

Dichotomies No More: (Em)Powering Mathematics Teaching

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Land Acknowledgement

We are gathered on the ancestral lands and waters of many nations, including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee, and the Wendat peoples—lands that now are home to many diverse First Nations, Inuit, and Métis peoples.



Local Love Magazine. (2018, November 5). *Land acknowledgements: Uncovering an oral history of Tkaronto* [video]. YouTube. <https://www.youtube.com/watch?v=voXySM-knRc>



The argument of today's talk

1. The premise: Mathematics education is not working for most young people and this matters.
2. “Reforms” are, in part, rooted in persistent myths and not in knowledge of what real improvement would take.
3. Polarizing and dichotomizing discourses take the focus away from practice.
4. Improving young people’s mathematics learning will depend on challenging taken-for-granted normative practices that are harmful.
5. It will take centering the work of teaching as a powerful lever for justice, and a deep understanding of what it takes to disrupt embedded patterns and develop practice.



repairing longstanding
patterns of racial inequity

building the STEM
workforce

What are we after?

improving mathematics
achievement by students

growing a generation
of adults who don't
disidentify with math

broadening our conceptions
of mathematics and
mathematical competence



But we have been here before.



But we have been here before.



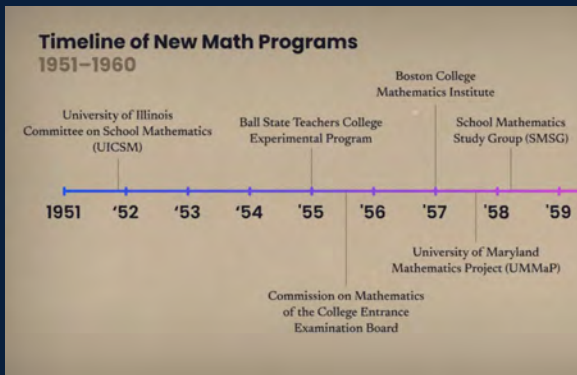
many times



A 1953 issue of *The Mathematics Teacher* stated that
“competence in mathematics widespread among our people
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1950-60s

Schools' Back-to-Basics Drive Found to Be Working in Math
By EDWARD B. FISKE

The back-to-basics movement in education that began in the 1970's has succeeded in assuring that almost every American high school graduate can handle simple mathematics, new testing data released yesterday suggest. But the data show that virtually no progress has been made on developing more complicated mathematical skills, normally taught in high school, that are increasingly sought by employers.

Only half the nation's 17-year-olds, for example, can solve mathematics problems at the junior high school level and fewer than one in 10 can cope with problems at the high school level that take several steps or involve algebra or geometry.

Students Up From Bottom
“Thanks to the back-to-basics thrust, we've brought up the students who were at the bottom,” said Gregory Atrig, president of the Educational Testing Service of Lawrence Township, N.J. “Now the challenge is to do something about the upper end of the academic scale.”

The new data were the latest mathematics survey from “The Nation's Report Card,” or the National Assessment of Educational Progress. The results confirmed trends apparent in a study of students' reading capabilities released earlier this year.

The report, “The Mathematics Report Card: Are We Measuring Up,” included these findings:
 • Most of the gains in basic skills were a result of improvements among black and Hispanic students and among those living in the Southeast.
 • Teachers have recently begun to assign more homework and do more testing of students in the classroom.
 • Most mathematics teaching is rather dull, with few teachers using calculators, computers and other new technologies.
 • Most students see mathematics as a chore.

Moderately Complex
Refer to the following graph. This graph shows how far a typical car travels after the brakes are applied.

Distance (ft)	Car Speed in Miles Per Hour
0	0
10	10
20	20
30	30
40	40
50	50
60	60

A car is traveling 35 miles per hour. About how far will it travel after applying the brakes?
 25 feet
 200 feet
 240 feet
 350 feet
 I don't know

The New York Times/June 6, 1984
Question of the type found too difficult by half of 17-year-olds.
Continued on Page A11, Column 4

1970-1985



1990s

“The widespread adoption of the Common Core State Standards for Mathematics (CCSSM) presents an unprecedented opportunity for systemic improvement in mathematics education in the United States.”

— NCTM Position Statement

2010-



What have been the patterns?

repeated investments in designing and implementing new curriculum materials



What else have been the patterns?

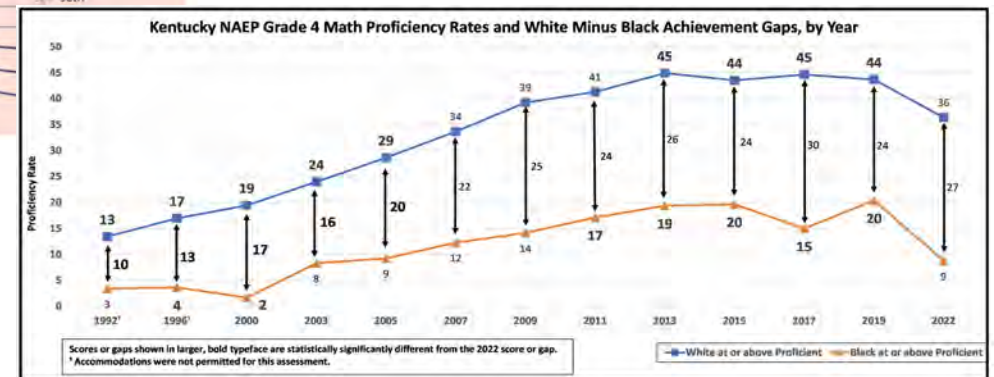
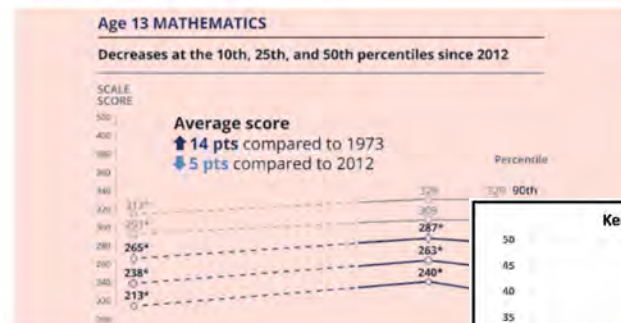
recurrent worries about achievement data and persistent narratives about “gaps”

U.S. STUDY SHOWS PUPIL ACHIEVEMENT AT LEVEL OF 1970

American elementary and secondary school pupils have made some educational progress in recent years, but they are only now reaching the achievement levels of students in 1970, according to a major Federal report issued today, which added that students are unprepared for the complex and demanding world of the 21st century. "Today's children seem to know about as much math and about as much science and read about as well as their parents did at that age about 20 years ago," Education Secretary Lamar Alexander said of the report, "Trends in Academic Progress."

October 1, 1991

Long-Term NAEP Scores for 13-Year-Olds Drop for First Time Since Testing Began in 1970s — ‘A Matter for National Concern,’ Experts Say



And another pattern . . .

A systematic lack of understanding of the work of teaching and its centrality to learning



and instead working *around* teachers to improve learning



Meanwhile, arguments and polarized discourses persist.



And after seven decades of cycles of “reform,” there is little significant change.

