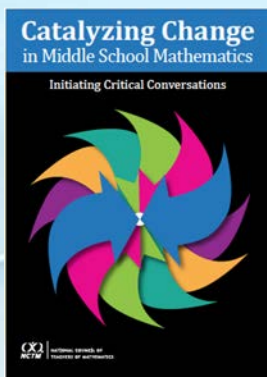




# *Catalyzing Change in Middle School Mathematics: Implementing Critical Conversations Centered on the 4 Key Recommendations*

National Council of Teachers of Mathematics  
100 Days of Professional Learning  
May 28, 2020



**Sarah B. Bush**  
**Christa Jackson**  
**George J. Roy**  
**Eric Milou**





# Who is in the Chat?

Introduce Yourself and Share Your Role

- Classroom Teachers
- Instructional Coaches/Specialists
- School Administrators
- District Leaders
- University and College Faculty
- Graduate Students
- Family and Community Members
- Other Stakeholders in Mathematics Education



# Writing Team: Catalyzing Change in Middle School Mathematics



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# Agenda



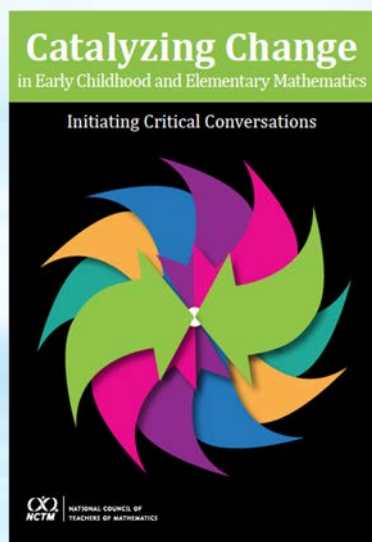
- Catalyzing Change Movement
- Catalyzing Change in Middle School Mathematics
- Recommendation 1: Broaden the Purposes
- Recommendation 2: Create Equitable Structures
- Recommendation 3: Implement Equitable Instruction
- Recommendation 4: Develop Deep Understanding
- Next Steps

Use the “Chat” to engage in conversation during the webinar

Use the “Q & A” to pose questions directly to the presenters.

# Catalyzing Change Series

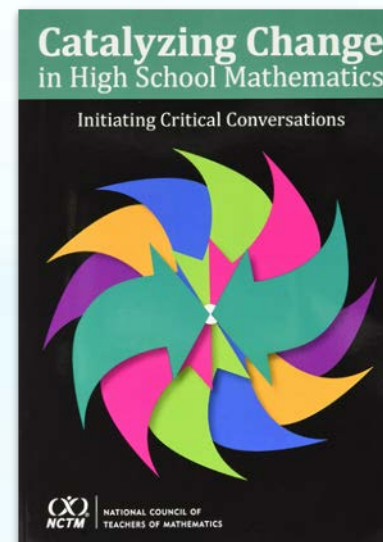
*Official Positions of the National Council of Teachers of Mathematics*



NCTM (2020)



NCTM (2020)



NCTM (2018)



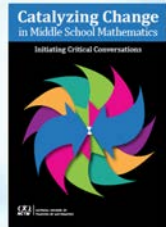


# Conversation Starter

Share a strategy you use to ensure middle school mathematics is a positive experience for each and every student?

*Share in the chat!*



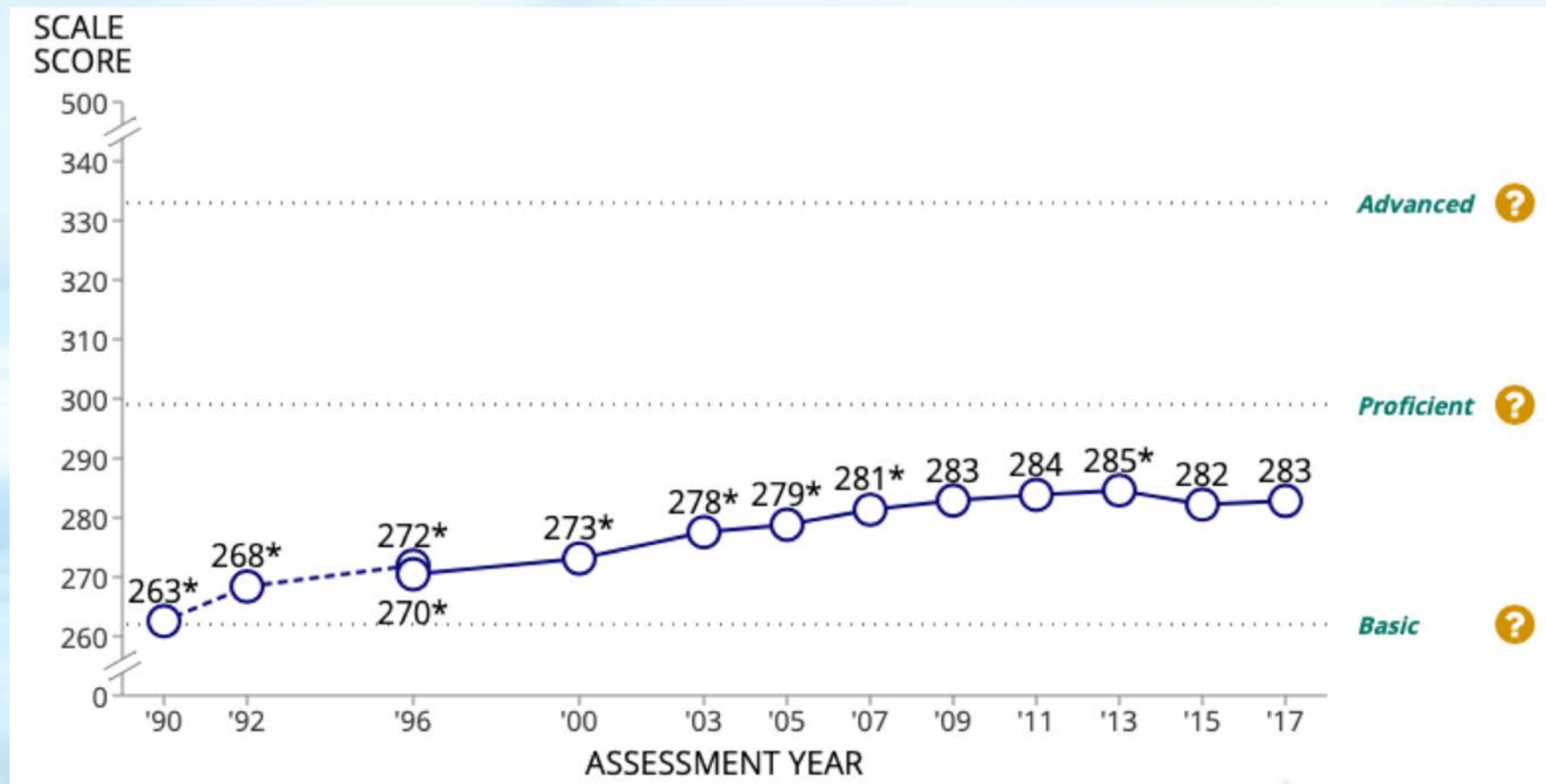


# Recommendations Across the Series

	Early Childhood and Elementary	Middle School	High School
<b>Broaden the Purposes of Learning Mathematics</b>	Each and every child should develop deep mathematical understanding as confident and capable learners; understand and critique the world through mathematics; and experience the wonder, joy, and beauty of mathematics.	Each and every student should develop deep mathematical understanding, understand and critique the world through mathematics, and experience the wonder, joy, and beauty of mathematics, which all contribute to a positive mathematical identity.	Each and every student should learn the Essential Concepts in order to expand professional opportunities, understand and critique the world, and experience the wonder, joy, and beauty of mathematics.
<b>Create Equitable Structures in Mathematics</b>	Early childhood and elementary mathematics should dismantle inequitable structures, including ability grouping and tracking, and challenge spaces of marginality and privilege.	Middle school mathematics should dismantle inequitable structures, including tracking teachers as well as the practice of ability grouping and tracking students into qualitatively different courses.	High school mathematics should discontinue the practice of tracking teachers as well as the practice of tracking students into qualitatively different or dead-end course pathways.
<b>Implement Equitable Mathematics Instruction</b>	Mathematics instruction should be consistent with research-informed and equitable teaching practices that nurture children's positive mathematical identities and strong sense of agency.	Mathematics instruction should be consistent with research-informed and equitable teaching practices that foster students' positive mathematical identities and strong sense of agency.	Classroom instruction should be consistent with research-informed and equitable teaching practices.
<b>Develop Deep Mathematical Understanding</b>	Early childhood settings and elementary schools should build a strong foundation of deep mathematical understanding, emphasize reasoning and sense-making, and ensure the highest-quality mathematics education for each and every child.	Middle schools should offer a common shared pathway grounded in the use of mathematical practices and processes to coherently develop deep mathematical understanding, ensuring the highest-quality mathematics education for each and every student.	High schools should offer continuous four-year mathematics pathways with all students studying mathematics each year, including two to three years of mathematics in a common shared pathway focusing on the Essential Concepts, to ensure the highest-quality mathematics education for all students.



