

Wifi:  
Cornell-Visitor

## *Catalyzing Change in High School Mathematics*

# Welcome

### **DO Math!**

Before we start, take a few minutes to review the problem you received:

1. How might you use this problem in your class?
2. What is the mathematics embedded in the problem?
3. How might you connect to your students' prior knowledge?

**#NCTMCHANGE**



***Catalyzing Change in High School Mathematics Unpacking  
Challenges, Critical Conversations, and Next Steps***  
**#NCTMCHANGE**

*“The system of high school mathematics is complex, and it is the system and its structures—school and district policies, practices, and conditions that either support or impede student learning of mathematics—that need to be critically examined and improved.”*

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# AGENDA

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- Introductions and Overview of Catalyzing Change
- Broadening the Purposes of HS Mathematics
- Dismantling Structural Obstacles
- Implementing Equitable Instructional Practices
- LUNCH
- Identifying Essential Concepts
- Organizing the HS Curriculum
- Planning for Actions

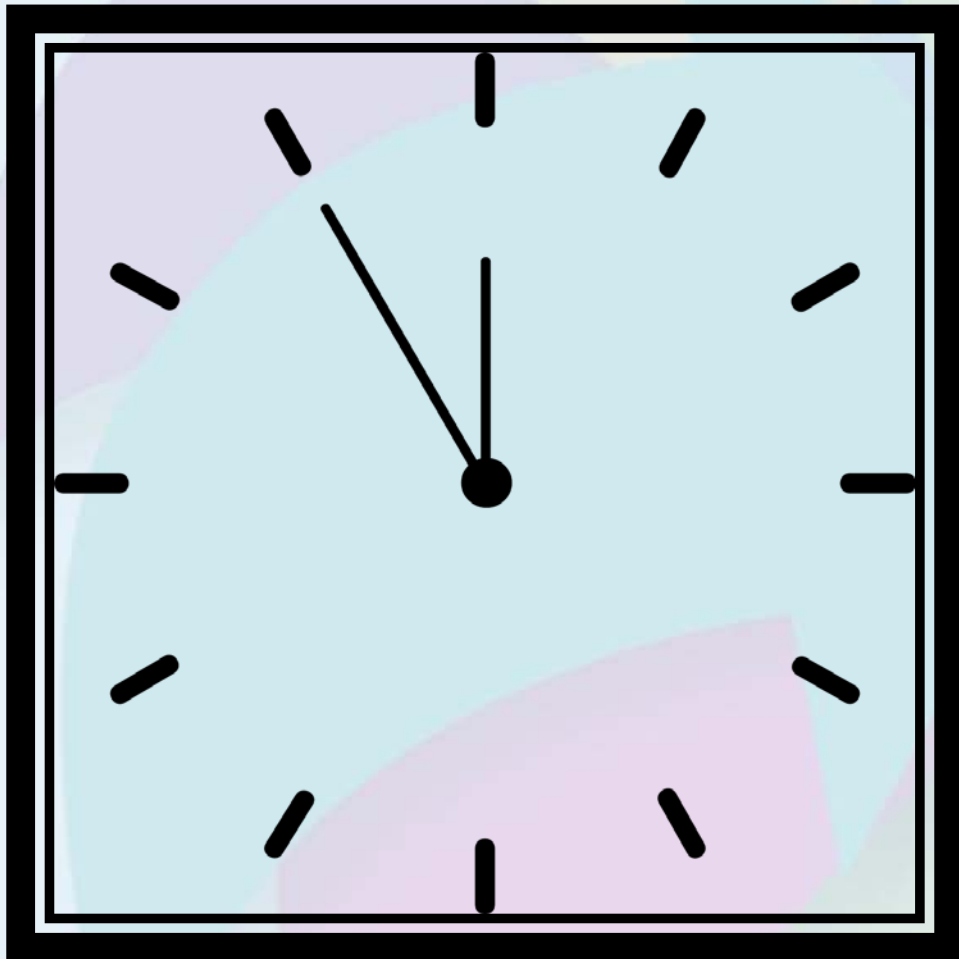
# Who is in the room?

- Teachers
- School Administrators
- Coaches/Facilitators
- District Leaders
- University and College Faculty
- Graduate Students
- Other





# 12-O'clock and 2-O'clock Partners



# Essential Question

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What do we want all students to know and be able to do?

- How might we make high school mathematics work for more students?
- How might we promote learning that is meaningful, relevant, and accessible?

# Structural Barriers



- What is one condition or systemic structure that is currently a barrier to creating a positive mathematical experience for students?
- Which stakeholders from your mathematics education community need to be a part of the ongoing conversation to address the barrier?
- Are these same stakeholders in position to break down these structural barriers? Why or why not?



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# Engaging in the work

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**What?** Condition or systemic structure

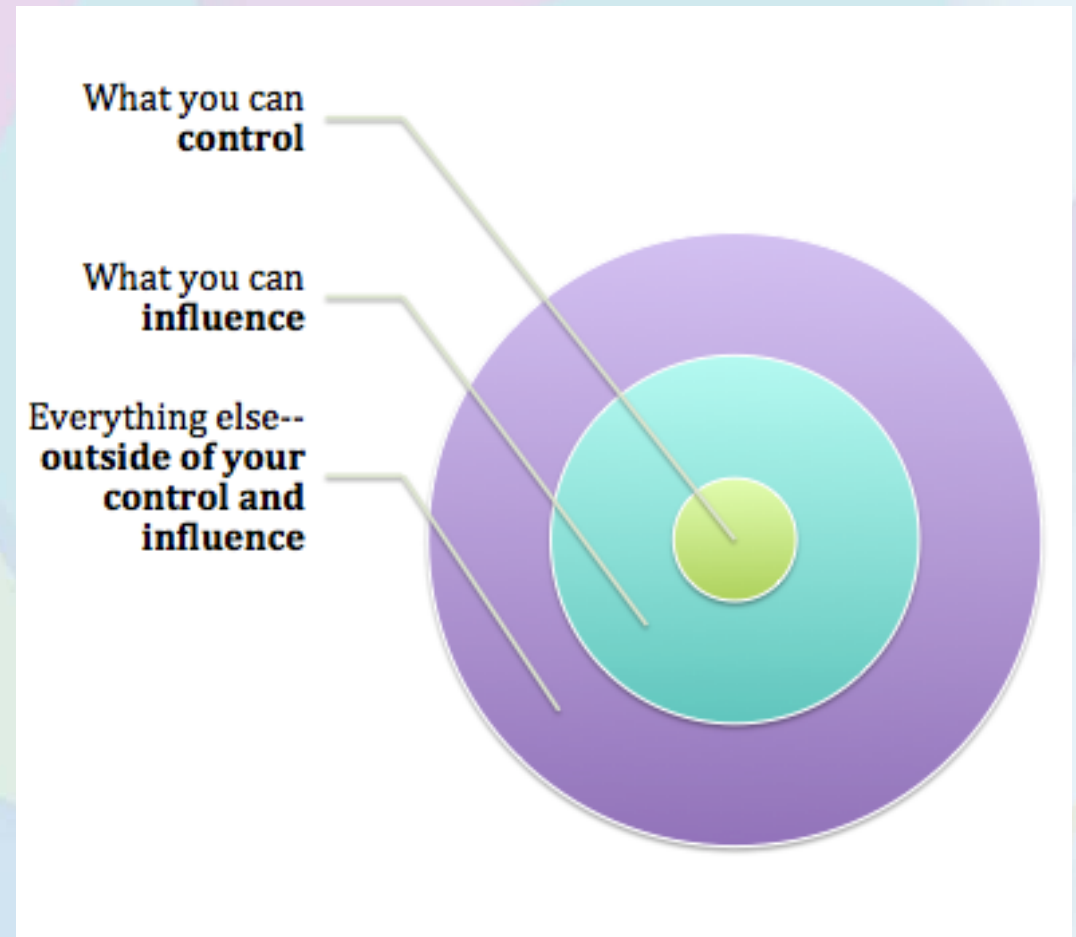
**Who?** Stakeholders

**How?** Data, research, professional learning

# Engaging in the work

How might we...?

- The **how** part assumes there are solutions out there – it provides creative confidence.
- **Might** says we can put ideas out there that might work or might not—either way, it's okay.
- The **we** part says we're going to do it together and build on each other's ideas.



# Reflecting on the work

## Planning For Action

**Chapter 3 - Creating Equitable Structures (CC-Tools 3.0 – 3.10)**

**Key Recommendation:** *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.*

**Findings & Additional Questions**

**Actions**

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**Tool(s) Used:**

**Who else needs to join the conversation?**

# What intentional actions might I take...?

# Catalyzing Change in High School Mathematics

Initiating Critical Conversations



NATIONAL COUNCIL OF  
TEACHERS OF MATHEMATICS

*Initiating Critical Conversations identifies and addresses critical challenges in high school mathematics to ensure that each and every student has the mathematical experiences necessary for his or her future personal and professional success.*

