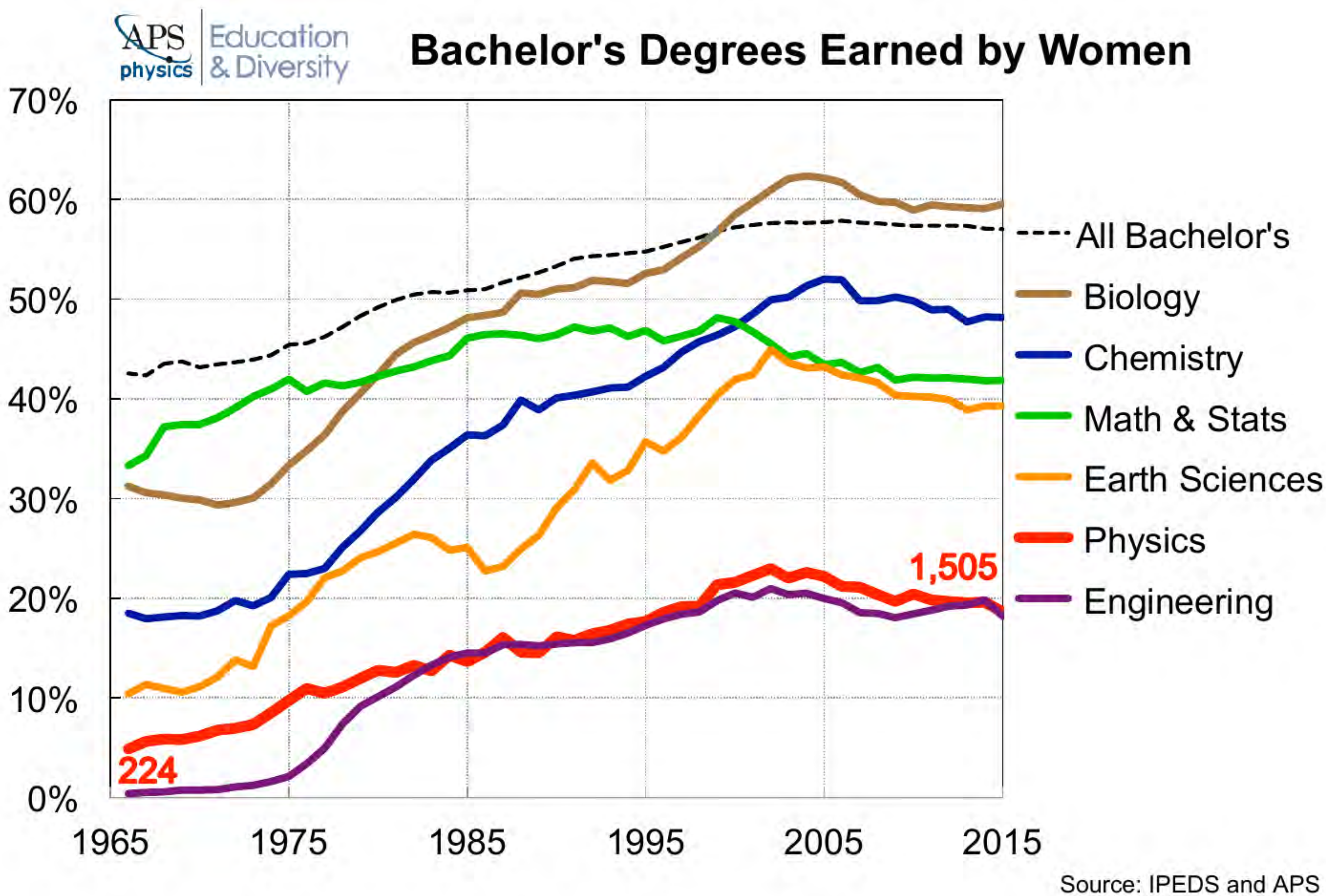
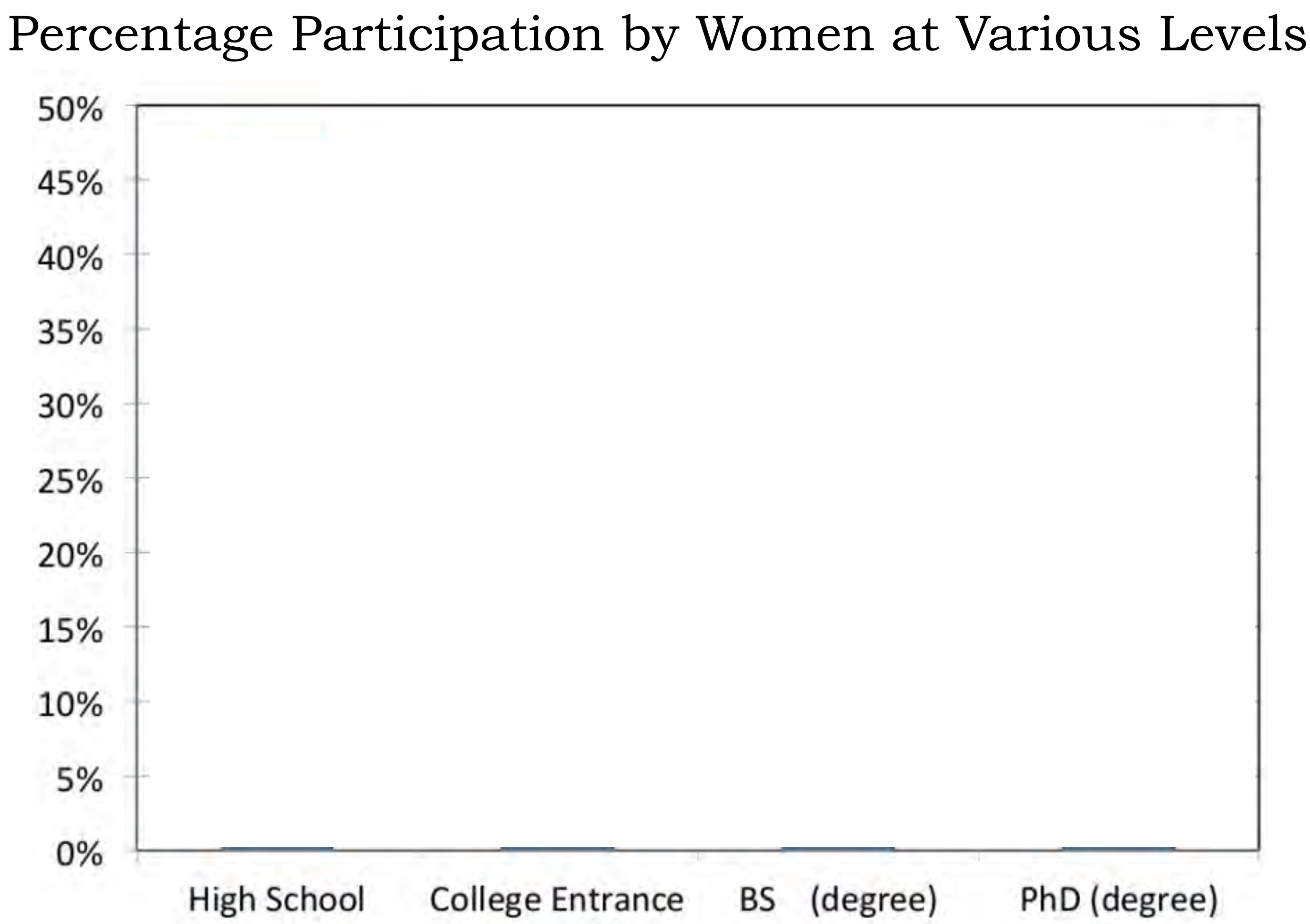
Supporting Teachers to Encourage the Pursuit of Undergraduate Physics for Women

Zahra Hazari
Florida International University
Dept. of Physics Colloquium, Jan. 26th, 2018

Women’s Representation in STEM



When does this difference emerge?



(Hodapp & Hazari, 2015)