## Why Catalyzing Change Now? (8<sup>th</sup> Grade Data)



SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1990–2017 Mathematics Assessments.





# Why We Need to Catalyze Change in Middle School Mathematics

- The evidence is compelling that students who are identified as Black, Latinx, Indigenous, language learners, poor, with disabilities, and other marginalized learners do not have the same access to high-quality mathematics programs.
- Structures and traditions in mathematics education are deeply rooted. Those that impede development of student mathematical identity, agency, and growth must be identified and dismantled. Structures, policies, and practices that encourage positive identity, a strong sense of agency, and mathematical development must be adopted and strengthened.



# Why We Need to Catalyze Change in Middle School Mathematics

- To motivate and engage students in learning mathematics, instructional practices must be examined to systemically support, enhance, and adopt practices that are equitable and provide high-quality learning opportunities.
- Ensure the mathematical ideas developed, including mathematical practices, processes, and content, support students as they continue their study of mathematics and navigate their lives.
- Mathematical learning experiences that engage students in rich investigations reinstate mathematics to its rightful position as a magnet to STEM.



# So... What is *Catalyzing Change in Middle School Mathematics* all About?

A Gateway, not a Gatekeeper

Collaborative Endeavor

Deep Mathematical Understanding

Connected to students' interests and out-of-school experiences

Equitable, Just, and Inclusive

**Imagine mathematics in the middle as...**



# 4 Key Middle School Recommendations

1. **Broaden the Purposes of Learning Mathematics:** Each and every student should develop deep mathematical understanding, understand and critique the world through mathematics, and experience the wonder, joy, and beauty of mathematics, which all contribute to a positive mathematical identity.
2. **Create Equitable Structures in Mathematics:** Middle school mathematics should dismantle inequitable structures, including tracking teachers as well as the practice of ability grouping and tracking students into qualitatively different courses.
3. **Implement Equitable Mathematics Instruction:** Mathematics instruction should be consistent with research-informed and equitable teaching practices that foster students' positive mathematical identities and strong sense of agency.
4. **Develop Deep Mathematical Understanding:** Middle schools should offer a common shared pathway grounded in the use of mathematical practices and processes to coherently develop deep mathematical understanding, ensuring the highest-quality mathematics education for each and every student.



# Recommendation 1

## Broaden the Purposes of Learning Mathematics

Each and every student should develop deep mathematical understanding, understand and critique the world through mathematics, and experience the wonder, joy, and beauty of mathematics, which all contribute to a positive mathematical identity.



# Recommendation 1

## Broaden the Purposes of Learning Mathematics

*“Developing a deep understanding of mathematics and a positive mathematical identity are connected and not mutually exclusive.” (p. 9)*



# Recommendation 1

## Broaden the Purposes of Learning Mathematics

Each and every student should:

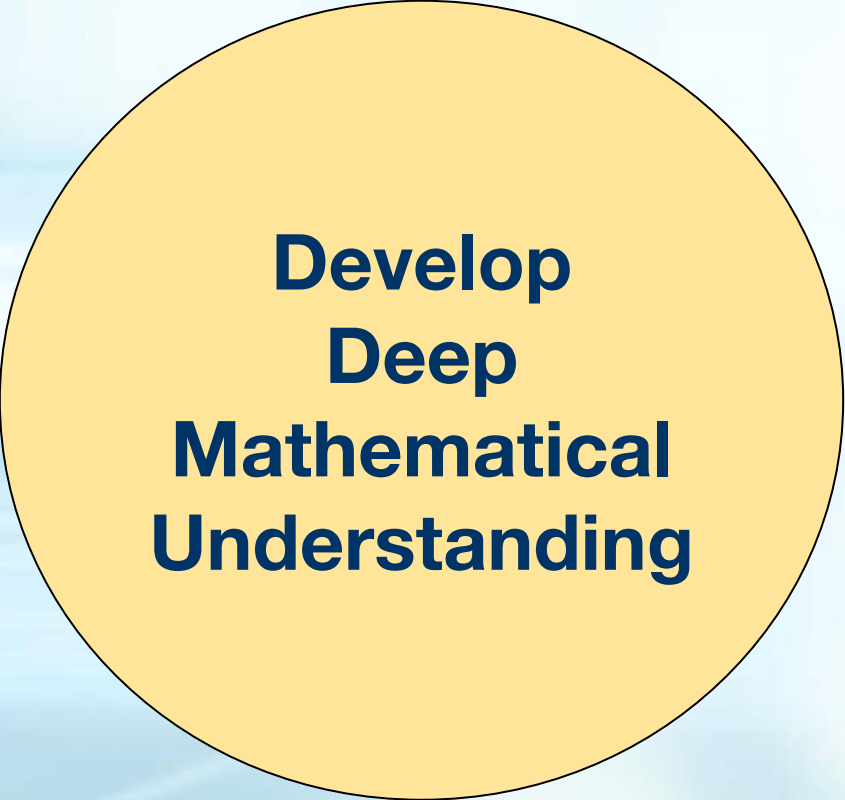
- develop deep mathematical understanding
- understand and critique the world through mathematics
- experience the wonder, joy, and beauty of mathematics

.... which all contribute to a positive mathematics identity.



# Recommendation 1

## Broaden the Purposes of Learning Mathematics



**Develop  
Deep  
Mathematical  
Understanding**

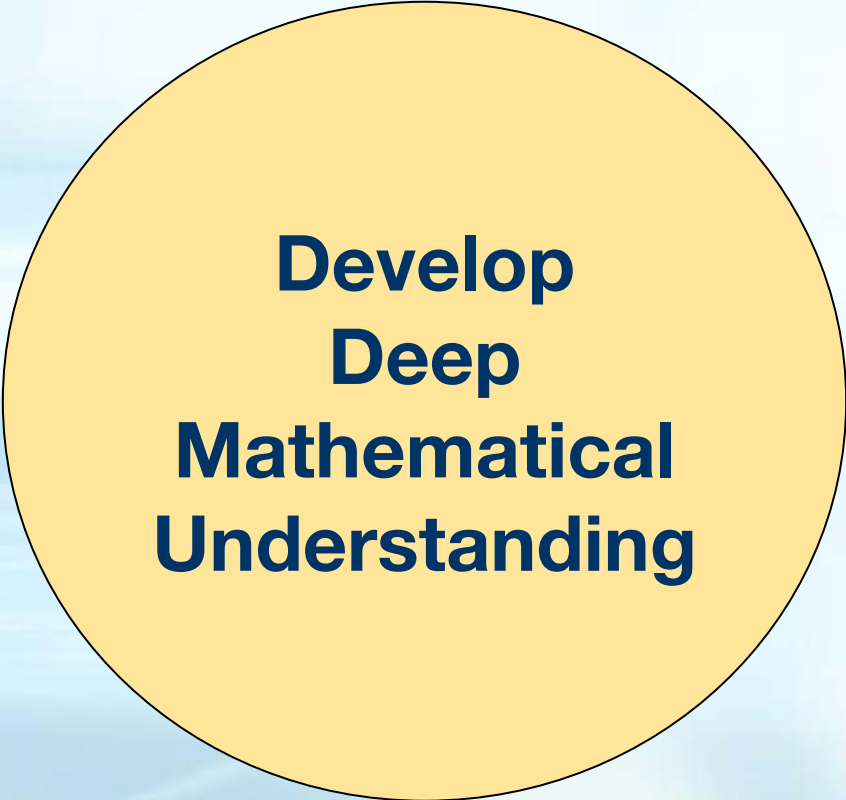
The mathematics that students learn during middle school includes many of the most useful mathematics concepts that students will use as adults.

