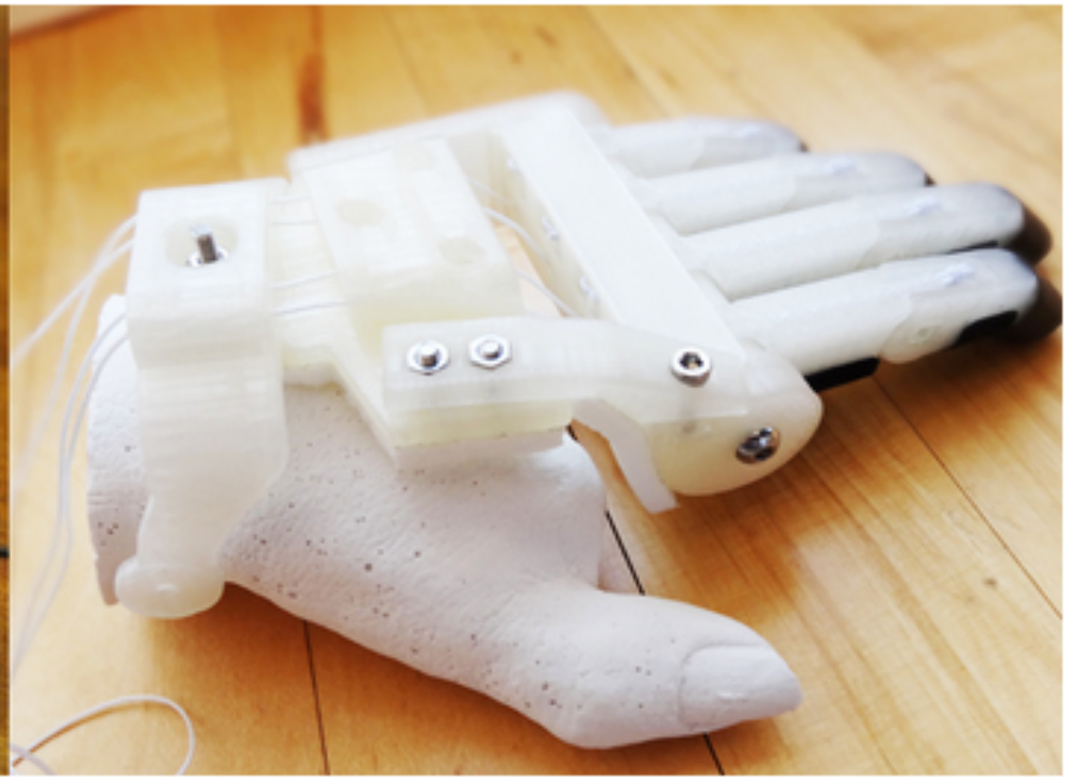


- Maker tools, materials, & tech
- Tinkering mindset
- Engineering design
- How to make the case for "making" in the classroom

robotics e-textiles 3D printing Arduino Scratch Raspberry Pi programming electronics sensors laser cutters STEM/STEAM

E-NABLING THE FUTURE

A network of passionate volunteers using 3D printing to give the World a "Helping Hand."



