

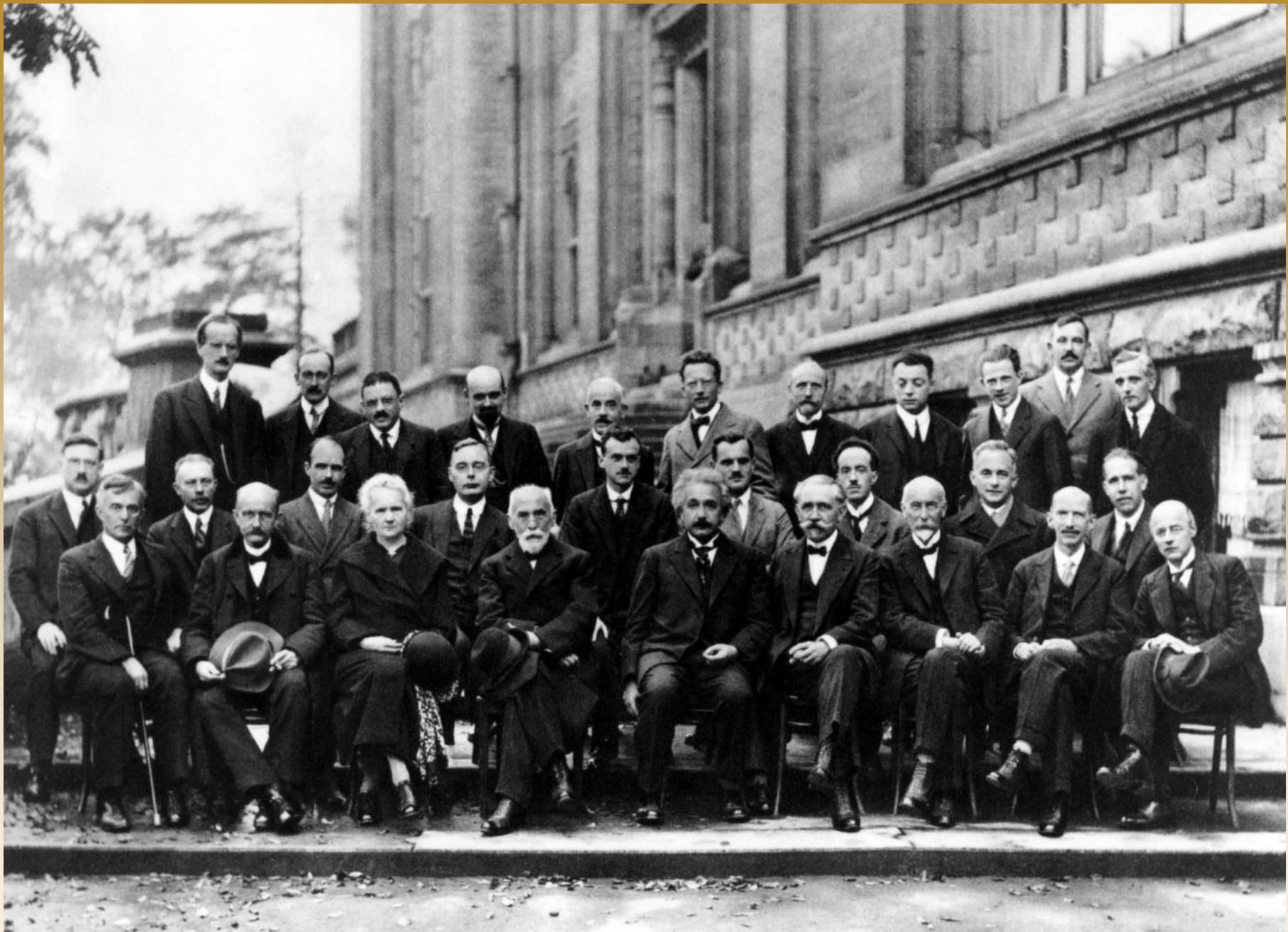
How to Enhance STEM by Making it Inclusive