(NCEE, 2013; OECD, 2016)



# Recommendation 1

## Broaden the Purposes of Learning Mathematics



**Develop  
Deep  
Mathematical  
Understanding**

The learning of mathematics is inextricably linked to students' identities and how they and others see them as learners and doers of mathematics.

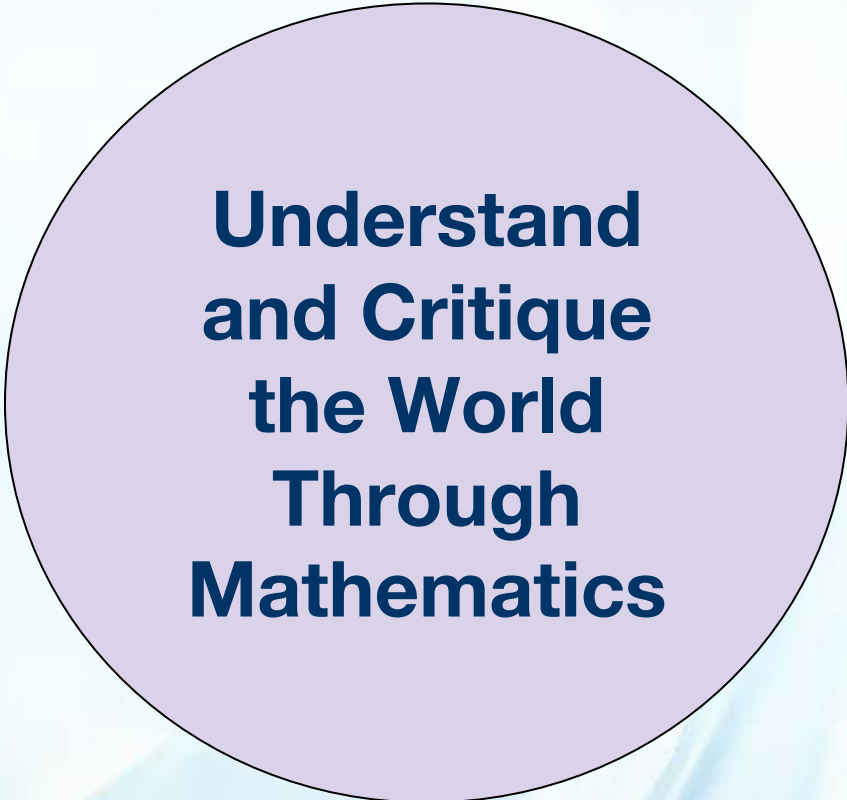
(Aguirre, Mayfield-Ingram, and Martin 2013; Jackson and Delaney 2017; Wood et al. 2019)

# Recommendation 1

## Broaden the Purposes of Learning Mathematics

Middle school mathematics programs must challenge students to reason, and, most important, they must be respectful of students' distinctive cultural and developmental needs and interests.

(Gutstein 2003; Lipstitz and  
West 2006; Lounsbury  
2015)



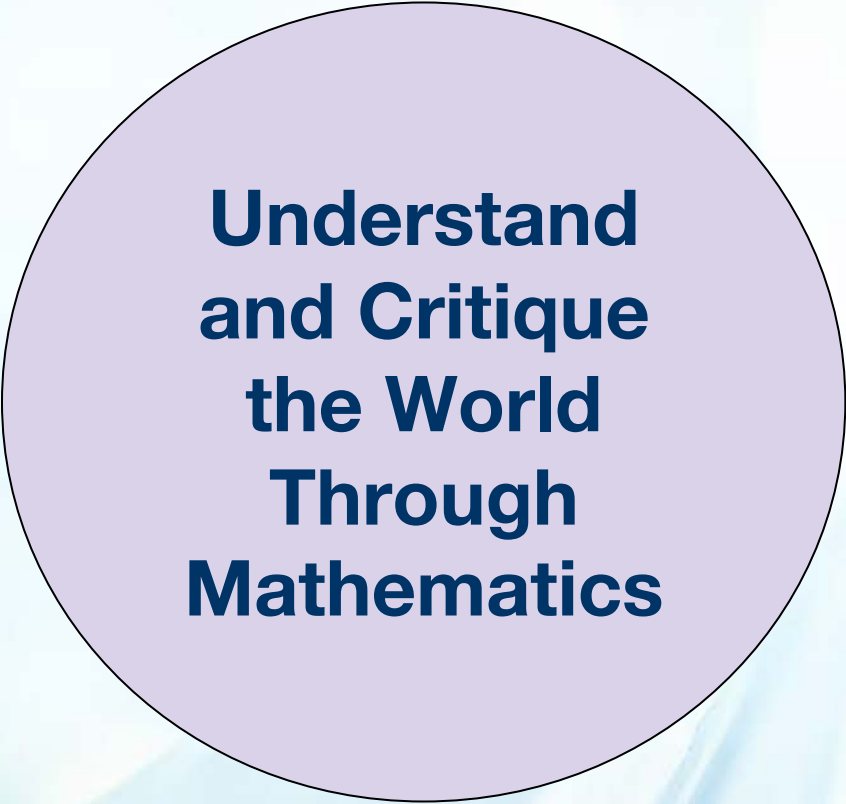
**Understand  
and Critique  
the World  
Through  
Mathematics**

# Recommendation 1

## Broaden the Purposes of Learning Mathematics

Middle school students are exploring who they are, who they can be, what they should be, and what they should do as they forge their own identity and explore how they fit into larger societal structures.

(Beane 1997)



**Understand  
and Critique  
the World  
Through  
Mathematics**

# Recommendation 1

## Broaden the Purposes of Learning Mathematics

- *“Students need to have opportunities to see themselves in the curriculum (mirror) as well as have a view onto a broader world (window).”* (Gutiérrez 2007, p. 3)
- Mirrors and windows afford middle school mathematics teachers the opportunity to leverage these concerns as a way to nurture their students’ identity in action or strong sense of mathematical agency, which empowers them to explore mathematics in personally and socially meaningful ways.  
(Berry 2018a)

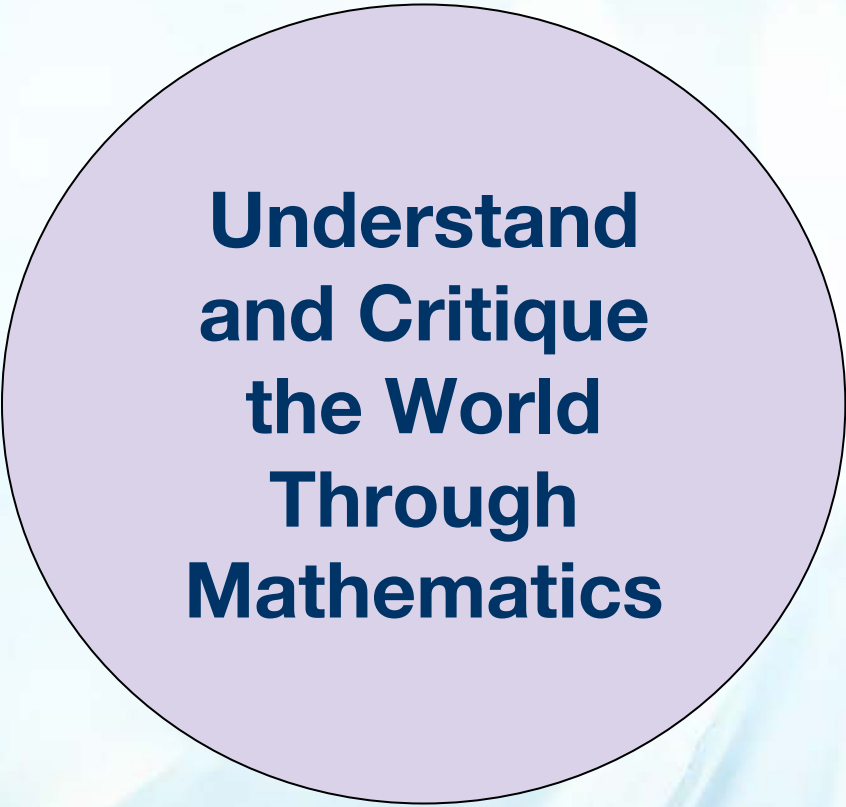
**Understand  
and Critique  
the World  
Through  
Mathematics**