Hands Across Borders • Scout Troops Make 3D Printed Hands For Syrian Refugees

November 18, 2014
by Warm Fuzzy Revolutionist
1 Comment

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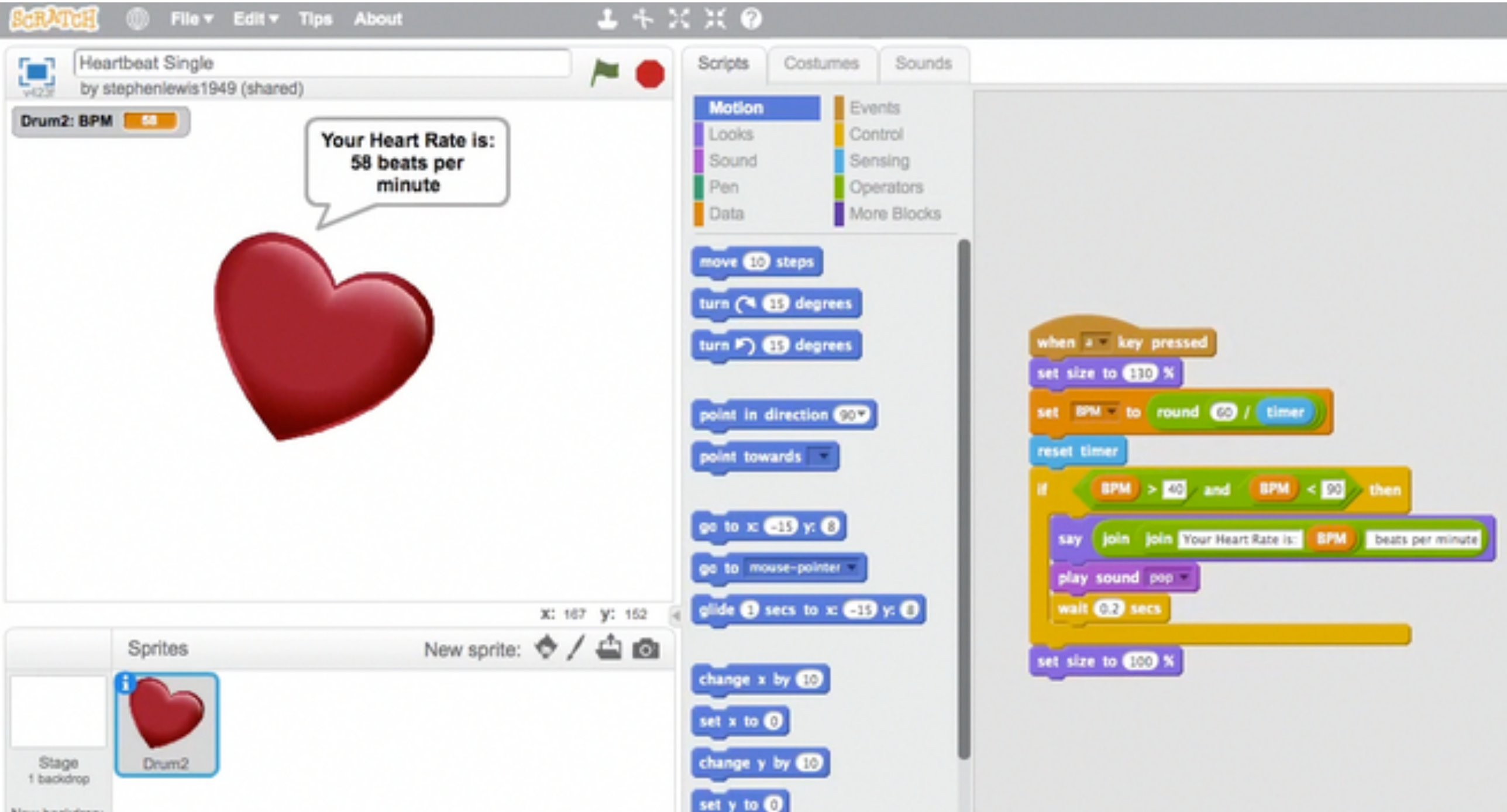
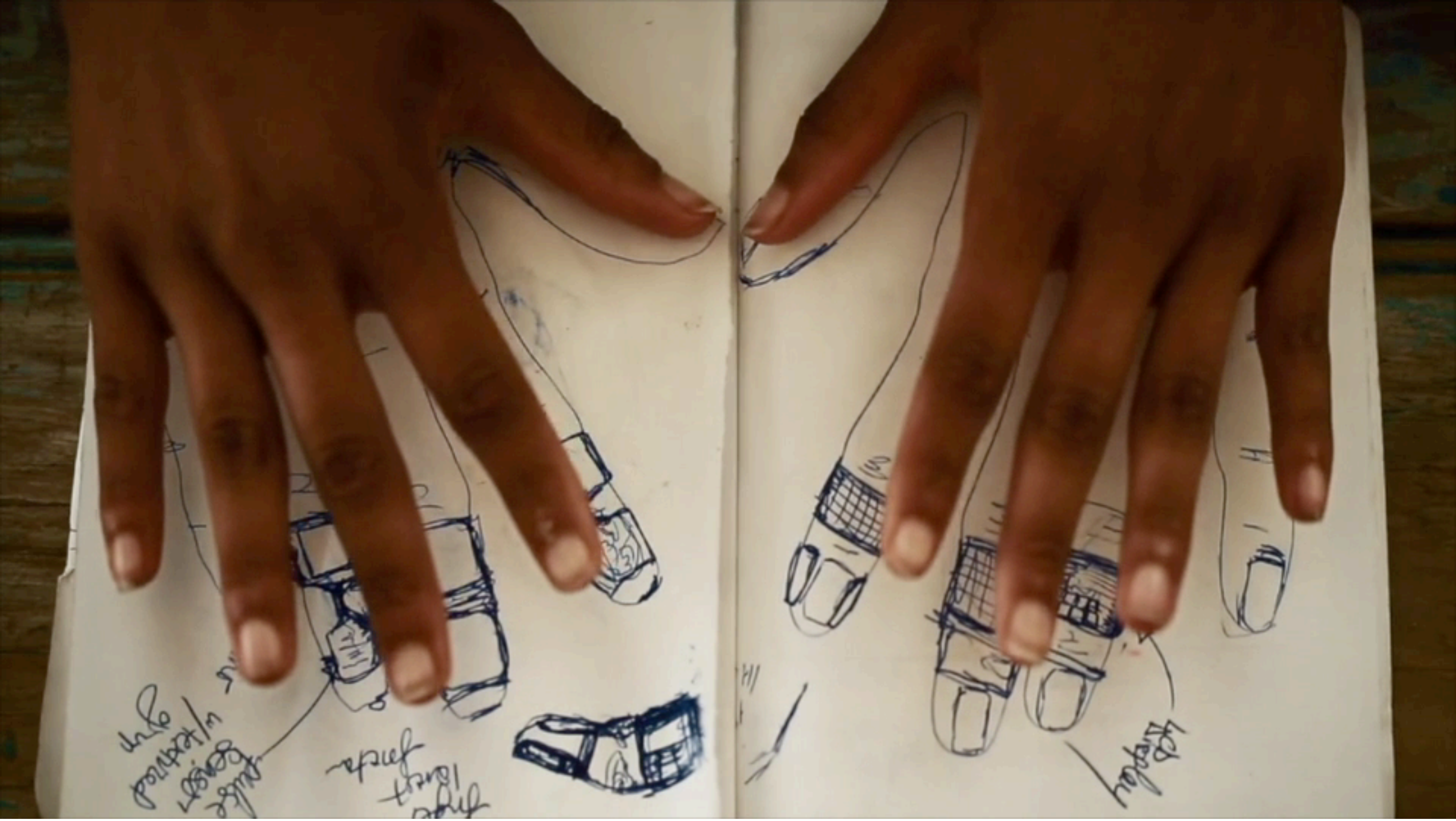
The ball says:
Like a Boss

