CHANGING THE SIGNS:
MORE POSITIVES FOR WOMEN IN MATH

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OUR MOTIVATIONS FOR DOING THIS TALK
OVERVIEW OF THE PRESENTATION

1. Overview of the shortages and issues
2. How the gender gap impacts society
3. Reasons for the gender gap
4. The motivations of women
5. Implications for teaching
6. Recruitment strategies
7. Some conclusions and questions
1. Overview of the Shortages and Issues
FUTURE SHORTAGES IN STEM

- **STEM**: Science, Technology, Engineering, and Math

- By 2020 there will be 1.4 million unfilled jobs in STEM and we will be able to fill only 400,000 of them.
HIGH SCHOOL GIRLS AND STEM EDUCATION

• Higher percentages of girls are taking math classes than boys.

• 74% of high school girls across the country are interested in STEM.

• For high school girls: 88% want to make a difference in the world, and 90% want to help people.
Women earned 57% of bachelor’s degrees in all fields.

Women earn the following percentages of the STEM degrees:

- Over 50% of biological science,
- 18% of computer science,
- 19% of engineering,
- 19% of physics, and
- 43% of math and statistics.

Source: National Science Foundation, whitehouse.gov
Minority women received 16% of all bachelor degrees.

Minority women earn the following percentages of the STEM degrees:

- 3% of engineering,
- 6.5% of physical sciences,
- 5.4% of math and stats,
- 4.8% of computer science, and
- 9.7% of biology.

Source: National Science Foundation
Each generation of women is more represented in STEM degrees.
Women and STEM Industries

- Women make up 47% of the total U.S. workforce.
- Women in STEM industries hold 26% of STEM jobs.
  - 13% of engineering jobs, and
  - 25% of computer science and math jobs

*Source: National Science Foundation*
GROWTH IN STEM INDUSTRIES

- Women’s rates of growth in STEM fields has increased more than in any other broad occupational area.

- However, women’s presence as computer/mathematical scientists declined from 31% to 25% because men’s rates of growth were higher.

- “Efforts to Close Gender, Race Gaps in STEM not Working”

Source: Forbes. DiverseEducation.com
2. HOW THE GENDER GAP IMPACTS SOCIETY
IMPACT OF DIVERSITY ON DECISION MAKING

- Study after study (McKinsey and others) say that diversity improves organizational performance
  - Lower job turnover/attrition
  - Higher productivity
  - Higher satisfaction
- Why?
WHO HAS THE BUYING POWER?

- 73% of all buying decisions are made by women
- 83% of general retail purchases made by women
- Women control $12 trillion of $18 trillion in consumer spending

Lack of diversity in people is lack of diversity in THOUGHT. The products change when you change the makeup of the room.
WOMEN BRING A DIFFERENT PERSPECTIVE

- Example: Automotive industry
- Example: Only 31.5% of women support fracking, while 58% of men support it. (University of Nottingham Study.)
WHAT IS SOCIETY MISSING OUT ON?

More gender equal societies tend to be healthier and happier: Men are healthier, women are healthier, and children are healthier and do better in school.
WHAT ARE WOMEN MISSING OUT ON?

- **Higher paying careers**: Women in STEM jobs earn 33 percent more than non-STEM.
- **Making an impact in careers they care about**: Women want to help people.
- **Growing opportunities**: STEM fields are booming.
- **Leadership positions**: The ability to climb higher in their chosen fields.
3. MYTHS AND REASONS FOR THE GENDER GAP
STEM MYTH #1

STEM is for men.

- Gender roles and identity play a significant role in our society.
- Example: 58% of high school students think of computer scientists as being white males.
STEM jobs aren’t creative or collaborative.

- Women often think they will be isolated at a desk with a computer.
- There is a lot of research showing this myth is a huge factor for why women don’t go into STEM fields.
STEM MYTH #3

**STEM training is only for STEM fields.**

- 67% of tech jobs are **outside** the tech industry.
- **Interdisciplinary communication** is key and the future of **all** industry.
- The following Google video helps dispel some of these myths.
EVERY COMPANY IS A TECH COMPANY.

Technology is really important for the future and a lot of great leaders, not just of technology companies, but of every company will have to have a technology background.

– Sheryl Sandberg, Chief Operating Officer for Facebook
Max Levchin, CEO of Slide, is a successful creator of applications for Facebook. He stated the following:

“Our competitive advantage is actually our **math skills**, which is probably not something you would expect from a media company.”
IMPLICIT BIAS TOWARD GENDER IN STUDENT EVALUATIONS
EXAMPLES OF IMPLICIT BIAS

- Faculty are more likely to hire/mentor/respond to research emails when they believe the student is a man.

- Implicit bias is exhibited equally by faculty of different genders, ranks, and academic disciplines.

**Source**: Whithouse.gov
RECOGNIZING IMPLICIT BIAS

- Bias with Harvey Mudd College Engineering Awards
BLIND SPOTS BETWEEN WOMEN AND MEN

1. **Women care more about the collaborative process of reaching goals**, whereas men care more aboutresults.

2. **Women feel excluded by oblivious men.** 82% of women feel some form of exclusion, whether in social events, conversations, or in getting feedback, while 92% of men don’t believe they’re excluding women.

3. **Women want feedback.** Some 82% of women say they want to get direct feedback from men, while 79% of men feel they have to be careful and indirect.

4. **Women like to ask questions.** 80% of women say they prefer to ask questions even when they know the answer, while 72% of men say that women ask too many questions.