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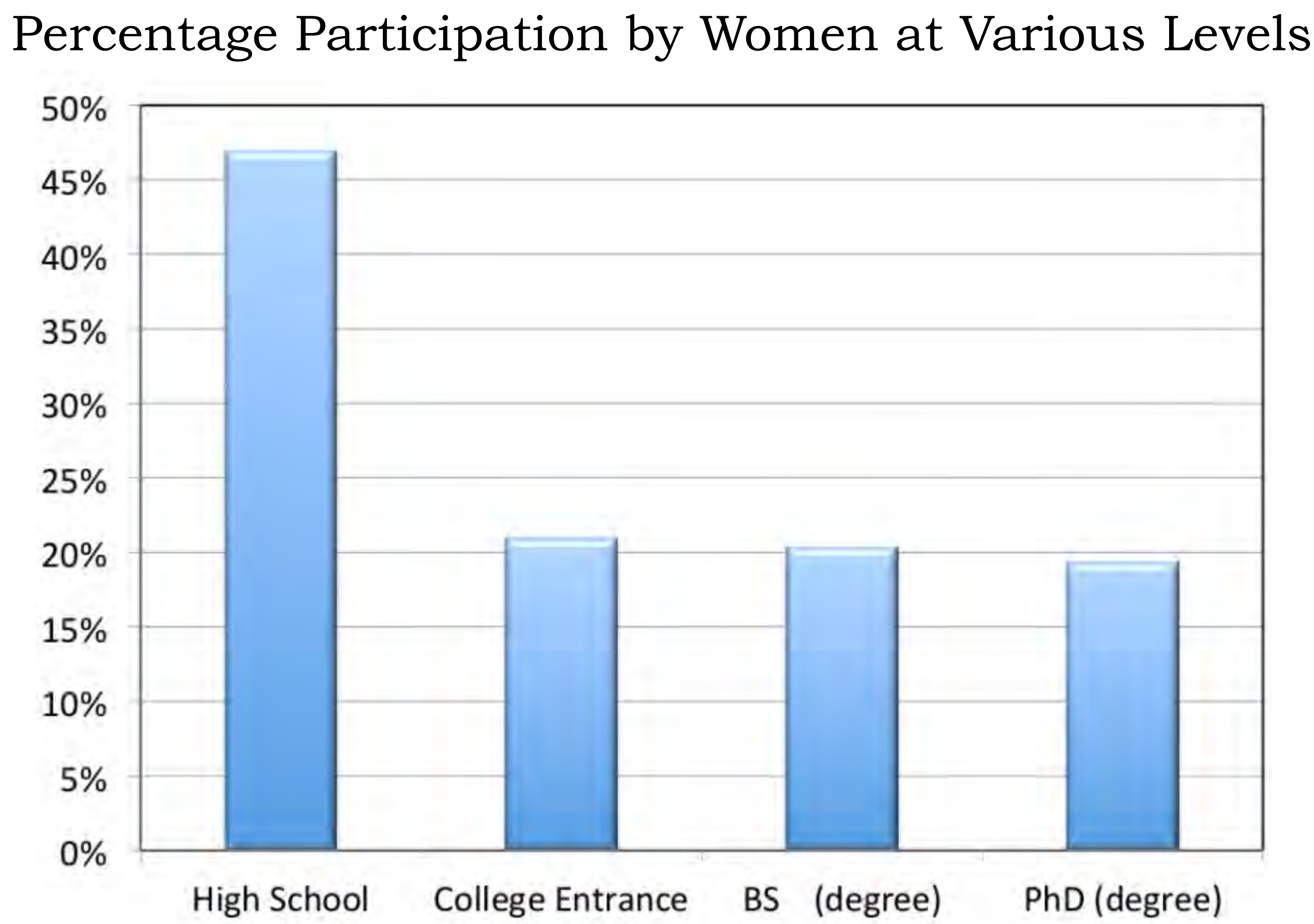
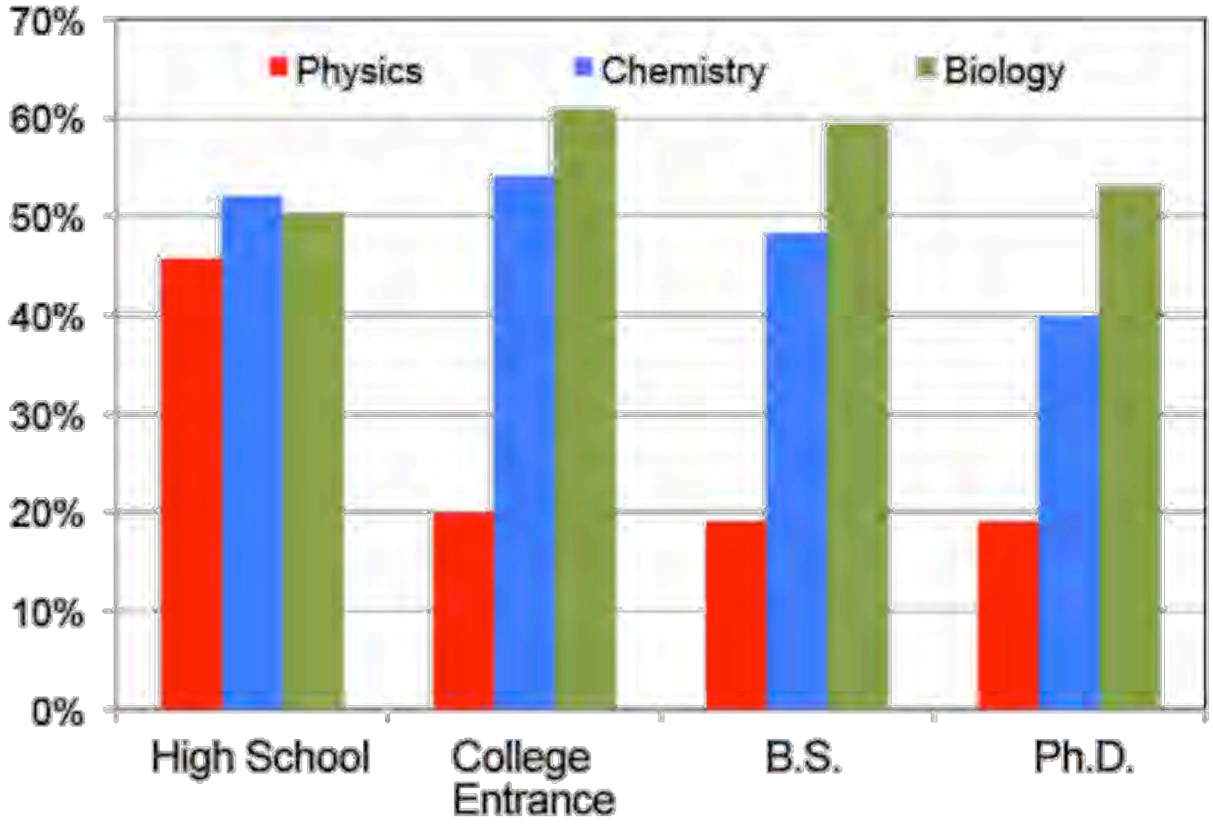


(Hodapp & Hazari, 2015)

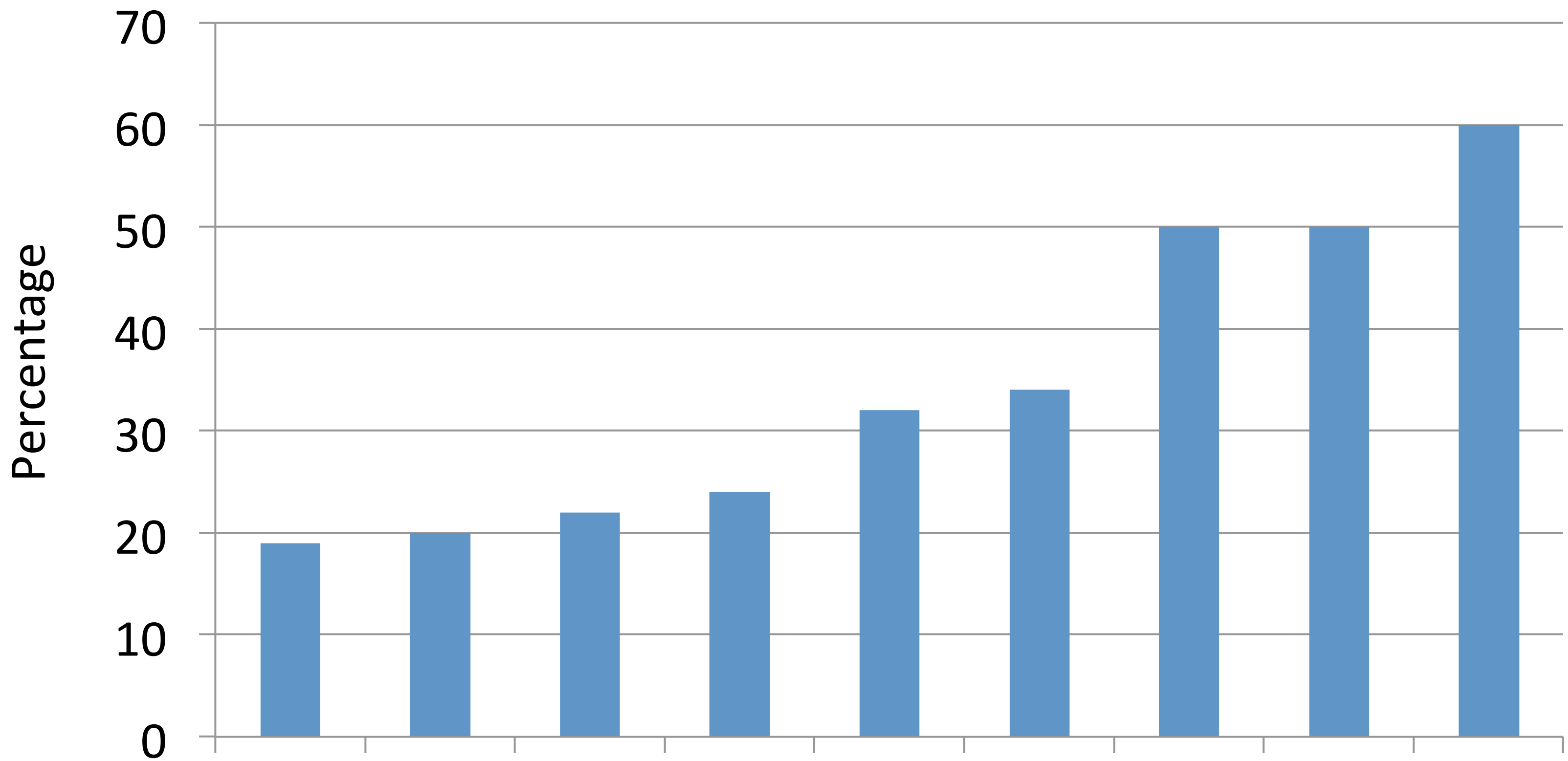
Compared to Other Sciences

Percentage Participation by Women at Various Levels by Field



What about other countries?