Many (even most) classrooms look much the same.



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Many (even most) classrooms look much the same.

What would it take to NOT be having this same conversation in 2033?



First, we would have to sort out myths from truths.

Two definitions of “myth”:

1. a traditional story or set of stories, especially one concerning the early history of a people or explaining some natural or social phenomenon
2. a commonly believed but false idea



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Myth or true?

1. In most classrooms, students explore mathematical concepts and are not expected to carry out procedures or develop fluency in mathematics.
2. We do not recruit the best and the brightest to teaching.
3. Problems of inequity are bigger than can be addressed inside of math teaching.
4. Developing high-quality mathematics curriculum is the way to improve mathematics learning.



Myth or true?

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M | MARSAL EDUCATION

 TeachingWorks

What would it
take to break the
cycles of “reform”
and the polarized
discourses?

UNIVERSITY OF MICHIGAN
MARSAL FAMILY SCHOOL OF EDUCATION
TEACHINGWORKS

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Focus on the **work of
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M MARSAL EDUCATION

TeachingWorks

What would it take to break the cycles of “reform” and the polarized discourses?

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TEACHINGWORKS

Creating a classroom environment for learning
Using curriculum materials skillfully
Assessing students' learning
Communicating with families
Focus on the **work of teaching** mathematics.
Connecting mathematics to students' knowledge
Understanding and harnessing the power
inside the discretionary spaces of teaching.
Knowing and using mathematical contexts



In this session we'll focus on two of these things about the work of teaching mathematics, one we probably agree on — and one we don't talk about enough.

And they both could help us move past paralyzing dichotomies.



Here's the first — something on which we agree:

Teaching mathematics requires
knowing the subject matter.

**But if we want to improve mathematics learning, we must
revise common ideas about what this entails.**



1. Teaching mathematics requires specialized understanding of and fluency with mathematical content.



$$\begin{array}{r} 49 \\ \times 25 \\ \hline \end{array}$$



What mathematical steps produced each of these answers?
Why might someone do the problem in this way?

(a)

$$\begin{array}{r}
 49 \\
 \times 25 \\
 \hline
 405 \\
 108 \\
 \hline
 1485
 \end{array}$$

(b)

$$\begin{array}{r}
 49 \\
 \times 25 \\
 \hline
 225 \\
 100 \\
 \hline
 325
 \end{array}$$

(c)

$$\begin{array}{r}
 49 \\
 \times 25 \\
 \hline
 1250 \\
 25 \\
 \hline
 1275
 \end{array}$$



Here's the second — something that we talk too little about:

Understanding and harnessing the power inside the discretionary spaces of teaching.

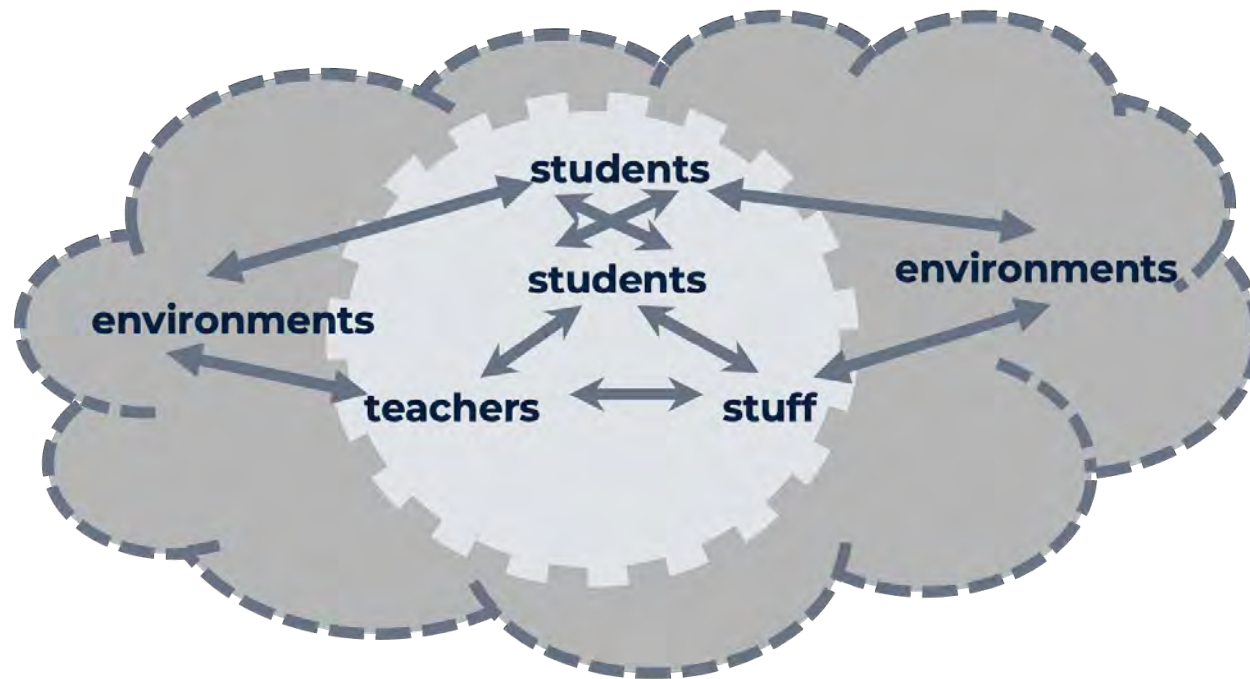
This is something we know intuitively and do not confront for its harms or use for its power for good.



2. Teaching mathematics involves tremendous discretion, and this both reproduces harm and can be a means for powerful good.



1. Teaching and learning are constructed interactively and are interpretive.
2. They take place within broad historical and socio-political environments.

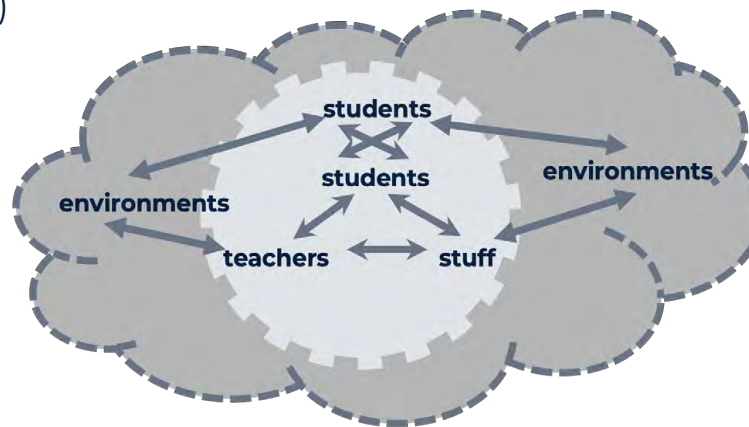


How do macro level factors interact with everyday practices?