# Recommendation 1

## Broaden the Purposes of Learning Mathematics

When students are allowed to pose questions about their lives, contest injustices, and critically challenge how their world is shaped, the utility of mathematics for social justice is visible to them because they are empowered to be part of a solution. (Gutstein 2003)



**Understand  
and Critique  
the World  
Through  
Mathematics**



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# 100 Days of PROFESSIONAL LEARNING

Using Math to Make Sense  
of Our World: Pandemics,  
Viruses, and Our Actions

Speakers: Beth Kobett, Jeff Shih,  
Sarah Bush, Dan Teague, and David Barnes

April 2, 2020 • 7:00 p.m. EDT

# Recommendation 1

## Broaden the Purposes of Learning Mathematics

**Experience  
the Wonder,  
Joy, and  
Beauty of  
Mathematics**

“Mathematical play builds virtues that enable us to flourish in every area of our lives. ...

Math play builds community — when you share in the delight of working on a problem with another human being.

And math play builds perseverance . . . math investigations make us more fit for the next problem, whatever that is, even if we don’t solve the current problem.”



# Conversation Starter

In what ways can the unique backgrounds, experiences, cultural perspectives, traditions, and knowledge that students bring to the classroom be leveraged to deepen their mathematical understanding?

*Please share in the chat.*







# Recommendation 2

## Create Equitable Structures in Mathematics

Middle school mathematics should dismantle inequitable structures, including tracking teachers as well as the practice of ability grouping and tracking students into qualitatively different courses.





# Recommendation 2

## Create Equitable Structures in Mathematics

### Barriers to Equitable Structures

Deficit views about students that are deeply rooted in the broader culture of mathematics education and grounded in long-standing structures and practices.



# Recommendation 2

## Create Equitable Structures in Mathematics

- Shifting deficit beliefs is often challenging as many do not recognize the deficit perspectives they hold.
- *“The question is not whether all students can succeed in mathematics but whether adults organizing mathematical learning opportunities can alter traditional beliefs and practices to promote success for all.”* (NCTM 2014, p. 61)

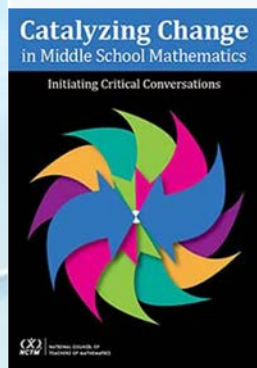


# Recommendation 2

## Create Equitable Structures in Mathematics

### Barriers to Equitable Structures

Deficit views about students that are deeply rooted in the broader culture of mathematics education and grounded in long-standing structures and practices.



### Strategies to Build Equitable Structures

- Engage in this work with colleagues to initiate the confrontation, identification, and examination of deficit-based beliefs about students (or their families and communities).
- Immediately stop the use of “deterministic” labels for students, such as “gifted,” “honors,” “college prep,” “regular,” “intensive,” or “remedial.” Similarly, while you may have students who are currently struggling with a concept, avoid labeling students as “struggling.”

# Recommendation 2

## Create Equitable Structures in Mathematics

**The brilliance and capability of each and every student must be acknowledged.**

**Systemic change is critical.**

**The success of each and every student is a collective responsibility.**



## Recommendation 2

### Create Equitable Structures in Mathematics

- Ability grouping and tracking sort middle school students based on perceived ability
- Ability grouping is an inequitable structure that perpetuates privilege for a few and marginality for others.
- Tracking places students into qualitatively different pathways or qualitatively different mathematical experiences.





## Recommendation 2

### Create Equitable Structures in Mathematics

There is no reason to justify why a particular race does better or worse in mathematics, other than institutionalized racist structures within many U.S. schools (Battey & Leyva 2016), educators and families must acknowledge and begin to disrupt these structures.





# Conversation Starter

What supports are needed in our school and district to discontinue the inequitable practices of ability grouping and tracking?

*Please share in the chat.*



# Recommendation 2

## Create Equitable Structures in Mathematics

### Action steps for de-tracking:

- Identify, analyze, and evaluate policies and practices to assess the impact of tracking
- Provide each and every student access to grade-appropriate intellectually challenging curriculum
- Provide on-going professional development and support
- Provide time and space for educators to collaborate

(Berry 2018)



# Recommendation 3

## Implement Equitable Mathematics Instruction

Mathematics instruction should be consistent with research-informed and equitable teaching practices that foster students' positive mathematical identities and strong sense of agency.







# Recommendation 3

## Implement Equitable Mathematics Instruction

Equitable instruction requires that teachers take direct action stemming from intentional planning and reflection informed by data from their students.

Deficit views about some students' intellectual potential should not be tolerated to any degree.

Ensuring students have shared authority aligns with believing that each and every student should have access to high-quality mathematics instruction, is capable of doing mathematics, and is mathematically competent.





# Conversation Starter

What are some characteristics of students with a positive mathematical identity?

*Share in the chat.*



# Recommendation 3

## Implement Equitable Mathematics Instruction

**Positive  
Mathematical  
Identity**



**Strong Sense  
Mathematical  
Agency**



**Shared  
Mathematical  
Authority**

**Students as Empowered  
Thinkers and Doers of Mathematics**

### *Mathematical identity is ...*

- ▶ A view of oneself as a doer, knower, and sense maker of mathematics
- ▶ A deeply held belief about one's own ability to engage successfully with mathematics
- ▶ Impacted by how students are positioned in the mathematics classroom

### *Mathematical agency is ...*

- ▶ One's mathematical identity in action
- ▶ Evidenced by how students engage in the middle school mathematics classroom
- ▶ Created in a space and place where students are empowered to be doers and thinkers of mathematics

### *Shared mathematical authority is ...*

- ▶ Students contributing valuable knowledge to the classroom conversation
- ▶ Students developing their own mathematical ideas
- ▶ Students engaging in meaningful mathematical discourse with each and every student positioned as a contributor to the collective knowledge of the class

## Recommendation 3

### Implement Equitable Mathematics Instruction

- Quality of mathematics learning experiences rather than quantity of problems
- Mathematics is seen as a collaborative endeavor
- Students are asked to solve problems in more than one way
- Students are encouraged to share their thinking, not just solutions