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Solvay conference, 1927



Aguilar, Walton & Wieman, 2014
Photograph by Ken Cole

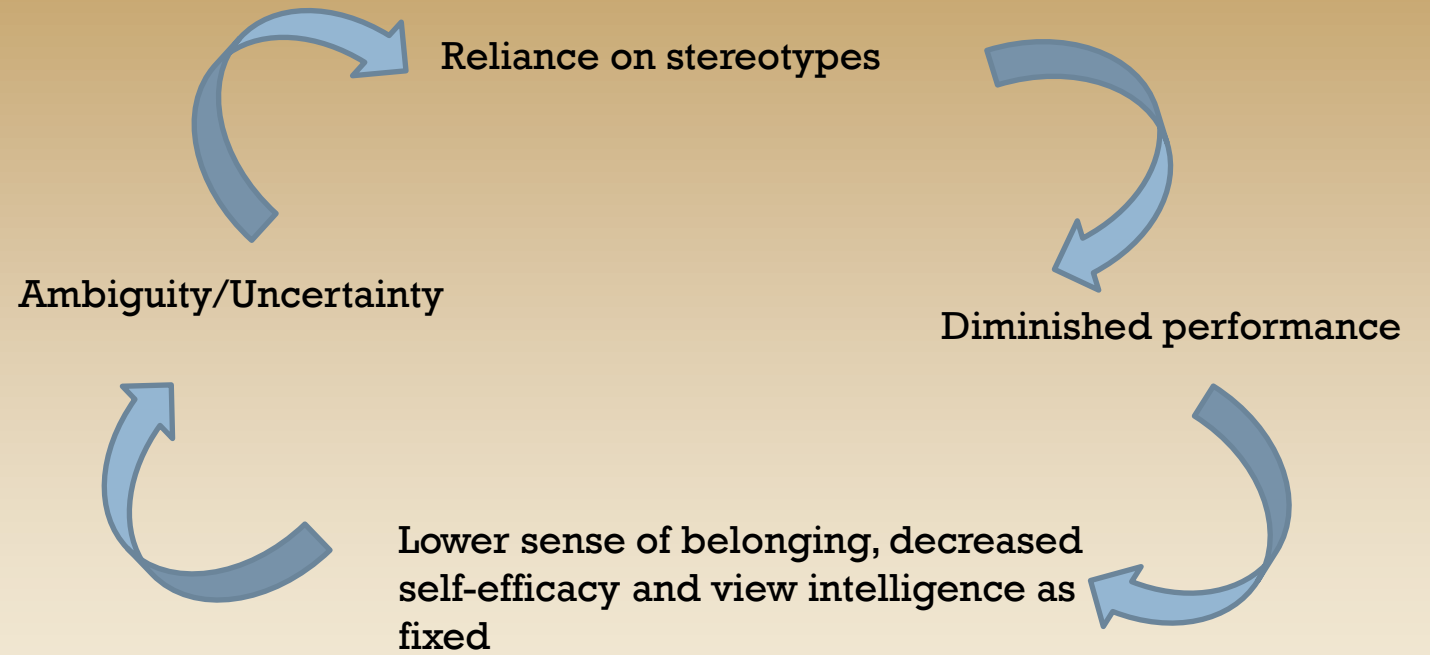
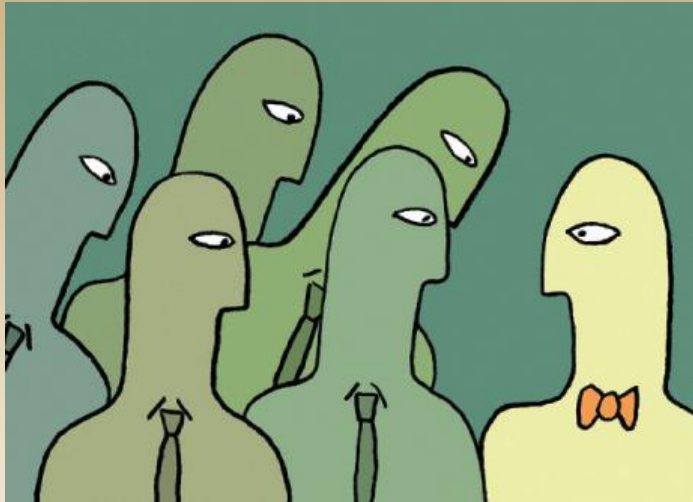
- ***How does your classroom look to a student sitting at a desk in the third row?***
- ***Can it increase some student's anxiety about being in the class?***
- ***How might some students feel about their potential in the course? Can a student's gender or race affect how they feel?***
- ***What do you as an instructor do to empower your students to embrace their struggle and use them as a learning opportunity in a low anxiety learning environment?***

- Stereotype threat – fear of confirming a negative stereotype about oneself (associating yourself to a group, e.g., women or racial/ethnic minorities in a discipline)
 - Awareness of stereotypes is taxing, takes cognitive resources, hurts performance
 - Demotivating (“I am struggling because I am not as good as other people, What’s the use of trying if people like me aren’t likely to be successful?”)