The relationships between—
Macro-level structures (in environments)
(e.g., institutional racism, history of intelligence as the property of white people, anti-Black “scientific” racism; legacies of violence against Black and Indigenous people)

and

Micro-level interpersonal interactions
(in everyday life and in classrooms)
(e.g., teachers’ judgments of students, who is seen as “smart,” disproportional punishment and assignment to special ed and gifted programs)

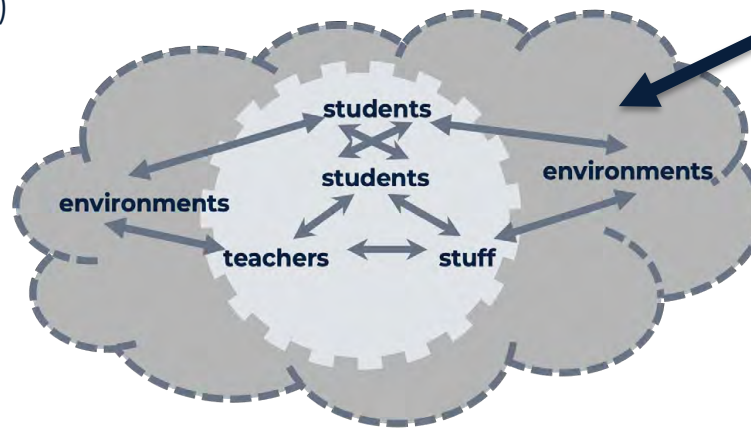


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Notice that the arrows run both ways.

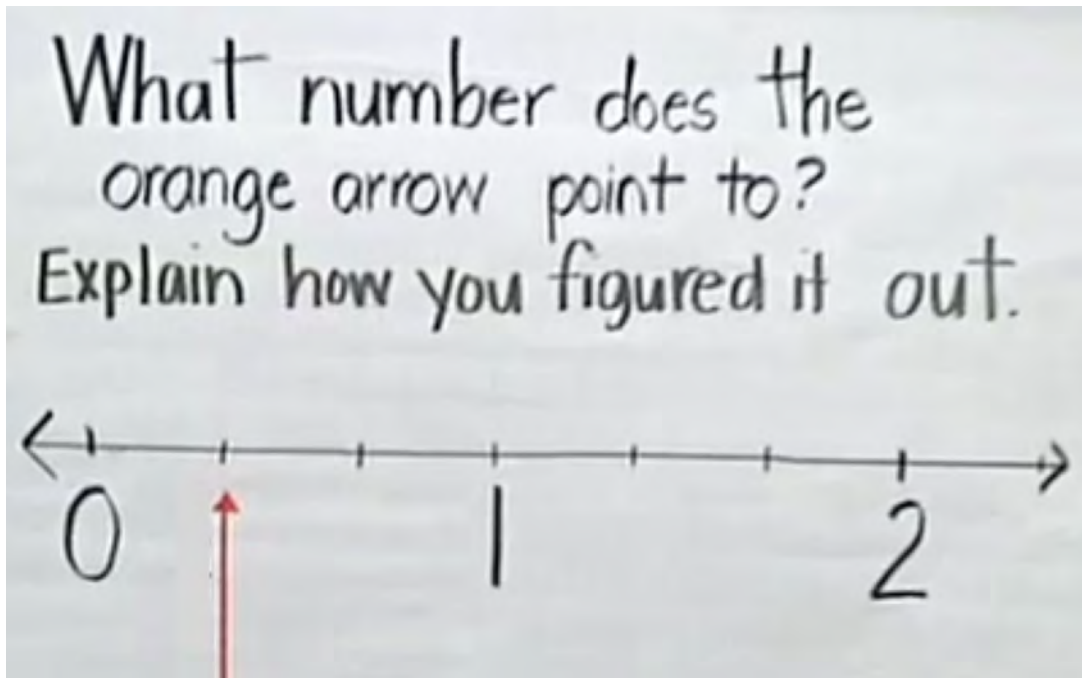
The environments in which we are all steeped shape what we take for granted and do, but learning these as normal further reinforces their persistence in society.

1. **Teaching is powerful.** When it is done with care and judgment, students can thrive — learn mathematics, develop positive identities, learn to value others and work collectively.
2. Teaching also involves **enormous discretion.**
3. How that discretion is exercised can either reinforce racialized and oppressive patterns of social, personal, and epistemic injustice and harm, or it can **disrupt these patterns.**

Fractions as numbers: The instructional goal for student understanding

3.NF.2.a

Represent a fraction $1/b$ on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into b equal parts. Recognize that each part has size $1/b$ and that the endpoint of the part based at 0 locates the number $1/b$ on the number line.





Aniyah



Toni

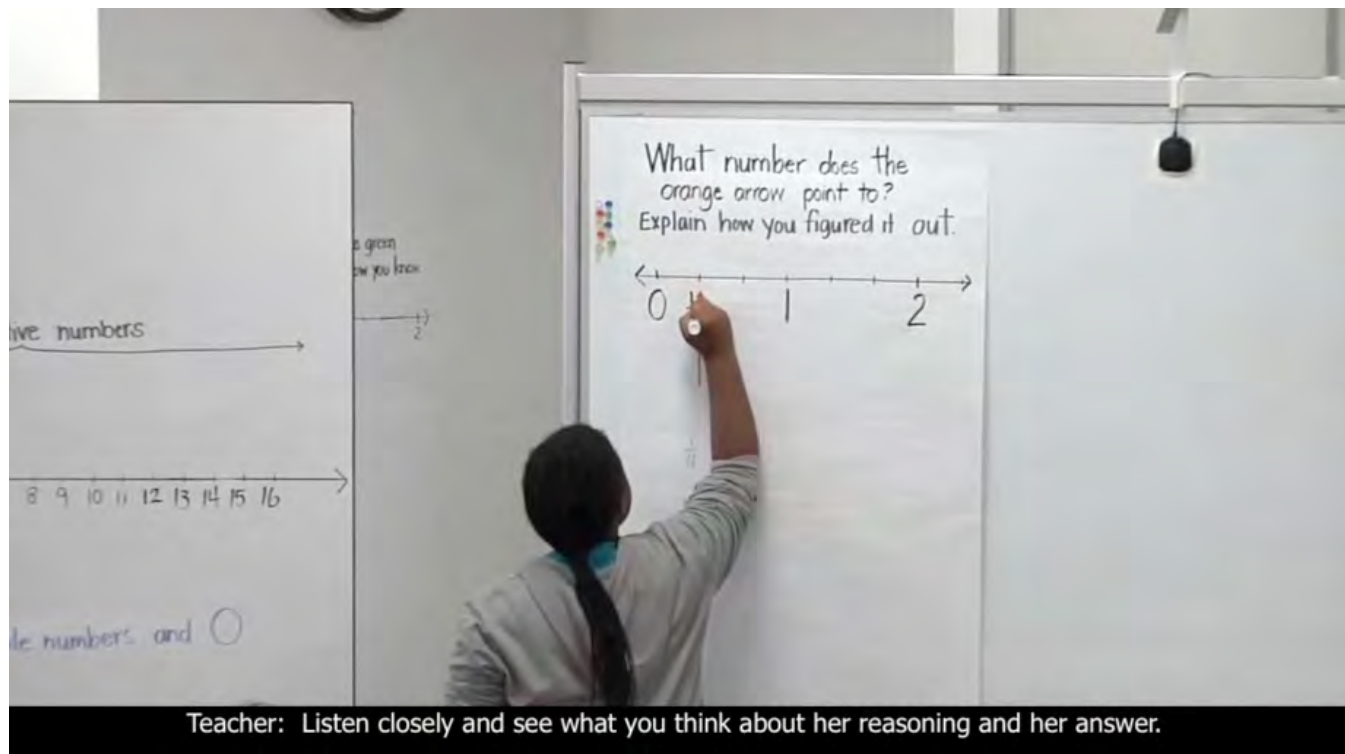


Viewing focus

What do you see about each girl's mathematical knowledge and skill?