*Source: *8 Blind Spots Between Men and Women at Work*
4. THE MOTIVATIONS OF WOMEN
NONFACTORS FOR CHOOSING STEM

Factors that **ARE NOT** significant for women choosing STEM:

1. Having parents or siblings in STEM
2. Having teachers in high school with a lot of experience in the field
3. **Concerns about grades or thinking the coursework is hard**

*Source:* Google
PRECOLLEGE FACTORS

Precollege factors made up 61% of the decision to go into STEM:

1. Encouragement from parents and teachers
2. Exposure to the subject (familiarity)
3. Self perception and confidence in coursework
   • Women face the “Imposter Syndrome”

Source: Google, Institute for Women in Trade Technology
THE IMPOSTER SYNDROME

- The Google research shows it can be just a phase if women stick it out and get the encouragement.
- Sheryl Sandberg, COO for Facebook, talks about the imposter syndrome in her book, *Lean In*, as being a common feeling even with very successful women in industry.
The following are predictors of women staying in collegiate STEM:

1. Quality and engaging courses

2. Engaging extracurricular or clubs
   - Male dominated classes and clubs are typically not the place.

*Source:* Google
WHICH MAKES YOU WANT TO KNOW MORE?

- This machine is the first dynamic high-volume CT that utilizes 320 ultra-high-resolution detector rows to image an entire organ in a single gantry rotation.

- If you enter the hospital having suffered a stroke or a heart attack, doctors will be able to make a much more accurate diagnosis in far less time and that could save your life. Our product could mean the difference between a full life or never recognizing your family again.
WOMEN ARE MOTIVATED BY APPLICATIONS

- A higher number of men are excited about the features of technology.
- Women care more about how STEM can be used to help others and create social impact. They care about the direct applications of the technology, not the technology for its own sake.

Source: IWITTS
WOMEN PREFER LEARNING IN CONTEXT

Women are motivated by seeing the concepts in context and getting a sense of the practical application right up front.

1. Carnegie Melon Computer Science Study

2. Carnegie Melon Intro to Engineering Study

• Transformed retention from 54% to 80%
WOMEN PREFER COLLABORATION

- Studies show collaborative, non-competitive learning is powerful for women. Collaborative learning also tends to be more applied.
- Dr. Charlie McDowell- Professor of CS at University of CA Santa Cruz: “Pair Programming Improves Student Retention, Confidence, and Program Quality”
RESULTS

• Female enrollment in the next class went from 44% to 68%.
• A year later 46% of women from pairing class declared, while only 11% of non-pairing
• In proposed majors, 22% of women in control class declared a major while 60% from the paired class declared
  • In men this number went from 47% to 74%
• More women in general just made it through the intro class than in the solo
• “Confidence of solutions” gender gap decreased
• Scores were similar, but more of the students finished the pairing course.
**WOMEN PREFER COLLABORATION**

- Barbara Dufrain from Delmare College in Corpus Christi, Texas
- Transformed female CS retention from 0% to 86% and male retention from 70% to 93%.
  1. Flipped the class
  2. Ice breakers projects
  3. Welcoming conversation

These strategies help all the underprepared students, not just women.
5. IMPLICATIONS FOR TEACHING
Women learn better through context and direct application.

- Present context as a motivator that shows the big picture.
- It is essential to make connections between math and helping people.
- Move from concrete ideas to abstract concepts.
MULTIPLE REPRESENTATIONS

• Looking at and solving a problem in more than one way—not just algebraically/symbolically
• Support diverse learning styles
AN IMPORTANT COMPONENT OF MULTIPLE REPRESENTATIONS: VISUALIZATION

- Visualization encourages learners to consider other ways of thinking and reasoning without immediately resorting to algorithms. The evocation of a visual event also assists in retaining and in further developing knowledge.

—Association of Teachers of Mathematics
Visual learners are 65% of the population.

Variations in learning styles have been linked to gender: women tend to be more visually oriented than men.

Consequently female students are more prone than men to suffer the negative effects of a learning style-teaching method mismatch.

WHAT CAN WE DO IN THE CLASSROOM?

- Promote mastery learning and collaboration.
  - Women respond more to this non-competitive form of learning.
  - It builds confidence.

- Take every question equally seriously.
  - Try not to patronize diversity without realizing it.
  - Encourage questions in class.
  - Encourage women to seek out more female dominated clubs on campus to ask additional questions.

- Give all students direct feedback.
  - Women especially want to know “they’re on the right track”.


1. Driver/navigator technique
2. Pair female students together.
3. Assign different roles then rotate.
6. RECRUITMENT STRATEGIES
RECRUITING WOMEN: CASE STUDY

• Barbara Dufrain, Delmare College
• Launched an outreach campaign called “Smart Wonderful Women.”
• Targeted women who did well in math.
In order to attract women in STEM, we have to have role models at the collegiate level.

When selecting a major, students identify more with the person teaching the class than they do with the subject material being taught.
WHERE DO WE START?

- Dr. Liz Orwin, Chair of Engineering at Harvey Mudd College
- In 2014, 56% of engineering grads at Harvey Mudd College were female.
- Nationally this number is 19%
- “Just start chipping away. It’s an evolving process.”
- “Cultural shifts happen slowly. We need to get to the point where it’s not unusual to be a female engineer.”
7. SOME CONCLUSIONS AND QUESTIONS
Women care about people, communicating, and collaboration. These interests, combined with STEM skills are a powerful combination, and ones our companies look for everyday.

This is a win-win-win.
Math may be *timeless* …

… *but our teaching methods are not.*
GOOD THINGS ARE HAPPENING!

- Math education is moving away from exclusivity toward inclusivity.
- Today there are countless, dedicated mathematics and STEM instructors working on improving courses for ALL students.
Thank You for Attending!

www.garyrockswold.net