Strategies for equitable and engaging mathematics teaching

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Overview

- Facilitation Strategies
  “Gallery Walk”
- Participation and Learning
- Equity Data
- Case Study: Dr. Adams
- Closing
Facilitation Strategies
“Gallery Walk”
What strategies are you currently using to get students to talk about math?
Equitable Talk

What strategies do you use to promote equitable discussions?
Identities

How do you ensure that specific social marker groups (e.g., gender, race, disability) have sufficient opportunities to participate?
Participation and Learning
Learning from Everyday Experience
Participation is crucial to learning

01  Explanation helps consolidate understandings

02  Social interactions provide practice and feedback

03  Competent, public participation supports identity development
Participation is generally inequitable

- Men talk more than women
- White students talk more than students of color
- Nondisabled students participate more than disabled students

Participation opportunities are connected to broader policies and Discourses about students.

Participation predicts performance

20 inquiry math classes (matched comparison)

Inquiry outperformed lecture (overall)

Men significantly outperformed women (inquiry)

\[ GPD = -0.59 + 0.09 \cdot (WPR) \]

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Equity Data
Social Marker Specificity

To create equitable classrooms, instructors need data about who is participating and how, according to student social markers (e.g., race, gender, disability, SES).

This allows strategies to be used in a targeted way to support specific students.
EQUIP

EQUIP is a customizable observation tool for tracking patterns in student participation. The goal is simple: to empower teachers in building more equitable classrooms. EQUIP can be used in real-time or with videos of classroom teaching. After completing an observation, EQUIP generates instant analytics that teachers can use to improve their practice.
Framing equity in terms of social markers

- Are only White and Asian boys participating?
- What % of high-level questions are going to Black girls?
- Are emergent multilingual students receiving sufficient wait time?
Social Marker Analytics

Discourse Dimensions

Teacher Question
Revoicing Moves
Student Talk: Type
Student Talk: Length
...

Social Markers

Race
Gender
Language
Disability
...

Social Marker Analytics
**EQUIP**: How it Works

**Step 1: Set Up Your Classroom**

**Step 2: Conduct an Observation**

**Step 3: Analyze Your Data**
Reflection Cycles (3-4 per semester)
Case Study: Dr. Adams
Equity Learning Communities

• Faculty begin as participants
• Receive EQUIP-based coaching (1-3 semesters)
• Former participants then become coaches
• Student researchers support coding and feedback

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Coach: Dr. Wilson

We can talk about equity all day, but...it’s a different level to be able to really re-evaluate your practice and step down from that pedestal that we as faculty members like to sit on.
Dr. Adams

- Full Professor
- Successful career at elite university
- Strong advocate for women in math

Dr. Rao

- Assistant Professor
- Teaching at a women’s college
- Award winning instructor
Dr. Adams: Classroom Demographics

• Population: 29 students
• Gender: 17 Men (59%), 11 Women (38%), 1 unknown
• Race: 14 White, 11 Asian, 4 unknown
Norms For Watching Video

• Critique the Practice not the Instructor or Student(s)
• Do not make assumptions
• Ask questions
Reflection Questions

• What do you notice?
• What do you wonder?
• How could you use this in your own teaching?
Observation 1: Matrix Multiplication
Reflection Questions

• What do you notice?
• What do you wonder?
• How could you use this in your own teaching?
Dr. Adams: Observation 1 (Interactive Lecture)

Dr. Adams: This is in general how we’re going to do matrix multiplication. We can take an $n$ by $m$ matrix, and multiply it by an $m$ by 1 vector, that’s what Robin just said, and then we’ll get an $n$ by 1 vector. And each element of the output is the dot product of a row of the matrix, with $x$.

Dr. Adams: Now back at the factory, remember that each of these components for the computers require a certain amount of base elements, copper, zinc, glass, plastic, etc. So, if I ask the question, I want to make 10 T1s, 21 T2s, and 11 T3s, how much of the raw materials of copper, zinc, glass, and plastic, will I need? Any thoughts?

[Dr. Adams pauses for a couple of seconds, students are silent.]

Dr. Adams: What if I said, how much copper is needed to make all the stuff for the T1s? How much copper? [Pauses.] I need two units of copper for each transistor, two units for each resistor, and three for each computer chip. For the T1s I need five transistors, seven resistors, and 20 buttons.

Rahul: [raises hand] 36.

Dr. Adams: How did you get 36?

Rahul: Um, 2x5 in the first row, 2x7, and 3x4.
Dr. Adams: Debrief 1

Student data
  • 16 contributions (12 unique students; 41% of the class)
  • 7 White students, 7 Asian students, 2 unknown race
  • 12 men, 4 women; (0.7 vs 0.36 avg. contributions)

Average contributions calculations: (0.7 = 12/17; 0.36 = 4/11)
Dr. Adams: Debrief 1

“I really want to address this business of the women not speaking. It bothers me. It just doesn’t go away. They have a woman standing up in front of them, and they talk to me outside of class, but it’s so hard, the social structures are so entrenched...”
Dr. Adams: Debrief 1