Imogen Heap

Programming that connects to robots and real world





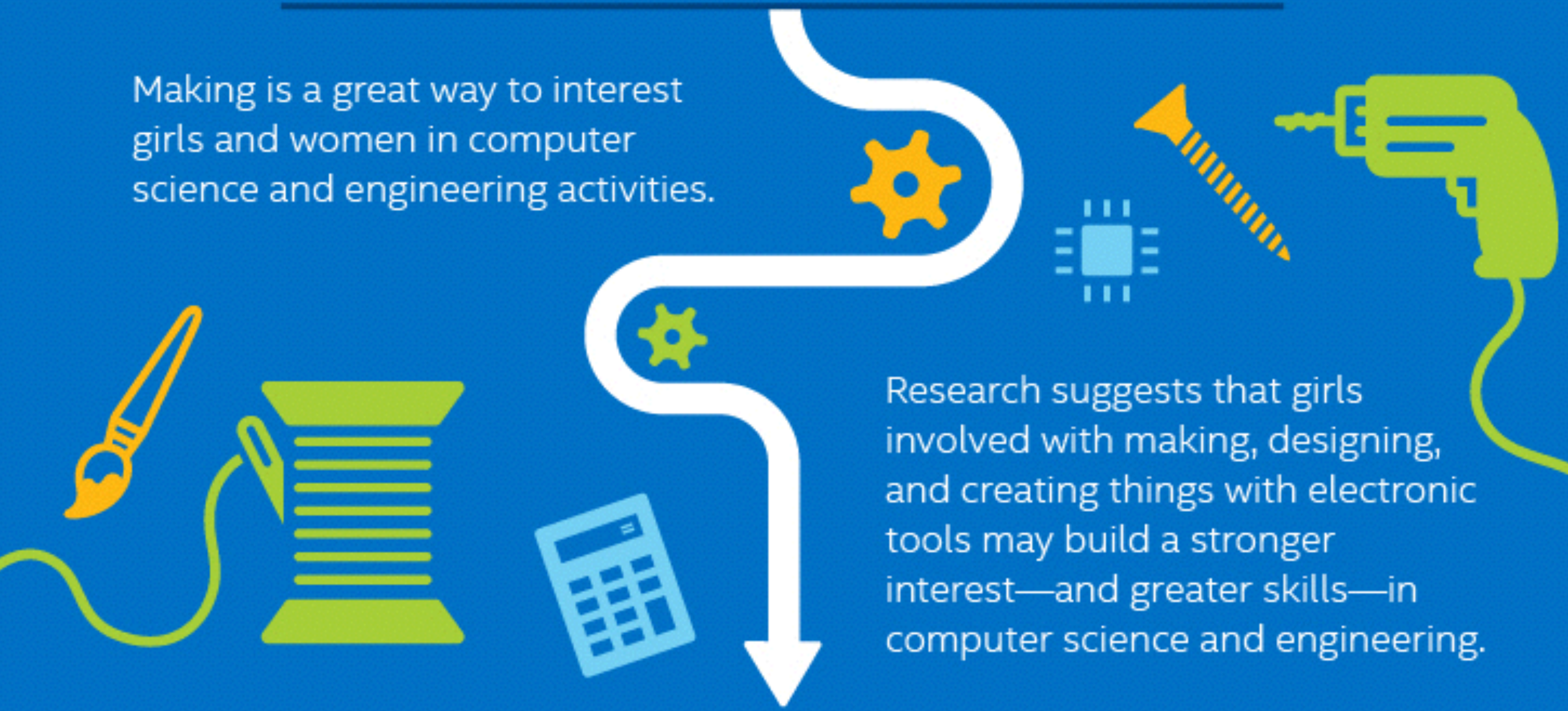
No girls?