Video: Aniyah and Toni



This video and additional supporting materials are available online [here](#).

Discuss

What do you see about each girl's mathematical knowledge and skill?



What would
happen
next?

What are the
possible
results?



In the next moment, what is likely to happen?

NORMALIZED NEXT MOVES

RESULTS



In the next moment, what is likely to happen?

NORMALIZED NEXT MOVES

- “Can someone help Aniyah out and show what we call the whole on the number line?”

RESULTS

- Aniyah is excluded and her mathematical contributions are sidelined.



In the next moment, what is likely to happen?

NORMALIZED NEXT MOVES

- “Can someone help Aniyah out and show what we call the whole on the number line?”
- “Great, Aniyah, almost! But remember that the whole is from 0 to 1.”

RESULTS

- Aniyah is excluded and her mathematical contributions are sidelined.
- Aniyah’s answer is signaled to be incorrect and she is positioned as not having contributed to the work.



In the next moment, what is likely to happen?

NORMALIZED NEXT MOVES

- “Can someone help Aniyah out and show what we call the whole on the number line?”
- “Great, Aniyah, almost! But remember that the whole is from 0 to 1.”
- “Thumbs up if you agree with Aniyah; thumbs down if you disagree.”

RESULTS

- Aniyah is excluded and her mathematical contributions are sidelined.
- Aniyah’s answer is signaled to be incorrect and she is positioned as not having contributed to the work.
- Aniyah’s solution is “voted” on by her classmates.



What else is likely?

NORMALIZED NEXT MOVES

RESULTS



What else is likely?

NORMALIZED NEXT MOVES

- “Toni, when you’re ready to participate appropriately by not playing with your hair and laughing, and have a question to ask, I will come back to you.”

RESULTS

- Toni is publicly excluded from the discussion.



What else is likely?

NORMALIZED NEXT MOVES

- “Toni, when you’re ready to participate appropriately by not playing with your hair and laughing, and have a question to ask, I will come back to you.”
- “You need to be a better listener, Toni. Aniyah already explained why she picked one-seventh. Who else has a real question for Aniyah?”

RESULTS

- Toni is publicly excluded from the discussion.
- Toni is judged to not be listening, her question is judged as not good, and she is excluded from the discussion.



What else is likely?

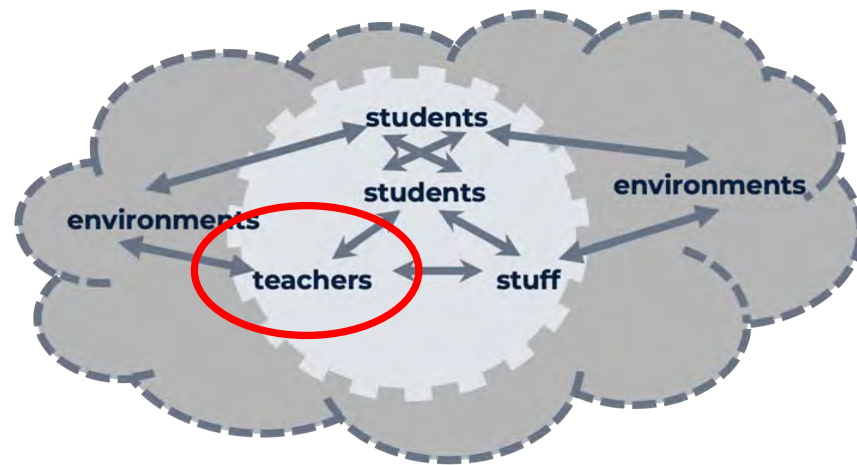
NORMALIZED NEXT MOVES

- “Toni, when you’re ready to participate appropriately by not playing with your hair and laughing, and have a question to ask, I will come back to you.”
- “You need to be a better listener, Toni. Aniyah already explained why she picked one-seventh. Who else has a real question for Aniyah?”
- “In this classroom, we are respectful of one another. When you are ready to be respectful, you can rejoin the discussion, Toni.”

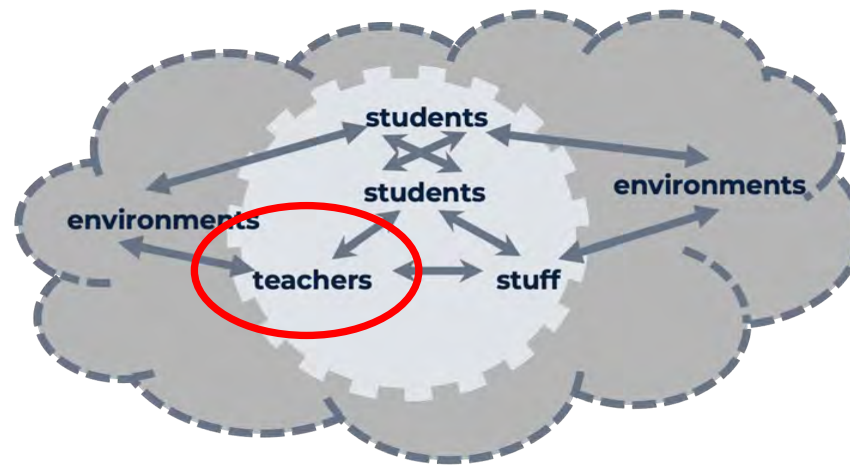
RESULTS

- Toni is publicly excluded from the discussion.
- Toni is judged to not be listening, her question is judged as not good, and she is excluded from the discussion.
- Toni is publicly named and shamed as “disrespectful,” rebuked, and her role in advancing the mathematics is sidelined.