- *Professor Smith is concerned about the high failure rate in his introductory course. To encourage students to work harder, he starts the first class by telling the students how difficult the course is and that usually about 25% of the students fail. They must be careful particularly if they think that their background preparation is weak.*

Adapted from Aguilar, Walton &
Wieman, 2014



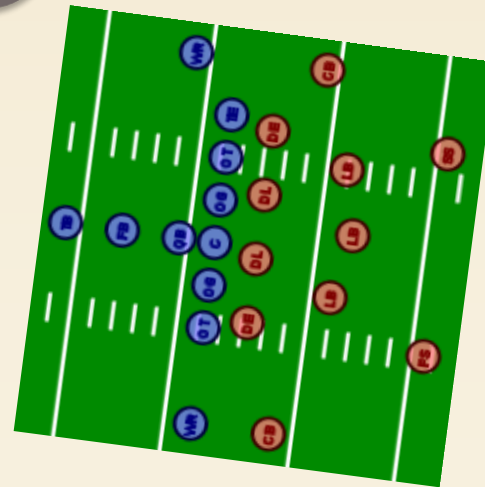
“Defense”

Belonging
Identity
Intelligence mindset
Self-efficacy
Interest
Achievement goals



“Offense”

Efficient problem solving
effective problem-solving
skills
transfer of learning
robust understanding



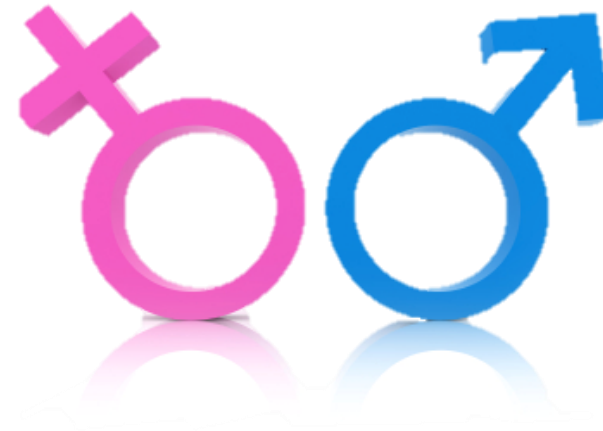


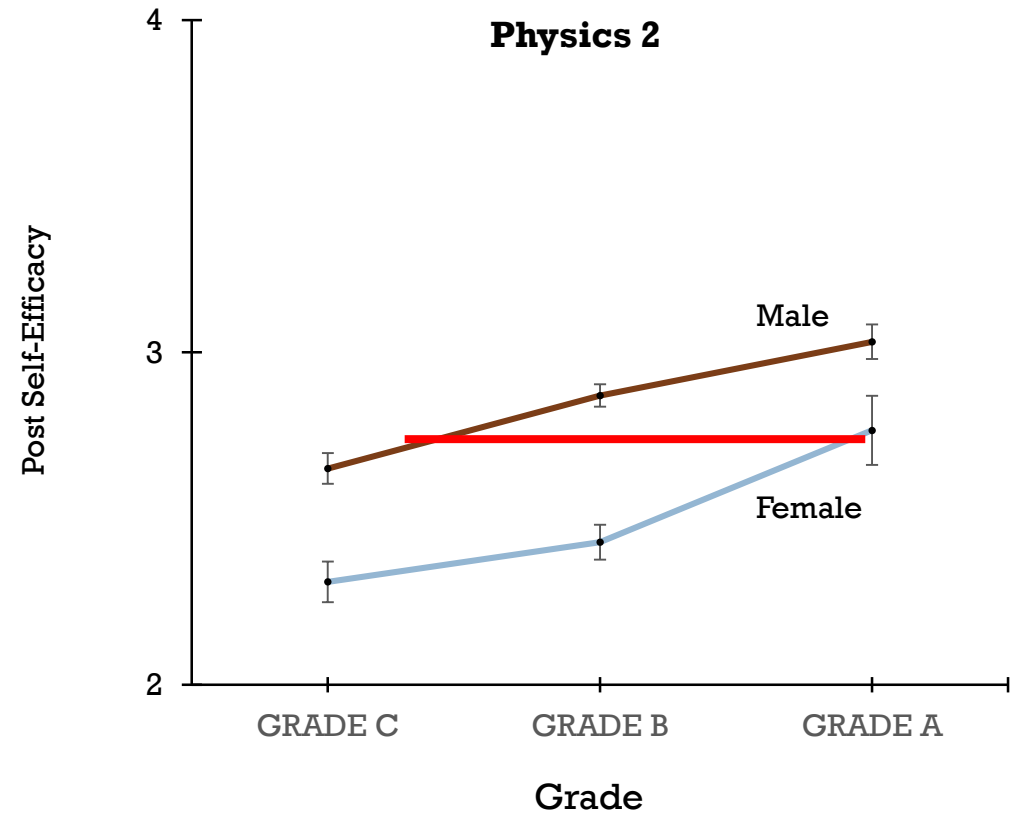
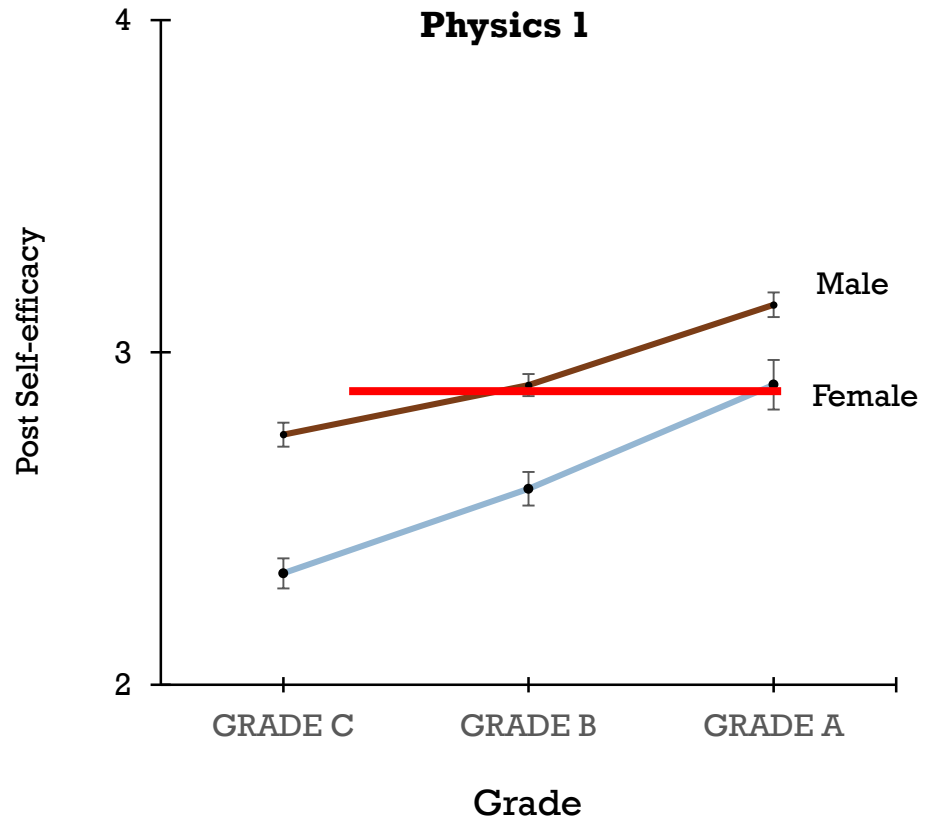
Self-efficacy