# TASK FORCE/WRITING TEAM

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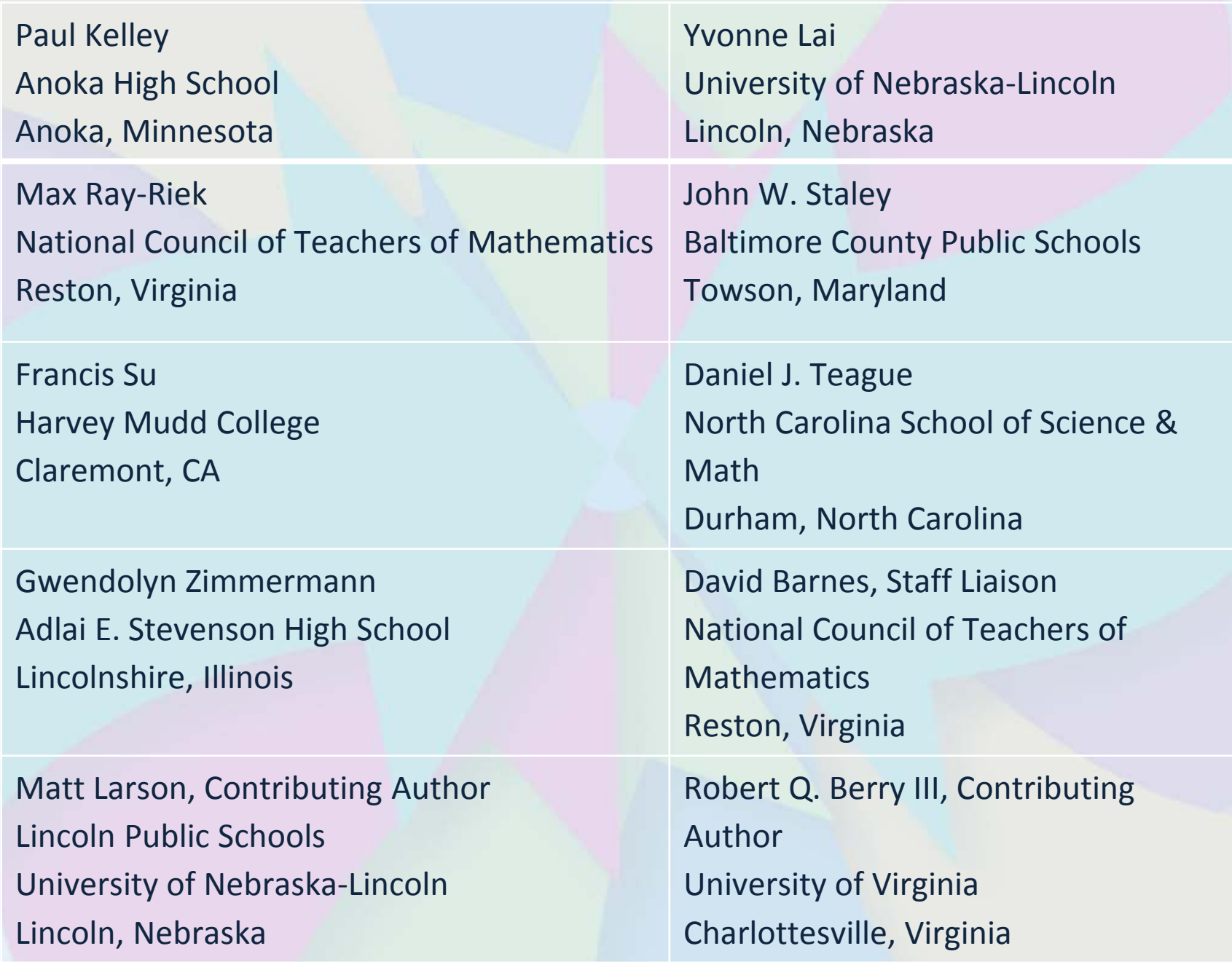
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## *The Challenge...*

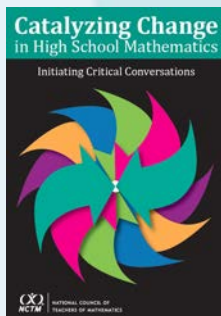
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*“The fact that significant numbers of high school students develop unproductive mathematical identities and see little value in mathematics, while the need for mathematical skills is increasing to meet workplace and postsecondary education requirements, and to ensure active participation in our democratic society.”*

# *Catalyzing Change initiates Critical Conversations...*

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1. Explicitly broadening the purposes
2. Dismantling structural obstacles
3. Implementing equitable instructional practices
4. Identifying Essential Concepts
5. Organizing the high school curriculum



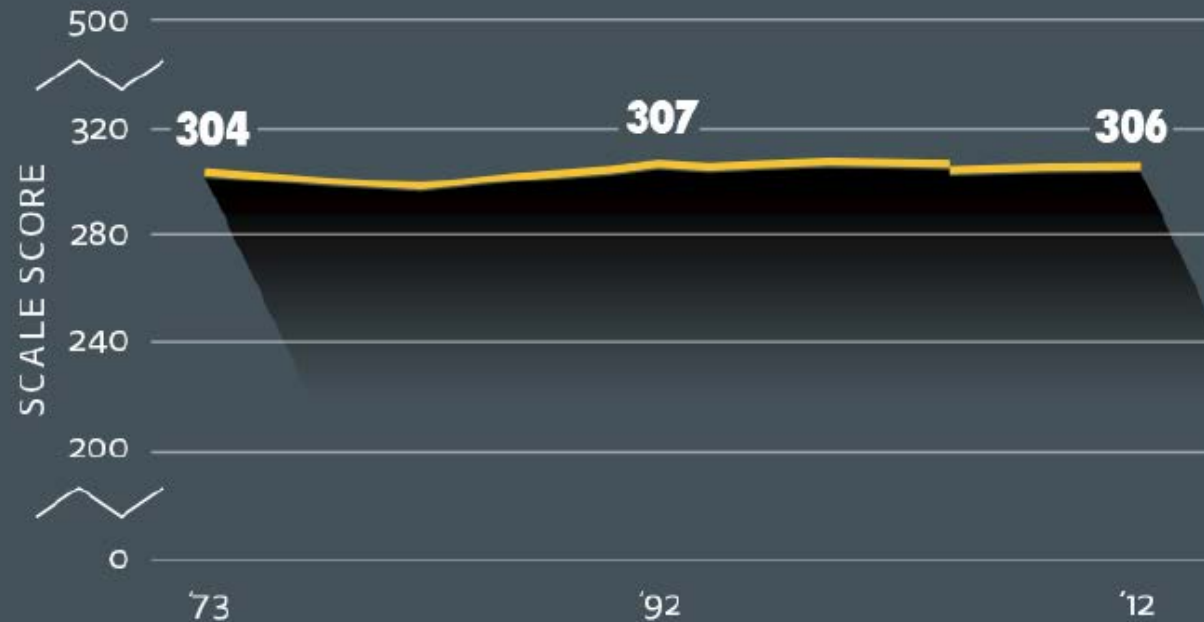
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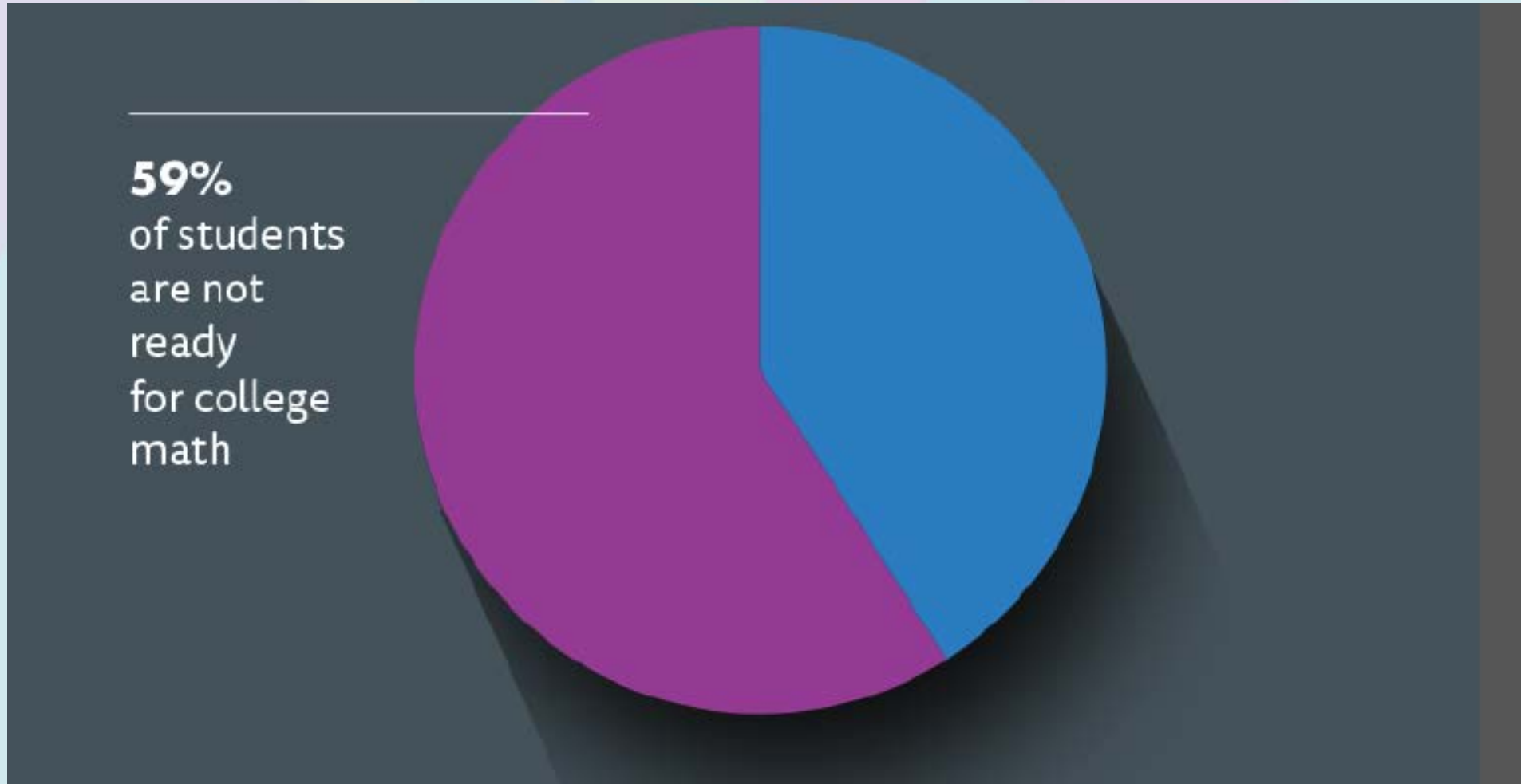
# Why Catalyzing Change?

## HIGH SCHOOL MATHEMATICS IS **NOT** WORKING

High school math scores have remained flat  
for the past 40 years.



# Why Catalyzing Change?



# Why Catalyzing Change?

## MANY STUDENTS **NOT SUPPORTED** BY HIGH SCHOOL MATHEMATICS

Abilities to apply and interpret mathematics are not developed.

Problem-solving and analysis skills are not developed, limiting students' meaningful participation in democratic institutions.