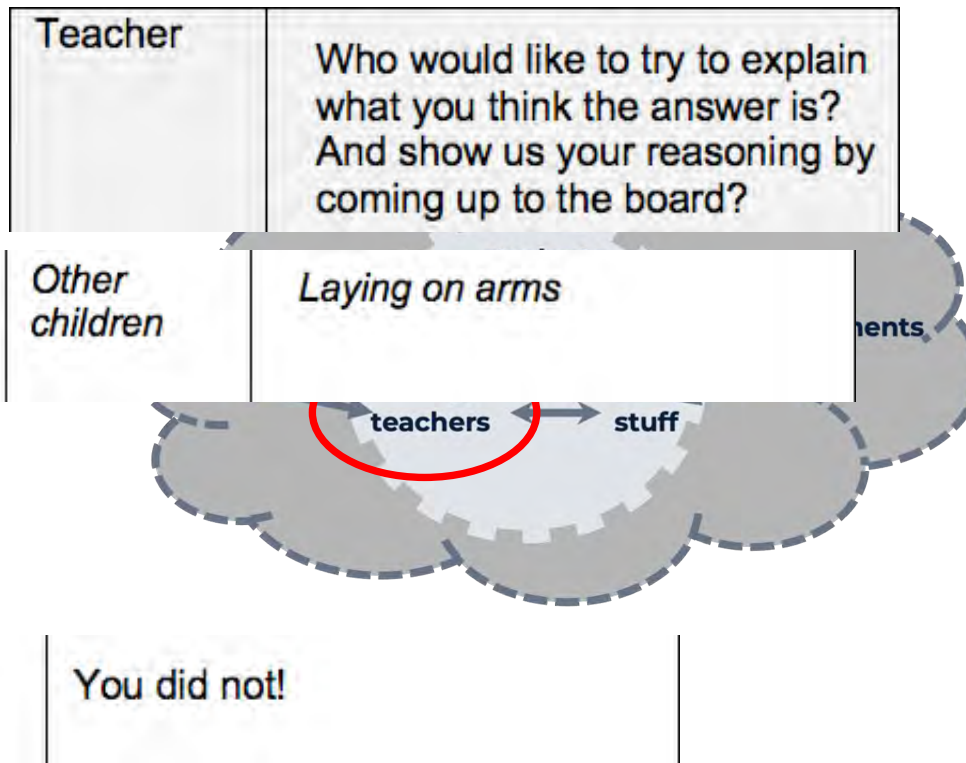




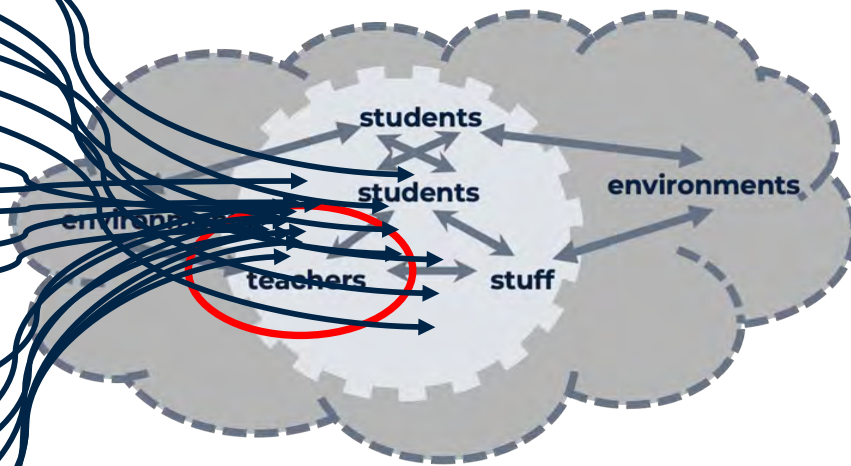
Speaker	Talk	Discretionary space
Teacher	Who would like to try to explain what you think the answer is? And show us your reasoning by coming up to the board? Who'd like to come up to the board and try to tell- And you know, it might not be right. That's okay because we're learning something new. I'd like someone to come up and sort of be the teacher and explain how you are thinking about it. Who'd like to try that this morning?	1. Deciding when to open whole-group discussion 2. Deciding what to do to launch discussion 3. Framing the expectation for presenting 4. Framing of what it "coming to the board" entails
Teacher	Okay. Aniyah?	5. Selecting a student to present
Toni	Playing with hair	6. Deciding whether to comment
Other children	Laying on arms	7. Deciding whether to comment
Teacher	When someone's presenting at the board, what should you be doing?	8. Setting norms for what to do when a student is presenting
Students in chorus	Looking at them.	
Teacher	Looking at that person-	9. Responding to students
Teacher	Uh-huh?	10. Taking up an individual student question
Aniyah	You want me to write it?	
Teacher	You're trying to mark what you think this number is and explain how you figured it out.	11. Clarifying task
Teacher	Listen closely and see what you think about her reasoning and her answer. [Aniyah writes 7/ by the orange line].	12. Setting task for the other students
Aniyah	I put one-seventh because there's-	
Toni	Did she say one-seventh?	13. Responding to student
Aniyah	(turns to Toni) Yeah. (continues to class) Because there's seven equal parts, like one, two, three, four, five, six, and then seven. (Uses her fingers to count the parts on the number line).	
Teacher	Before you agree or disagree, I want you to ask questions if there's something you don't understand about what she did. No agreeing and disagreeing. Just: All you can do right now is ask Aniyah questions. Who has a question for her?	14. Setting task for responding to student explanation
Teacher	Okay, Toni, what's your question for her?	15. Selecting student to speak
Dante	You did not!	16. Responding to student speaking across room
Toni	Why did- (laughs at another student who says something to her from across the room)	17. Responding to student laughing
Teacher	Go ahead, it's your turn.	17. Responding to student laughing
Toni	Why did you pick one-seventh?	
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Teacher	Let's listen to her answer now. That was a very good question.	19. Setting task for class 20. Responding to student



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Teacher	Okay. Anyah?	5. Selecting a student to present
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Teacher	Listen closely and see what you think about her reasoning and her answer. [Anyah writes $\frac{1}{7}$ by the orange line].	12. Setting task for the other students
Anyah	I put one-seventh because there's-	
Toni	Did she say one-seventh?	13. Responding to student
Anyah	(turns to Toni) Yeah. (continues to class) Because there's seven equal parts, like one, two, three, four, five, six, and then seven. (Uses her fingers to count the parts on the number line).	
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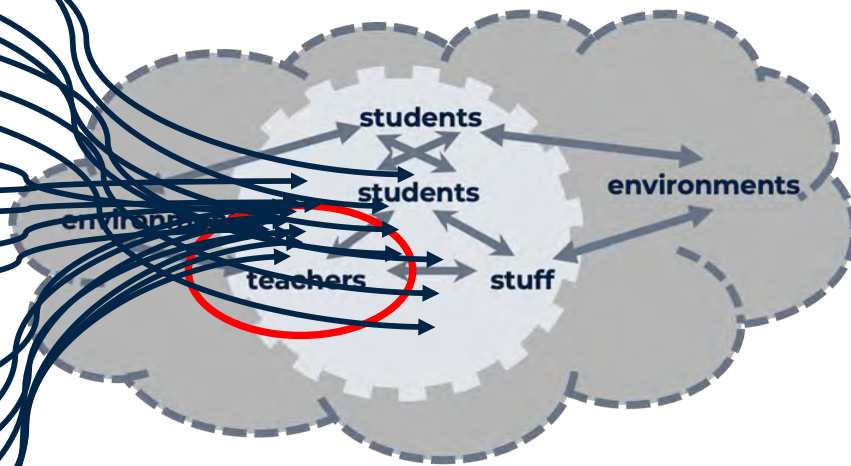


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Teaching is dense with “discretionary spaces”

Speaker	Talk	Discretionary Space
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20 in 1:28



Video: Aniyah and Toni



This video and additional supporting materials are available online [here](#).

Using discretionary spaces with care



- Interpreting Toni as asking a real question that she means.
- Hearing Toni's question as central to advancing the mathematical content.
- Reinforcing her mathematical identity, not choosing to read her body as disruptive.