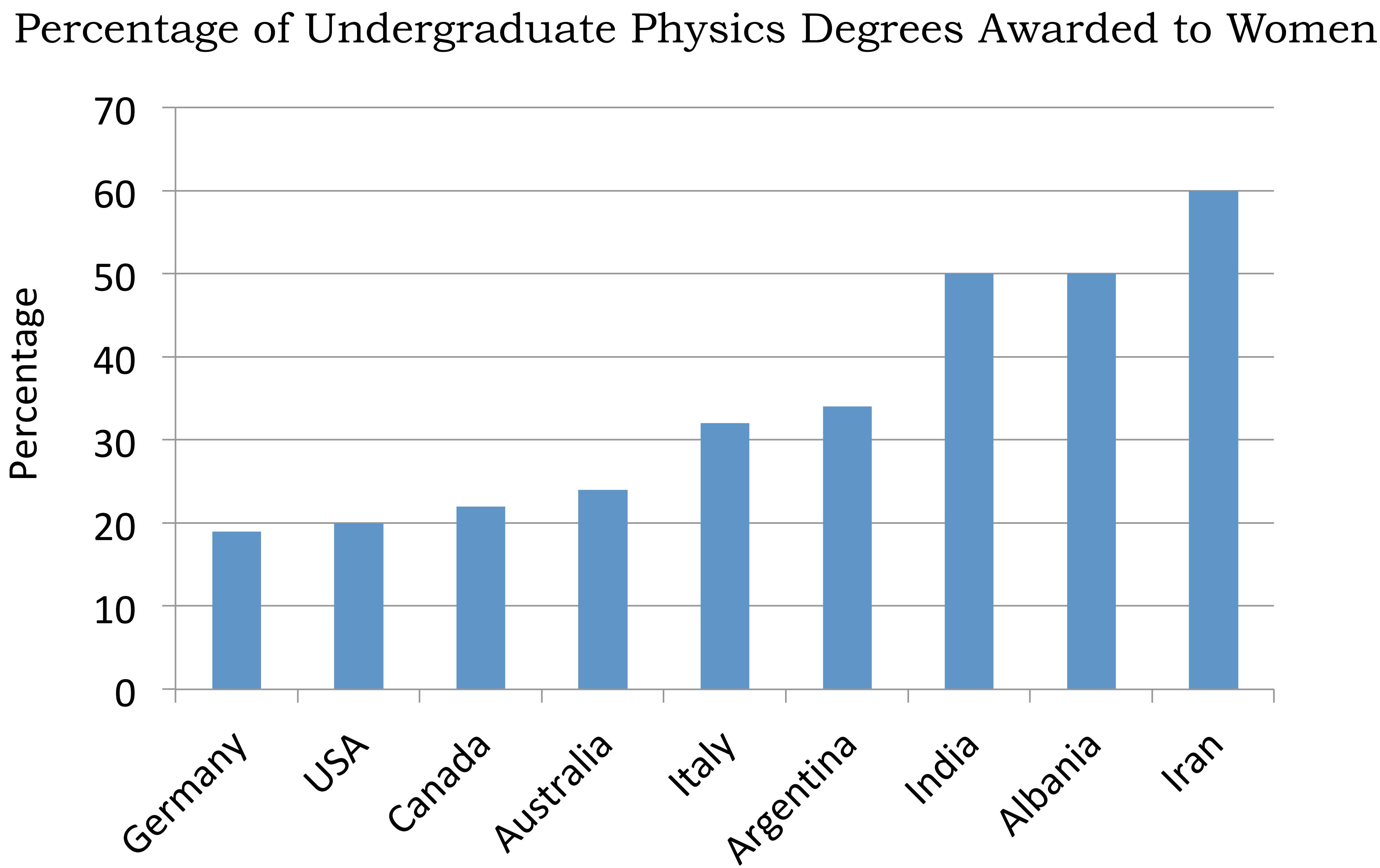
Percentage of Undergraduate Physics Degrees Awarded to Women



A: Germany **B:** India **C:** Iran **D:** USA

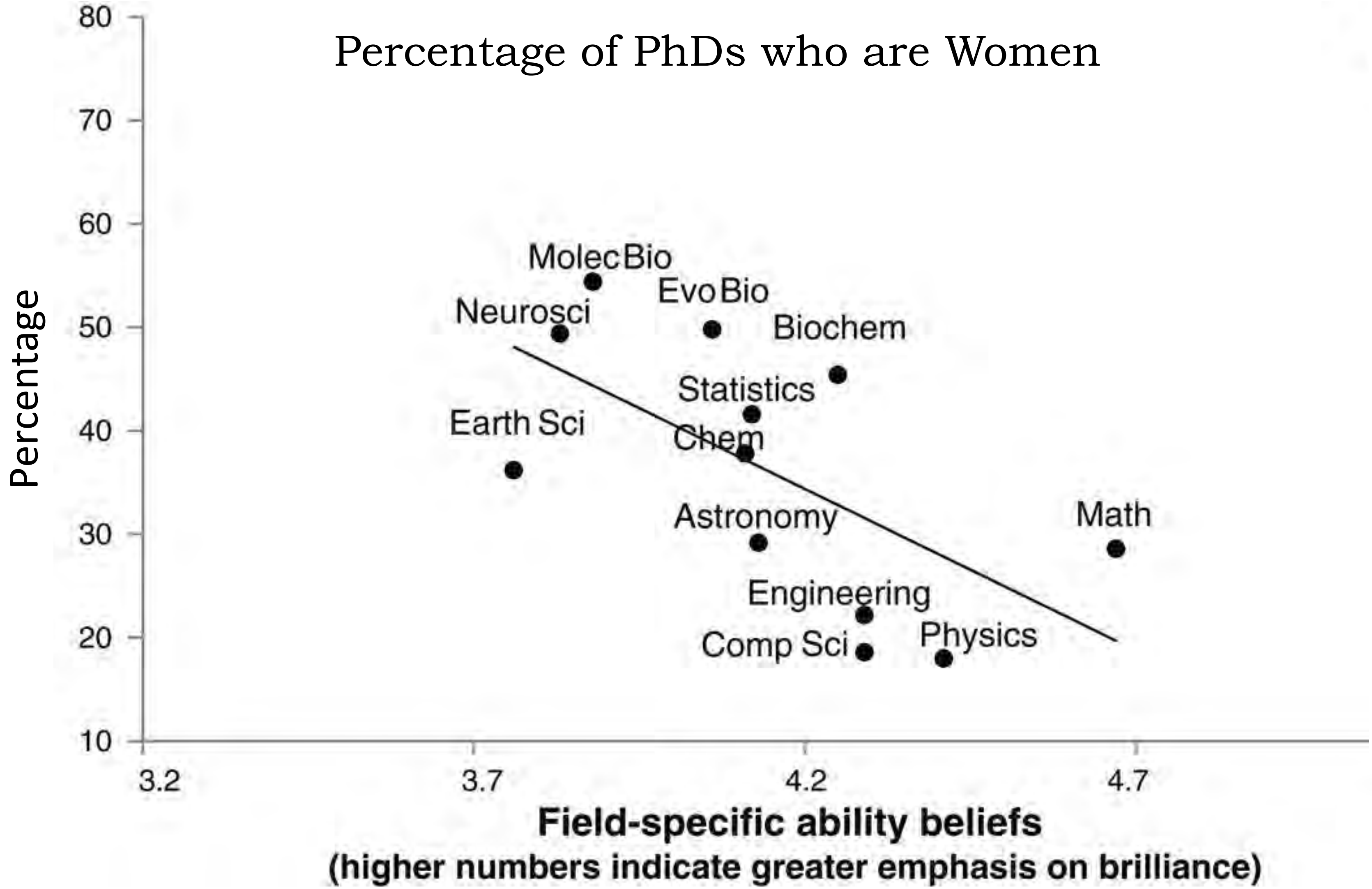
(IUPAP International Conference on Women in Physics Proceedings, 2005-2013)

What about other countries?



