Making the Argument

How connecting mathematics and science practices can improve student discourse

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Raise your hand if…

- You teach K-2
- You teach 3-5
- You teach 6-12
- You teach science
- You have another role (coaching, leadership, university, etc.)
- You are familiar with the Standards for Mathematical Practice (CCSS-M)
- You are familiar with the Science and Engineering Practices (NGSS)
- You love being in San Diego right now!
- You love math!

Goals

In this session, we will:

- Identify and explore the Standards for Mathematical Practice (CCSS-M) and Science and Engineering Practices (NGSS) most relevant to student discourse.
- Experience strategies to support student discourse in math and science.
- Consider how discourse helps us attend to equity by developing students' mathematical identities.

Connecting the Practices

A Look to the Future

"By one popular estimate, 65% of children entering primary schools today will ultimately work in new job types and functions that currently don't yet exist."

-Schwab & Samans (2016)

Communication and STEM Careers

The STEM 2026 Report from the U.S. Department of Education recognizes...

"Collaboration and building necessary social skills"

among other key components as necessary for students to work together to

"tackl[e] the grand challenges facing society: food, water, housing, transportation, information, climate, security, and so on."

Standards for Mathematical Practice (CCSS-M)

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

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SMP 6: Attend to precision.

"Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning...In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions."

CCSS-M, Standards for Mathematical Practice

Science and Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

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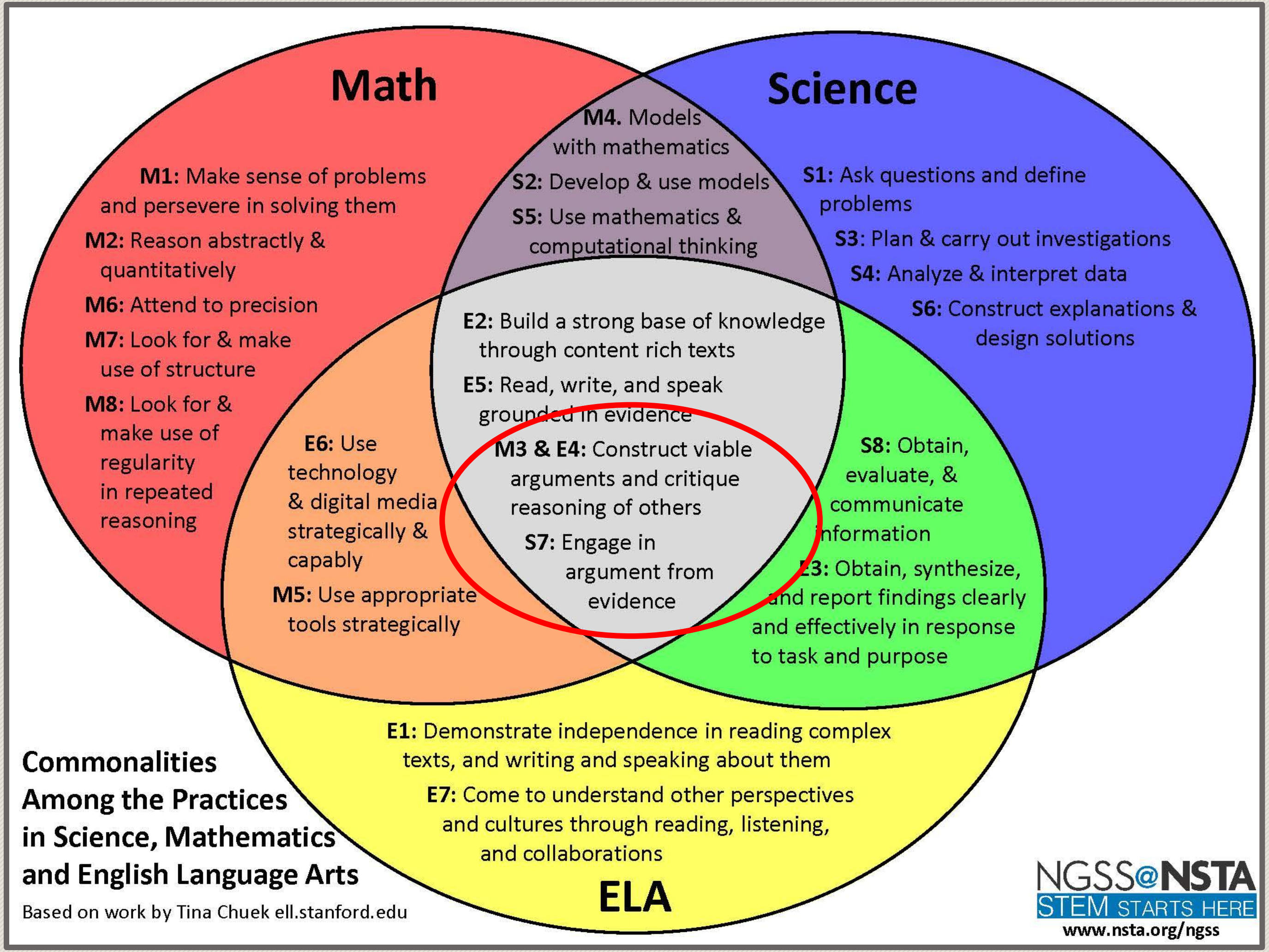
Where is the Science?

