Research-Informed Practices for Inclusive STEM Classrooms: Strategies for Educators to Close the Gender Gap

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Skills to Emphasize

- **Develop Spatial Skills**
  - Integrating STEM disciplines with spatial reasoning and problem-solving activities
  - Utilizing hands-on materials and software

- **Emphasize Communication**
  - Facilitating peer collaboration and discussion
  - Incorporating group projects and presentations

- **Clarity in Grading Policies**
  - Providing clear, consistent, and fair grading criteria
  - Encouraging feedback and revisions

Scaffolding to Implement

- **Archive Expert Roles**
  - Creating a diverse and inclusive expert panel
  - Incorporating real-world experts in STEM fields

- **Demonstrate and Encourage Resistance**
  - Highlighting successful female mentors and role models
  - Discussing common barriers and solutions

- **A Foundation in Calculus**
  - Developing a strong calculus foundation
  - Utilizing interactive and visual aids

Thank you.
Research-Informed Practices for Inclusive STEM Classrooms: Strategies for Educators to Close the Gender Gap

Problem:
- Under-representation of women in STEM
- Gender's relation to K-12 STEM clusters
- Bridge research to practice

Literature Review
- Analyze gender as a variable
- Awareness, then implementation
- Benefits can be broadened

Purpose
- 2 key practices
  - Interdisciplinary

Methodology
- Criteria since 2005, high school focus
- 20 studies cited
- 8 key practices

The Right Foot
- "Use" vs. "Teach" as attribution issue
- Ideal balance and over-generalization
- Identity, self-esteem, self-efficacy

The Paper
- More studies, and in greater detail
- Suggestions for concrete actions
- Possible directions for future research

Acknowledgments
- Stanford University
- University of California, Berkeley
- University of California, San Diego

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Skills to Emphasize

A Foundation in Calculus
- Show the power of calculus on the lead-up to learning a quantitative property for girls through "Do it yourself" problems and group work
- "Use" vs. "Teach" as attribution issue
- Ideal balance and over-generalization
- Identity, self-esteem, self-efficacy

Demonstrate and Encourage Resilience
- The more women perceived as belonging in the workplace, the more they maintained a sense of belonging to mathematics
- "Use" vs. "Teach" as attribution issue
- Ideal balance and over-generalization
- Identity, self-esteem, self-efficacy

Active Expert Roles
- Mastery experiences significantly predicted self-efficacy
- "Use" vs. "Teach" as attribution issue
- Ideal balance and over-generalization
- Identity, self-esteem, self-efficacy

Scaffolding to Implement

Develop Spatial Skills
- Improving spatial skills through targeted training
- Benefits for females: 75% to 88%, males: 81% to 92%
- Spatial skills are multiplier in hours
- 2-year learners: < 1.5 km walked over 3 years
- 1-year learners: > 2.5 km walked over 3 years

Emphasize Communication
- Scoring highly in English negatively impacts a student's self-competence in math
- "Use" vs. "Teach" as attribution issue
- Ideal balance and over-generalization
- Identity, self-esteem, self-efficacy

Clarity in Grading Policies
- Grades have limited self-efficacy
- "Use" vs. "Teach" as attribution issue
- Ideal balance and over-generalization
- Identity, self-esteem, self-efficacy

Re-evaluate Group Work Practices
- Engineering, math, and science were more likely to show negative conclusions about self-efficacy when comparing different groups
- "Use" vs. "Teach" as attribution issue
- Ideal balance and over-generalization
- Identity, self-esteem, self-efficacy
Research-Informed Practices for Inclusive STEM Classrooms: Strategies for Educators to Close the Gender Gap

**Literature Review**
- Gender's relation to K-12 STEM classes
- Bridge research to practice

**Purpose**
- Analyze gender as a variable
- Awareness, then implementation
- Benefits can be broadened

**Methodology**
- Criteria: since 2000, high school focus
- 80+ studies read, 21 studies cited
- 7 key practices
- Interdisciplinary

**The Right Foot**
- "Sex" vs. "Gender": an attribution issue
- Avoid overemphasis and over-generalization
- Identity, self-concept, self-efficacy
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Problem:

⚠️ Under-representation of women in STEM
Literature Review

- Gender's relation to K-12 STEM classes
- Bridge research to practice
Skills to Emphasize

A Foundation in Calculus
The positive effect of calculus on the development of scientific literacy is greater for girls than boys.