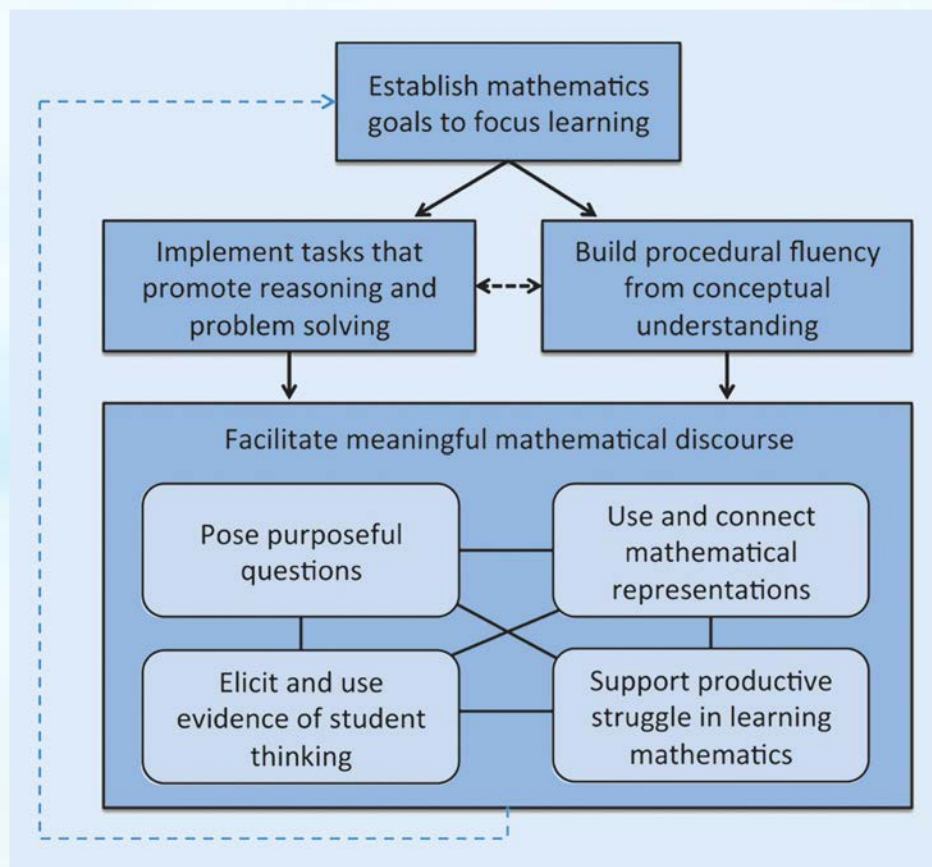
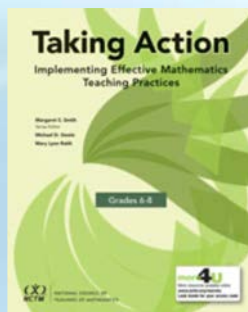
# Recommendation 3

## Implement Equitable Mathematics Instruction

NCTM's (2014) Eight  
Mathematics Teaching  
Practices

Mathematics Teaching  
Framework  
(Smith, Steele, & Raith 2017)

Research-informed and inherently  
represent good teaching







## Recommendation 3

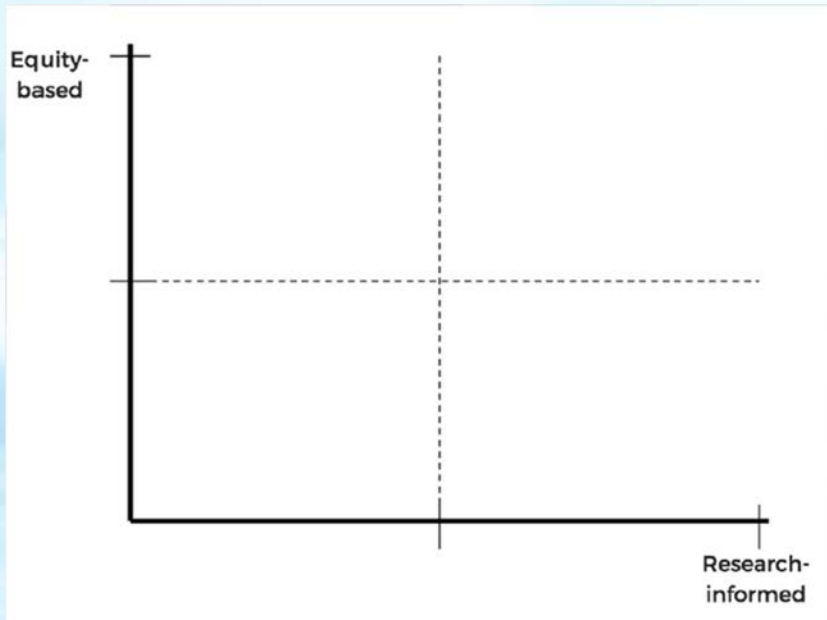
### Implement Equitable Mathematics Instruction

Ideas and  
Strategies to  
Further  
Establish  
Equitable  
Mathematics  
Instruction

- **Culturally Relevant Pedagogy** (Ladson-Billings 1995; 2014) & **Culturally Responsive Teaching** (Gay 2000; 2018)
- **Complex Instruction** (Cohen et al. 2002; Featherstone et al. 2011; Horn 2012)
- **Five Equity-Based Mathematics Teaching Practices** (Aguirre, Mayfield-Ingram, and Martin 2013)
- **Nine Equitable Mathematics Teaching Practices** (Bartell et al. 2017)
- **Universal Design for Learning** (UDL; CAST 2018)

# Recommendation 3

## Implement Equitable Mathematics Instruction



\_\_\_\_\_ % of the time I am intentional in my actions to use/support teaching practices in mathematics that are

- *research-informed*
- *equity-based*

# Supporting the Implementation of Equitable Mathematics Instruction

*“In an excellent mathematics program, educators hold themselves and their colleagues accountable for the mathematical success of every student and for personal and collective professional growth toward effective teaching and learning of mathematics.” (NCTM 2014, p. 99)*



- Schools should purposefully prioritize time and space for teacher collaboration during the school day.
- Supporting incoming and early career teachers is essential.

# Recommendation 4

## Develop Deep Mathematical Understanding

Middle schools should offer a common shared pathway grounded in the use of mathematical practices and processes to coherently develop deep mathematical understanding, ensuring the highest-quality mathematics education for each and every student.





## Recommendation 4

### Develop Deep Mathematical Understanding

*“A mathematics teacher who plans at the outset with the **proficiencies, practices, and processes** in mind has the mindset to engage each and every student as active participants in their and their peers’ mathematics learning.” (p. 67)*

*“Engaging students in the mathematics of **relevant, often sensitive or controversial topics**, requires careful attention and thoughtful implementation, but should and needs to be a part of students’ middle school mathematical learning experience.” (p. 68)*





# Recommendation 4

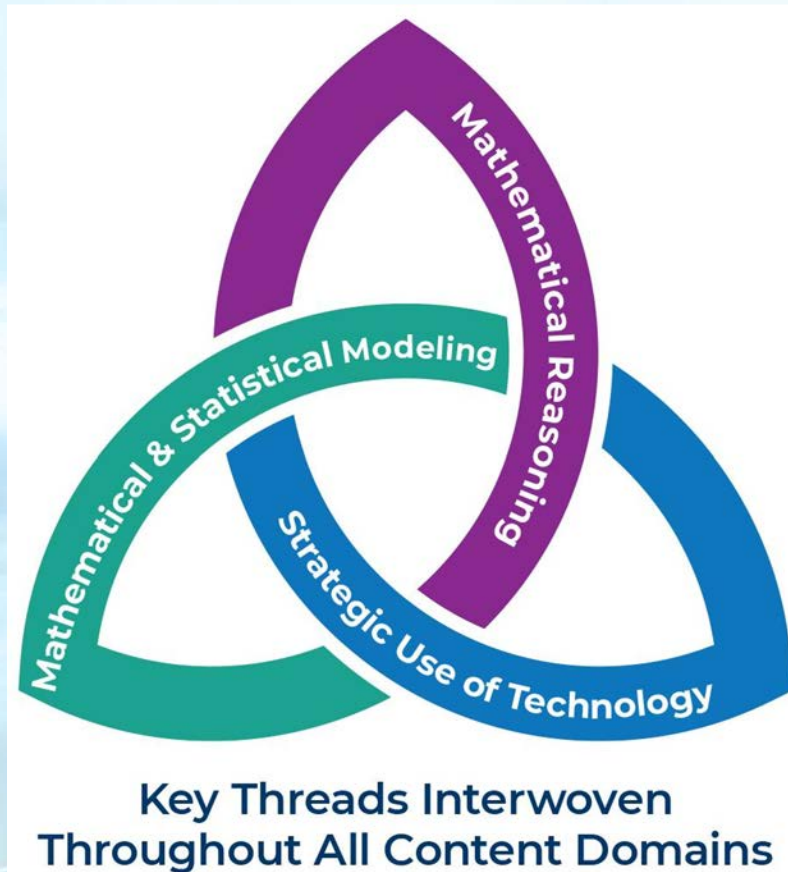
## Develop Deep Mathematical Understanding