SEP 6: Constructing explanations

Students demonstrate their understanding of a scientific idea by developing their own explanations of phenomena, whether based on observations they have made or models they have developed.

SEP 7: Engaging in argument from evidence

Students get a sense of the process of argument necessary for advancing and defending a new idea, and the norms for conducting such arguments. Students should argue for the explanations they construct and defend their interpretations of the associated data.


Math
Science
ELA
M4. Models with mathematics
S2: Develop & use models
S5: Use mathematics & computational thinking
M1: Make sense of problems and persevere in solving them
M2: Reason abstractly & quantitatively
M6: Attend to precision
M7: Look for & make use of structure
M8: Look for & make use of regularity in repeated reasoning
S1: Ask questions and define problems
S3: Plan & carry out investigations
S4: Analyze & interpret data
S6: Construct explanations & design solutions
E2: Build a strong base of knowledge through content rich texts
E5: Read, write, and speak grounded in evidence
M3 & E4: Construct viable arguments and critique reasoning of others
S7: Engage in argument from evidence
E6: Use technology & digital media strategically & capably
M5: Use appropriate tools strategically
S8: Obtain, evaluate, & communicate information
E3: Obtain, synthesize, and report findings clearly and effectively in response to task and purpose
E1: Demonstrate independence in reading complex texts, and writing and speaking about them
E7: Come to understand other perspectives and cultures through reading, listening, and collaborations
Commonalities Among the Practices in Science, Mathematics and English Language Arts
Based on work by Tina Chuek ell.stanford.edu
NGSS@NSTA
STEM STARTS HERE
www.nsta.org/ngss

Connecting the Practices

- Can use existing curriculum/resources
- Focuses on the act of doing math, the act of doing science
- Allows for more time spent with each subject
- “Real-world” contexts - math and science do not exist in isolation

Strategies to Support Discourse

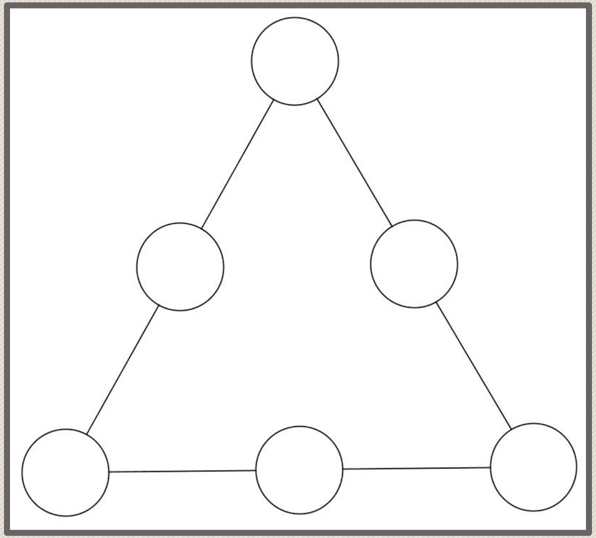
Collaborating around science and math in K-8

Connections project

- 17 months
- Cohort of 32 Chicago Public Schools teachers
- Four teachers from each of eight schools: two K-5 teachers, one MS math teacher, one MS science teacher from each
- Summer institutes, evening sessions, Saturday sessions

The Triangle Game

Place the numbers 1 to 6 in the circles so that the sum along each side is the same.



Sally, J. D. & Sally, Jr., P. J. (2003).

The Triangle Game

With a partner, discuss:

- Are your solutions the same?
- Have you found all of the solutions? Push yourselves to find them all!
- What questions do you have?

Sharing and Building on Each Other's Ideas

How do you know you have found all of the solutions?
Support your argument with evidence.

Where is the Science?