- Recruit and nurture girls (guidance counselors)
- Don't completely depend on gender-segregated experiences to keep girls interested.
- Solve problems in your school or community. Make things for band, drama, and science classes.

NEW RESEARCH FINDINGS

The road from Maker to computer science and engineering for girls and women

Making is a great way to interest girls and women in computer science and engineering activities.



Research suggests that girls involved with making, designing, and creating things with electronic tools may build a stronger interest—and greater skills—in computer science and engineering.

MakeHers: Engaging Girls and Women in Technology through Making, Creating, and Inventing intel.com/girlsintech

Maker Empowerment

"A **sensitivity** to the designed dimension of objects and systems, along with the **inclination** and **capacity** to shape one's world through building, tinkering, re/designing, or hacking."

- Agency by Design, Harvard Graduate School

Making is not a magic wand…

if the question is "**How can we get more women to participate?**"

…

"Generally, **the responses focus on transforming women**, on areas that need to be corrected, such as raising confidence, creating more woman/girl friendly learning environments, increasing ability in math and science, and so on. **The women themselves cause the problem**; they lack confidence, they are unable to learn in the 'normal' STEM environment, they do not embrace their full capability in math and science.

It is the women who are deficient."

-Lauren Britton

Power, Access, Status: The Discourse of Race, Gender, and Class in the Maker Movement - Lauren Britton

Top 10 Ways To Be a Male Advocate for Technical Women

1. Listen to women's stories
2. Talk to other men (privately & publicly)
3. Seek out ways to recruit women
4. Increase the number and visibility of female leaders
5. Mentor and sponsor women/have a woman mentor

National Center of Women & Informational Technology
https://www.ncwit.org/resources/read-online-maleadvocate