Access is denied to meaningful mathematics through lower-level courses or terminal pathways.

Learning experiences foster student identities as not capable of mathematics impacting their futures.

# *Catalyzing Change proposes actions...*

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- Teachers, Schools, and Districts
- Policy Makers
- Postsecondary Educators

...can take to initiate critical conversations to improve learning experiences and outcomes for each and every high school student.



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# Why We Engage in This Work

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**Why?**



## **Explicitly broadening the purposes**

Dismantling structural obstacles

Implementing equitable instructional practices

Identifying Essential Concepts

Organizing the high school curriculum

# *Why Learn Mathematics?*

*This is a simple question, but worth considerable reflection. Because how you answer this question will strongly determine **who you think** should be doing mathematics, and **how you will teach it?***



Su, F. (2017). *Mathematics for Human Flourishing*. Presidential Address, AMS-MAA Joint Math Meetings, Atlanta, January 6, 2017.

# Common Answers

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- “To be college and career ready”
- “You’ll use it later”



Opinion

# Make Your Daughter Practice Math. She'll Thank You Later.

The way we teach math in America hurts all students, but it may be hurting girls the most.

By **Barbara Oakley**

Ms. Oakley is an engineering professor and the author of a book on learning.

Aug. 7, 2018



NY Times August 7, 2018



# Key Recommendation

*Each and every student should learn the Essential Concepts in order to expand professional opportunities, understand and critique the world, and experience the joy, wonder, and beauty of mathematics.*



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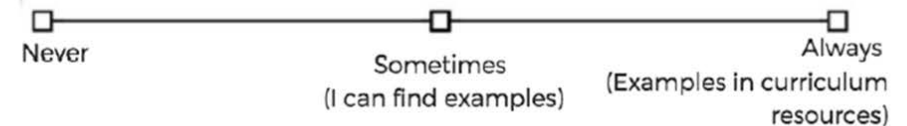
# Broadening the Purposes of HS Math

## Why do I have to learn this?

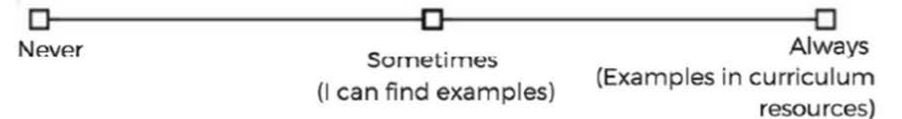
Note the focus beyond college/career readiness:

- *Expand professional opportunities*
- *Understand and critique the world*
- *Experience the joy, wonder, and beauty of mathematics*

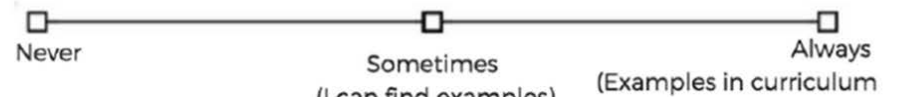
Professional Opportunity



Understand and Critique the World



Wonder, Joy, Beauty



# To achieve these purposes

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- Students should have opportunities to:
  - Reflect
  - Observe Patterns
  - Notice and Wonder
  - Critique Information
  - Learn to Ask Questions
- Potential prompts:
  - What patterns do you see in the world around you?
  - What is wonderful and joyful about mathematics?
  - What are you learning in this class about the process of doing or creating mathematics?
  - How would a mathematician respond?

# Professional Opportunities



How do you share professional opportunities with your students?

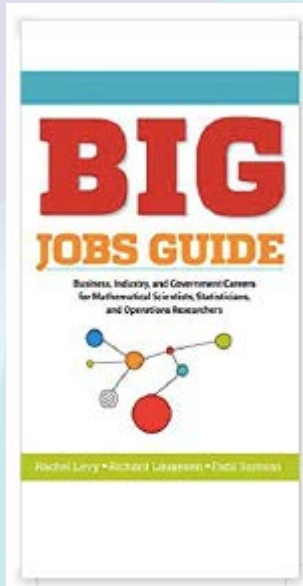
STEM

STEM-Related

non-STEM

# Professional Opportunities Resources

- [Careers in Applied Mathematics](#) (Brochure)
- [This is Statistics](#)
- [We Use Math](#)



# Understand and Critique the World

According to a September 27, 2017, newspaper article (Long and Jan 2017), the typical household net worth increased by 30% for African American households and by 46% for Hispanic households from 2013 to 2016.

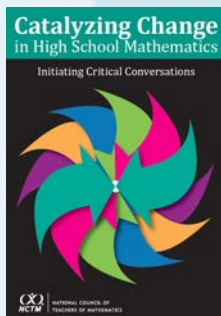
- (a) What questions should you ask to make sense of this information?
- (b) In 2013, a typical net worth was \$13,600 for African American households and \$14,200 for Hispanic households. What was the typical household net worth for each of these two groups in 2017?
- (c) The poverty level for a three-person household in 2017 was \$19,530, and the poverty level for a four-person household was \$20,000. How does the typical net worth of African American and Hispanic households in 2017 compare with the poverty levels?

# Joy, Wonder, and Beauty of Mathematics

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## Reflect, Observe, Wonder

“The ability to reflect on a phenomenon and experience awe is a distinctly human activity, and seeing the world through a mathematical or statistical lens can help students experience wonder and beauty in the world in unexpected places.”

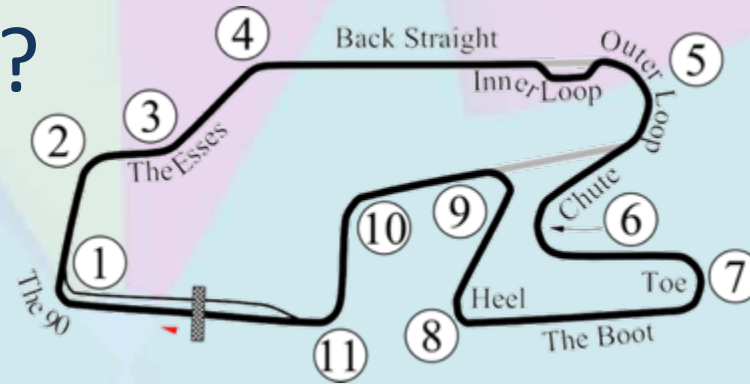
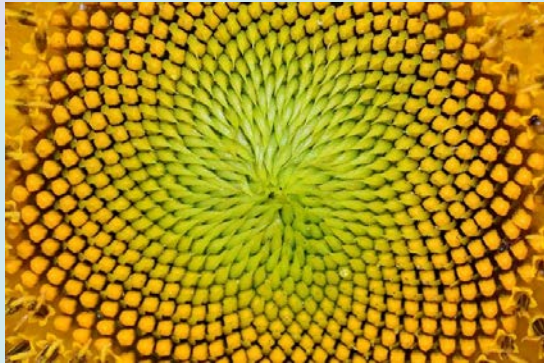


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# Wonder in unexpected places

What patterns do you see?  
What do you wonder?







Explicitly broadening the purposes

**Dismantling structural obstacles**

Implementing equitable instructional practices

Identifying Essential Concepts

Organizing the high school curriculum

# Equity in Mathematics



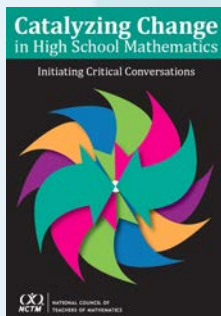
- *...equity in mathematics education will not be achieved until it is no longer possible “to predict mathematics achievement and participation based solely on student characteristics such as race, class, ethnicity, sex, beliefs, and proficiency in the dominant language” (Gutiérrez 2002b, p. 153).*
- What “predictions” about mathematics achievement and participation in your school/district can be made based on race, class, ethnicity, gender, beliefs, and proficiency in the dominant language?



# Key Recommendation



*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.*



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# You might be tracking students if...

1. Mark yes or no for each question.
2. List any current wonderings for each question.
3. Revisit the questions as you complete your inquiry cycle for chapter 3.

	YES	NO
1. Are there different course levels that are aligned (at least 80%) to the same set of standards? (i.e. a Standard Algebra 1/Integrated Course 1 vs Honors Algebra 1/Integrated Course 1)		
2. Is the cognitive demand (i.e. Bloom's Taxonomy, Webb's Doman of knowledge,...) different based on the course level?		
3. Are students' access to courses predetermined by a predefined course sequence?		
4. Are students performing at similar achievement levels based on course level?		
5. Are there different end of unit or end of course assessments based on course level?		

# Student Tracking

- Different course levels
- Detracking
- Tracking vs Acceleration



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# Student Tracking

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*Tracking that puts students into qualitatively different course pathways, where some students have access to mathematics instruction that prepares them for postsecondary education opportunities and others do not, reinforces the misguided notion that only some people are capable of achieving in mathematics. (Boaler 2011)*



# Students and Teachers

1. Tracking students into course pathways that do not prepare them for continued study of mathematics
2. Tracking teachers in ways that deny certain students access to high-quality instruction
3. Providing inadequate instructional supports both before and during high school for students who would benefit from the support



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# Student Tracking



## Different course levels

- Courses in a track sequence often place students in different levels of the same course, with the levels identified by tags such as “honors,” “advanced,” “regular,” or “remedial” or “adjusted.”

*Do any pathways currently exist that are not mathematically meaningful and do not prepare students for any continued study of fundamental mathematical concepts?*



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# Student Tracking

## Characteristics of de-tracked high school programs

1. Connections and meaning in mathematics are emphasized by teachers
2. Curricula are focused on key mathematical ideas (Horn 2006)



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# Student Tracking

## Tracking vs Acceleration

- Acceleration should be along a single common shared pathway that provides each student with an opportunity to learn the same Essential Concepts

*Consider the students demographics in your accelerated mathematics courses, are they evenly distributed across racial, gender, linguistic, cultural, and economic lines?*



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# Teacher Tracking

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*Like mathematics students, mathematics teachers themselves are often tracked, with the most experienced teachers, or those who are perceived to be the most effective, assigned to upper-level mathematics courses and the least experienced teachers assigned to entry-level-mathematics courses.*

(Darling-Hammond 2007; Strutchens, Quander, and Gutiérrez 2011)

# You might be tracking teachers if...

## Who's teaching which courses???

35+									
34									
33									
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1									
	Grade	Average	Grade	Average	Grade	Average	Grade	Average	
	9	G9	10	G10	11	G11	12	G12	

CC-Tool 3.9a

# Teacher Tracking



- How are teachers in your school/district currently identified to teach mathematics courses based on Grade levels ( 9<sup>th</sup> – 12<sup>th</sup> ) and Course levels (i.e. standard, honors, accelerated/gifted and talented)?
- Are teaching assignments balanced to include both upper-level and entry-level mathematics courses?
- Which characteristics of the teacher/students are considered when making these decisions?