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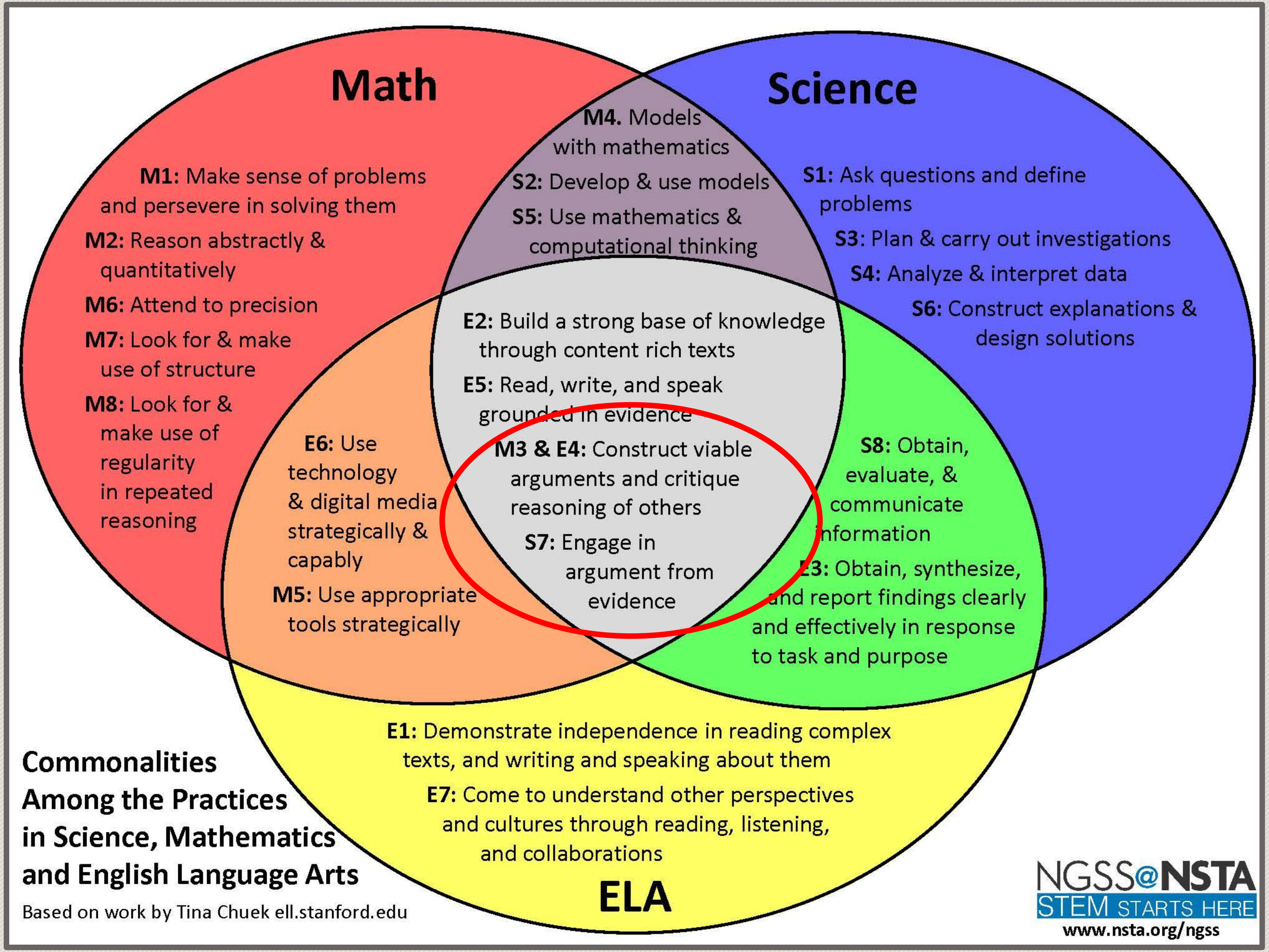
The Triangle Game - Where is the science?

4th Grade Classroom

The class has been using stream tables to investigate the effect of vegetation on erosion. At the end of class, the teacher leads a discussion where students construct explanations and argue from evidence.

Look back at the conversation guide - did you hear students in the video using any of this language?



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Making Connections Meaningful

- Be explicit
- Collaborate with the science teacher(s)
- Post and discuss the Science and Engineering Practices throughout the year

Planning for Math and Science Connections

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Connections Planning

Subject Area: Math
Source: *TriMathlon*, STEM Teaching Tools Talk Resource Tools
Lesson/Activity: Triangle Game
Content Standard(s)/Performance Expectation(s): 4.OA.C.5: Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.

