Promoting Equity in Undergraduate STEM Classrooms through Pedagogical Approaches

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MOVING EQUITY AND INCLUSION FROM THE MARGINS TO THE CENTER OF UNDERGRADUATE STEM CLASSROOM PRACTICE:

TRANSFORMING OUR TEACHING USING PRINCIPLES OF CULTURALLY RESPONSIVE TEACHING

Roni Ellington, PhD
AAAS-IUSE
Thursday, May 13, 2021
Thank You for the Invitation To Speak with you today!
Thank you for the Invitation

It is my pleasure and honor to be here today!
An Invitation

Listen with your Head and Your Heart
The state of STEM

The State of Women in STEM
The STEM Pipeline is Leaking Badly

Approximately, 4 million 9th graders entered high school in 2001... Four years later, 2.8 million of them graduated and 1.9 million then went to either two- or four-year colleges; however, only 1.3 million were actually prepared for college. Less than 300,000 majored in STEM fields and only about half graduated college with a STEM degree by 2011.

For African-Americans the STEM yield is ~1-2%; we need to increase the yield 10X!

The Price of Failing to Address Equity and Inclusion Crisis

What will this STEM Table look like in 10-50 years?
A 911 in STEM Education

After years of well-intentioned efforts focused on diversity, inclusion, social justice, feminism, special education and anti-racist education, particularly in STEM, we still see very little movement in our equity and inclusion related outcomes?

Why have such “smart,” evidenced driven folks allowed these results to be “ok”? 
A short story...
Fast Forward
My Research

- Understanding the experiences of high achieving students in Math/STEM disciplines
- Socio-cultural factors that impact students success in math and STEM disciplines
- Curriculum, Instruction and Assessment
- Interdisciplinary and Transdisciplinary learning
- Parental Involvement
- Development of a Inclusive Framework for STEM education that can be applied in all disciplines
Reframing the Equity Discussion

FROM: “us” vs “them”, “right” vs. “wrong” or “good” vs. “bad” perspectives.

To: An Authentic Humanistic Approach that is MESSY at Best and Terrifying at worst
A Transformative Framework for STEM Education

Student Identity, Agency, Resiliency and Belonging

Transformative Pedagogical Practices and Innovative CIA

Teacher/Leader Professional Development and Empowerment

Utilizing and Contributing to Community Social, Cultural, Political and Economic Capital
Our Focus Today.....

Culturally Responsive Teaching as a Transformative Pedagogical Practice

Message:
“STEM Education is Critical, Vital and Relevant to each of us, our communities, solving real-world problems and understanding the world around us”
Unpacking CRT

- **Culturally**: Relating to Social values, cognitive codes, behavioral standards, worldviews and beliefs we use to give meaning to our lives. (Gay, 2000)
- **Responsive**: saying or doing something as a reaction to something or someone, especially in a quick or positive way: alertness, approachability, receptivity, sensitivity, acceptance, broad-mindedness, interest, receptiveness, tolerance
- **Teaching**: Teaching is the process of attending to people’s needs, experiences and feelings, and intervening so that they learn particular things, and go beyond the given.
Culturally Responsive Teaching?

“An educator’s ability to recognize students' cultural displays of learning and meaning making, respond positively and constructively with teaching moves that use cultural knowledge as a scaffold to connect what the student knows to new concepts and content in order to promote effective information processing. (Hammond, p. 15)

Zaretta Hammond, author of Culturally Responsive Teaching and the Brain defines Culturally Responsive Teaching
Key Instructor “Moves” in CRT

- Recognize students' culture
- Respond positively and constructively
- Use cultural funds of knowledge
- Scaffold instruction
- Connect content to students lived reality
- Promote effective learning
CRT is not

- A one size fits all model or set of principles
- Devoid of Context and Is driven by the institutional context
- Just about “strategies” but about who we are and how we approach our work
- “Comfortable” but requires a self-reflective stance
MSU CRT Principles

CRT P1: Incorporate physical and hands on activities in instructional practice

CRT P2: Incorporating more student led discussions and teaching opportunities class

CRT P3: Becoming conscious of biased judgements about students based on limited perceptions of them and being willing to change these perceptions

CRT P4: Having student apprenticeships that foster empowered learning communities

CRT P5: Using students’ lived experiences as context for course content and activities
The Elephant in the Room

How do I do this?
A Paradigm for Transformation

Be
Context
Intention
Who you are
Where you come
From

Do
Strategies
Actions
Policies
Practices
Programs

Have
Results
Impact
Statistics
Learning
Outcomes
Being Comfortable with the Gap

Current Pedagogical Practices

CRT Aligned Practices

The Gap
The Million Dollar Proposition:

- Are we willing to be who we need to be to get the STEM diversity and inclusion results that we wish to have?
- Strategies for increasing equity and inclusion have little traction to foster real change if we don’t have the BEING that is aligned with the strategies.
- Equity and Inclusion will remain on the margins until we become people who are willing to make it central to who we are and the work we do.
Some CRT Strategies

- Connect classroom experiences to the lived realities of students
- Incorporate Social Justice based learning experiences
- Adopt pedagogical approaches that draw on various Ways of knowing
- Develop Structured study groups that empower learners
- Engage in content focused activities that allow students to unpack issues of race, class, sex, and ability
- Challenge dominant narratives and encourage counter narratives
More Strategies

- Use Constructivist, Humanist and Critical Paradigms of Teaching and Learning
- Develop a Culture of Care in your classroom
- Incorporate Interdisciplinary and Transdisciplinary Teaching and Learning
- Use Problem-Based Learning approaches
Strategies

- Repositioning content in curriculum to address contextual realities of students and their communities
- Challenges to Absolutist and Positivist frameworks of knowledge
- Confronting notions of “the other” in one's experience and practice
- Reframing achievement gap discussion to education debt (Ladson-Billings, 2006)
Some more strategies

- Engage in Authentic Partnership Building with Students and Communities
- Connect Learning Experiences to community concerns and issues
- Using STEM to empower and liberate marginalized communities
- Integrate an Entrepreneurial STEM focus curriculum
Who do we have to “be” to realize Diversity and Inclusion?

- Agents of Transformation not simply content experts
- Adopt a perspective that values how students see themselves AND Content Mastery
- Never sell out on them because the “problems” get hard
- Being willing to interrogate your own conceptions of power, privilege, normality, and centrality
Thank You for the Bottom of my
How to Enhance STEM by Making it Inclusive

Chandralekha Singh\textsuperscript{1}, Emily Marshman\textsuperscript{2}, Yasemin Kalendar\textsuperscript{3}, Danny Doucette\textsuperscript{1} Department of Physics, \textsuperscript{1}Univ. Pittsburgh, \textsuperscript{2}CCAC, \textsuperscript{3}Harvard Univ.

Kevin Binning, LRDC, University of Pittsburgh
• 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.
Ambiguity/Uncertainty

Reliance on stereotypes

Diminished performance

Lower sense of belonging, decreased self-efficacy and view intelligence as fixed
Belonging
Identity
Intelligence mindset
Self-efficacy
Interest
Achievement goals

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
Classroom-level random assignment

Experimental classrooms undergo intervention

Control classrooms do business as usual group activities

Introduction: “It can be easy to feel overwhelmed or to sometimes wonder to yourself ‘do I really belong here?’”
…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 with 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 and become accustomed to college life.
Classroom-level random assignment

Experimental classrooms undergo intervention

Control classrooms do business as usual group activities

Introduction: “It can be easy to feel overwhelmed or to sometimes wonder to yourself ‘do I really belong here?’”

Independent reflective writing activity.

Students listen to quotes from graduating seniors designed to highlight overcoming challenges and initial loneliness.
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].
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
Classroom-level random assignment

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Control classrooms do business as usual

Introduction: “It can be easy to feel overwhelmed or to sometimes wonder to yourself ‘do I really belong here?’”

Independent reflective writing activity.

Students listen to quotes from graduating seniors designed to highlight overcoming challenges and initial loneliness.

Discuss essay and quotes with teammates.
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?
Classroom-level random assignment

Experimental classrooms undergo intervention

Control classrooms do business as usual

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Discuss essay and quotes with teammates.

Recitation-wide discussion and sharing by undergraduate teaching assistants and students
Results (Psych. Science, 2020)

The graph shows the average course grade for women and men in the control and social belonging conditions. Women in the social belonging condition had a higher average course grade compared to men and those in the control condition.
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
Facilitated Breakout Rooms:

1. Navigate to the bottom of your screen and click “Breakout Rooms” button
2. Self-select into your breakout group based on your topic interest and last name

Note: If you do not see the Breakout Rooms button, please post in the chat to ask to be placed in a breakout room.
Discussion Breakout Room Recap

Roni Ellington
Chandralekha Singh
Asia-Lige Arnold
Emily Marshman
Danny Doucette
Thank you for attending!

Slides and recording will be available in the coming weeks.

We value your feedback, please take a few minutes to complete the survey.

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