- Criteria: since 2004, high school focus
- 2 key practices: multidisciplinary
- A concern: gender bias

Suggestion: To encourage girls to take calculus in secondary school.

Demonstrate and Encourage Resilience
The more women perceive the feasibility of environments, the more they retain a sense of belonging to math.

- (Kaw at al., 2012)

Suggestion: Encourage the power of practice over inherent talent, growth mindset.

Active Expert Roles
Mastery experiences significantly predicted self-efficacy.

- (Kaw at al., 2012)

Suggestion: Integrate the above activities into curricula.

Develop Spatial Skills
Improving spatial skills through targeted training improves retention of engineering students.

- Females: 77% to 88%, Males: 66% to 75%
- Spatial skills are available in hours 1/2 to lecture + 1/2 in lab per week for one semester.

Suggestion: Integrate workshops into high school curriculum.

Emphasize Communication
Scoring highly on English can negatively impact a student's self-perceived math ability.

- Conditional effect: stronger for females

Suggestion: Integrate workshops and STEM activities to improve language and math skills, which are mutually exclusive.

Clarity in Grading Policies
Students have low self-efficacy.

- Females receiving higher grades in science courses, girls report higher science self-efficacy and lower science self-competence than males.

Suggestion: Evaluate the grading policy and ensure the feedback is clear and aligned.

Scaffolding to Implement

Re-evaluate Group Work Practices
Engineering majors were more likely than other groups to show negative conclusions about self for math learners.

- Females: 40%, Males: 30%

Suggestion: Go beyond hot topics for group formation, manage group dynamics.
Purpose

• Analyze gender as a variable
• Awareness, then implementation
• Benefits can be broadened
Methodology

- Criteria: since 2000, high school focus
- 80+ studies read, 21 studies cited
- 7 key practices
- Interdisciplinary
The Right Foot

- "Sex" vs. "Gender": an attribution issue
- Avoid overemphasis and over-generalization
- Identity, self-concept, self-efficacy
1. **A Foundation in Calculus**

   The positive effect of calculus on likelihood of choosing a quantitative major is greater for girls than boys.
   - Increases likelihood 3.22 times for females, 2.27 times for males
   - A conditional effect

   (Correll, 2001)

   Suggestion: Encourage girls to take calculus in high school

2. **Develop Spatial Skills**

   Improving spatial skills through targeted training improves retention of engineering students.
   - Females: 77% to 48%, Males: 61% to 52%

   Spatial skills are malleable in hours
   - 1/2 hr lecture + 1.5 hrs worksheet + 2 hrs computer lab per week for one semester

   (Sorby, 2007)

   Suggestion: Short workshops integrated into high school courses

3. **Emphasize Communication**

   Scoring highly on English can negatively impact a student's self-perceived math ability.
   - Conditional effect - stronger for females

   (Correll, 2001)

   Suggestion: Work communication into STEM activities to show that language and math skills are not mutually exclusive. Teach that better communicators are better engineers.
A Foundation in Calculus

The positive effect of calculus on likelihood of choosing a quantitative major is greater for girls than boys

- Increases likelihood 3.22 times for females, 2.27 times for males
- A conditional effect

(Correll, 2001)

Suggestion: Encourage girls to take calculus in high school
② Develop Spatial Skills

Improving spatial skills through targeted training improves retention of engineering students
Females: 77% to 48%, Males: 61% to 52%