- Belief in one's capability to succeed in a particular task, course or subject area [Bandura, 1974]
- Can impact students' persistence and engagement [Zimmerman, 2000]
- Can affect science course performance even after controlling for prior knowledge and skills [Pajares and Miller, 1994]
- Can impact time on task
- Can impact the effectiveness with which students engage with learning
- Feedback loop

Self-efficacy and gender in physics

- On average, women have lower self-efficacy than men in physics and other STEM domains
- Prior work has focused on gender differences in learning outcomes and / or self-efficacy [Hazari et al, Marshman et al]
- Do gender differences in self-efficacy exist at ***MATCHED*** performance levels?





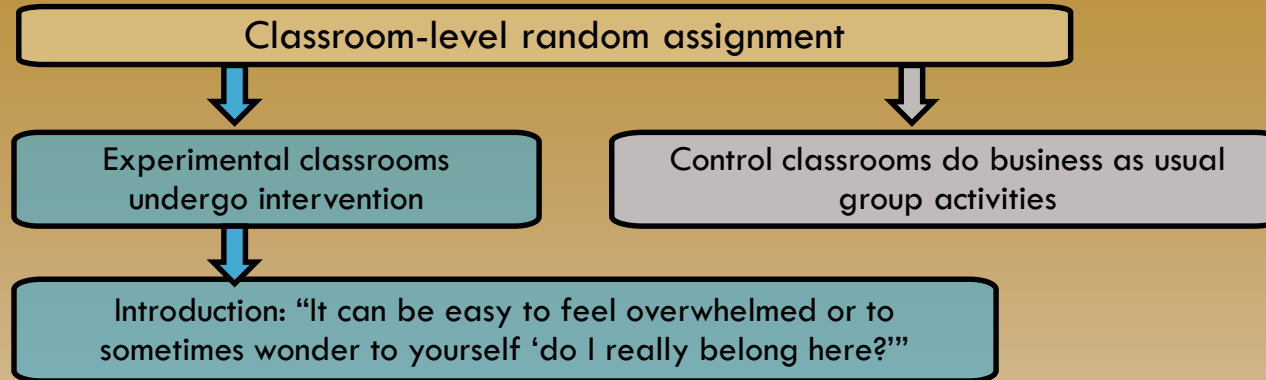
I have pretty low self-confidence when I see how other people are so smart. Other people understand more than I do what is going on in the physics courses ... I feel like I have to work a lot harder to understand something.