Top 10 Ways To Be a Male Advocate for Technical Women

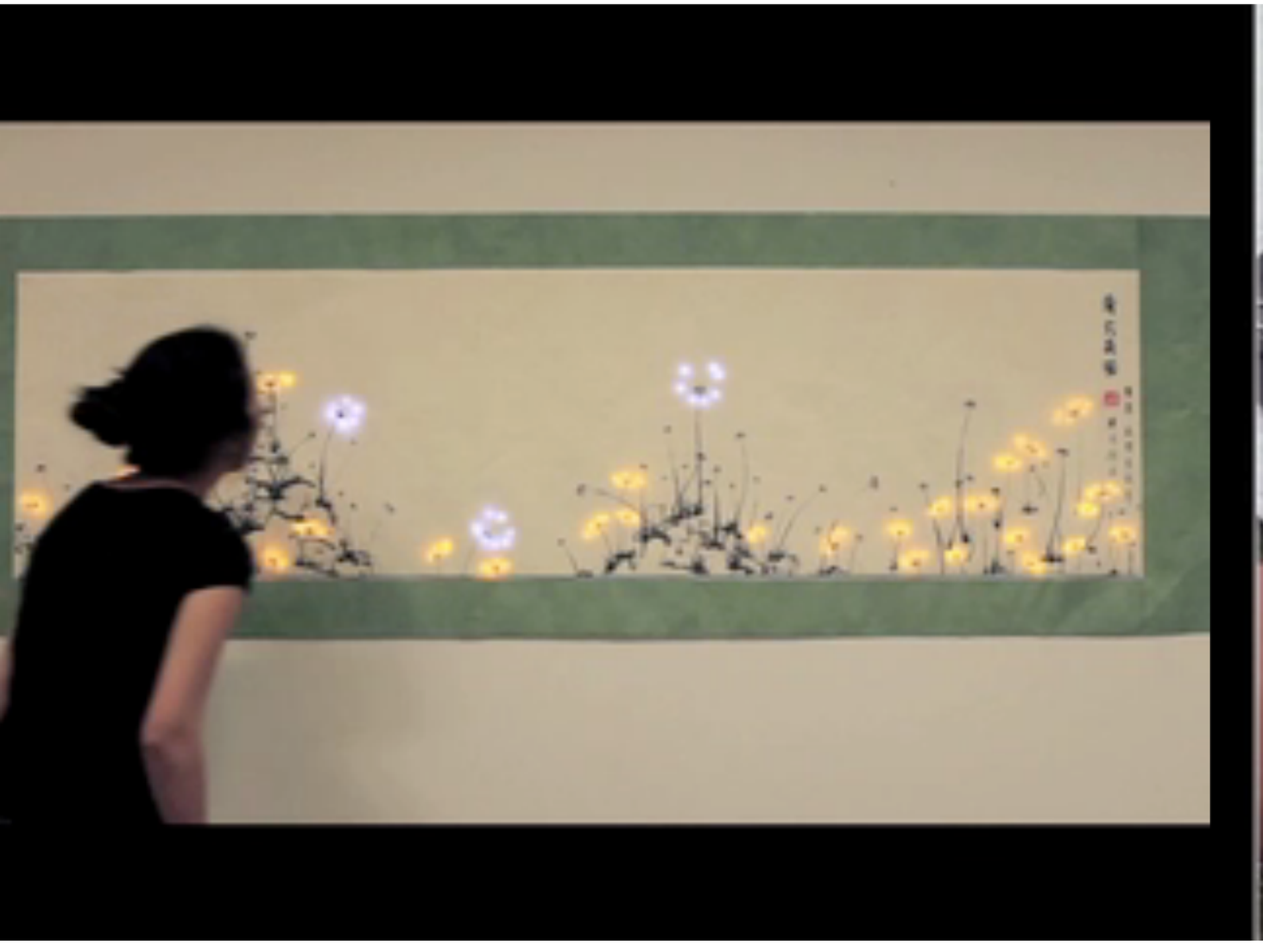
6. Notice and correct micro-inequities or instances of unconscious bias
7. Establish accountability metrics
8. Model alternative work/life strategies & balance
9. Make discussions of gender less “risky"
10. Reach out to formal and informal women's groups

National Center of Women & Informational Technology

https://www.ncwit.org/resources/read-online-maleadvocate

Classroom
Office
Teacher's Lounge
Boardroom
Lecture Hall
Lab
Conference
Podium

Great materials + Inspiration



Opportunities for cultural awareness, identity, art, mindfulness

Cultural awareness

Model equity, cultural awareness, artistic spirit,
& inclusion to make all feel welcome

Cultural awareness not cultural appropriation

Technologies of the Heart: Beyond #BlackLivesMatter and Towards #MakingLiberation