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# Benefits of Balancing Teaching Assignments

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- Deepens teachers' knowledge of the overall curriculum expectations
- Can reduce burnout among new teachers
- Can populate collaborative teams with experienced teachers
- Can develop among teachers a collective sense of responsibility for all students

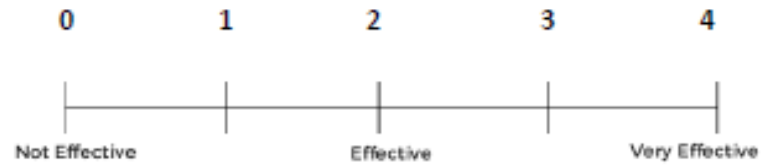
(Gutiérrez 2002a; Strutchens, Quander, and Gutiérrez 2011)





**Take a few minutes to add your reflection(s) to page 12.  
Creating Equitable Structures**

# Supports for Students



Efficacy \_\_\_\_

Timeliness \_\_\_\_

Structure \_\_\_\_

Targeted \_\_\_\_

# Supports for Students

## Issues from K - 8

- Student tracking at K - 8 level
  - Low, middle, high classes as early as elementary grades
- Traditional way math interventions are structured that frequently remove students from the grade-level curriculum



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# Supports for Students

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## **Additional Instructional Time**

- Effective interventions recognize that not all students learn at the same pace and provide *additional instructional time* instead of removing students from grade-level instruction. Additional time should
  - be fluid,
  - provide students with multiple opportunities to demonstrate their learning, and
  - allow students to enter and leave as needed

## **Grade-level Content**

- Effective targeted instructional support should be focused on content that is connected with and promotes the grade-level curriculum (Balfanz, Maclver, and Byrnes 2006; Burris, Heubert, and Levin 2006) and should not simply be a review of low-level procedural skills.

# Supports for Teachers

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## Professional Learning Opportunities

1. Deepen and extend content knowledge
2. Expand repertoires of pedagogical strategies
3. Collaboration



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***Critical Conversations...***

Explicitly broadening the purposes

Dismantling structural obstacles

**Implementing equitable instruction practices**

Identifying Essential Concepts

Organizing the high school curriculum

# *Equitable Mathematics Teaching Practices*

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*Mathematics teaching involves not only helping students learn concepts and develop skills and understanding but also empowering students **to see themselves as capable of participating in and being doers of mathematics.***



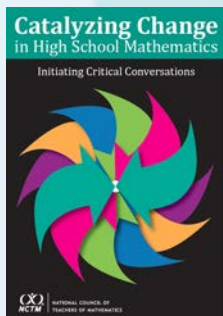
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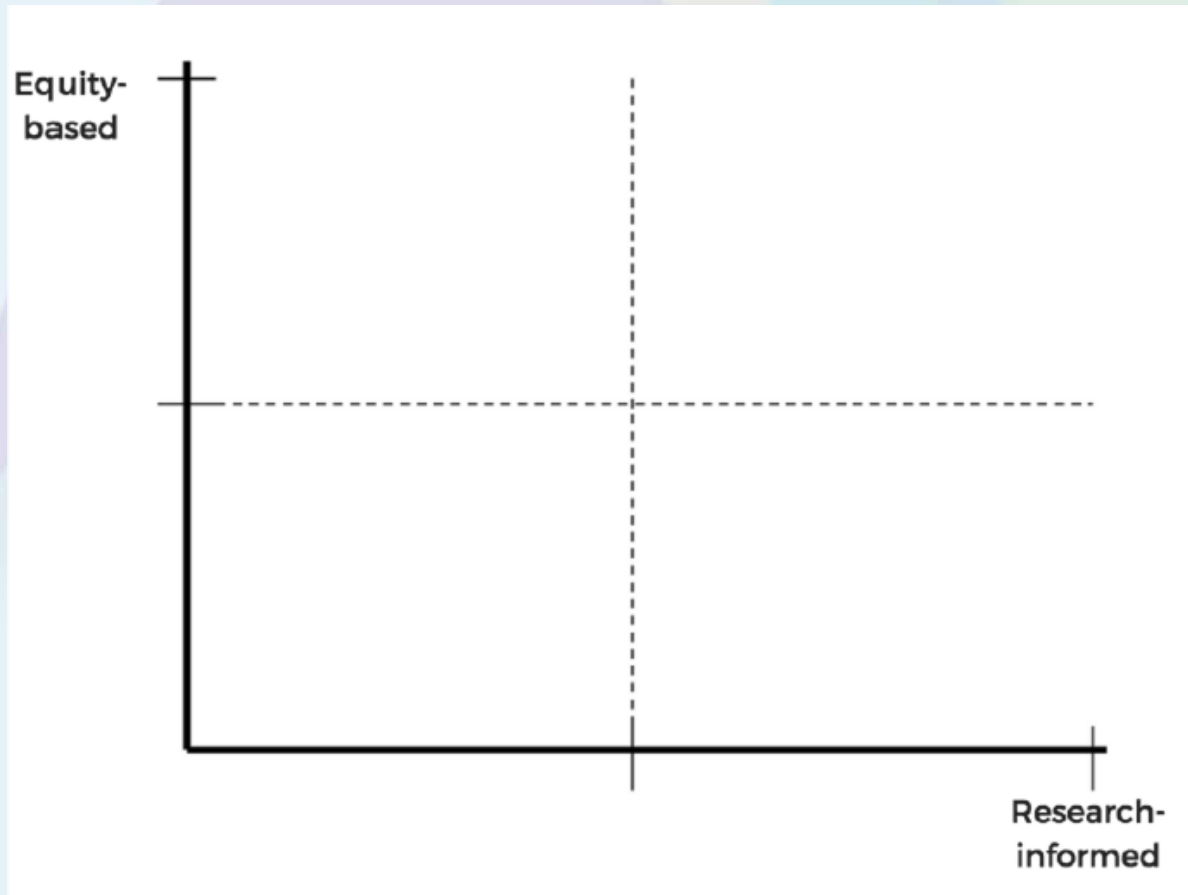
# Key Recommendation

*Classroom instruction should be consistent with research-informed and equitable teaching practices.*



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# Students and Teachers



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

- research-informed
- equity-based

# Mathematical Identity

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Mathematical Identity – the dispositions and deeply held beliefs that students develop about their ability to participate and perform effectively in mathematical contexts and to use mathematics in powerful ways across the contexts of their lives.

Aguirre, Mayfield-Ingram, Martin, *The Impact of Identity in K–8 Mathematics*, NCTM (2013)

# Agency

Agency refers to the expression of one's identity. (Murrell, 2007)

*... agency is expressed in ways that students engage in productive struggle, take risks to make their mathematical thinking visible, and understand that learning results when they successfully leverage an approach that works for them.*