For physics I feel like I don't connect things well enough when we get a hard problem, I don't have enough confidence that I'll be able to do it, it makes me nervous.

I don't feel comfortable in this class, physics gives me a sinking feeling, it kinda scares me. I compare myself to other people; it feels like I don't belong in this physics course.

Belonging and Mindset Intervention

- We incorporated a social-belonging and mindset activity in calculus-based introductory physics courses
- ~25 minute activity done in the second recitation
 - 3 instructors participated
 - 6 recitations participated in the activity
- Struggling is the only way to learn something new
 - Be proud of struggling since that means that you are already on your way to learning something new
 - Be proud of doing challenging problems and pat yourself on the back
 - Facilitator talks about their own struggle
- By reducing anxiety, reduce procrastination, increase enthusiasm for solving challenging problems and ensure that limited cognitive resources are used for problem solving not anxiety



Activity Message

...It can be easy to feel overwhelmed and to ask yourself, “Do I really belong here?” and “Am I smart enough to make it?” These kinds of experiences are normal in the transition to college. Almost everyone goes through them, and they get better with time.

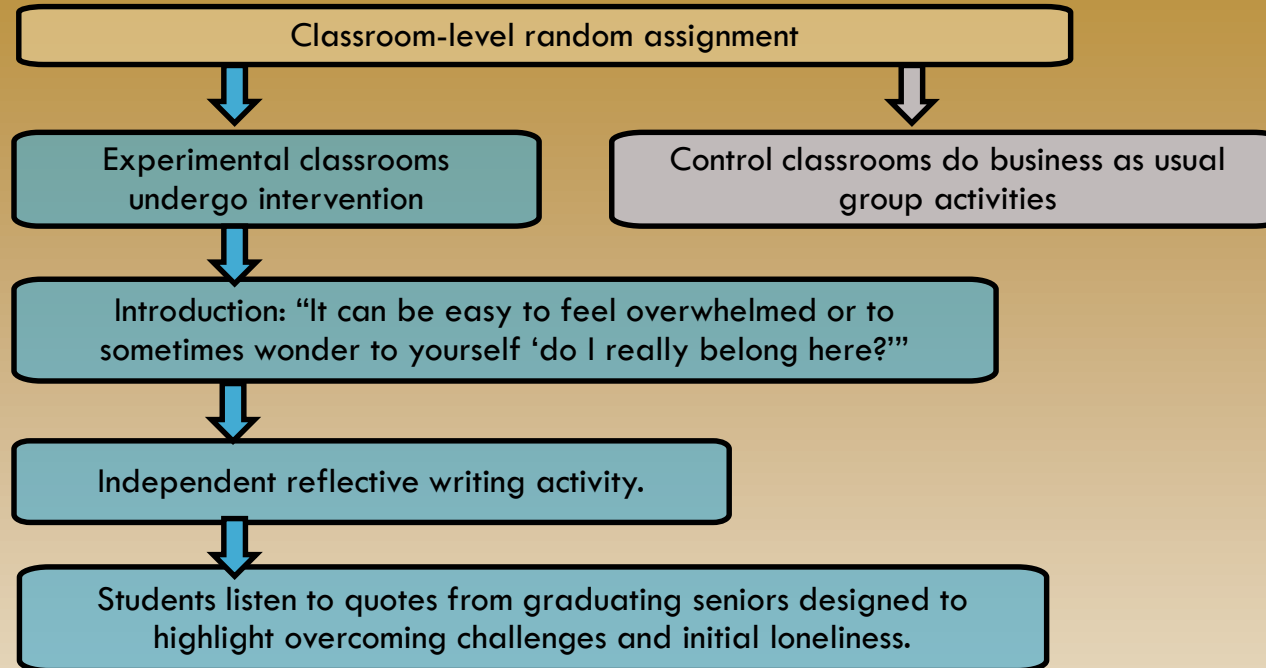
Writing exercise

- Write about concerns you have about college, e.g., worries about your coursework, or thoughts about taking this college physics course? How do you think these concerns will change over time. Please don't put your name on it. It will not be graded.
- *What do you think students wrote about?*

Many students experience difficulties and worries coming to college, from living in a new place, to trying to make new friends, to finding their way in a new academic environment. Take a few minutes to write about some concerns you have about college, e.g., the challenges in the transition to college, worries about your coursework, or thoughts about taking a college physics course. How do you think these concerns will change over time?

Please don't put your name on it. It will not be graded.

I am extremely worried that I have wrongly overcalculated my mental abilities by ending up in the engineering program. Right now all the information I am learning in my classes isn't new, but I am still not seeming to do as well in it as I hoped I would be doing. This worries me, because seeing so many smart people around me, I feel like I do not belong here. I am also concerned w/ time management and my ability to create a good social, health, and academic balance in my life. I hope this will change as time goes on and I get better study skills & become accustomed to college life.