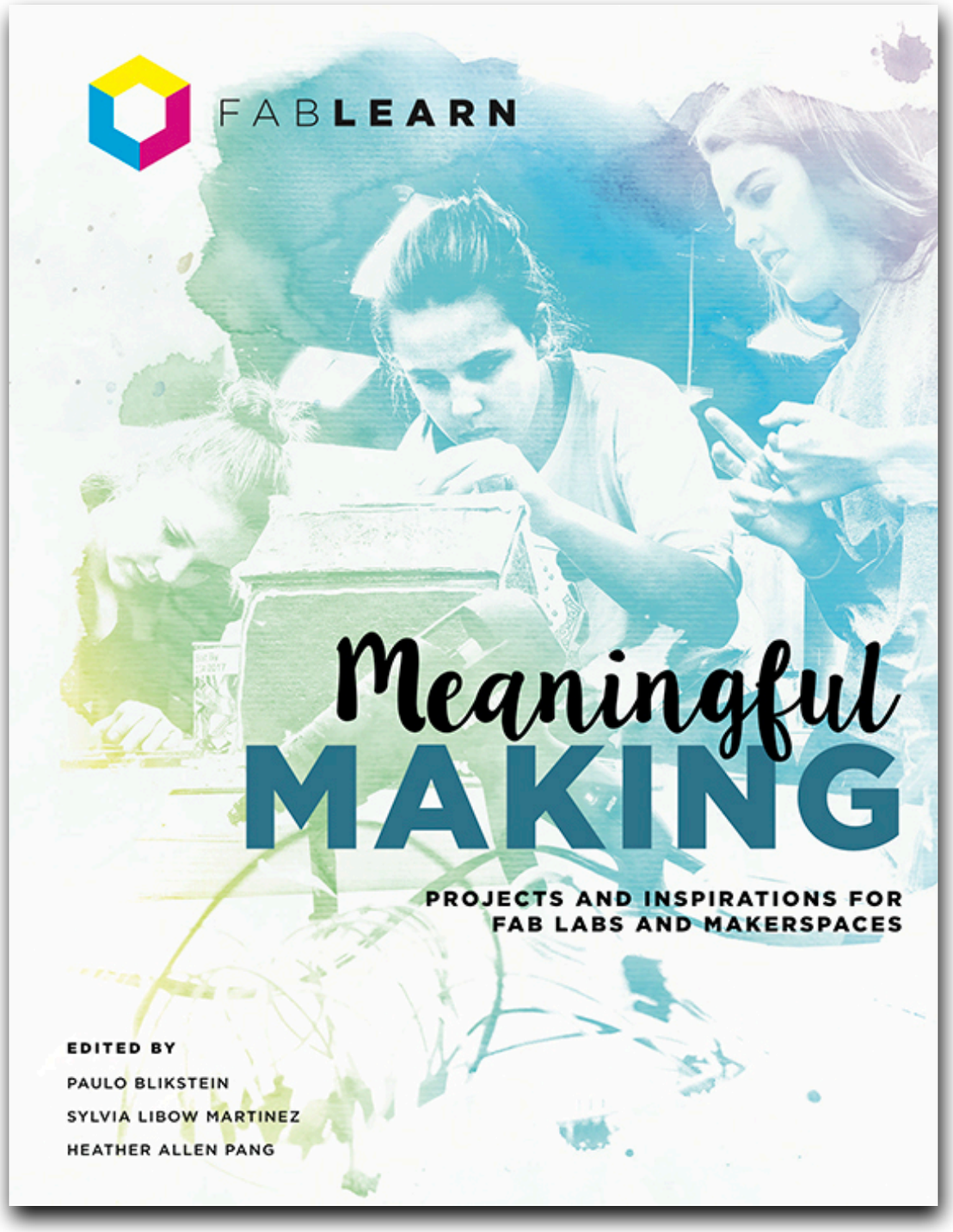
Susan Klimczak, Adia Wallace, and Nettrice Gaskins - South End Technology Center @ Tent City, Boston

The Rainbow Glove by Mariela, Antwain, and Steven

"To see color, you have to have light. When light shines on an object some colors bounce off the object and others are absorbed by it. Our eyes only see the colors that are bounced off or reflected.

Racism works that way too. People only see what's reflected back, not what is absorbed.

In my own life, I absorb people's criticism of me, I absorb the negative feelings when they don't see who I really am and when they don't believe I am capable or smart."



Meaningful Making

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cmkpress.com/meaningful-making

From Constructing Modern Knowledge Press

Full steam ahead

- Flexible, open spaces, owned by the inhabitants
- Honor culture, community
- Model the maker mindset - “I don’t know, let’s find out!”
- Real problems, real research, real tools
- Value all kinds of making, tools, materials (craft vs. tech)
- Reduce risk, reduce stakes, reduce barriers to entry - open doors, transparency
- Peer mentors, leaders, experts
- Constant reflection and course correction

Proceed with caution

- Role models - work with, not talk at
- Gender differentiated experiences - supportive or enshrining segregation?
- Student-led, student voice - is it the voice of a mono-culture?
- Embrace differences, don't enshrine them. Young people try on new identities.

Question

- Activities that differentiate boys from girls (stereotype threat)
- Adding "school" frameworks (grades, pre-requisites)
- What is popular
- Everything being a competition. Can the same quality of experience be had without a prize?

Full stop

- Micro-inequalities (actions and words)
- Cheerleading - “Girls can be anything!”… Reinforces the unsaid stereotype.
- A deficit frame - we aren’t “fixing” girls or improving their self-confidence
- Unconscious bias - difficult to see your own bias.