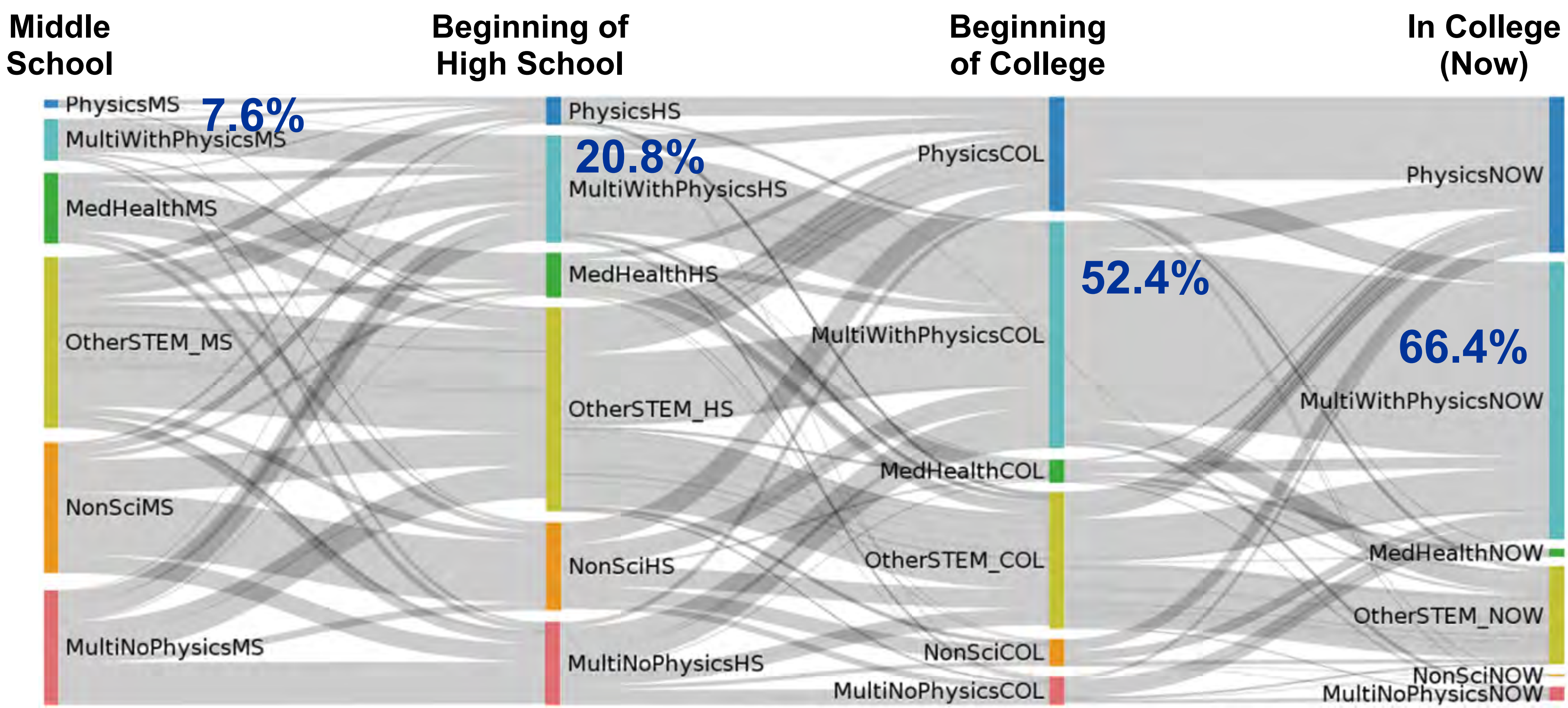
(IUPAP International Conference on Women in Physics Proceedings, 2005-2013)

What are some of the cultural issues?



(Leslie et al., 2015)

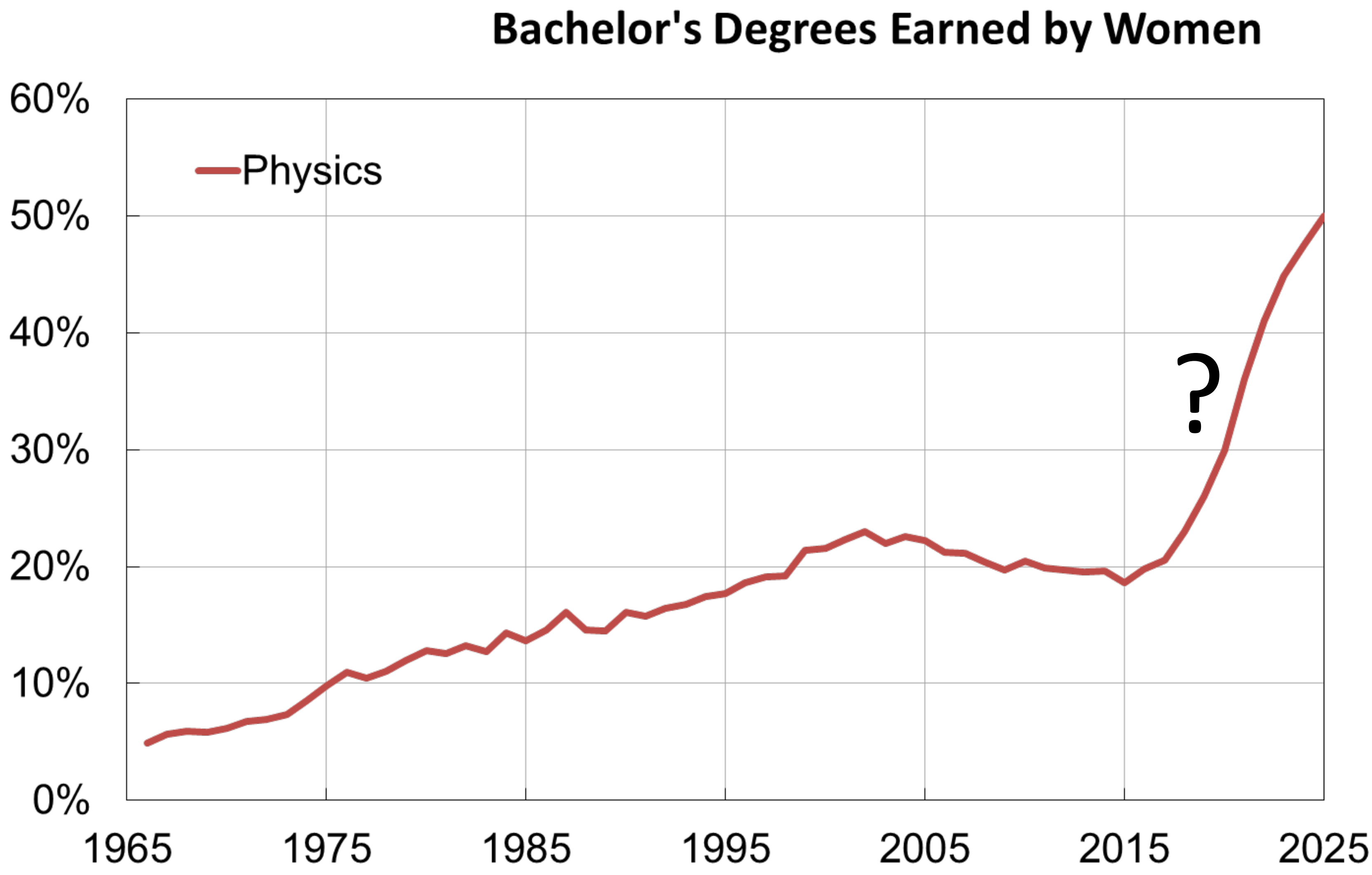
Why focus on high school?



- 962 women physics majors
- Most were attracted to physics in high school

(Hazari, Brewe, Goertzen, & Hodapp, 2017)

STEP UP 4 Women Project Goal



STEP UP 4 Women Project

- More than 1.3 million students taking physics
  - 47% are women (635,000 in 2009)
- ~27,000 high school physics teachers
- Need ~18,000 for equal representation entering as physics majors
  - Already have ~4500 entering now
  - Need ~13,500 additional

If half of the teachers recruit one additional female student to a physics major, the incoming college gap will be closed

(HERI, 2017; Mulvey & Nicholson, 2015; White & Tesfaye, 2011; White & Tyler, 2014)

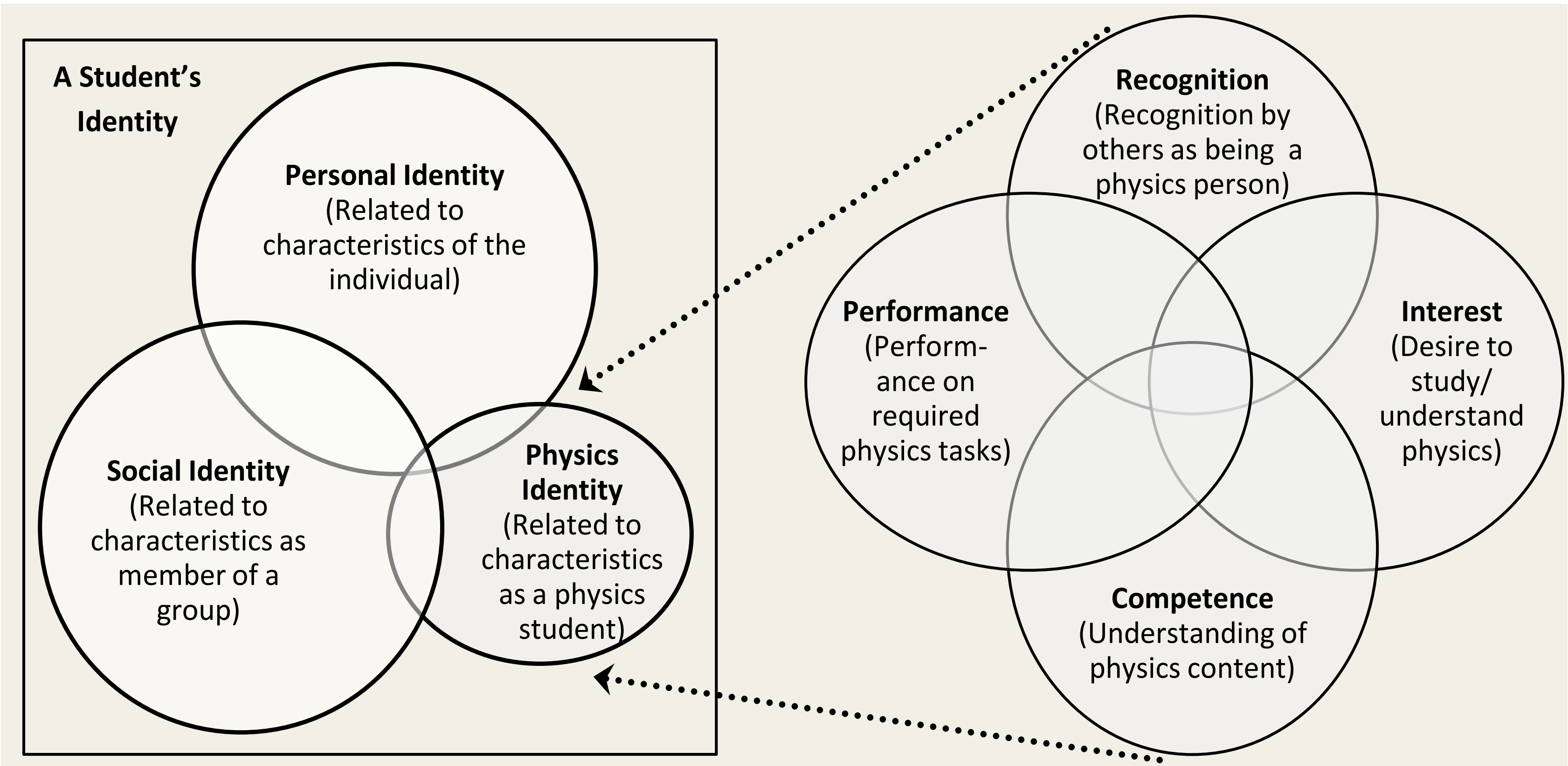
Framework: Why Identity?