Strands of Mathematical Proficiency (NRC 2001)	Standards for Mathematical Practice (NGA Center and CCSSO 2010)	Process Standards (NCTM 2000)
<ul style="list-style-type: none"><li>• Conceptual Understanding</li><li>• Procedural Fluency</li><li>• Strategic Competence</li><li>• Adaptive Reasoning</li><li>• Productive Disposition</li></ul>	<ol style="list-style-type: none"><li>1. Make sense of problems and persevere in solving them</li><li>2. Reason abstractly and quantitatively</li><li>3. Construct viable arguments and critique the reasoning of others</li><li>4. Model with mathematics</li><li>5. Use appropriate tools strategically</li><li>6. Attend to precision</li><li>7. Look for and make use of structure</li><li>8. Look for and express regularity in repeated reasoning</li></ol>	<ul style="list-style-type: none"><li>• Problem Solving</li><li>• Reasoning and Proof</li><li>• Communication</li><li>• Connections</li><li>• Representation</li></ul>

It's implementing the content standards in ways that embody the proficiencies, practices, and processes that will help us realize the full potential of middle school mathematics and our students.

# Recommendation 4

## Develop Deep Mathematical Understanding



- Mathematical & Statistical Modeling
- Mathematical Reasoning
- Strategic Use of Technology

Meaningful learning experiences in these three key threads should be interwoven throughout the content domains.



## Recommendation 4

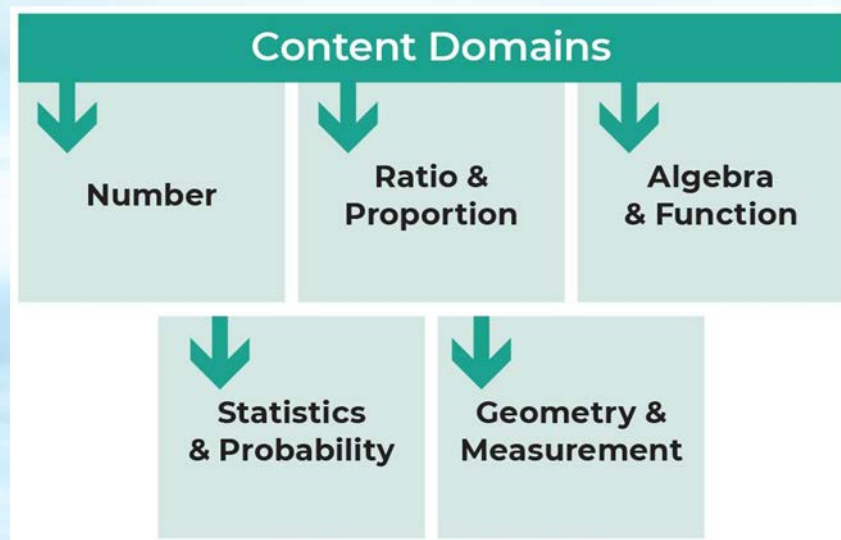
### Develop Deep Mathematical Understanding

*“It is the responsibility of middle school educators to ensure that mathematics content is taught through engaging students using the mathematical practices and processes in **ways that focus on depth and coherence, where mathematics is not overproceduralized.***”

*Such meaningful mathematical learning experiences equip and empower students with the awareness and ability to use mathematics as a way to make sense of the world and make informed decisions as members of a democratic society. School mathematics should be a gateway to students’ success, not a gatekeeper.” (p. 73)*

# Recommendation 4

## Develop Deep Mathematical Understanding



*Catalyzing Change in Middle School Mathematics* is organized into **five content domains**, guided by the curricular focal points (NCTM 2006) and current college and career readiness standards, including the Common Core State Standards for Mathematics (NGA Center and CCSSO 2010).

# Example

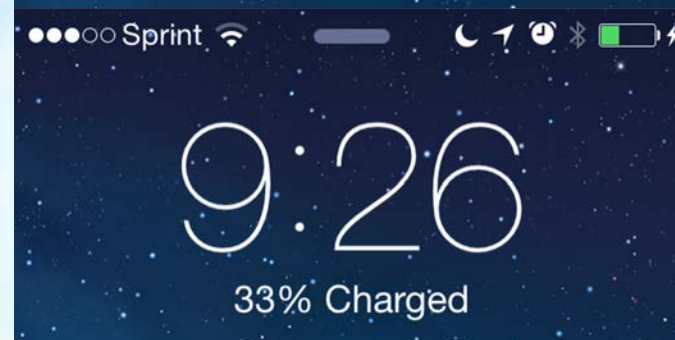
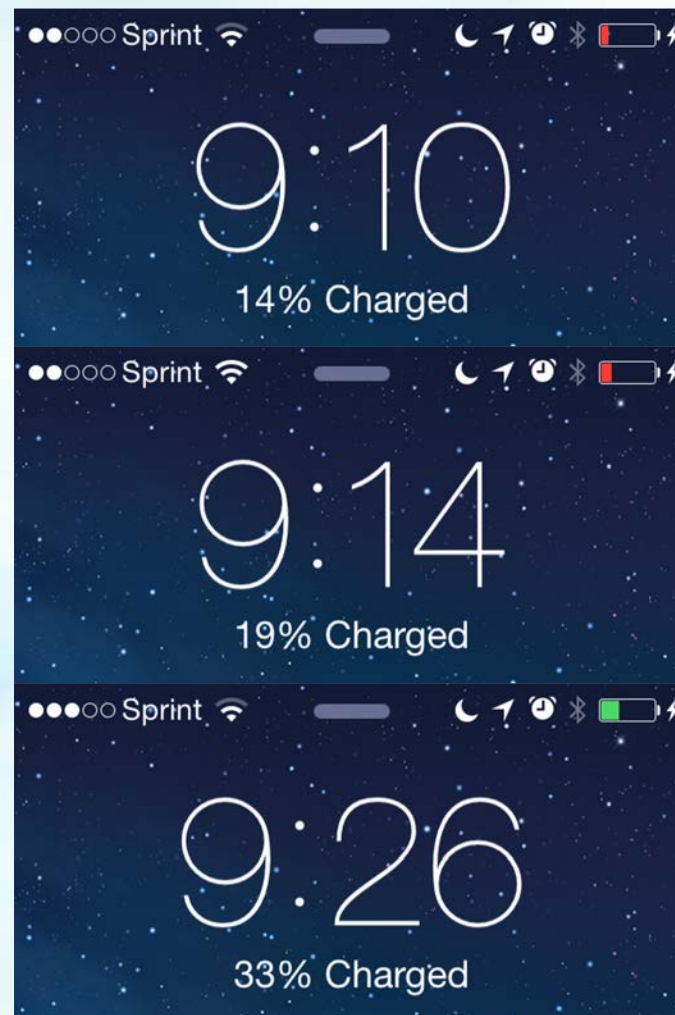
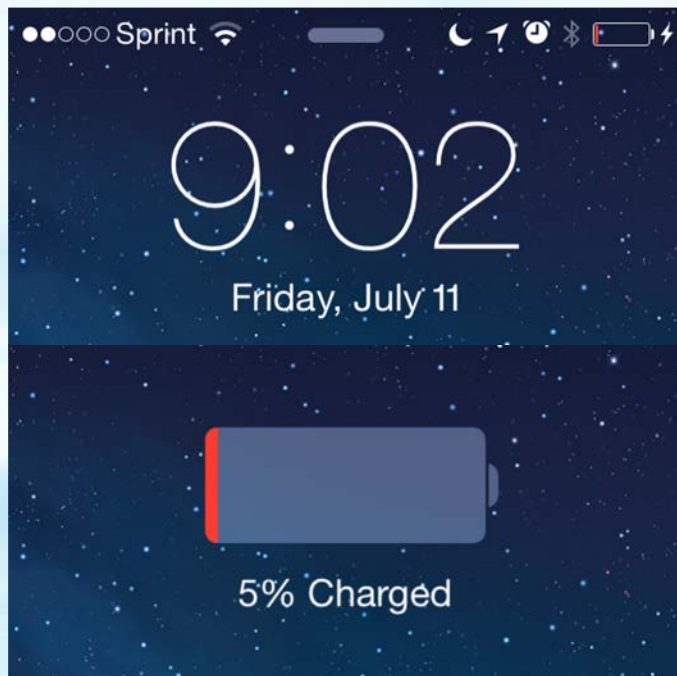