STEM for girls

STEM for all

How do teachers learn to teach this way?

http://www.inventtolearn.com/workshops/

http://constructingmodernknowledge.com

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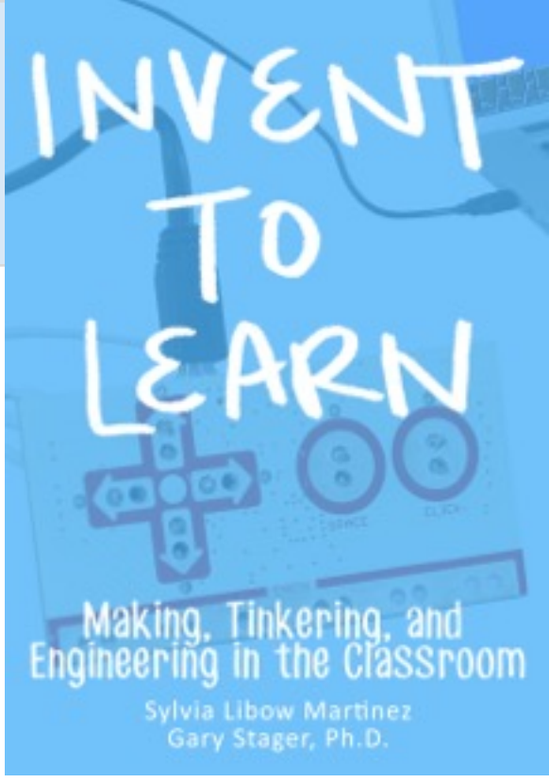
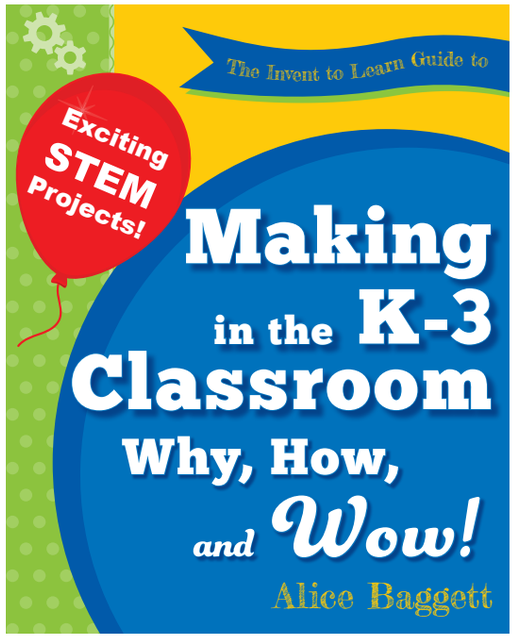
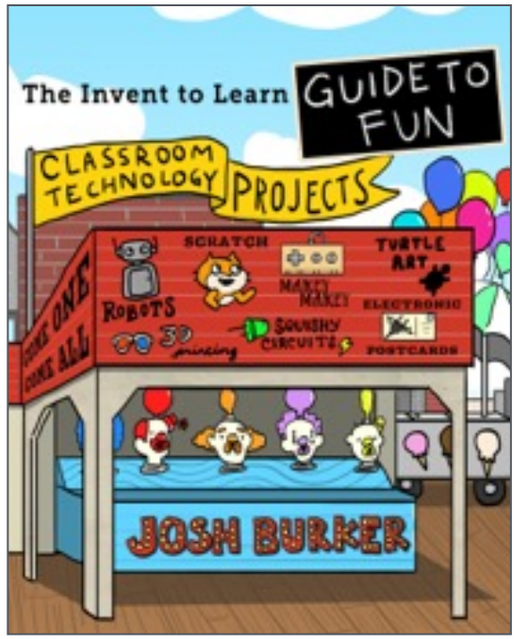
Seize this moment in history to give ALL kids the mindset, tools, and techniques to *make sense* and *take charge* of their world.