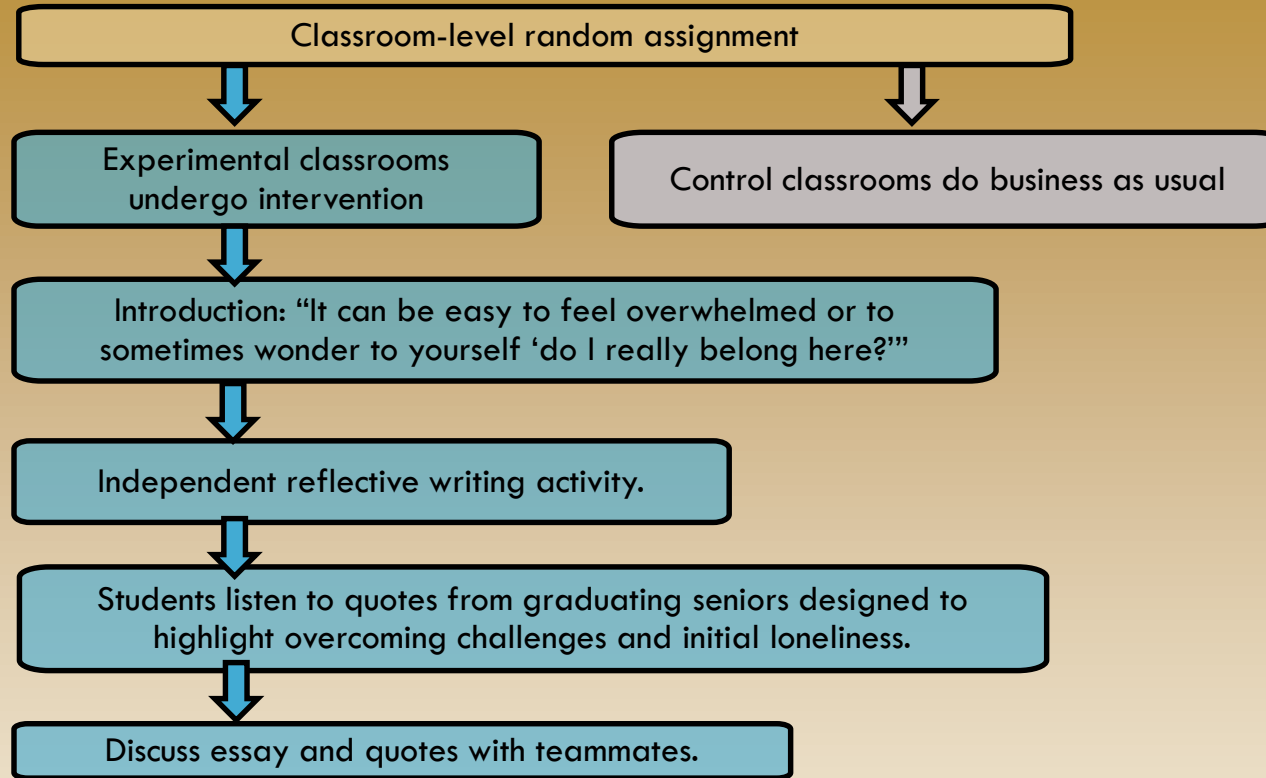
Provide narratives to scaffold experiences with adversity

- Students' path to success is a journey with a beginning, middle, and an end. Along that path, some struggles will be encountered but they will be overcome with effort and using your struggle as a learning opportunity [Yeager, Walton & Cohen, 2013].

Example of narrative

I was one of just a handful of women in one of my intro physics study groups, and sometimes I felt a little embarrassed to ask questions. However, I quickly learned that other students usually had the same question I did, and we all benefitted from working with each other and learning from each other. Sometimes I had difficulty with an idea that my classmates understood. Other times, they struggled with concepts that I understood. I remember there wasn't always an "aha!" moment, where everything clicked. It was usually much more gradual, with some concepts only becoming clear after lots of practice and discussion with my study group. I realized that everyone struggles some times, and the important thing is to not give up and help each other out.