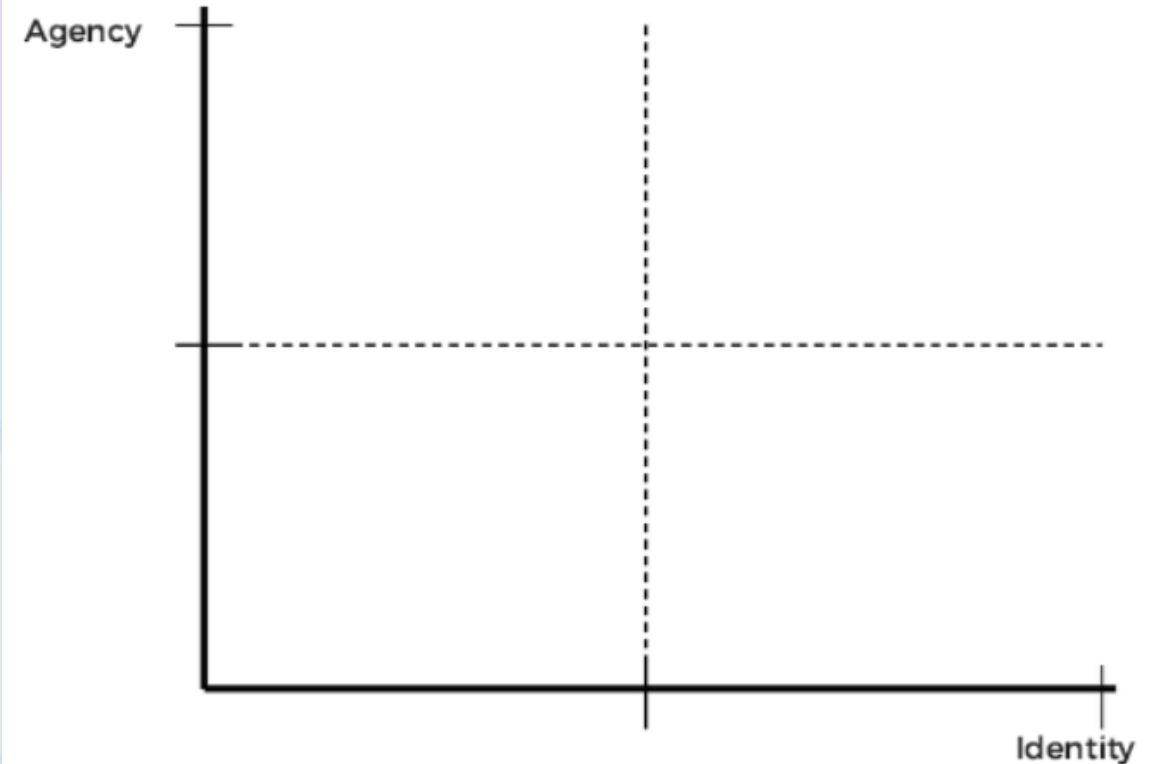


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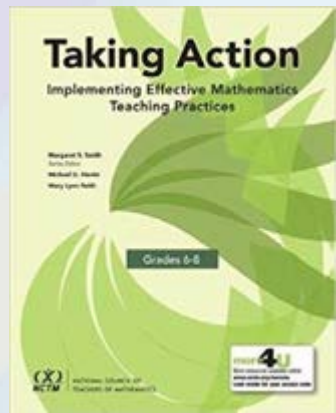
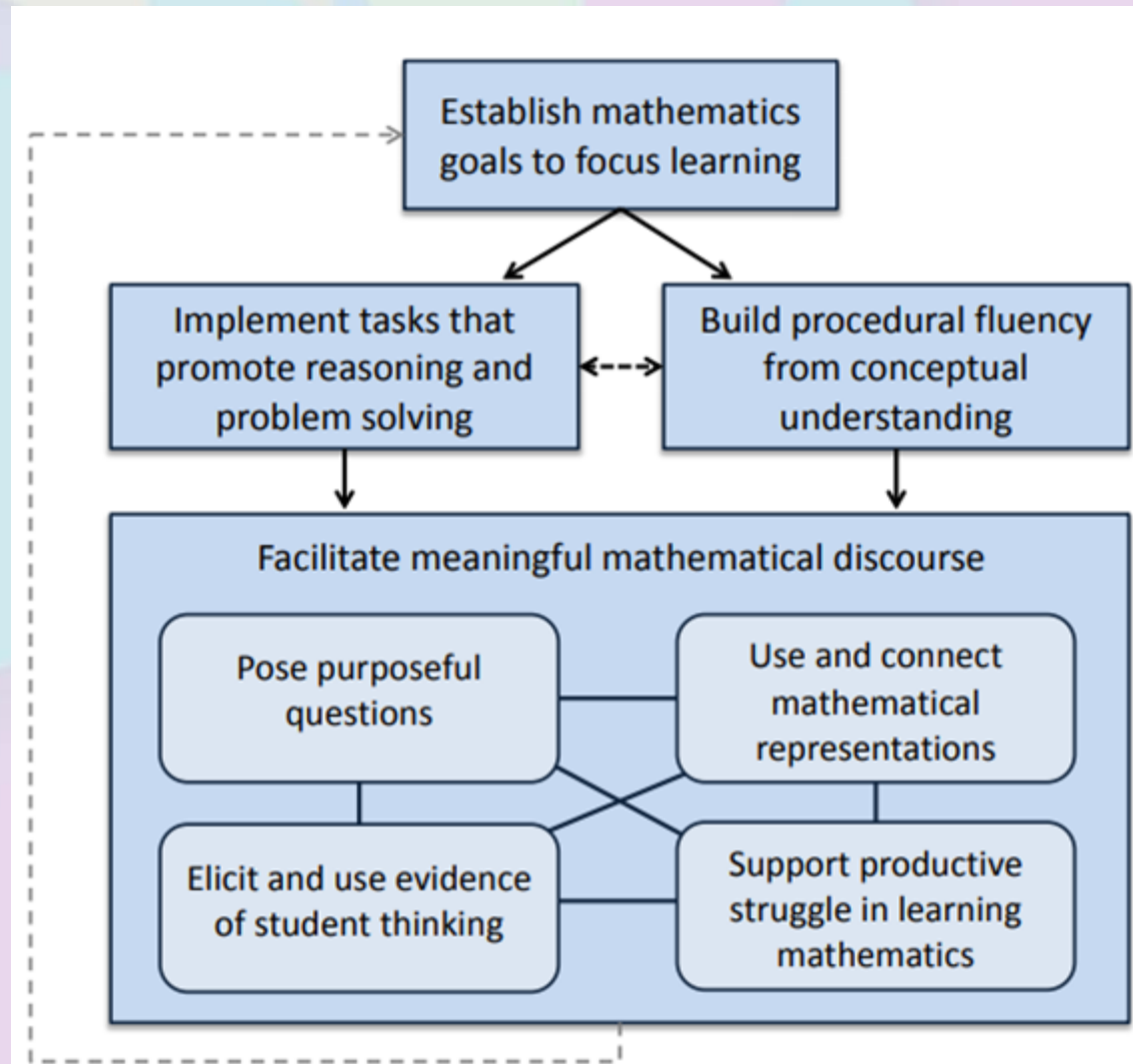
# Students and Teachers

\_\_\_\_% of the time I am intentional in my actions to build my students'

- mathematical identity
- agency



# Mathematics Teaching Practices



# Equitable Teaching Practices

- Going deep with mathematics
- Leveraging multiple mathematical competencies
- Affirming mathematics learners' identities
- Challenging spaces of marginality
- Drawing on multiple resources of knowledge (math, culture, language, family, community)

The  
**Impact**  
of Identity  
in K-8  
Mathematics

**Rethinking**  
Equity-Based Practices

Lila Aguirre  
Karen Mayfield Ingram  
Doris Bernard Martin

**mon4u**  
The national center for  
math equity and leadership  
www.mon4u.org/mon4u  
Lead equity for your entire school

# Connecting Math Teaching Practices to Equitable Teaching

## Mathematics Teaching Practices: Supporting Equitable Mathematics Teaching

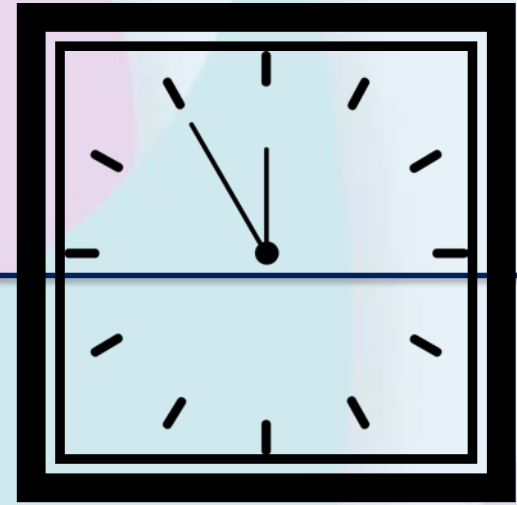
Mathematics Teaching Practices	Mathematics Teaching Practices: Supporting Equitable Mathematics Teaching		Equitable Teaching
	Mathematics Teaching Practices	Equitable Teaching	
<p><b>Establish mathematics learning goals to focus learning.</b> Effective teaching establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.</p>	<p><b>Establish mathematics goals to focus learning.</b> Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.</p>	<ul style="list-style-type: none"> <li>Establish learning progressions that build students' mathematical understanding, increase their confidence, and support their mathematical identities as doers of mathematics.</li> <li>Establish high expectations to ensure that each student has the opportunity to meet those expectations for participation that identify each student as a competent learner of mathematics in environments that promote equity, justice, equitable, and</li> <li>Engage students in tasks that are culturally relevant, thus enhancing each student's mathematical identity and sense of agency.</li> </ul>	<p>...ions that build understanding, increase their confidence, and support their mathematical identities as doers of mathematics. ... to ensure that each student has the opportunity to meet those expectations for participation that identify each student as a competent learner of mathematics in environments that promote equity, justice, equitable, and</p>

What are teachers doing?  
 What are students doing?





# 12-O'Clock Partner



**Take a few minutes to reflect on this section.**

**Practice/share with your partner**

- **What?** Condition or systemic structure
- **Who?** Stakeholders
- **How?** Data, research, professional learning

**What intentional actions might I take...?**

## ***Critical Conversations...***

Explicitly broadening the purposes

Dismantling structural obstacles

Implementing equitable instructional practices

**Identifying Essential Concepts**

Organizing the high school curriculum

# Essential Concepts

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The Essential Concepts represent a distillation of the critical concepts and skills that, regardless of a state's, province's, or district's standards, students should acquire. Essential Concepts **do not represent yet another set of standards** or a list of disjoint topics to be covered.



NCTM. (2018). *Catalyzing change in high school mathematics: Initiating critical conversations*. Reston, VA: NCTM.



# Key Recommendation

*Each and every student should learn the Essential Concepts in order to expand professional opportunities, understand and critique the world, and experience the joy, wonder, and beauty of mathematics.*



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# Essential Concepts

- *Catalyzing Change* identifies a set of **Essential Concepts** from the content domains of number, algebra and functions, statistics and probability, and geometry and measurement.
- Essential Concepts represent the **most critical content from the content domains** – the deep understandings that are important for students to remember long after they have forgotten how to carry out specific techniques or apply particular formulas.



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# Role of Modeling, Proof, and Technology

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## Reasoning/Proof and Modeling:

- cut across content areas
- empower students
- support development of math identity and agency