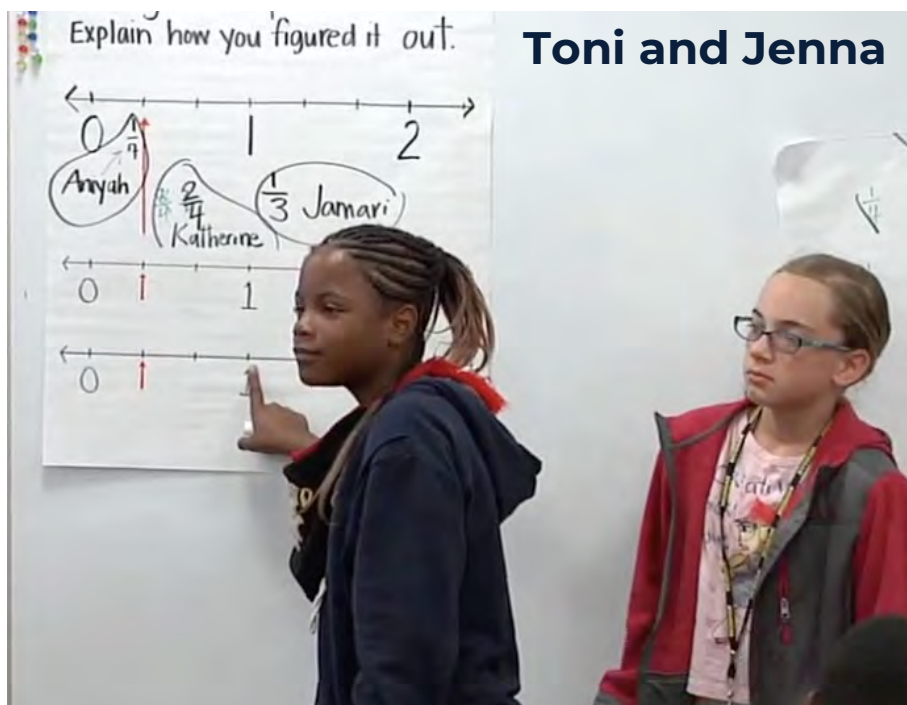


- Other children hear Aniyah as getting the discussion going, and Toni as asking an important mathematical question.
- Aniyah and Toni are both positioned as contributing to the discussion.
- Children see a teacher attending to Black girls as mathematical thinkers and contributors to collective work.



- Interpreting Aniyah as competent to answer questions about her ideas.
- Hearing Aniyah's explanation as central to advancing the mathematical content.
- Reinforcing her mathematical identity, not choosing to read her body as struggling.

14 minutes after where we stopped

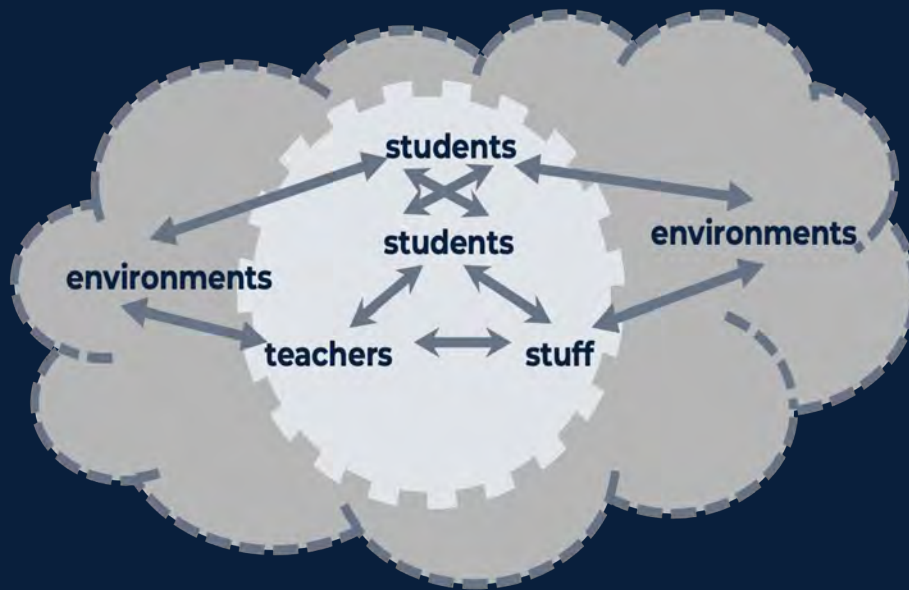


Aniyah

I did well on my goal today because my goal was to to share my ideas with the class and I did I went up to the board And share my idea with the Class on Fractions.

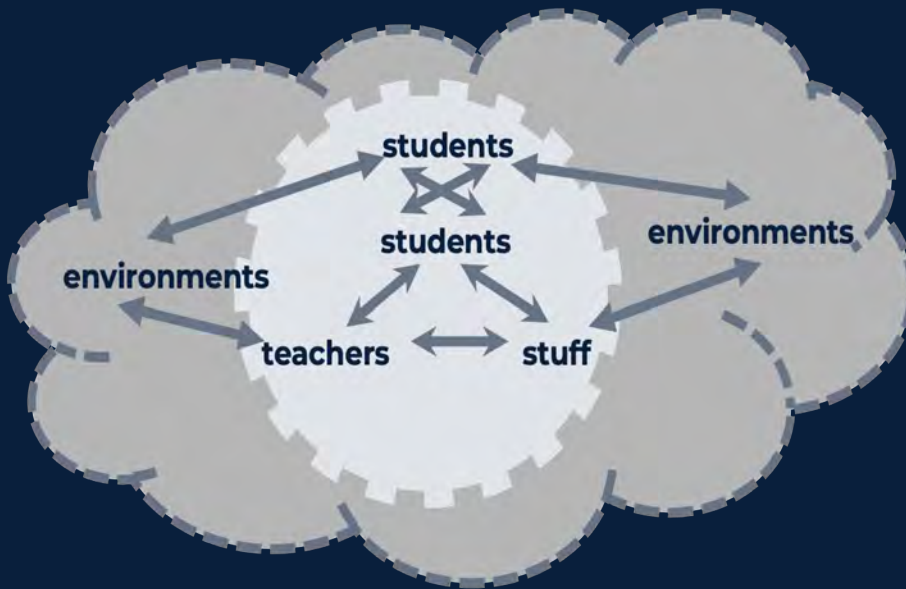
AND: On an “exit ticket,” 28 of the children were able to correctly identify a different fraction ($\frac{2}{5}$) on the number line.

What regularly fills the discretionary spaces in teaching?



