Strategies for teaching in classrooms with ever increasing diversity

Cathy Drennan
Department of Chemistry and Biology
HHMI Professor and Investigator
Massachusetts Institute of Technology
“I never had a chemistry TA that believed in me.”

“I never saw anyone in chemistry who looked like me.”
My Goals

• Create TA-training material on diversity issues

• Implement lessons from training in the classroom

• Create teaching material to show what chemists really look like
Who are the TAs that we are training?

First year graduate students in chemistry at MIT
40-60 total per year, ~10 for Fall 5.111 and ~5 for Spring 5.111
Of total: 45% female; 0.09% URM; 37% International
What we tried

**Fall 2007:** Invited speaker on topic of diversity for all Chemistry Department TAs; 5.111 TAs also read article on Stereotype Threat (no discussion of article)

**Fall 2008:** Only 5.111 TAs received diversity training; read same article as year before, but discussed article in small group, four days into the training when everyone knew each other

**Fall 2009:** All Chemistry TAs read same article and discussed article in small groups, but people in groups didn’t know each other

**Spring & Fall 2010-2011**: All Chemistry TAs read a custom prepared article and discussed article in small groups, after three days into training when everyone knew each other
Articles that we used


81% found the second diversity reading assignment effective
67% found it enjoyable
Major goals of the training

Understand what stereotype threat is
Stereotype threat is the perceived risk of confirming a negative stereotype.

Understand that stereotype threat can cause underperformance

Understand that everyone can be a victim as stereotype threat

Understand that there are ways to mitigate the effects of stereotype threat
Example: Give wise criticism – Criticism where you explicitly let the student know they are capable of a higher level of achievement.
Stereotype threat leads to feelings of being judged unfairly

Asked volunteers to test whether they were treated differently by others if they had a scar on their face

Volunteers spent time in make-up and saw how they looked with the scar

but before they went into the meeting, the scar was wiped off without their knowledge

Volunteers reported discrimination

Kleck & Strenta 1980
Exercise

Turn to your neighbor, can you recall a time that you felt judged by some for a superficial characteristic or when you worried about confirming a negative stereotype.
UNDESERVED PRAISE

This is a good score for you! You should be pleased.

Yeah, you’ll need to try harder than that if you want to pass my class.

BAD CRITICISM

She thinks I’m an idiot. I knew I didn’t belong here.

You nailed the titration questions, so I know you can do well on tough material. You’re having a tougher time with thermochemistry. Let’s talk about what you can do to improve.

NO FEEDBACK

WISE CRITICISM
Exercise

Turn to your neighbor, think of the last criticism you gave a student or a criticism that you are planning to give. Phrase it in an unwise way and then think of a “wise” way to say it.
Assessment of training

Teaching and Learning Laboratory at MIT

• TA surveys
• Individual TA interviews (post-bootcamp and post-course)
• Student survey on the TA and recitation experience

Rudolph Mitchell
Associate Director
## Evaluation of TA training (2010 data)

### TAs' confidence in understanding diversity issues increased*

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
<td>p</td>
</tr>
<tr>
<td>Understanding diversity issues in the classroom.</td>
<td>4.23</td>
<td>1.15</td>
<td>5.94</td>
<td>0.86</td>
<td>48</td>
<td>0.000</td>
</tr>
<tr>
<td>I am familiar with strategies to alleviate diversity issues in the classroom.</td>
<td>3.53</td>
<td>1.41</td>
<td>5.53</td>
<td>1.06</td>
<td>47</td>
<td>0.000</td>
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</table>

*Students use a seven-rating scale to rate each item.*
## Evaluation of TA training (2010 data)

### TA attitudes changed

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
<td>Statistics</td>
</tr>
<tr>
<td>I believe to be an effective teacher, a TA must understand how</td>
<td>4.60</td>
<td>1.23</td>
<td>5.85</td>
<td>1.10</td>
<td>47</td>
<td>0.000</td>
</tr>
<tr>
<td>diversity issues and stereotypes can affect the learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>experience.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In addition to my teaching, I can apply diversity training</td>
<td>4.94</td>
<td>0.99</td>
<td>5.91</td>
<td>1.06</td>
<td>47</td>
<td>0.000</td>
</tr>
<tr>
<td>to other aspects of my life.</td>
<td></td>
<td></td>
<td></td>
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</table>
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• Create teaching material to show what chemists really look like
Who are the students of these TAs?

Student makeup of one version of MIT freshman chemistry (5.111)

In fall course, 210-300 students

Female: ~66%

URM students: ~25%

In spring course, 120-220 students

Female: ~57%

URM students: ~20%
Implementation of training

Idea

Build team using clickers and in-class competitions
Consider a drug, HA, that is active only in the deprotonated (A⁻) form. The pKa of the drug is 4.0, and the pH of blood is 7.4.

Select the correct statement below.