- Physics/science identity has been found to be predictive of:
  - Physics/science achievement
  - Physics/science persistence

Physics Identity – How students see themselves with respect to physics which evolves with their perceptions and navigation of experiences with physics

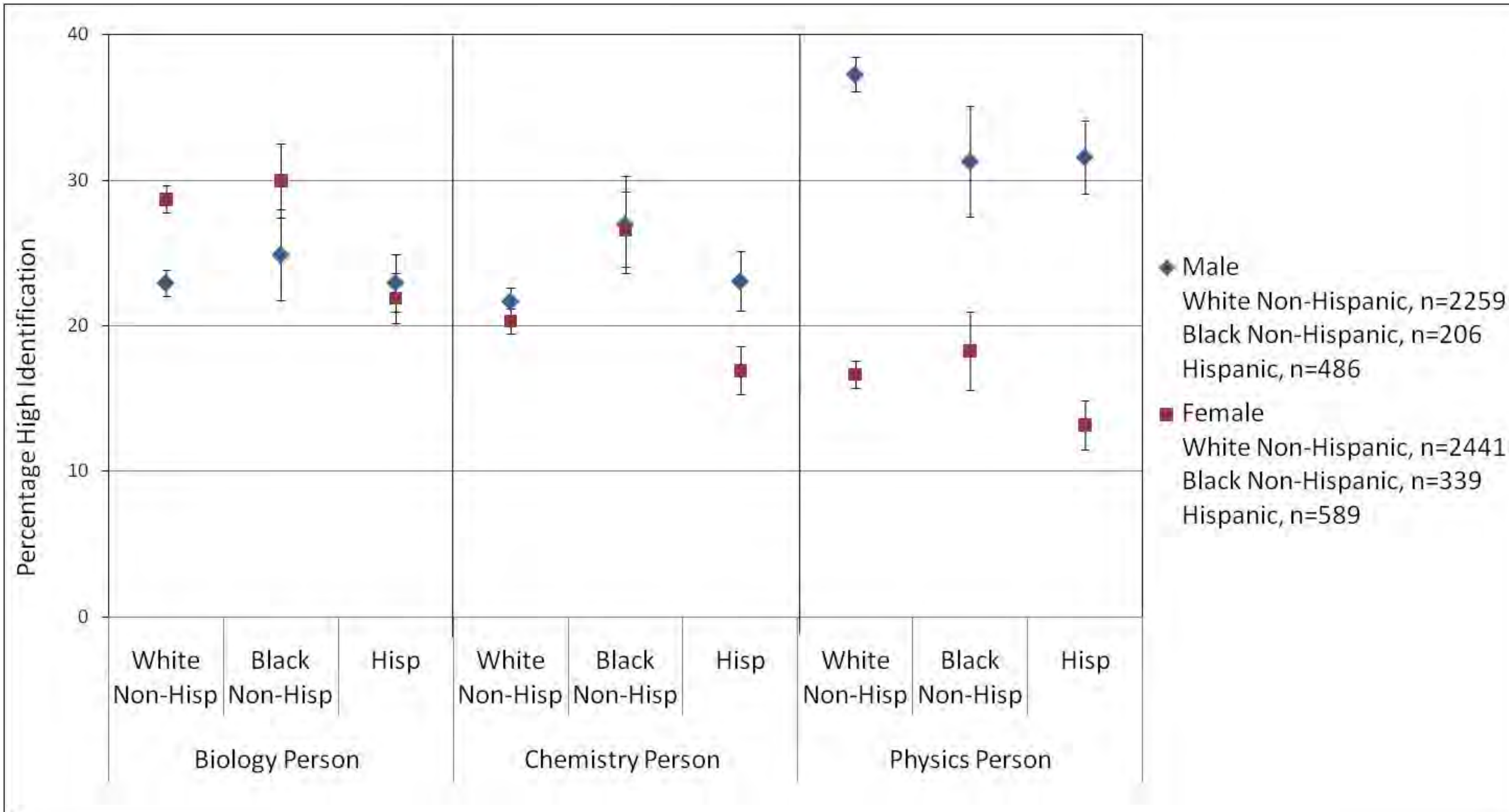
(Aschbacher et al., 2010; Basu, 2008; Barton & Tan, 2009; Carlone & Johnson, 2007; Gilmartin et al., 2007; Hazari et al., 2010; Olitsky, 2007; Shanahan, 2009)

Framework: Physics Identity



(Carlone & Johnson, 2007; Hazari et al., 2010)

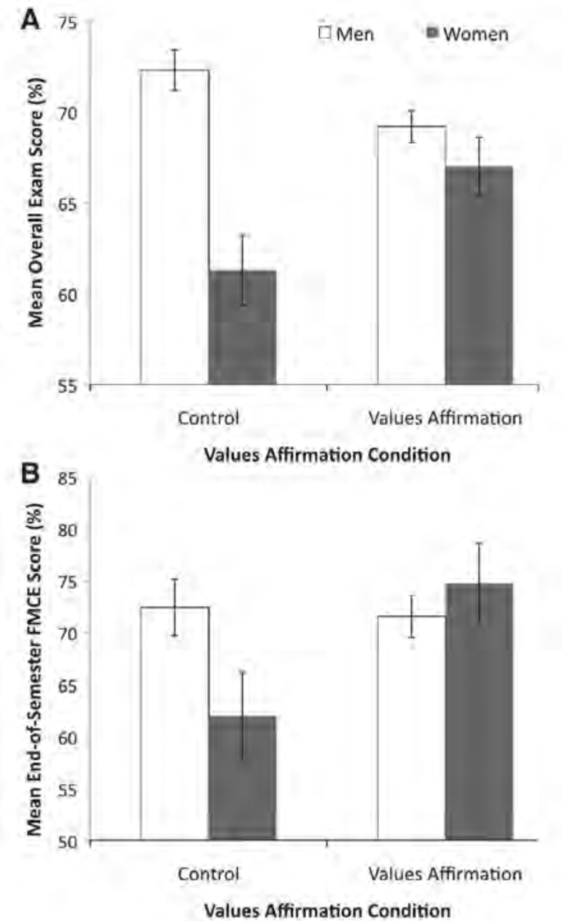
Is identity an issue for women?



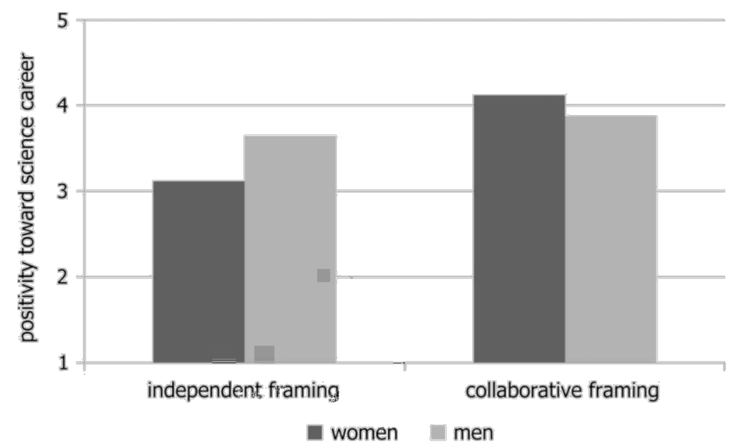
(Hazari et al., 2014)

What might help?