## Technology:

- to explore, build intuition, deepen understanding



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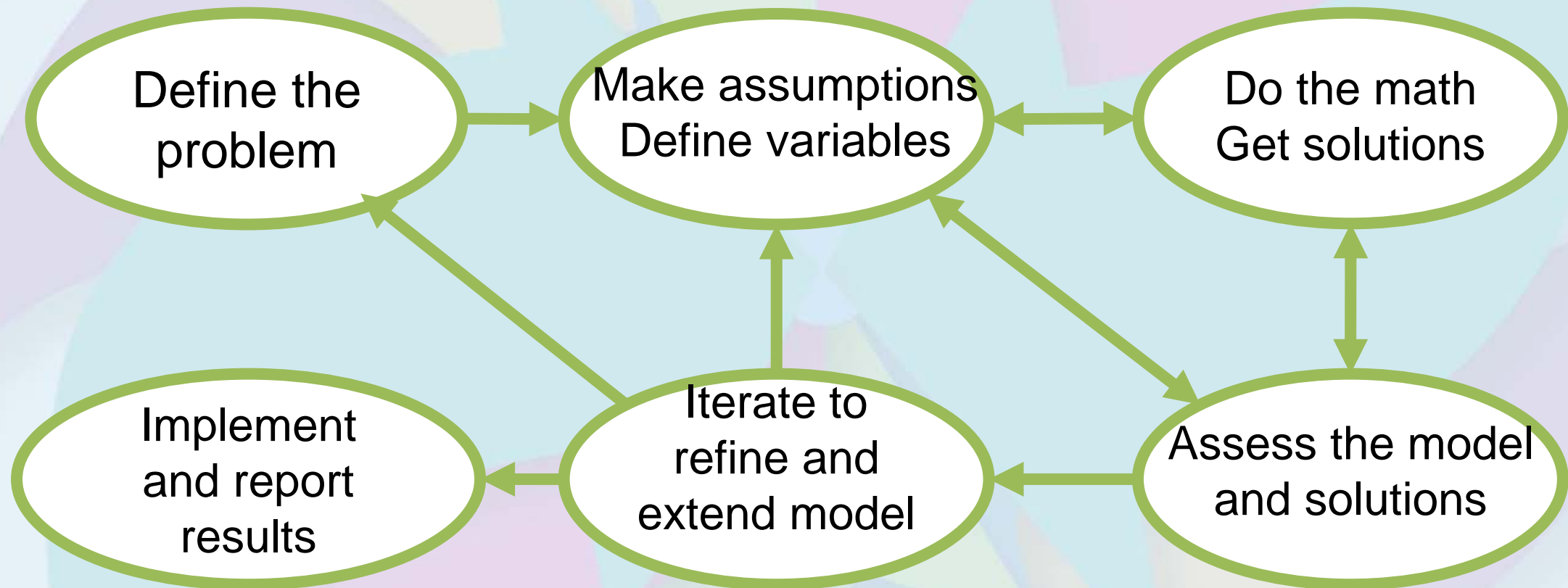
# The role of technology: A shift in focus

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- From learning to perform algebraic **manipulations “by hand”** to learning to recognize which techniques produce a desired outcome, to **interpret** the outcome mathematically, and to **use** the outcome to move forward in analyzing a situation or solving a problem ...
- From learning many **individual procedures** for algebraic manipulations to considering multiple **equivalent forms** of expressions and equations, **interpreting** the results of manipulations, and **making strategic choices** about which forms of an expression or equation to use (p. 77)



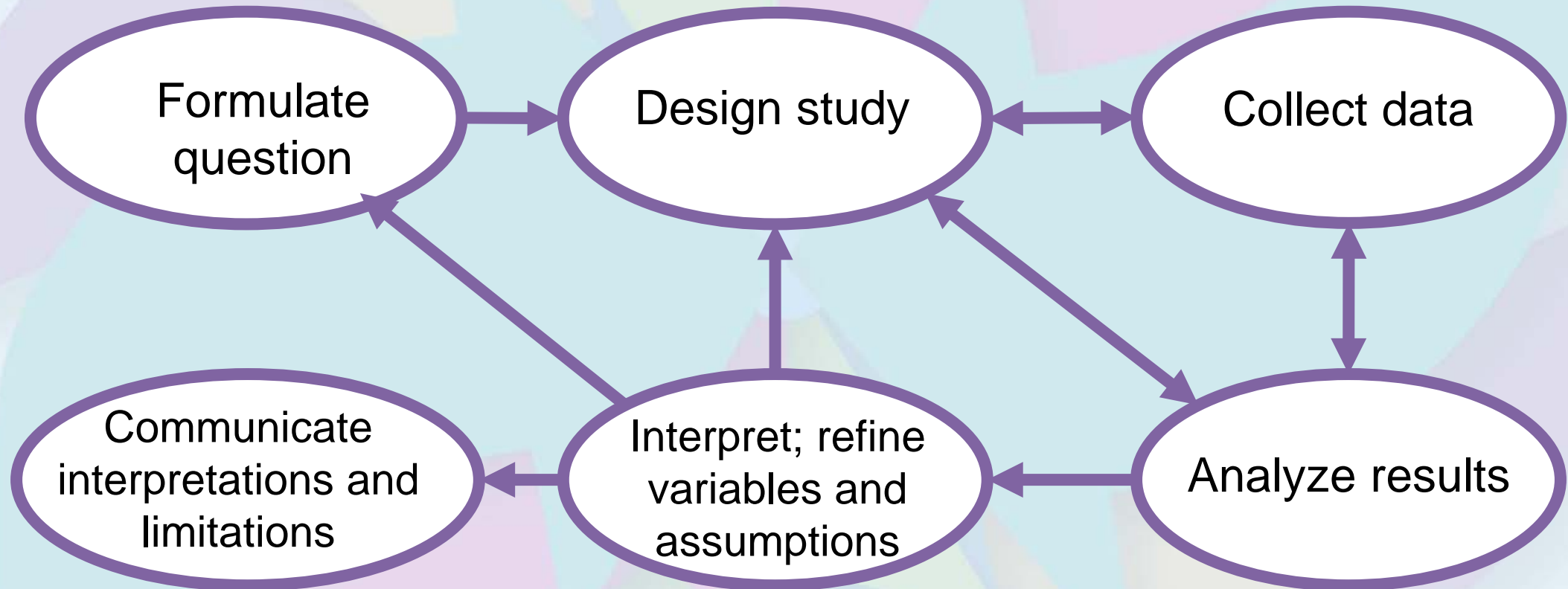
# Parallels in reasoning across mathematical sciences



**Mathematical Modeling Cycle**

# Parallels in reasoning across mathematical sciences

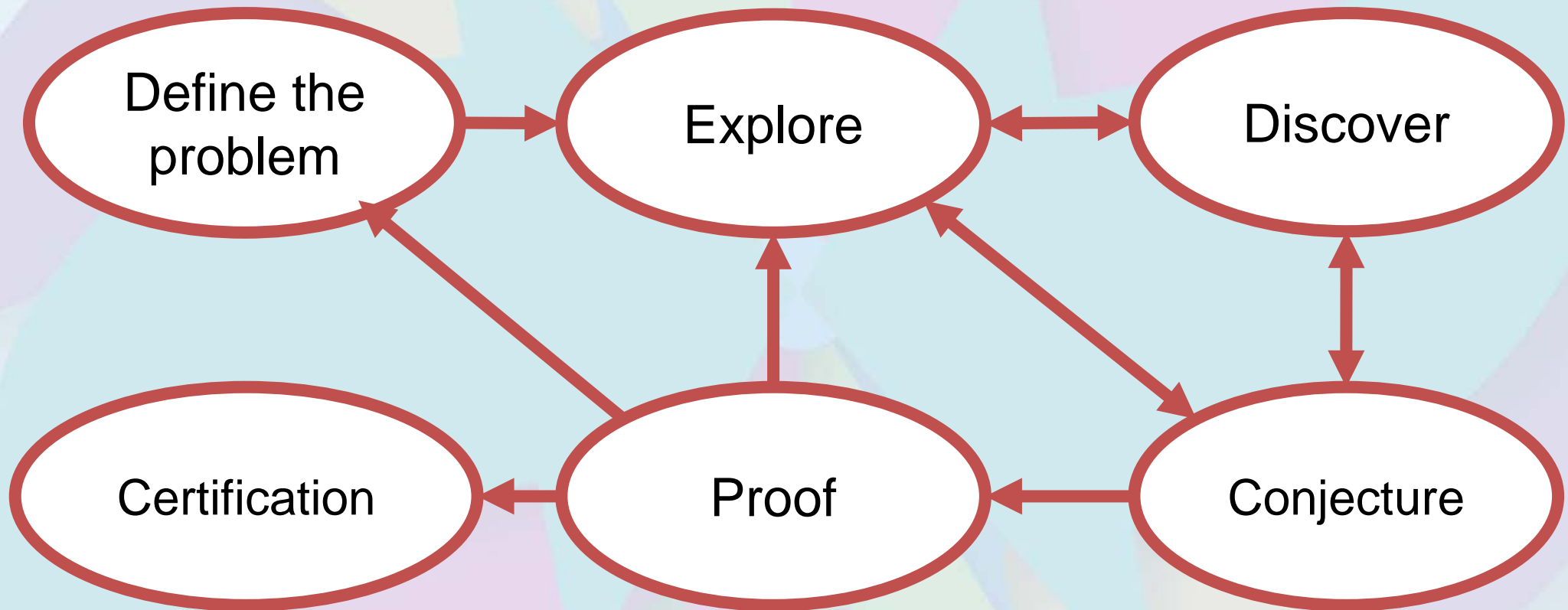
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**Statistical Problem Solving**

# Parallels in reasoning across mathematical sciences

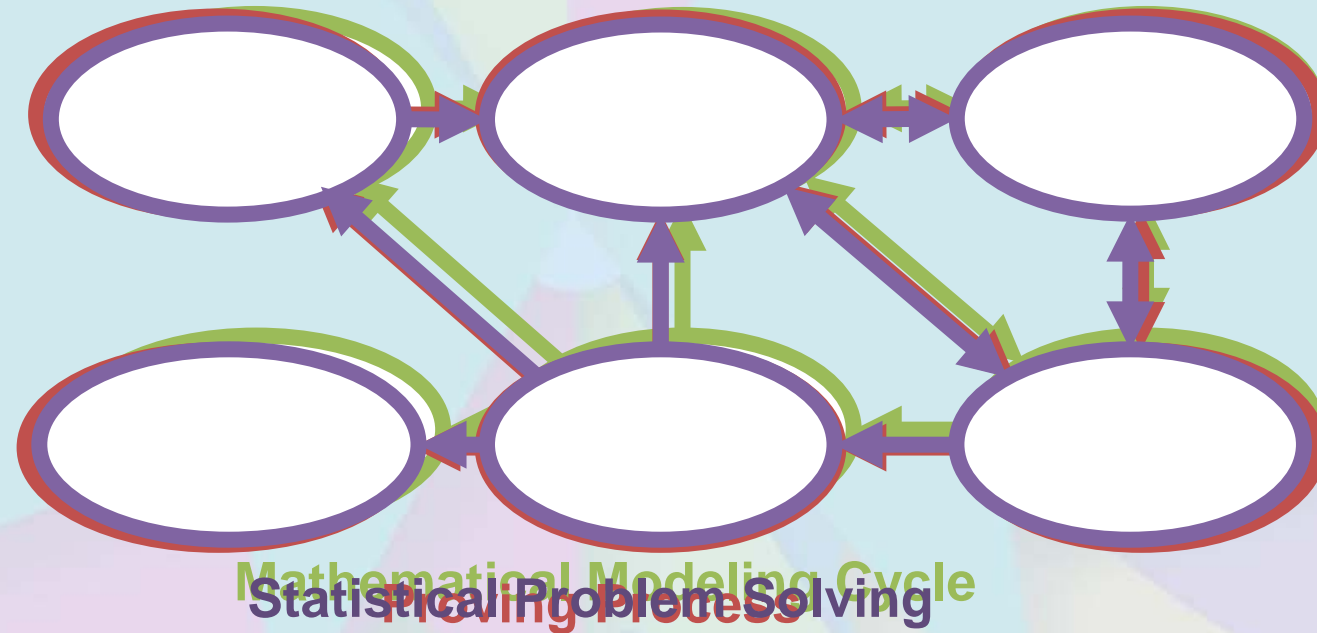
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**Proving Process**