1. Most of the drug will be in the active (A⁻) form in the bloodstream.

2. Most of the drug will be in the inactive (HA) form in the bloodstream.

3. The ratio of A⁻ to HA will be approximately 1:1 in the bloodstream.
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Implementation of training
### Freshmen response to their TAs

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>URM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>SD</td>
<td>N</td>
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<tr>
<td>My TA wanted us to do well.</td>
<td>6.6</td>
<td>.80</td>
<td>190</td>
</tr>
<tr>
<td>My TA was enthusiastic about</td>
<td>6.5</td>
<td>.79</td>
<td>191</td>
</tr>
<tr>
<td>chemistry.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My TA was well prepared.</td>
<td>6.2</td>
<td>1.1</td>
<td>191</td>
</tr>
<tr>
<td>Recitation complimented lecture</td>
<td>5.9</td>
<td>1.3</td>
<td>191</td>
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<td>concepts and attitude.</td>
<td></td>
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**7 point rating scale:** 1 = strongly disagree, 4 = neutral, 7 = strongly agree
### Freshmen response to clicker competitions

#### Student responses with (2008) and without (2007) clicker competitions

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<thead>
<tr>
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<tr>
<td>I made an effort to answer clicker questions as well as I could.</td>
<td>6.2</td>
<td>6.2</td>
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<td>5.1</td>
<td>5.7</td>
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<td>Clicker questions helped me <strong>identify weaknesses</strong> in my understanding</td>
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<td>5.6</td>
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The “Who” of Chemistry
Research Videos showing the Faces of Chemistry at MIT

The Why, What and Who of Chemistry

A series of 12 science videos and 12 personal videos that include

- twelve distinct general chemistry principles
- real-world applications in medicine, energy and environment
- a diverse group of researchers

Do people actually use the stuff they learn in freshman chemistry?

How can chemical principles be used to solve real-world problems?

What do real chemists look like?
Research Videos showing the Faces of Chemistry at MIT

Do people actually use the stuff they learn in freshman chemistry?

What do real chemists look like (apart from the dead white men in textbooks)?

General chemistry topic: pH and pKa
Research Videos showing the Faces of Chemistry at MIT

General chemistry topic: pH and pKa

Application: imaging diseased cells

MIT Researcher: undergrad Samuel Thompson
Samuel Thompson: MIT undergraduate in the Ting lab
Personal Videos showing the Faces of Chemistry at MIT

Equality Texas: Samuel’s Story
Personal Videos showing the Faces of Chemistry at MIT
Research Videos showing the Faces of Chemistry at MIT

Application:
Studying an anti-cancer and anti-bacterial enzyme target

General chemistry topic:
Chemical Equilibrium

MIT Researcher:
Postdoctoral fellow
Dr. Nozomi Ando
Chemical equilibrium is relevant to more than just gas molecules!

**Gas molecule example:**

\[ 2P_2 (g) \rightleftharpoons P_4 (g) \]

**Biochemical example:**

\[ 2E_{active} \rightleftharpoons E_{inactive} \]
Nozomi Ando: MIT postdoc in the Drennan laboratory
Nozomi Ando: MIT postdoc in the Drennan laboratory
Research Videos showing the Faces of Chemistry at MIT

General chemistry topics:
- Solubility
- Le Chatelier’s Principle

MIT Researcher:
Hector Hernandez

CO₂ sequestration and use
Hector Hernandez: MIT postdoc in the Thompson laboratory
Hector Hernandez: MIT postdoc in the Thompson laboratory
Assessing impact: Faces of Chemistry videos

From Spring 2011 Retrospective Survey (no videos yet!)

<table>
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<th>As a result of this class,</th>
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<td>I have been exposed to examples of chemists from different ethnic groups.</td>
<td>4.2</td>
<td>43%</td>
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1 = poor / strongly disagree 4 = neutral 7 = excellent / strongly agree
Assessing impact: Faces of Chemistry videos

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<td>43%</td>
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<tr>
<td>I have been exposed to examples of women who are chemists (in addition to my professors and TAs)</td>
<td>5.4</td>
<td>81%</td>
</tr>
<tr>
<td>I encountered examples of chemists with whom I could identify because of their gender/ethnicity/background.</td>
<td>4.4</td>
<td>42%</td>
</tr>
</tbody>
</table>

1.................4...............7
poor/ strongly disagree neutral excellent/ strongly agree
Acknowledgements

class of 2009

Beth Taylor  Wes Glenn  Rudy Mitchell  George Zaidan  Mary O’Reilly
Do people actually use the stuff they learn in freshman chemistry?

Research videos organized by chemistry topic

How can chemical principles be used to solve real-world problems?

Research videos organized by real world research topic

What do real chemists look like (apart from the dead white men in textbooks)?

Personal videos: real stories from real chemists

* Starring MIT chemists *
* Produced by chemists * Prof. Cathy Drennan, Dr. Beth Taylor, George Zaidan
* Directed by a chemist * George Zaidan
* Art by a chemist (yes, chemists can be artists too)* Dr. Mary O'Reilly
How do we increase the impact on URM students / women?

Inspiration from discussions and evaluation comments:

This is one of the very few science/engineering classes that are taught by female professors. I've been here at MIT for 4 years, and this class is the 2nd class I've had with female professors. I think it's super important to give a sense that women can do science and engineering too.
What do real chemists look like (apart from the dead white men in textbooks)?

**Personal videos: real stories from real chemists**

- Benjamin Ofari-Okai
  Graduate student

- Dr. Lourdes Aleman
  Postdoctoral associate

- Darcy Wanger
  Graduate student

- Dr. Sarah Bowman
  Postdoctoral associate

- Dr. Hector Hernandez
  Postdoctoral associate

- Dr. Nozomi Ando
  Postdoctoral associate

- Prof. John Essigmann
  Professor

- Wesley Glenn
  Graduate student

- Jingnan Lu
  Graduate student

- Prof. Cathy Drennan
  Professor

- Samuel Thompson
  Undergraduate student

- Stefanie Sydlik
  Graduate student