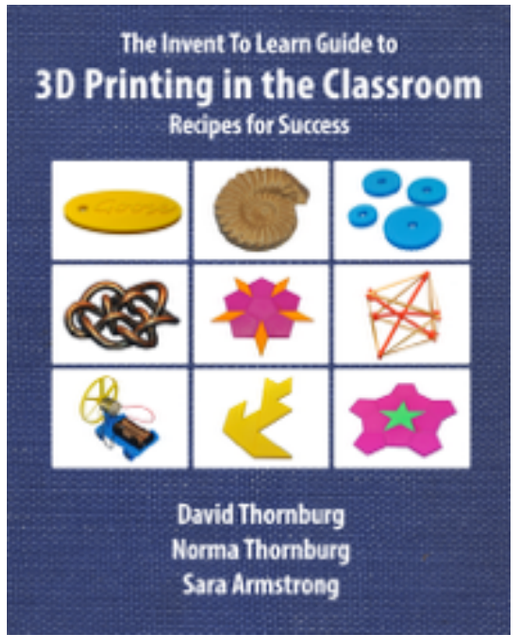
Books from CMK Press cmkpress.com

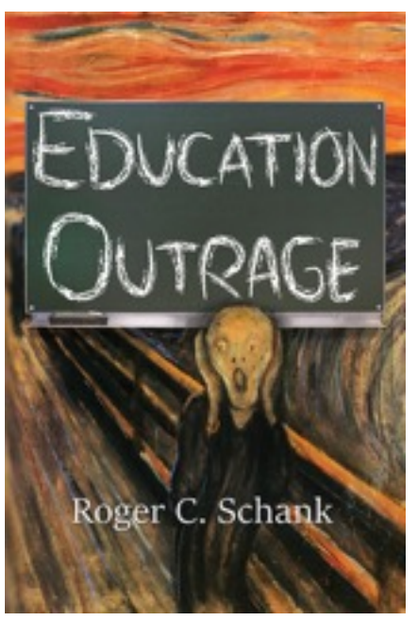


Invent to Learn Guides









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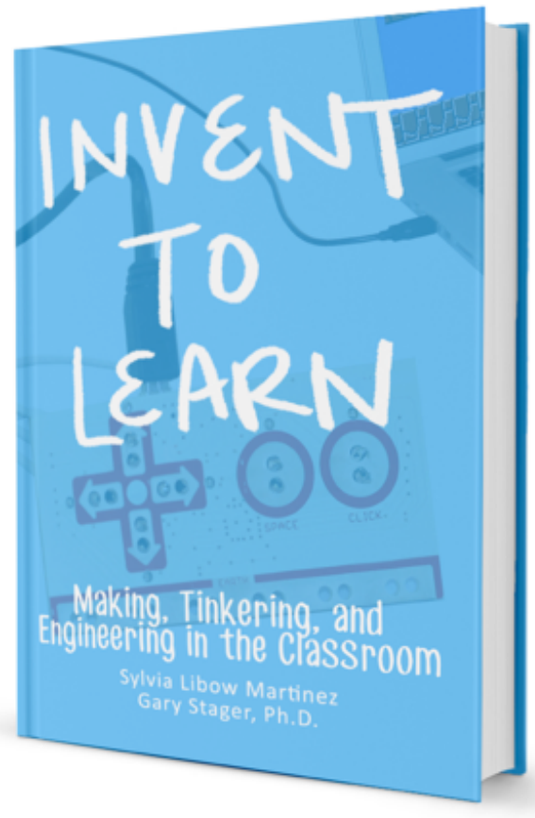

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Resources

Maker
Invent To Learn
MakeHers: Engaging Girls and Women in Technology through Making, Creating, and Inventing (Intel infographic)
Power, Access, Status: The Discourse of Race, Gender, and Class in the Maker Movement
Leah Buechley - Gender, Making, and the Maker Movement (video from FabLearn 2013)

Associations
National Girls Collaborative Project (links to many others)
National Council of Women and Informational Technology
American Association of University Women
WISE (UK) - campaign to promote women in science, technology, and engineering

Other posts about gender issues, stereotype threat, and other topics mentioned in this session
Stereotype Threat - Why it matters
Inclusive Makerspaces (article for EdSurge)
What a Girl Wants: Self-direction, technology, and gender
Self-esteem and me (a girl) becoming an engineer

Research
Securing Australia's Future STEM: Country Comparisons - Australian Council of Learned Academies
Generation STEM: What girls say about Science, Technology, Engineering, and Math - Girl Scouts of the USA (2012) (Girls 14-17)
Effective STEM Programs for Adolescent Girls: Three Approaches and Many Lessons Learned
Women's underrepresentation in science: Sociocultural and biological considerations. (2009)
Gresham, Gina. "A study of mathematics anxiety in pre-service teachers." *Early Childhood Education Journal* 35.2 (2007): 181-188.
Beilock, Sian L., et al. "Female teachers' math anxiety affects girls' math achievement." Proceedings of the National Academy of Sciences 107.5 (2010): 1860-1863.
Teachers' Spatial Anxiety Relates to 1st- and 2nd-Graders' Spatial Learning

Statistics
National Center for Educational Statistics
National Student Clearinghouse Research Center