Suggested Teaching Strategies

1. Five hands.

2. Priming students after work time.
Observation 2: Partner Work
Reflection Questions

• What do you notice?
• What do you wonder?
• How could you use this in your own teaching?
Dr. Adams: Observation 2 (Partner Work)

Dr. Adams: I want to know: what is the relationship is between these three spaces? The row space, null space, and column space of the matrix $A$ in a row-reduced form. Makes sense? […]
Dr. Adams: Talk to your partner for a moment, and ask, are they the same? Are these two spaces the same? Are they related at all? If you have an answer, you’ve got to have a reason for that answer.
[students talk in pairs for about 6 minutes]
Dr. Adams: Let’s come together and talk about these. These aren’t really easy questions, right? That’s great, because otherwise you wouldn’t be learning anything. All right.
Dr. Adams: How about Muriel and Anika, what did you decide about the row space?
Muriel: We decided that the row spaces are equivalent because $A$ and its image are both equivalent.
Dr. Adams: So, the word row equivalent…you think these are equal? What does $B$ being row equivalent to $A$ mean?
Muriel: It means that any linear combination of $B$ also contains part of $A$, the row space of $A$.
Dr. Adams: Okay, I like that. So, the linear combinations of the rows of $A$ give you rows of $B$. And so, their span should be the same. So, row equivalent actually means we got from $A$ to $B$ using elementary row operations.
Dr. Adams: Debrief 2

Student data

• 23 contributions (increase from observation 1)
• Average contributions: 1.1 men, 0.45 women
Dr. Adams: Debrief 2

“[In prior class sessions,] I had people blurting things out, and it feels dynamic. But then I realized not everyone was blurting things out! So now everyone knows I’m waiting, but that does cause some awkwardness.”
Dr. Adams: Debrief 2

Suggested Teaching Strategies

1. Support students to respond to each other.

2. Use think-pair-share to address silence.
Observation 3:
Think-Pair-Share
Reflection Questions

• What do you notice?
• What do you wonder?
• How could you use this in your own teaching?
Dr. Adams: I claim that these two vector spaces are orthogonal. Does anyone wanna tell me what that really means? [5 seconds of silence.]

Dr. Adams: Okay, talk to your partner for a second, confer. …

[Students talking to each other loudly for about a minute]

Dr. Adams: Okay, let’s see what you got. Anyone want to finish this sentence? “Two vector space are orthogonal if…”

[Anu raises hand, Ruth raises hand, another student raises hand]

Ruth: If the dot product of their bases is zero.

Dr. Adams: Okay, let’s write that down. But a basis has multiple things in that, so what do you mean by that?

Ruth: That it’s every basis vector.

Dr. Adams: I’ll write down what you said. That’s a good idea, I think. Ruth has a good idea. The dot product of bases equals zero.

Dr. Adams: So do you think that the vector space of the floor is orthogonal or perpendicular to the vector space of these lines. Do you think so? Let’s take a vote. How many people think yes?

[Students raise hands.]
Dr. Adams: Debrief 3

Student data
• 29 contributions (the most yet!)
• Average contributions: 1.1 men, 0.91 women
  • For women, this was **DOUBLE** the first two observations
Dr. Adams: Debrief 3

Conversation about participation

• “I really think the conversation about participation made a difference. I was making eye contact with the women. I had a couple of out of class conversations in office hours with the women individually.”

Two Voices Rule

• “We tried a wait two voices rule. So, if you say something, you have to wait until two other people talk before you talk again.”

Classroom Activities

• Students moving around like rows / columns
• Proving pairs of the “long theorem” with different students
Observation 4: Selecting
Reflection Questions

• What do you notice?
• What do you wonder?
• How could you use this in your own teaching?
Dr. Adams: Observation 4 (Selecting)

Dr. Adams: Now I know that if I can find lambdas that make that equal to zero, then those lambdas will be eigenvalues. So go ahead and work that out and tell me what you get.

[student work time, Dr. Adams circulates the room, walks over and talks with Emily.]

Dr. Adams: All right, Emily’s got it here, she’s gonna write it up on the board for us.

Emily: [writing solution on the board] Sorry it’s so messy, but it’s there.

Dr. Adams: So, we have two eigenvalues, does that surprise you? No. In fact, if you have a 2 by 2 matrix, and you put lambdas and find the determinant, you’ll always have a quadratic, so you expect no more than two eigenvalues.
Dr. Adams: Gender Trends
Acknowledging that some students may have a hard time sharing their views because of their prior trauma, or whatever the reason might be, I’ve learned some strategies. One of them is to have students talk to each other and then walk around and listen for when someone has a good idea. Then I’ll say “Emily had that idea, and Sarah has this good idea, do you want to share?” That gives them the courage to share and it really works. And it also works for me, that practice of listening to everyone to see what their ideas are. That’s really good.”
Your own learning

Have you ever watched a recording of your teaching?

Have you ever been observed with a formal protocol?

Would you join an equity learning community?
Equity Learning Communities: On Your Campus

- Institutional home (CTL, STEM Center, etc.)
- Initial cohort / champions
- Student support (GTAs, Graders, LAs, etc.)
- Plans for scaling
Equity Learning Communities: Leveraging Data to Transform Classroom Instruction

Forthcoming
Thank you!

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https://www.equip.ninja/

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