-Allison, Pitt Electrical Engineering
Senior

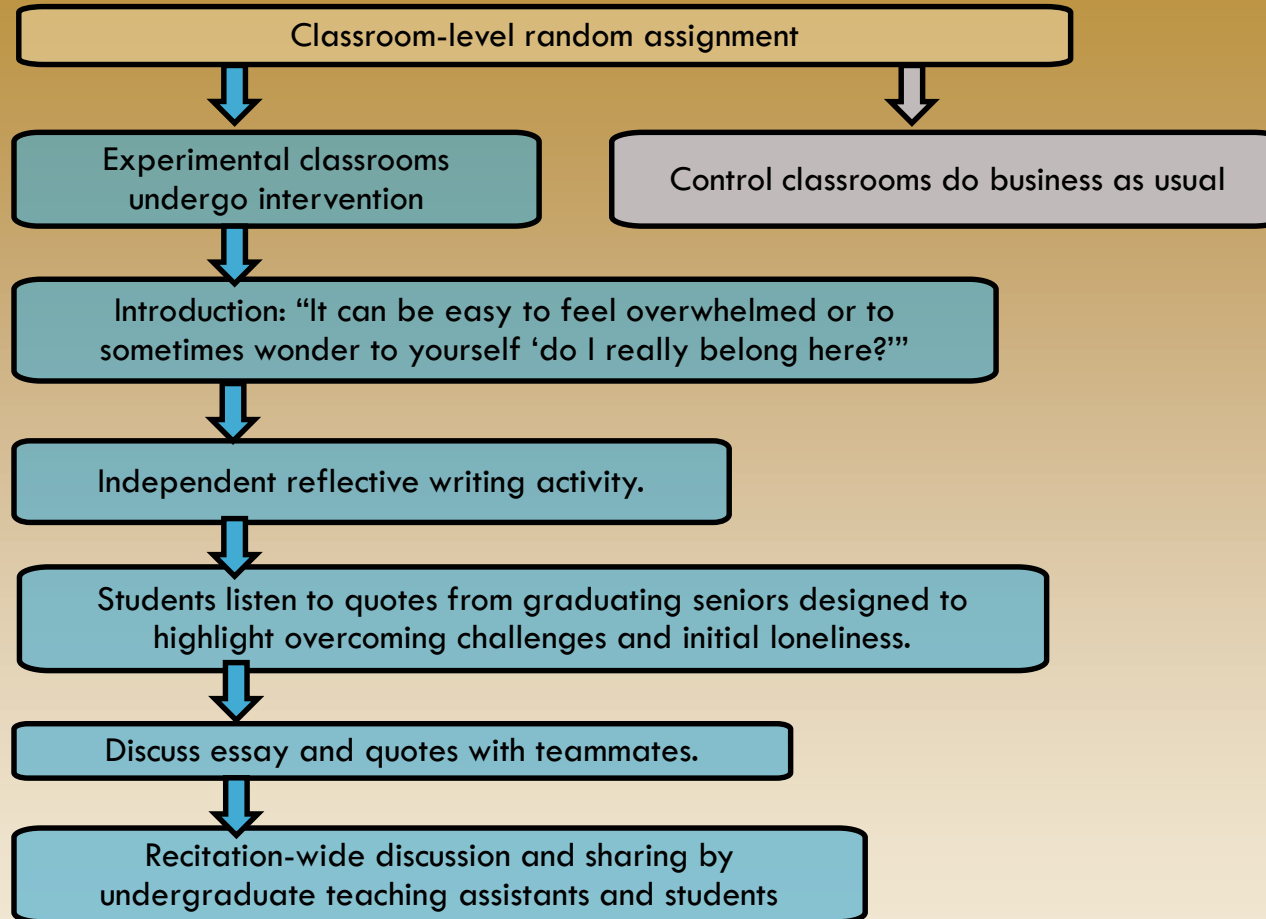


Group Discussion

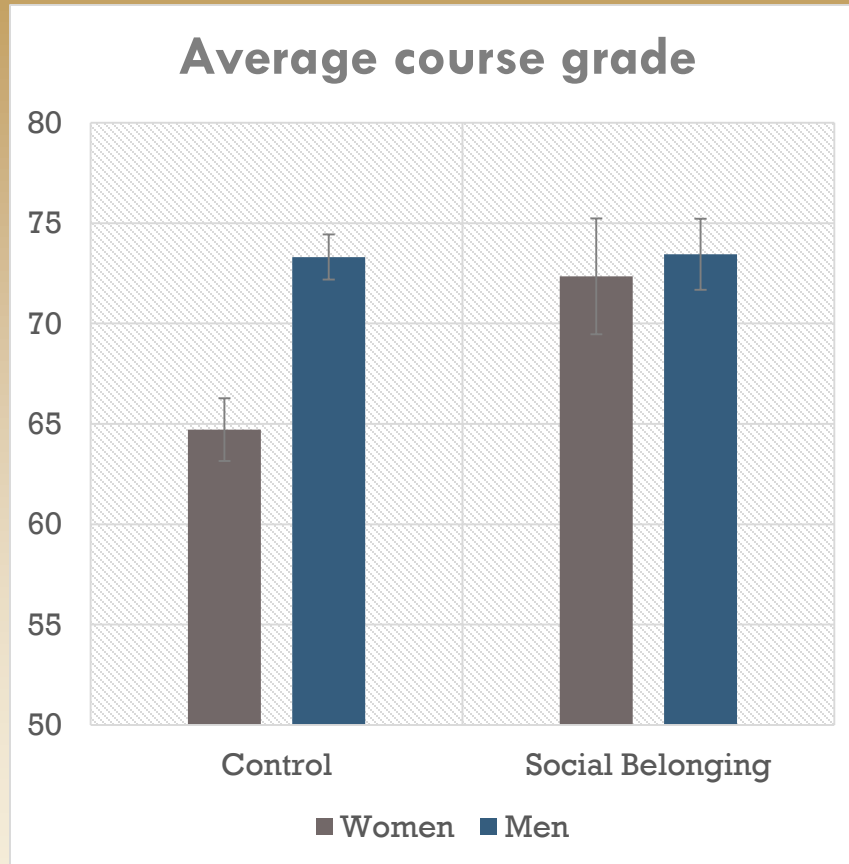
- Discussion generates social proof of intervention message:
 - Share what you wrote
 - Why do you think so many students don't realize other students are struggling?
 - How do you think your life will be different when you are a Junior or Senior?