What are the Primary Practice(s) and how could you strengthen these practices in your lesson?	What opportunities exist to make connections to Math/Science practices?	Additional notes (Content to include, other resources, etc.)
SMP 3: Construct viable arguments and critique the reasoning of others. Encourage students to explain how they know they found all the possible solutions. Give students the opportunity to challenge each other's arguments. SMP 6: Attend to precision. Ask what mathematical ideas/patterns provide evidence for their argument (commutative property, associative property, etc.)	SEP 7: Engaging in argument from evidence. STEM Teaching Tools - guide for sharing and building on ideas. SEP 6: Constructing explanations Focus on the "how" and "why" of the mathematics in whole-group discussion. *How did you find all the solutions? Why do these patterns emerge?*	TERC Talk Moves checklist Emphasize terms: • Patterns • Evidence • Explanation
Which strategies will help you attend to equity in this lesson?	STEM Teaching Tools discussion guide in partnerships - support English learners, encoura equity of voice in partnerships. Talk Moves: *Who can add on to the idea ____ is building? Who can explain what ____ means when he says that? Does anyone want to respond to that idea?*	

Making Connections Explicit

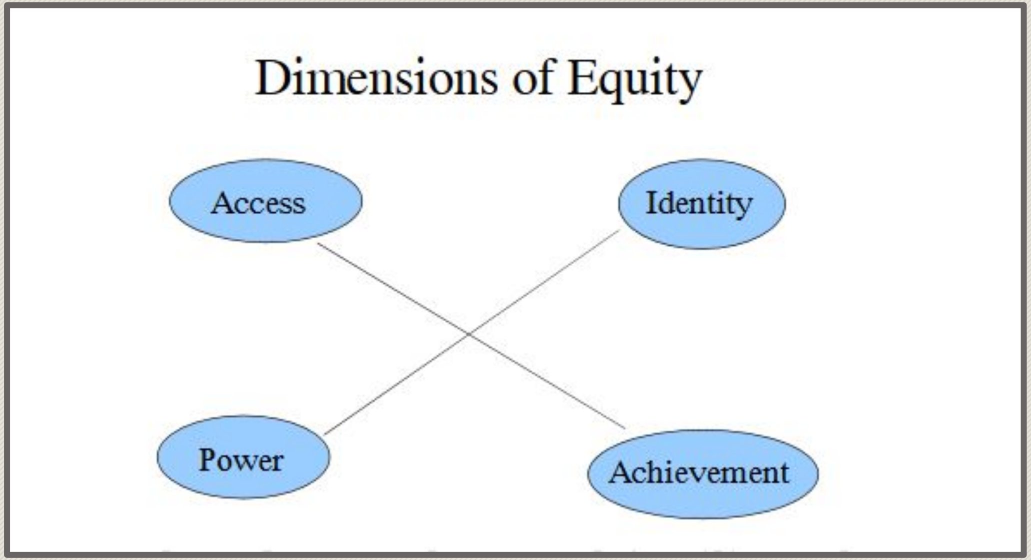
For example, a teacher might say:

“Today, as mathematicians we worked on constructing viable arguments and attending to precision. How is that similar to the work of a scientist?

...and then lead the discussion to help students identify that they are also working on constructing explanations and designing solutions, and engaging in argument from evidence.

Attending to Equity

Equity in Math and Science



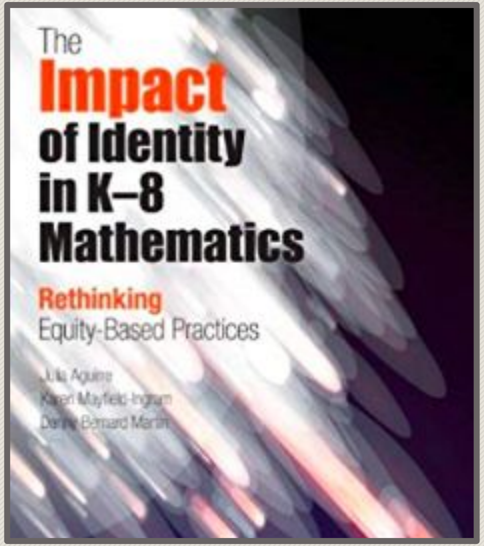
From Gutiérrez (2009)

"...the identity dimension also concerns itself with a balance between self and others in a global society...It includes whether students have opportunities to draw upon their cultural and linguistic resources...when doing mathematics."

-Rochelle Gutiérrez

The Bus Pass Problem

It costs $1.50 each way to ride the bus between home and work. A weekly pass is $16. Which is the better deal, paying the daily fare or buying the weekly pass?



From Aguirre, J., Mayfield-Ingram, K., & Martin, D. (2013). The Impact of Identity in K-8 Mathematics Learning and Teaching: Rethinking Equity-Based Practices.

Equity in Math and Science

The Bus Pass Problem

- Students make arguments based on evidence from their own experiences
- Students' mathematical computations are correct in the context of different sets of assumptions
- Students build identities as mathematicians and scientists

How do your mathematics lessons give students the opportunity to engage in arguing from evidence from their own experience when solving problems?

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Thanks...

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Any Questions?

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