- Values Affirmation



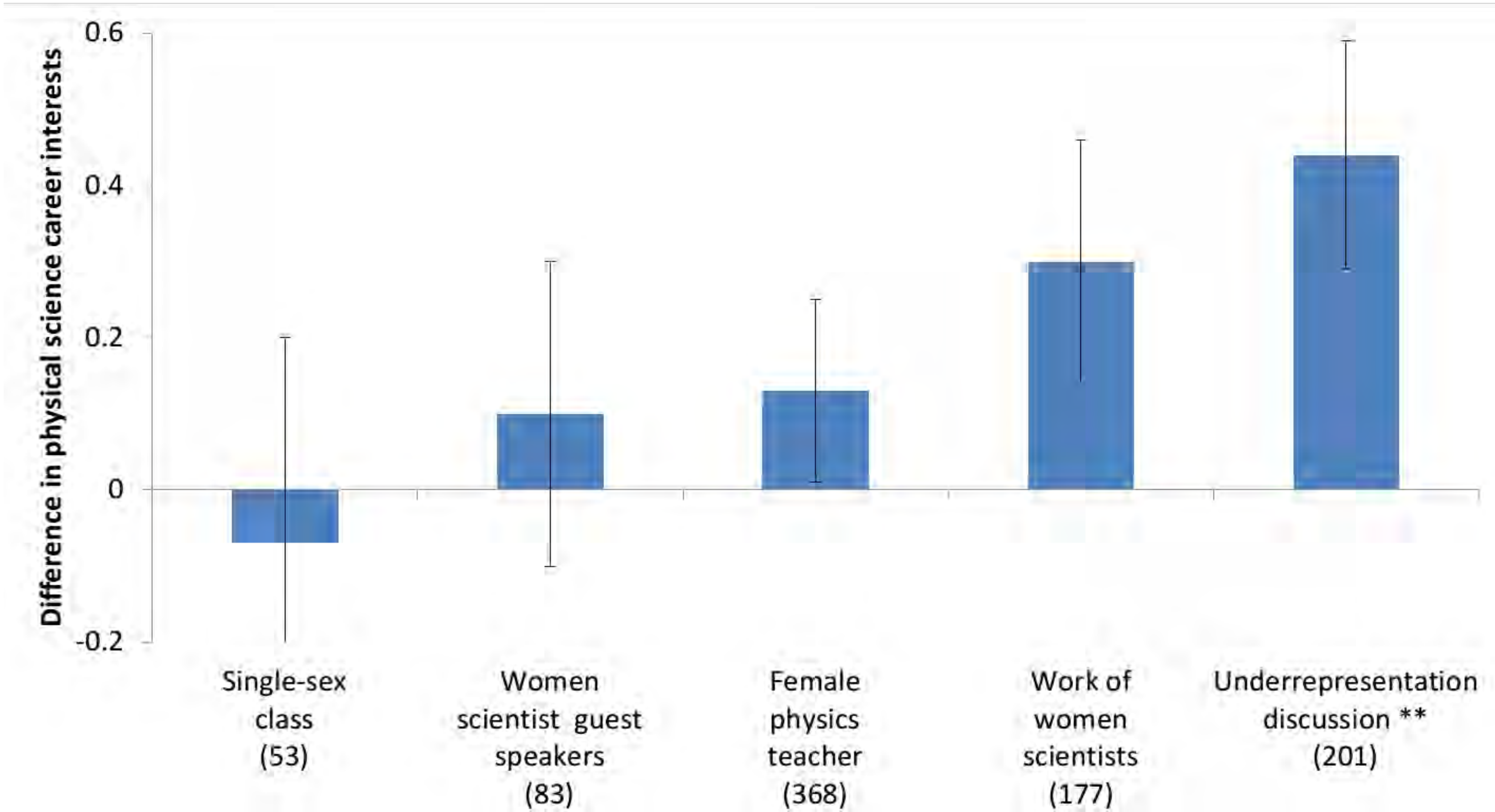
- Communal Goals



(Diekman et al., 2010; Diekman et al., 2011; Hazari et al., 2010; Miyake et al., 2010)

What might help in high school?

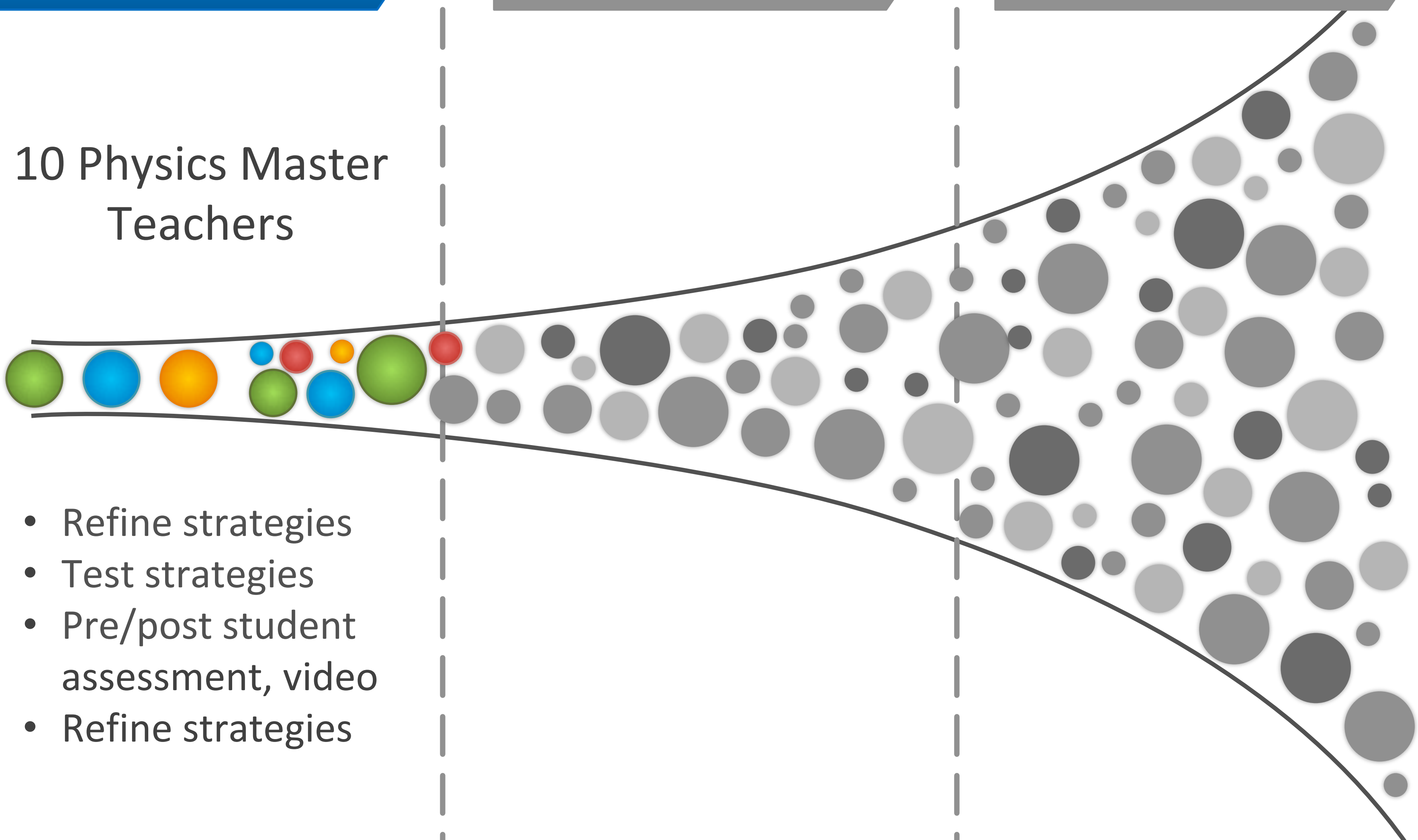
- Importance of Discussion



(Hazari et al., 2013; Lock & Hazari, 2016)