# Parallels in reasoning across mathematical sciences

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Content Area and Focus	Number of Essential Concepts
<b>Number</b>	2
<b>Algebra and Functions</b>	
Focus 1: Algebra	4
Focus 2: Connecting Algebra to Functions	2
Focus 3: Functions	4
<b>Statistics and Probability</b>	
Focus 1: Quantitative Literacy	2
Focus 2: Visualizing and Summarizing Data	6
Focus 3: Statistical Inference	7
Focus 4: Probability	2
<b>Geometry and Measurement</b>	
Focus 1: Measurement	3
Focus 2: Transformations	4
Focus 3: Geometric Arguments, Reasoning, and Proof	3
Focus 4: Solving Applied Problems and Modeling in Geometry	2

# Problem Groups

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- Find 4 or 5 other people that have the selected the same “Essential Concept Problem”
- Introduce yourselves and share your responses to the questions below. Record the major ideas on the chart paper posted around the room.
  - What is the mathematics embedded in the problem? How does it relate to the Essential Concept?
  - How might you use this problem in your class? How would your students approach the problem?
  - How might you connect the problem to your students’ prior knowledge?
  - What does the problem make you wonder about?

## EC Number

The equation  $y = 3.5x + 20.8$  describes the relationship between the number of times that a cricket chirps and the temperature. Respond to the following:

What do you need to know to interpret the rate of change in the context of the chirps and temperature?

Soren looked up the data and found that the temperature was recorded in degrees Fahrenheit, the cricket chirps were measured every 15 seconds, and the number of chirps was used to predict the temperature. Sally said that for every increase of 1 cricket chirp per 15 seconds, the predicted temperature increases by about  $3.5^{\circ}$  Fahrenheit. Samee disagreed and said that for every increase of 3.5 cricket chirps per 15 seconds, the predicted temperature increases by about  $1^{\circ}$  Fahrenheit. Who is correct and why?

## EC Statistics and Probability: Probability

Table 5 gives the results of the data from a sample used in a clinical experimental trial. Use the data in the table to find the probabilities in (a)–(c):

- (a) The probability that a randomly selected person from the sample will have the disease
- (b) The probability that a randomly selected person from the sample who has the disease tests positive
- (c) The probability that a randomly selected person from the sample who has the disease tests negative

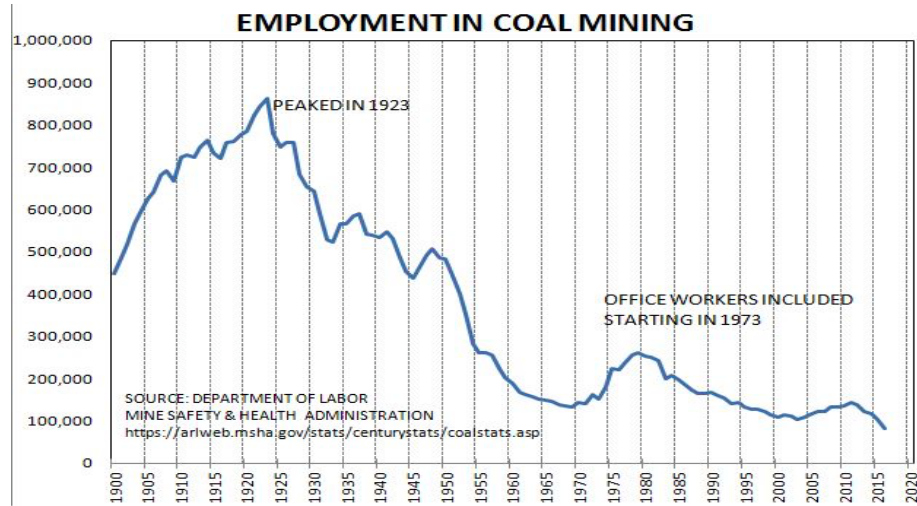
**Table 5.** Considering test results and disease

	Diseased	Not diseased	Totals
Test result positive	170	7,830	8,000
Test result negative	30	91,970	92,000
Totals	200	99,800	100,000

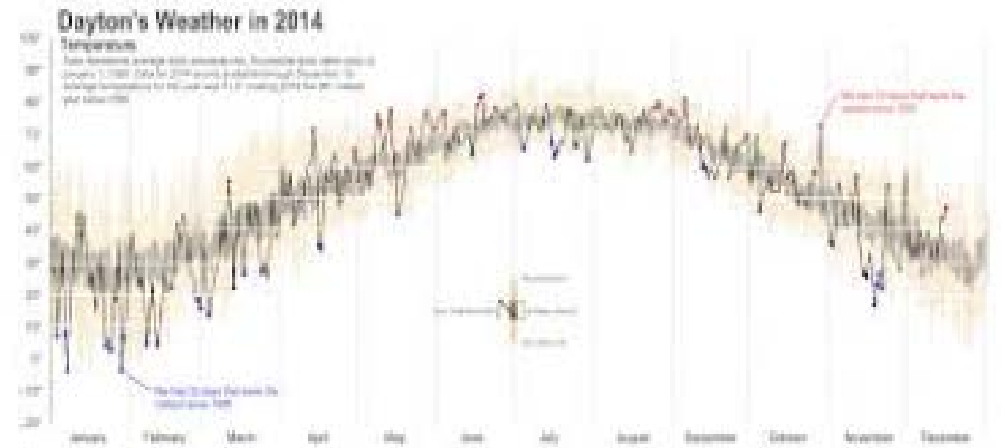
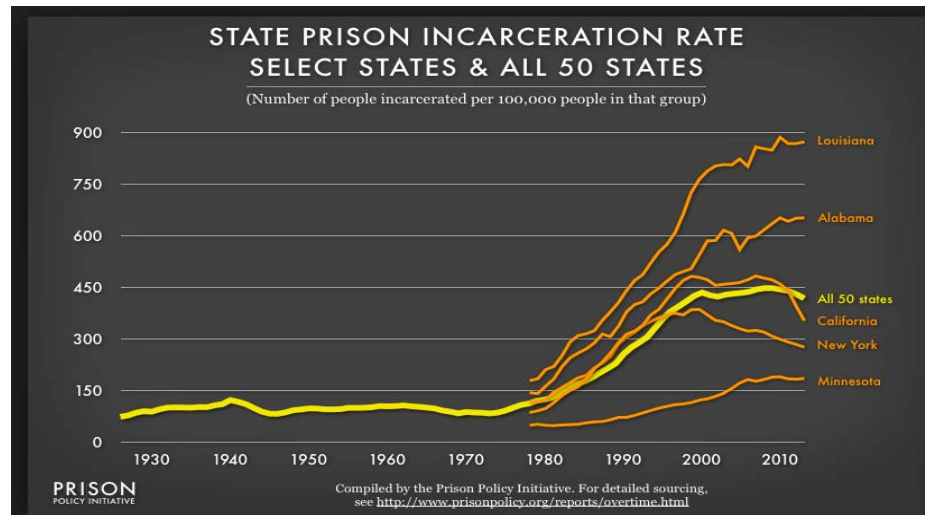
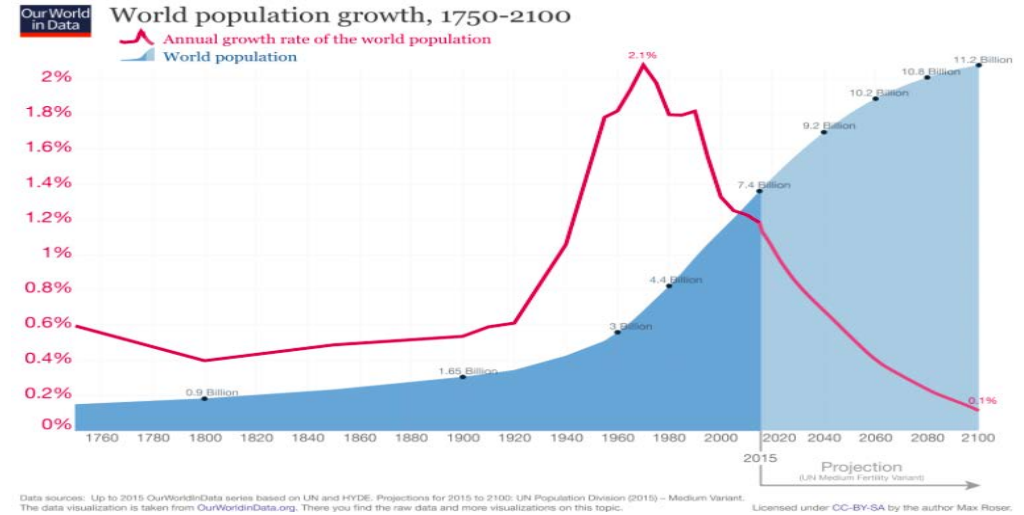
- (d) Do you think the clinical trial data present evidence justifying a very expensive test for the disease? Explain your thinking.