**Credit to Michael Fenton**





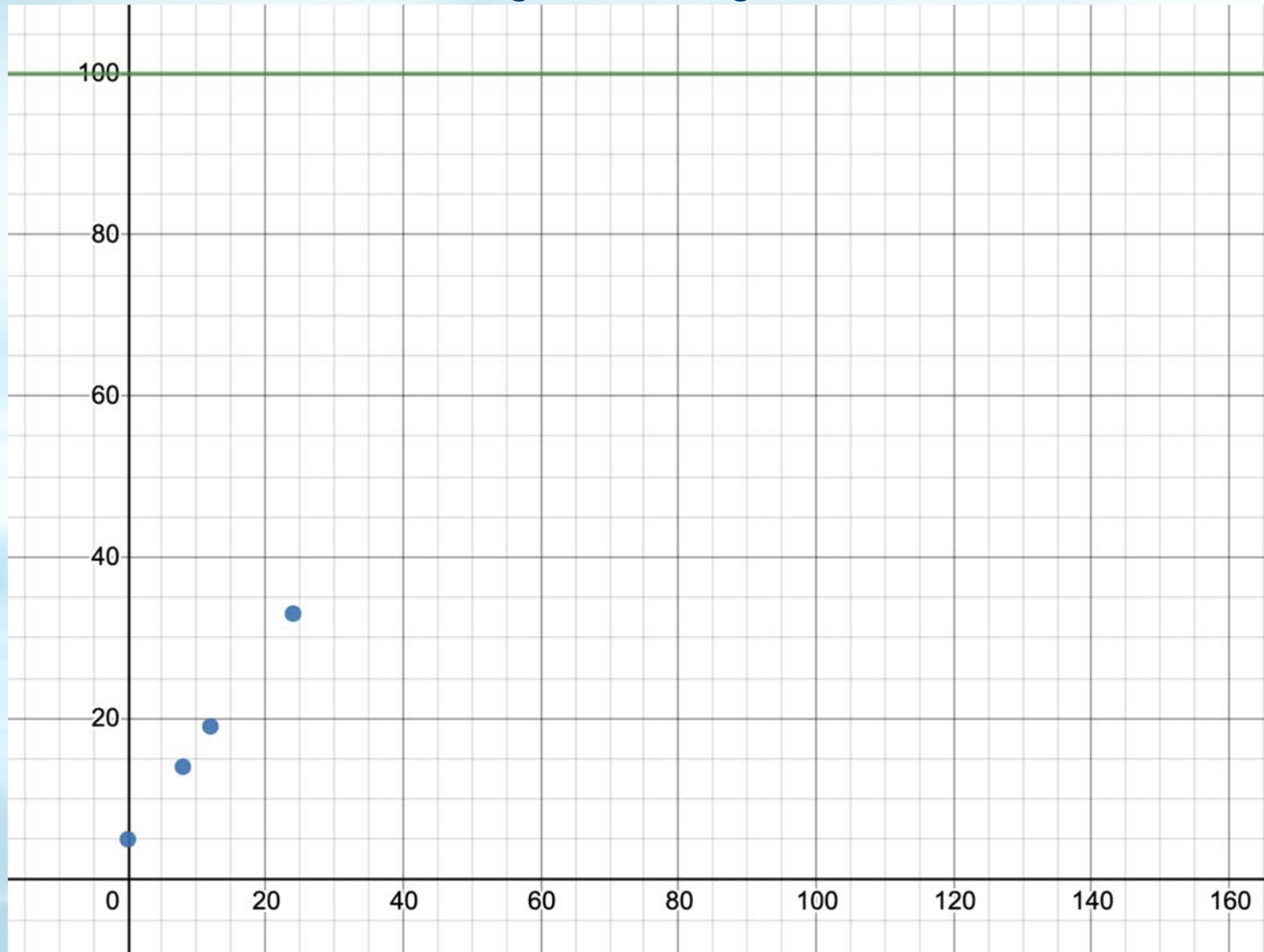
What do you notice?  
What do you wonder?





## Phone Charge Percentage Over Time

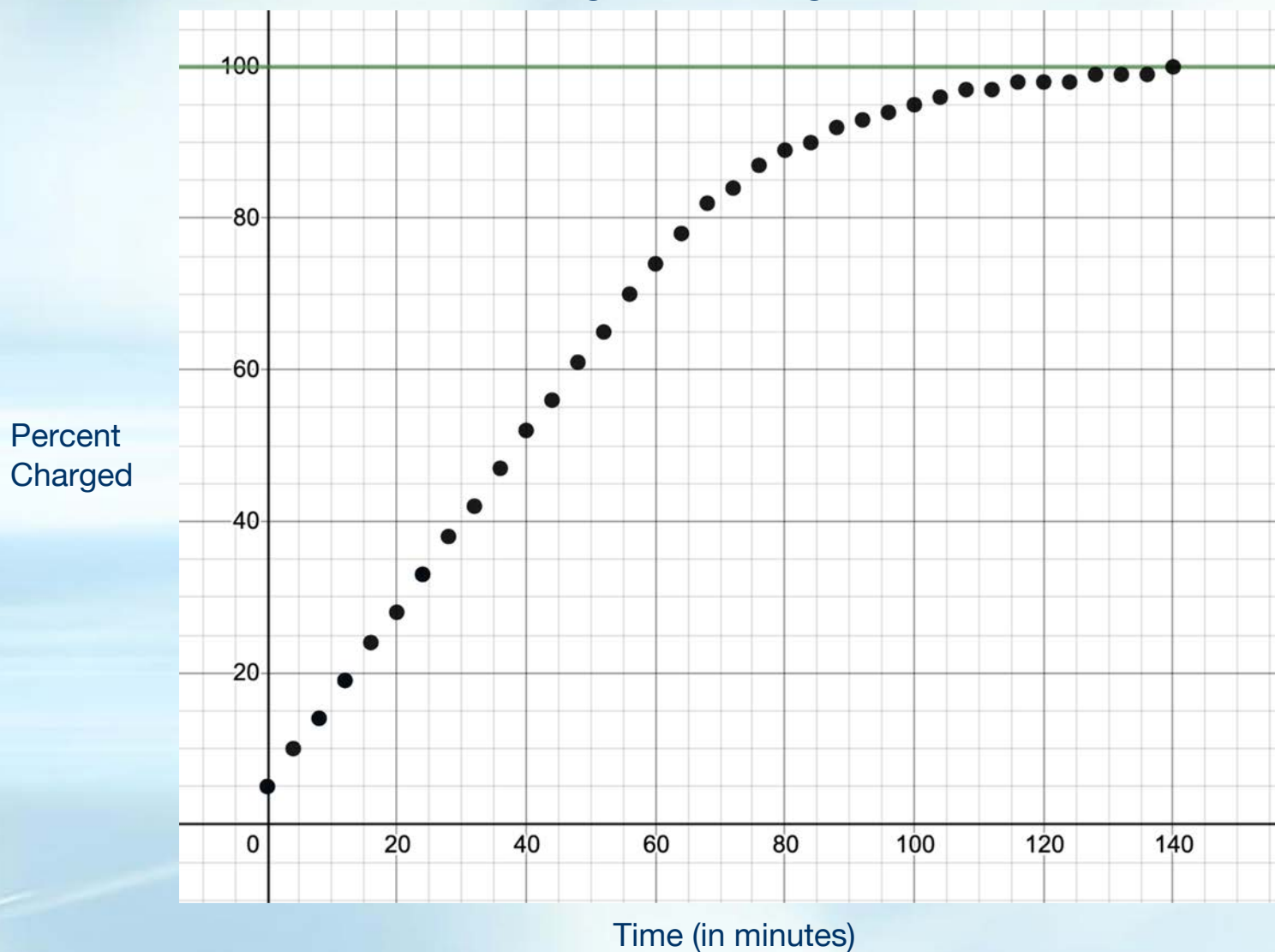
Percent  
Charged



Time (in minutes)