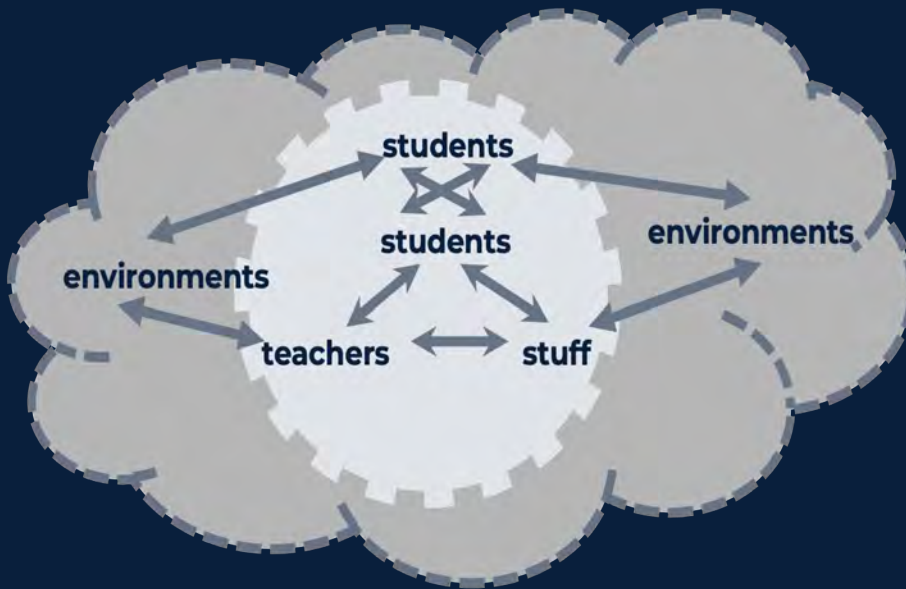
What regularly fills the discretionary spaces in teaching?

1. Teachers' experiences in a society filled with racism and oppression.



Lortie (1975), Banks, Grant and Koskela, Moll

What regularly fills the discretionary spaces in teaching?

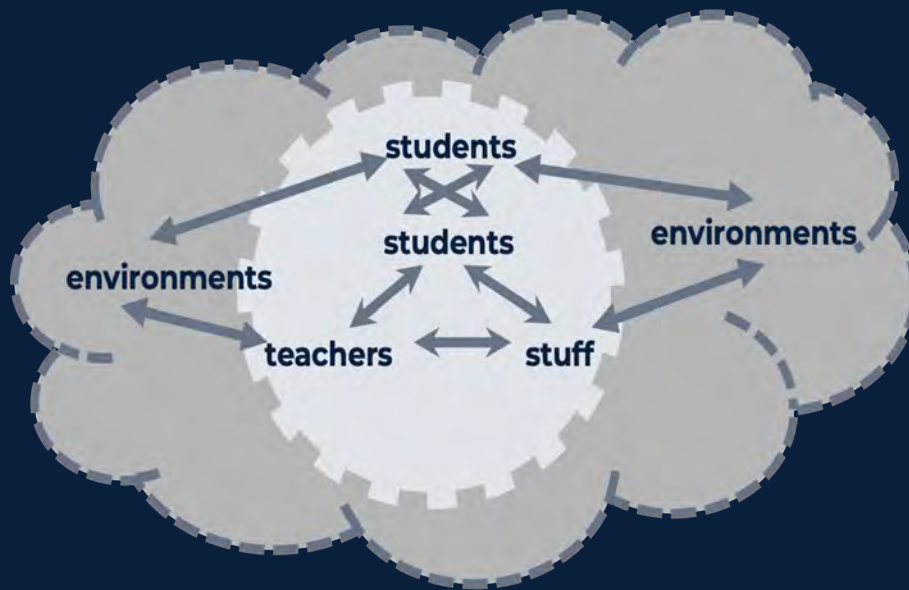


1. Teachers' experiences in a society filled with racism and oppression.
2. Normalized practices in schools that institutionalize dominant values and habits.

Lortie (1975), Banks, Grant and Koskela, Moll
Anyon (1981), Heath, Martin, Tuck

What regularly fills the discretionary spaces in teaching?

Professional education does not effectively intervene on these.



1. Teachers' experiences in a society filled with racism and oppression.
2. Normalized practices in schools that institutionalize dominant values and habits.

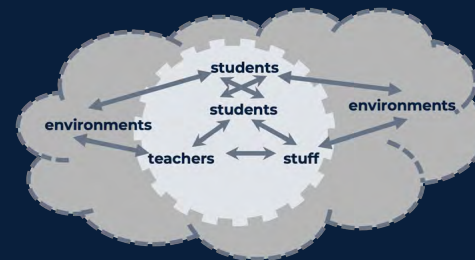
Professional education and teaching experience often teach these.

Lortie (1975), Banks, Grant and Koskela, Moll
Anyon (1981), Heath, Martin, Tuck

What does it take to disrupt the patterns that marginalize and reinforce racism?



Gholson & Martin, 2014; Langer-Osuna, 2015, 2017; Leonard & Martin, 2013; Martin, 2012, 2015

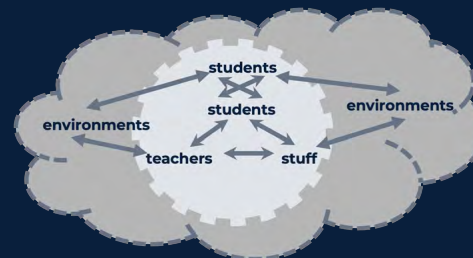


What does it take to disrupt the patterns that marginalize and reinforce racism?



- Seeing Aniyah's explanation and Toni's question as key to the class's work

Gholson & Martin, 2014; Langer-Osuna, 2015, 2017; Leonard & Martin, 2013; Martin, 2012, 2015

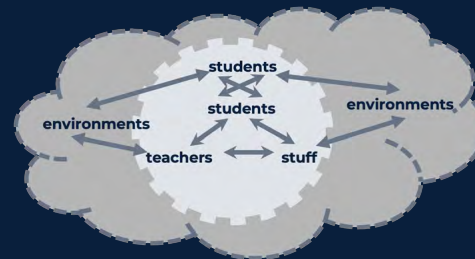


What does it take to disrupt the patterns that marginalize and reinforce racism?



- Seeing Aniyah's explanation and Toni's question as key to the class's work
- Taking as axiomatic the brilliance of Black children, and thus Toni and Aniyah

Gholson & Martin, 2014; Langer-Osuna, 2015, 2017; Leonard & Martin, 2013; Martin, 2012, 2015



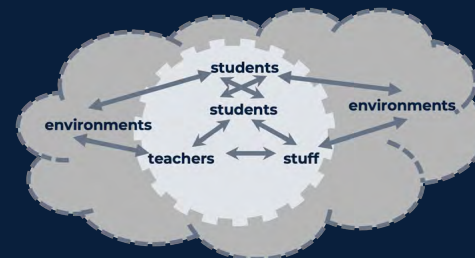
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Knowing and using mathematics in teaching (MKT)

Interpreting Toni as asking a mathematical question that she means



Gholson & Martin, 2014; Langer-Osuna, 2015, 2017; Leonard & Martin, 2013; Martin, 2012, 2015



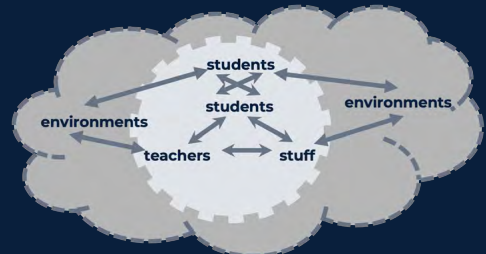
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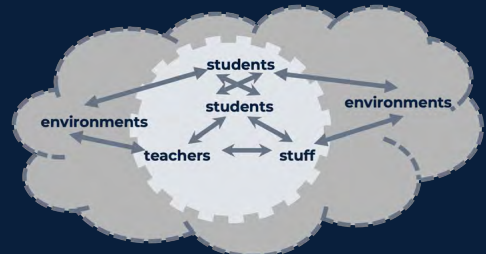


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Knowing and using mathematics in teaching (MKT)

Interpreting Toni as asking a mathematical question that she means

Having a repertoire of practices that can be adapted and used in contexts



Gholson & Martin, 2014; Langer-Osuna, 2015, 2017; Leonard & Martin, 2013; Martin, 2012, 2015



In these examples, what was needed?