# EC in Algebra and Functions: Functions

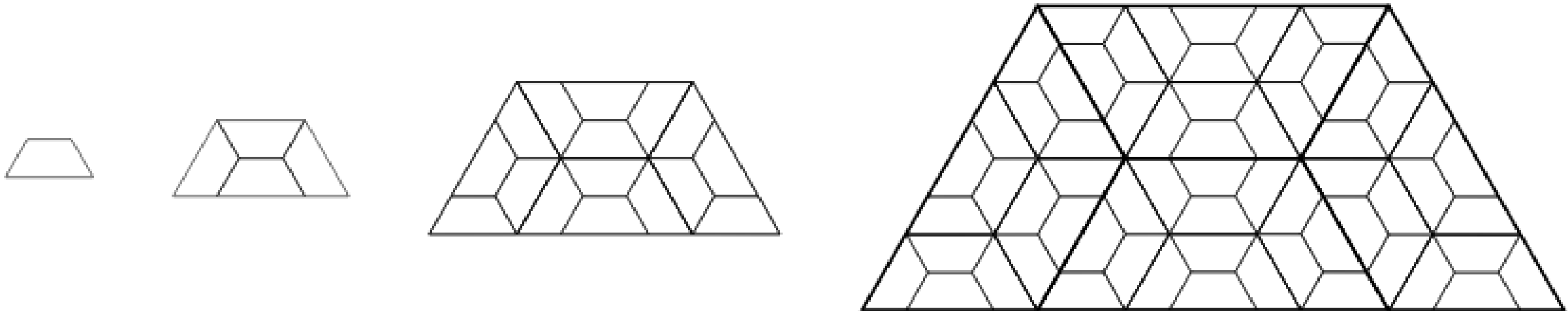


Write three sentences to tell the story described by the function in each of the graphs.



## EC Geometry and Measurement: Measurement

*The tilings are made of trapezoidal tiles. All the tiles are the same. How much larger is each tiling in the sequence than the preceding one, in terms of both side length and area? Given the trapezoid tilings in the figure, determine the proportions and angles of each trapezoid. Explain your reasoning.*



# Essential Concepts in number

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- Complete the study of irrational and rational numbers
- Numbers in context become even more important
- Attention to units of measurement, scales in graphing, and levels of accuracy in approximating values



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# Essential Concepts in Algebra and Functions

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*“The study of **algebra** and **functions** provides experiences for students to see how mathematics can be used systematically to represent patterns and relationships among numbers and other objects, analyze change, and model everyday events and problems of life and society.”*



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# Essential Concepts in Statistics and Probability

“All high school graduates will, as members of society, be presented with data-based claims throughout their lives. Therefore, they must be able to examine these claims and be intelligent consumers of studies, capable of reasoning critically and asking questions about the implementation of the statistical investigation process in those studies.”



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# Essential Concepts in Statistics and Probability

1. Quantitative Literacy
2. Visualizing and Summarizing Data
3. Statistical Inference
4. Probability



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# Essential Concepts in Geometry and Measurement

1. Measurement
2. Transformations
3. Geometric Arguments, Reasoning, and Proof
4. Solving Applied Problems and Modeling in Geometry



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# Reflection on Critical Conversations

**Recommendation:** Each and every student should learn the Essential Concepts in order to expand professional opportunities, understand and critique the world, and experience the joy, wonder, and beauty of mathematics.

## Actions:

- Analyzing and evaluating systemic policies, practices, and procedures that restrict student access to and success in mathematics

# What intentional actions might I take...?



## ***Critical Conversations...***

Explicitly broadening the purposes

Dismantling structural obstacles

Implementing equitable instructional practices

Identifying Essential Concepts

**Organizing the high school curriculum**

# *A high school mathematics program*

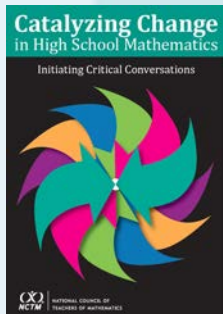
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*must be designed to give a diverse set of students a mathematics education that will not only prepare them for the next steps in their future but also give them an appreciation of what mathematics is and how it can be useful in their lives, no matter what their current post-high school plans are.*



# Key Recommendation

*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.*



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# What Do Students Need:

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- To be an educated citizen
- To be prepared for a Pathways program at a post-secondary institution
- To be prepared for a technical program or a less math-intensive STEM trajectory
- To be prepared for a math-intensive STEM trajectory such as engineering, physical science, or mathematical science



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# What Counts as a Mathematics Course?

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Only courses that address mathematical standards (including statistics) and that are mathematically demanding should count toward high school mathematics graduation requirements.



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# Mathematically Demanding Courses

- Require clarity and precision in reasoning
- Have focused and significant mathematics learning standards
- Maintain the integrity of the mathematical standards
- Are part of coherent mathematical learning progression (not dead-end courses)
- Approach mathematics in an instructionally balanced way



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# Sample Pathways

- Pathway A—Geometry First
- Pathway B—Integrated Approach
- Guard against the “race to calculus”
- Need for “targeted instructional support” for those beginning grade 9 without necessary foundation in K-8 mathematics curriculum



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# Pathway A—Geometry First

## 2 ½ Year

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- **Grade 9:** Geometry and Measurement Essential Concepts followed by Statistics and Probability Essential Concepts
- **Grade 10:** Algebra and Functions Essential Concepts
- **First Half of Grade 11:** Integrate Algebra, Geometry, and Statistics with emphasis on practices and processes.



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# Pathway B—Integrated Approach

## 3 Year

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- **Grade 9:** Integration of geometry and measurement with statistics and probability
- **Grade 10:** Algebra and functions
- **Grade 11:** Integration of functions, modeling and statistical inference



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# Possible Course Options beyond the Essential Concepts

- Precalculus
- AP Calculus
- AP Statistics
- IB Mathematical Studies
- Quantitative Literacy
- Financial Mathematics
- History of Mathematics
- Mathematical Modeling
- Discrete Mathematics
- Advanced Quantitative Reasoning (AQR) / Advanced Mathematical Decision Making (AMDM) (Dana Center 2017a)
- Statway and Quantway (Carnegie Math Pathways 2017a)
- Math Ready: Ready for College-Level Math (Southern Regional Education Board 2016)



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# Catalyzing Change Case Studies

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- [Colorado's Use of the Essential Concepts](#)
- [Escondido Union High School District A Systemic Approach to Change](#)
- [Louisiana's Intensive Algebra 1 Pilot](#)
- [San Francisco Unified School District's work to end student tracking and meaningful math instruction](#)

[www.nctm.org/change](http://www.nctm.org/change)

## ***Critical Conversations...***

Explicitly broadening the purposes

Dismantling structural obstacles

Implementing equitable instructional practices

Identifying Essential Concepts

Organizing the high school curriculum



# Key Recommendation

1. Each and every student should learn the Essential Concepts in order to expand professional opportunities, understand and critique the world, and experience the joy, wonder, and beauty of mathematics.
2. 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.
3. Classroom instruction should be consistent with research-informed and equitable teaching practices.
4. 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.



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# Essential Question

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What do we want all students to know and be able to do?

- How might we make high school mathematics work for more students?
- How might we promote learning that is meaningful, relevant, and accessible?

# What Actions Will You Take...

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... to initiate critical conversations to improve learning experiences and outcomes for each and every high school student?

- Teachers, Schools, and Districts
- Policy Makers
- Postsecondary Educators



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# Initiating Critical Conversations

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What can you do, what conversations can you start, when you get back to work on Monday with regards to ...

- the Essential Concepts and curriculum?
- professional development for teachers around equitable teaching practices?
- the role of technology?
- course pathways?
- other?

**What intentional actions might I take...?**



# 2-0'Clock Partner



## Practice/share with your partner

- **What?** Condition or systemic structure
- **Who?** Stakeholders
- **How?** Data, research, professional learning

**What intentional actions might I take...?**

# Actions for Teachers, Schools, and Districts

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1. Analyzing and evaluating systemic policies, practices, and procedures that restrict student access to and success in mathematics
2. Analyzing teachers' assignments to develop balanced and supportive assignments to provide high-quality, engaging learning experiences for all students
3. Consistently implementing and linking research-informed instructional practices and equity-based instructional practices
4. Providing students with targeted additional instructional time and other instructional supports on the basis of information from a variety of assessments that are connected with students' regular course work
5. Providing teachers and mathematics curriculum leaders with time to collaborate with their colleagues and postsecondary educators to develop mathematics pathways and courses that address the Essential Concepts, including innovative common shared pathways with a two- to three-year time frame, as well as courses that provide students with mathematical opportunities beyond the Essential Concepts
6. Providing teachers with time and space to collaborate with one another on instructional issues and to continue their own professional learning of both mathematics and mathematics-specific pedagogy

# Actions for Policy Makers

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1. Develop policies that support meaningful four-year pathways that support student learning of the Essential Concepts as well as additional mathematics
2. Developing policies that support the study of mathematics so that all students have professional opportunities, can understand and critique the world, and experience joy and wonder with mathematics
3. Deemphasizing the “race to calculus” and increasing the emphasis on developing and using the Essential Concepts
4. Developing assessments that are aligned with and emphasize the Essential Concepts

# Actions for Postsecondary Educators

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1. Ensuring strong articulation and seamless pathways between the high school and the postsecondary mathematics curricula
2. Collaborating with school- and district-based mathematics educators
3. Working with in-service and preservice teachers to support research-informed and equitable instructional practices focused on the Essential Concepts
4. Collaborating with school and district educators to develop additional mathematics pathways and populating courses with the Essential Concepts
5. Collaborating with school and district educators to challenge and dismantle system structures that impede students' access to and success in mathematics

# Catalyzing Change Resources

- More4U (access code in book)
- MyNCTM
- <https://www.nctm.org/change/>
  - Book Study Guide
  - Case Studies
    - Colorado’s Use of Essential Concepts
    - Escondido Union HS Systemic Approach to Change
    - Louisiana’s Intensive Algebra 1 Pilot
    - San Francisco Unified efforts to end student tracking



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***Catalyzing Change in High School Mathematics Unpacking  
Challenges, Critical Conversations, and Next Steps***  
**#NCTMCHANGE**

*“The system of high school mathematics is complex, and it is the system and its structures—school and district policies, practices, and conditions that either support or impede student learning of mathematics—that need to be critically examined and improved.”*

**Karen J. Graham, University of New Hampshire, Durham NH**

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