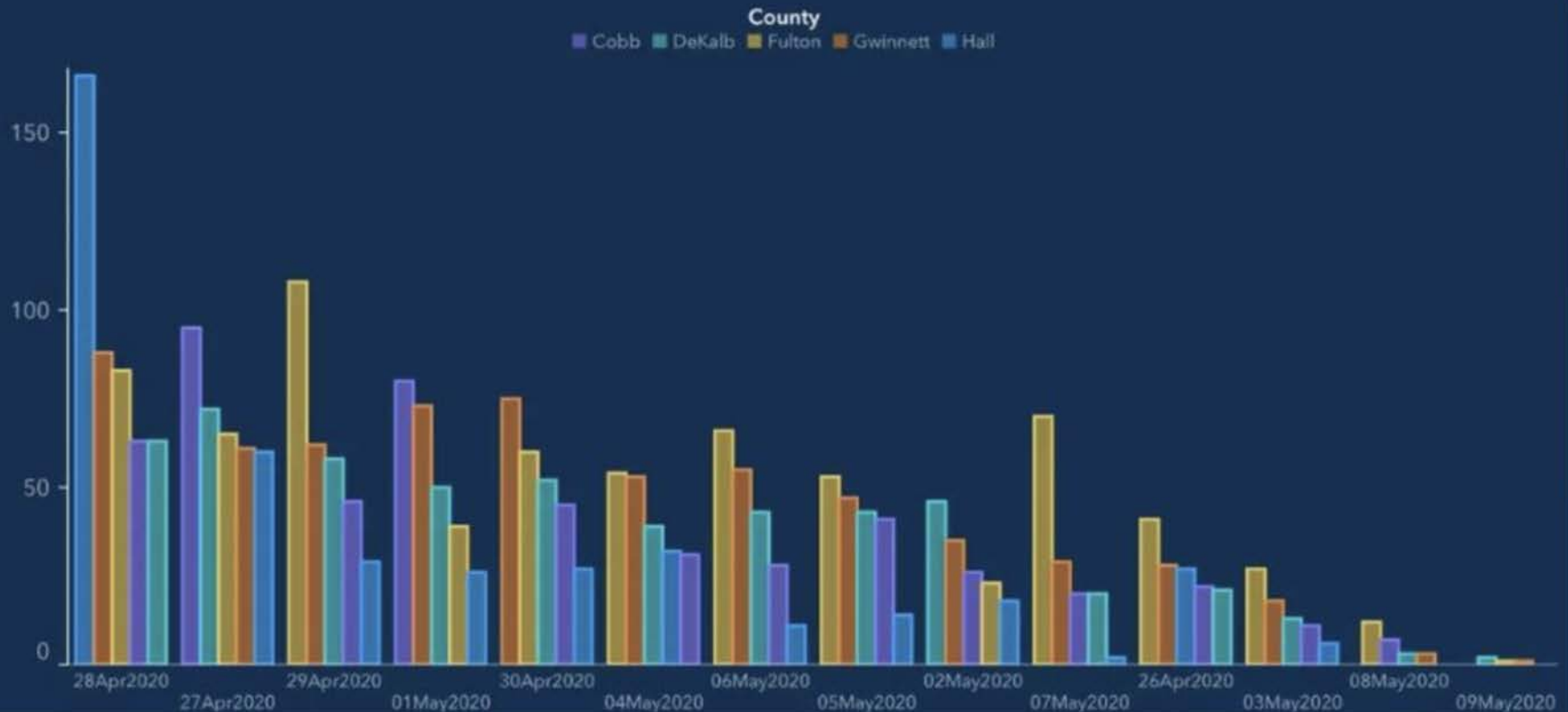
## Phone Charge Percentage Over Time



<https://www.desmos.com/calculator/hzlch8fx0x>

## Top 5 Counties with the Greatest Number of Confirmed COVID-19 Cases

The chart below represents the most impacted counties over the past 15 days and the number of cases over time. The table below also represents the number of deaths and hospitalizations in each of those impacted counties.







# Conversation Starter

What is one mathematical idea that is overproceduralized when taught in our school or district, and how can this be revisited to implement a more balanced approach?

*Share in the chat.*





# Supporting the Implementation of Mathematical Practices, Processes, and Content

- Teachers should not be expected, nor do they have adequate time, to pull resources at random
- *Catalyzing Change* does not prescribe what curriculum should be used, but advocate that teachers are supported in collective planning, implementing, and reflecting on the use of instructional materials
- Materials should be coherent, systematic, vetted, high quality, and embody the ideas in *Catalyzing Change* (p. 93)



# 4 Key Middle School Recommendations Restated

1. **Broaden the Purposes of Learning Mathematics:** Each and every student should develop deep mathematical understanding, understand and critique the world through mathematics, and experience the wonder, joy, and beauty of mathematics, which all contribute to a positive mathematical identity.
2. **Create Equitable Structures in Mathematics:** Middle school mathematics should dismantle inequitable structures, including tracking teachers as well as the practice of ability grouping and tracking students into qualitatively different courses.
3. **Implement Equitable Mathematics Instruction:** Mathematics instruction should be consistent with research-informed and equitable teaching practices that foster students' positive mathematical identities and strong sense of agency.
4. **Develop Deep Mathematical Understanding:** Middle schools should offer a common shared pathway grounded in the use of mathematical practices and processes to coherently develop deep mathematical understanding, ensuring the highest-quality mathematics education for each and every student.



# Next Steps for Catalyzing Change

The last chapter focuses on next steps for stakeholder groups.

Ensuring families and communities are informed on equitable instructional strategies (and why these strategies make sense)

Revisiting teacher collaboration time

Developing policies and assessments aligned with and that emphasize depth of understanding

Providing professional-learning opportunities focused on shifting to a strengths-based perspective



# Call to Action

What immediate step can you take to begin to catalyze change in your setting? Long-term steps?

*Please share in the chat.*



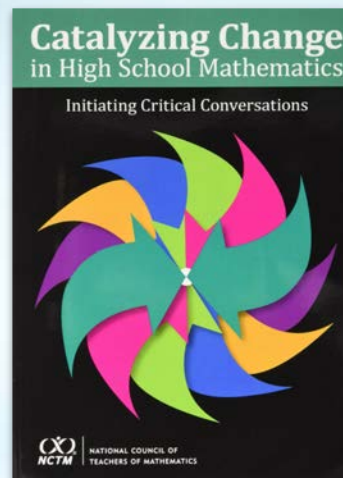
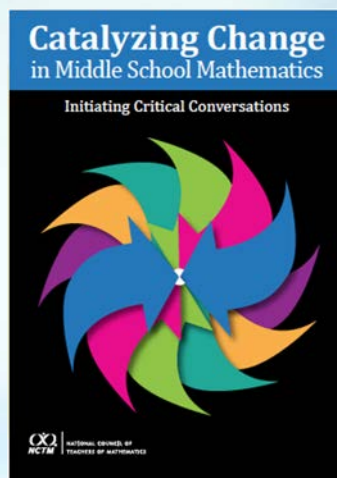
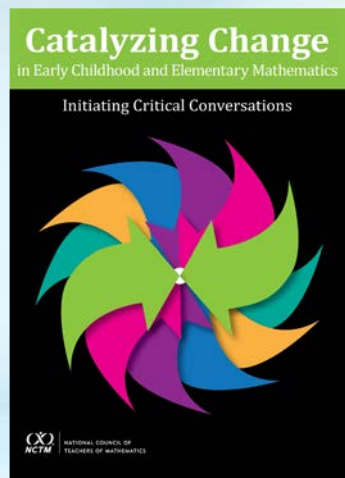




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- Print and ebook versions
- Book study guide
- Webinars
- Resources and more





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# Thank You

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