- A special kind of mathematical nimbleness and being able to see ideas from someone else's point of view
- Understanding how teaching has the power to create the stage for children to show up with their brilliance
- An acuity of mathematical listening to hear Aniyah and Toni
- The mathematical insight to disrupt pervasive patterns of interpreting and responding to Black children
- The awareness of and resources to use the discretionary spaces to support mathematics learning



Review: The argument of today's talk

1. The premise: Mathematics education is not working for most young people and this matters.
2. “Reforms” are, in part, rooted in persistent myths and not in knowledge of what real improvement would take.
3. Polarizing and dichotomizing discourses take the focus away from practice.
4. Improving young people’s mathematics learning will depend on challenging taken-for-granted normative practices that are harmful.
5. It will take centering the work of teaching as a powerful lever for justice, and a deep understanding of what it takes to disrupt embedded patterns and develop practice.



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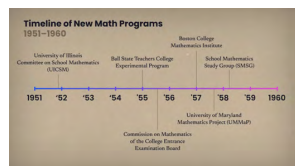


Image on slide 8:
A timeline of new math reform organisations in the 1950s, from “What Happened to ‘New Math’?” by Asher Isbrucker, *Medium*, April 20, 2021.
Retrieved from <https://medium.com/age-of-awareness/what-happened-to-new-math-eeb8522fc695>

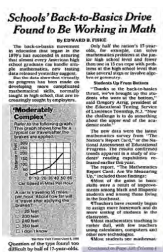


Image on slide 8:
Screenshot of “School’s Back-to-Basics Drive Found to be Working in Math,” by Edward D. Fiske, *New York Times*, June 8, 1988.
Retrieved from <https://www.nytimes.com/1988/06/08/us/schools-back-to-basics-drive-found-to-be-working-in-math.html>

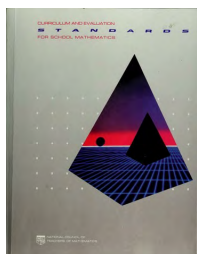


Image on slide 8:
Cover of *Curriculum and Evaluation Standards for School Mathematics*, by the National Council of Teachers of Mathematics Commission on Standards for School Mathematics, 1989.
Retrieved from <https://archive.org/details/curriculumevalua00nati/mode/2up>

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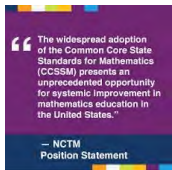


Image on slide 8:
Graphic from “Supporting the Common Core State Standards for Mathematics,” by the National Council of Teachers of Mathematics, August 2013.
Retrieved from <https://www.nctm.org/ccssmposition/>

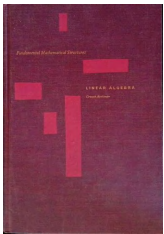


Image on slide 9:
Cover of *Linear Algebra*, 1965.
Retrieved from <https://www.amazon.com/Linear-Algebra-Fundamental-Mathematical-Structures/dp/B002NB51BM>

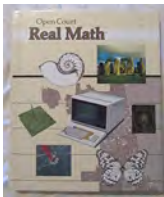


Image on slide 9:
Cover of *Open Court Real Math, Grade 7*, 1991.
Retrieved from <https://www.amazon.com/Open-Court-Real-Math-Grade/dp/081260637X>

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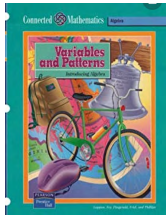


Image on slide 9:
Cover of *Connected Mathematics Variables and Patterns*, 2003.
Retrieved from <https://www.amazon.com/CONNECTED-MATHEMATICS-VARIABLES-PATTERNS-STUDENT/dp/0131808168>

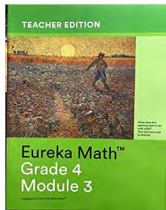


Image on slide 9:
Cover of *Eureka Math, A Story of Units: Grade 4, Module 3*, 2015.
Retrieved from <https://www.amazon.com/Eureka-Math-Grade-Module-Teachers/dp/1632553724>

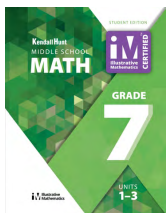


Image on slide 9:
Cover of *Illustrative Mathematics: Grade 7*, 2019.
Retrieved from <https://k12.kendallhunt.com/product/illustrative-mathematics-grade-7-student-edition-set>

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U.S. STUDY SHOWS PUPIL ACHIEVEMENT AT LEVEL OF 1970

American elementary and secondary school pupils have made some educational progress in recent years, but they are only now reaching the achievement levels of students in 1970, according to a major Federal report issued today, which added that students are unprepared for the complex and demanding world of the 21st century. "Today's children seem to know about as much math and about as much science and read about as well as their parents did at that age about 20 years ago," Education Secretary Lamar Alexander said of the report, "Trends in Academic Progress."

Image on slide 10:

Screenshot from "U.S. study shows pupil achievement at level of 1970," by Karen De Witt, *New York Times*, October 1, 1991.

Retrieved from <https://www.nytimes.com/1991/10/01/us/us-study-shows-pupil-achievement-at-level-of-1970.html>

Long-Term NAEP Scores for 13-Year-Olds Drop for First Time Since Testing Began in 1970s — 'A Matter for National Concern,' Experts Say

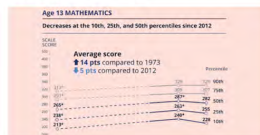


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Screenshot from "Long-Term NAEP Scores for 13-Year-Olds Drop for First Time Since Testing Began in 1970s — 'A Matter for National Concern,' Experts Say," by Kevin Mahnken, *The74*, October 14, 2021.

Retrieved from <https://www.the74million.org/article/naep-long-term-unprecedented-performance-drop-american-13-year-olds/>

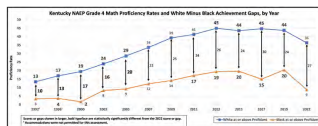


Image on slide 10:

Graphic from "What happened to Kentucky's NAEP achievement gaps for math?," by Richard Innes, Bluegrass Institute, October 30, 2022.

Retrieved from <https://bipps.org/blog/what-happened-to-kentuckys-naep-achievement-gaps-for-math>

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Image on slide 11:

Photo from “What do teachers need this school year? Laura McClure from TED-Ed resolved to find out,” by Laura McClure, TED, September 7, 2016.

Retrieved from <https://ideas.ted.com/how-to-help-a-teacher-out/>



Image on slide 12:

“Two groups of people arguing and fighting.”

Retrieved from https://www.freepik.com/premium-vector/two-groups-people-arguing-fighting-conflict-among-people-angry-characters-having-argument-disagreement-vector-illustration-colleagues-having-debate-misunderstanding_21715825.htm