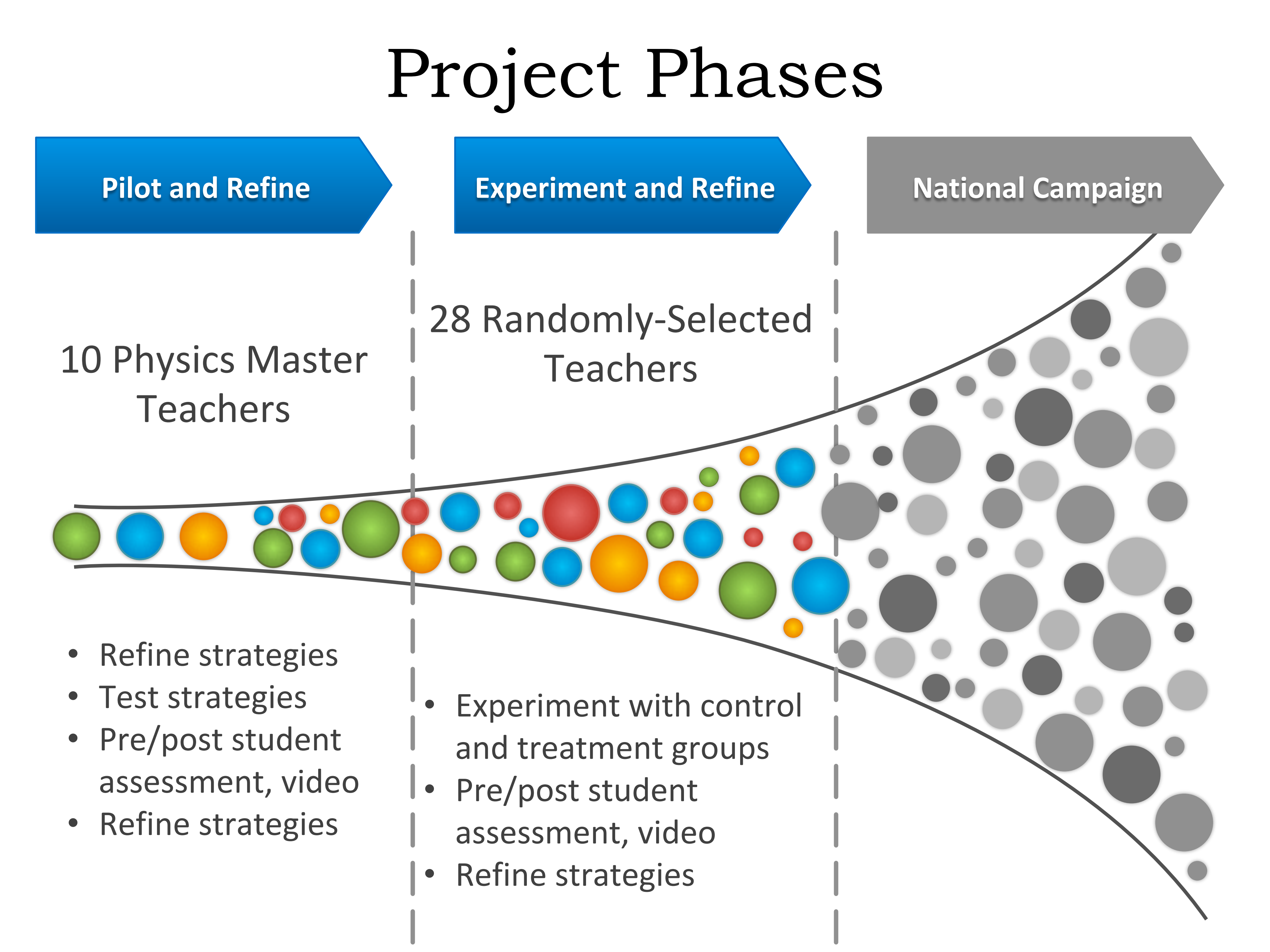
Project Phases

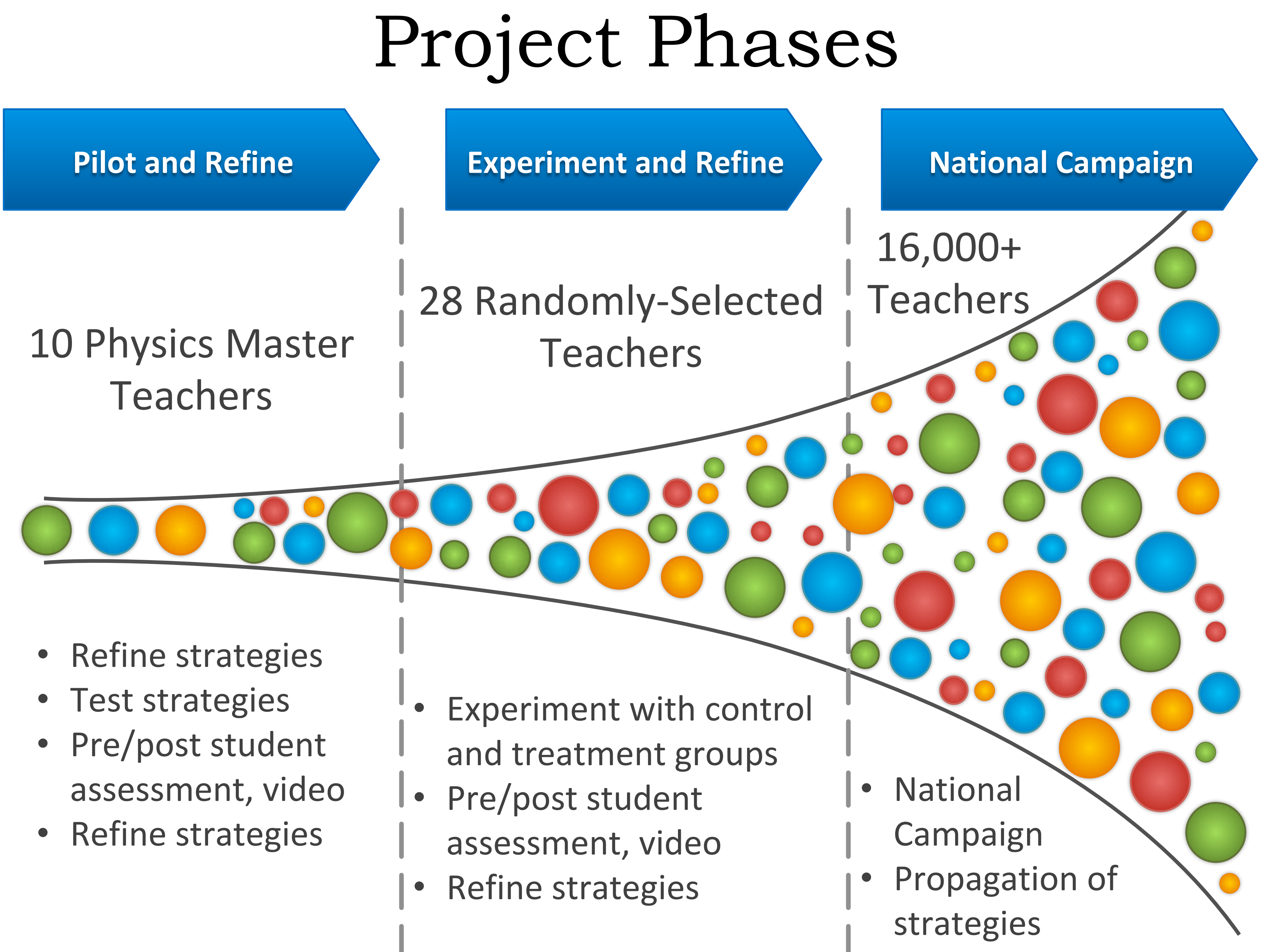
Pilot and Refine | **Experiment and Refine** | **National Campaign**



10 Physics Master Teachers

- Refine strategies
- Test strategies
- Pre/post student assessment, video
- Refine strategies


Project Phases
Pilot and Refine
Experiment and Refine
National Campaign
10 Physics Master Teachers
28 Randomly-Selected Teachers
• Refine strategies
• Test strategies
• Pre/post student assessment, video
• Refine strategies
• Experiment with control and treatment groups
• Pre/post student assessment, video
• Refine strategies



Project Phases
Pilot and Refine
Experiment and Refine
National Campaign
10 Physics Master Teachers
28 Randomly-Selected Teachers
16,000+ Teachers
• Refine strategies
• Test strategies
• Pre/post student assessment, video
• Refine strategies
• Experiment with control and treatment groups
• Pre/post student assessment, video
• Refine strategies
• National Campaign
• Propagation of strategies

What are the strategies?

- General Classroom Strategies
  - Focus on Explicit Recruitment, Reducing Marginalization, and Promoting Recognition

(Carlone, 2004; Danielsson, 2012; Dar-Nimrod & Heine, 2006; Dasgupta et al., 2015; Diekman, Brown, Johnston, & Clark, 2010; Gonsalves, 2014; Gonsalves, Danielsson, & Pettersson, 2016; Gonsalves, Rahm, & Carvalho, 2013; Haussler & Hoffmann, 2002; Hazari et al., 2013; Lock & Hazari, 2016; Potvin & Hazari, 2013; Stadler, Duit, Benke, 2000)

How will they help?

Physics identity development is impeded because female students:

- Have lower physics self-efficacy, feelings of competency
- Are often marginalized in group work and/or discussions
- Are less recognized in physics classes
- Experience stereotype threat, implicit and explicit bias
- Have communal goals not associated with physics
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- General Classroom Strategies
  - Focus on Explicit Recruitment, Reducing Marginalization, and Promoting Recognition
- Intervention 1 – Career Exploration Lesson
  - Focuses on Values Affirmation and Communal Goals

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- General Classroom Strategies
  - Focus on Explicit Recruitment, Reducing Marginalization, and Promoting Recognition
- Intervention 1 – Career Exploration Lesson
  - Focuses on Value Affirmation and Communal Goals
- Intervention 2 – Underrepresentation Lesson
  - Focuses on Discussion of Implicit Bias, Stereotypes, and Countering Myths

(Carlone, 2004; Carlone & Johnson, 2007; Carlone, Johnson, & Scott, 2015; Cohen et al., 2006; Cohen et al., 2009; Danielsson, 2012; Dar-Nimrod & Heine, 2006; Dasgupta et al., 2015; Diekman, Brown, Johnston, & Clark, 2010; Gonsalves, 2014; Gonsalves, Danielsson, & Pettersson, 2016; Gonsalves, Rahm, & Carvalho, 2013; Haussler & Hoffmann, 2002; Hazari et al., 2013; Johnson, 2007; Johnson et al., 2011; Lock & Hazari, 2016; Miyake et al., 2010; Potvin & Hazari, 2013; Stadler, Duit, Benke, 2000; Walton & Cohen, 2011; Weisgram & Bigler, 2007)

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Please Join the Movement!

Mobilize your local high school physics teacher to join

Mobilize other undergraduate students, graduate students, and faculty to reach out to their high school teachers to join

Sign up to be a part of the network:

www.stepup4women.org

STEP UP 4 WOMEN

Thank You!