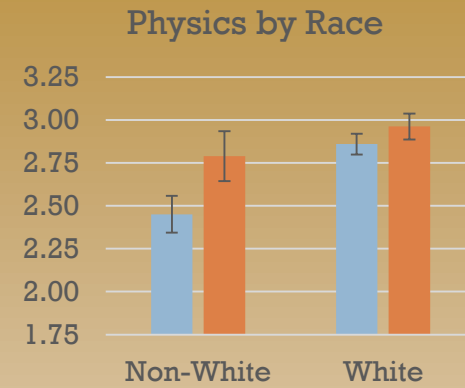
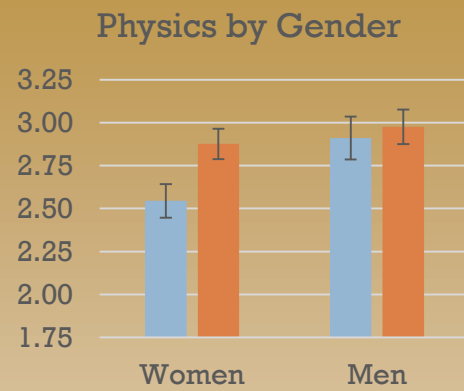


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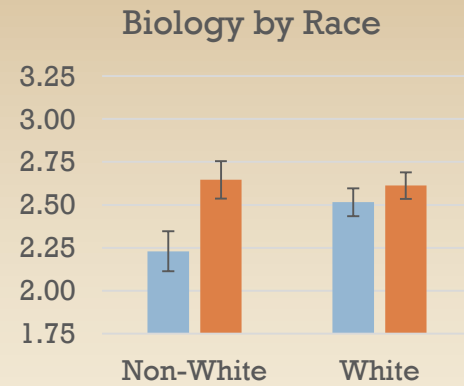
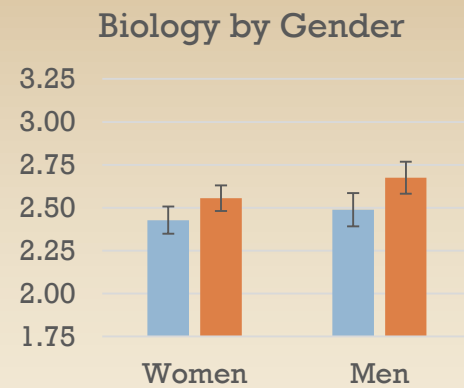


Results (Psych. Science, 2020)





Intervention
Control



Hot off the presses: We replicated the Biology findings in General Chem. at University of Minnesota



- A short activity focused on belonging and mindset helped reduce the gender gap in performance
- Future work:
 - Implementing the activity in all recitation sections
 - TA professional development focused on making the classroom environment and labs inclusive
 - Longer term effects?



- Similar issues in research labs for women and other students from underrepresented groups
- Lack of inclusive mentoring and supportive lab environment can increase their anxiety and rob them of their full potential
- Inclusive mentoring (similar to inclusive teaching) requires creating a bias/stereotype-free supportive environment where everyone is respected, has a great sense of belonging, and has self-efficacy to embrace struggles and use them as the stepping stones to learning and excelling



- Negative impact of stereotype threat is so great that lack of supportive environment can make them doubt their own skills and discount their own potential
- Our research (including some not presented here) shows that the group that is most vulnerable is most likely to benefit from creating inclusive classroom environment or inclusive mentoring and supportive lab environment
- Positive recognition by faculty can do wonders for underrepresented students in physics and increase their sense of belonging, interest, self-efficacy and enthusiasm