Spatial skills are malleable in hours
1/2 hr lecture + 1.5 hrs worksheet + 2 hrs computer lab per week for one semester  (Sorby, 2007)

Suggestion: Short workshops integrated into high school courses
3 Emphasize Communication

Scoring highly on English can negatively impact a student's self-perceived math ability
Conditional effect - stronger for females
(Correll, 2001)

Suggestion: Work communication into STEM activities to show that language and math skills are not mutually exclusive. Teach that better communicators are better engineers.
Demonstrate and Encourage Resilience

The more women perceived malleable-ability environments, the more they maintained a sense of belonging to math

(Good, Rattan, Dweck, 2012)

Suggestion: Encourage the power of practice over inborn talent, growth mindset
**Active Expert Roles**

Mastery experiences significantly predicted self-efficacy  
(Hazari et al., 2010)

Hands-on experiences, self-motivated learning, real life application, and problem-based projects correlated with pre-college science self-efficacy  
(Fantz et al., 2011)

Suggestion: Integrate the above activities into curriculum

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**Scaffolding to Implement**

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**Clarity in Grading Policies**

Females have biased self-assessments:

Despite girls earning higher grades in science courses, girls reported equal science self-efficacy and lower science self-concept than boys  
(Hazari et al., 2010)

Suggestion: Re-evaluate your grading policy and ensure the feedback you give is adequate and clear

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**Re-evaluate Group Work Practices**

Engineering males were more likely than other groups to draw negative conclusions about self-belittling speakers  
(Wolfe & Powell, 2009)

Group work in the first year may perpetuate skill set gaps  
(Chachra, 2012)

Suggestion: Go beyond best practices for group formation... manage group dynamics
Active Expert Roles

Mastery experiences significantly predicted self-efficacy
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Suggestion: Re-evaluate your grading policy and ensure the feedback you give is adequate and clear
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Group work in the first year may perpetuate skill set gaps (Chachra, 2012)

Suggestion: Go beyond best practices for group formation... manage group dynamics
The Paper

- More studies, and in greater detail
- Suggestions for concrete action
- Possible directions of future research
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Thank you
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**Problem:**
- Under-representation of women in STEM

**Literature Review**
- Gender's relation to K-12 STEM classes
- Bridging research to practice

**Purpose**
- Analyze gender as a variable
- Awareness, implementation
- Benefits can be broadened

**Methodology**
- Criteria since 2000, high school focus
- 8-10 studies cited
- 3 key practices: interdisciplinary

**The Right Foot**
- "Imp" vs. "gender": an attribution issue
- Mental models and stereotype threat
- Identity, self-concept, self-efficacy

**The Paper**
- More studies and in greater detail
- Suggestions for concrete actions
- Possible directions for future research

**Acknowledgments**

**Contact Info**

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Skills to Emphasize

**Develop Spatial Skills**
- Improving spatial skills through targeted training
- Improved retention of engineering students
- Females 75% to 98%, males 85% to 92%
- Spatial skills are multidimensional
- 2-hour lecture, 1-hour workshop

**Emphasize Communication**
- Scoring highly on English negatively impacts a student's self-composed math ability
- Conditional effect: stronger for females

**Clarity in Grading Policies**
- Teachers have biased self-assessments
- Despite performing higher in science exams, girls received lower grades on the same assignments

**Re-evaluate Group Work Practices**
- Engineering tasks were more likely than other groups to draw negative conclusions about self-facilitating behaviors

Scaffolding to Implement

**A Foundation in Calculus**
- The positive effect of calculus on the likelihood of choosing a quantitative major is greater for girls than boys
- Women had lower performance in advanced calculus courses

**Demonstrate and Encourage Resilience**
- The more women perceived inclusivity in the environment, the more they maintained a sense of belonging to math
- Women, Rattan, Dewey, 2013

**Active Expert Roles**
- Mastery experiences significantly predicted self-efficacy

**Scaffolding**
- Integrate the above activities into curricula

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Thank you.