$e=mc^2$
MEXIQUE
CUBA
CENTRALE
COLOMBIE
VENEZUELA
Caracas
Bogota
Panama
Quito
Guayaquil
Cuenca
Galapagos
Trujillo
EQUATEUR

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Prior research findings

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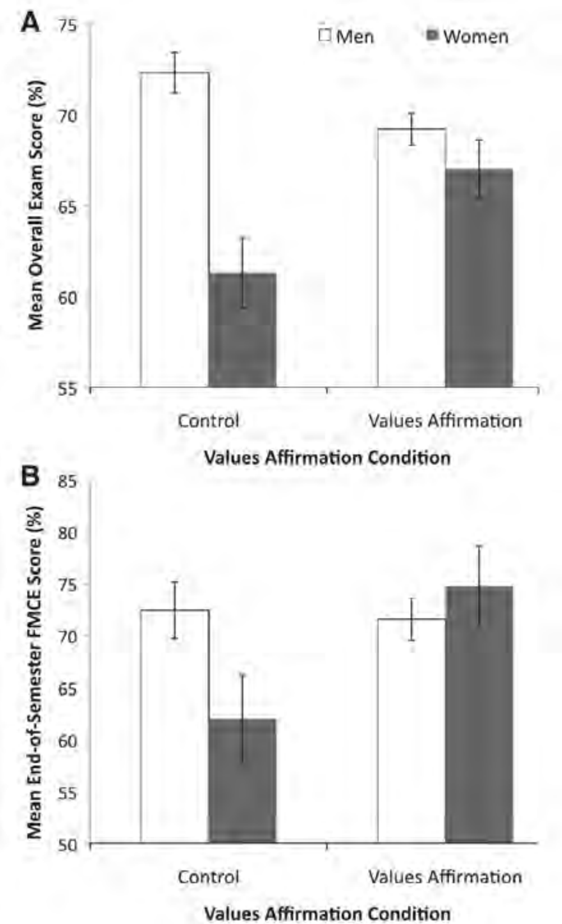
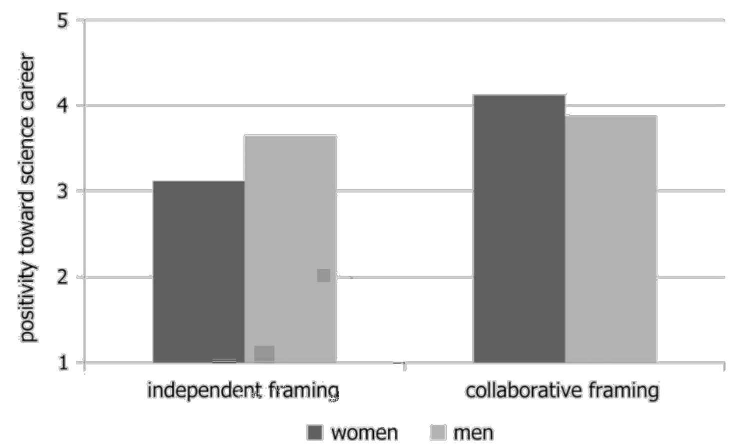
Prior research findings

- Values Affirmation



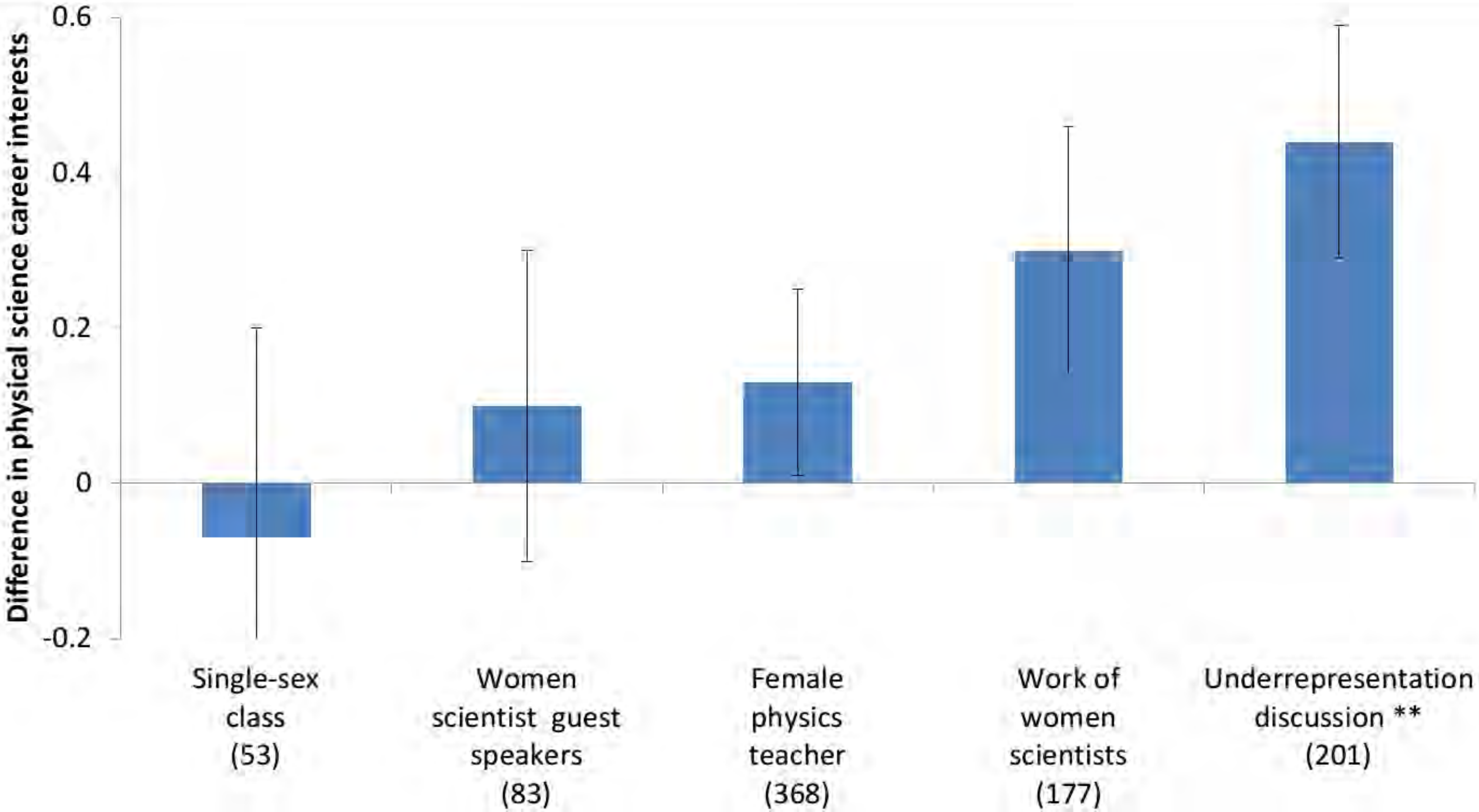
- Communal Goals



(Diekman et al., 2010; Diekman et al., 2011; Hazari et al., 2010; Miyake et al., 2010)

Prior research findings

- Importance of Discussion



(Hazari et al., 2013; Lock & Hazari, 2016)

General Strategies

- Direct recruiting
  - Rationale: Self-efficacy is lower for female students; implicit strategies may not be effective
- Reducing marginalization
  - Rationale: Stereotype threat, unconscious bias, and unsupportive environments experienced by female students
- Recognizing female students
  - Rationale: Recognition is the most important factor for physics identity development; women are less recognized than men

(Carlone, 2004; Carlone & Johnson, 2007; Carlone, Johnson, & Scott, 2015; Danielsson, 2012; Dar-Nimrod & Heine, 2006; Dasgupta et al., 2015; Haussler & Hoffmann, 2002; Johnson, 2007; Johnson et al., 2011; Potvin & Hazari, 2013; Stadler, Duit, Benke, 2000)

Career Exploration Lesson

- Goals – Students will
  - Reflect on their own career goals/values
  - Explore a breadth of physics career profiles, focusing on those that match their own goals/values
  - Discuss the skills of physicists that are transferable to many careers (e.g. medicine, climate science, arts, business)
  - Create their own career profile envisioning how a physics degree could help them achieve their goals

(Cohen et al., 2006; Cohen et al., 2009; Diekman et al., 2010; Diekman et al., 2011; Kessels, Rau, & Hannover, 2006; Miyake et al., 2010; Stadler, Duit, Benke, 2000; Walton & Cohen, 2011)

Underrepresentation Lesson

- Goals – Students will
  - Examine the conditions for women in physics through an interactive presentation of statistics and prior research
  - Engage in a discussion about gender issues drawing on their experiences with respect to famous physicists, gendered professions, and personal interactions
  - Propose and assess strategies that could be used to support women in physics

(Danielsson, 2012; Dar-Nimrod & Heine, 2006; Gonsalves, 2014; Gonsalves, Danielsson, & Pettersson, 2016; Gonsalves, Rahm, & Carvalho, 2013; Hazari et al., 2013; Lock & Hazari, 2016; Weisgram & Bigler, 2007)

National Campaign

- Strategies for Propagation
  - "Train the trainer" workshops for regional teacher leaders
  - Teacher workshops and webinars
  - Workshops for undergraduate students to mobilize teachers (through CUWiP and SPS Chapters)
  - Mass communication of campaign and modules through teacher networks and social media

NSF #1720810, 1720869, 1720917, and 1721021

Why High School?

- High school is the most strategic time point:
  - Most women physicists and physics undergraduates become interested in high school
  - Compared to elementary school, teachers have more content knowledge and confidence, more vested in physics
  - Compared to elementary/middle school, students are closer to decision-making time point
  - Compared to college, smaller classes and more time to build relationships

(Eagan et al., 2017; Hazari, Brewe, Goertzen, Hodapp, 2017; Ivie & Guo, 2006; Yilmaz-Tuzun, 2007)