CCSS mathematics

The chance for change…

And the challenge

Equivalence

4 + [ ] = 5 + 2

Write four fractions equivalent to the number 5

Write a product equivalent to the sum:

$3x + 6$

Write a product equivalent to $x^2 + x – 2$

Mile wide –inch deep

cause:

too little time per concept

cure:

more time per topic

= less topics

Why do students have to do math problems?

a) to get answers because Homeland Security needs them, pronto

b) I had to, why shouldn't they?

c) so they will listen in class

d) to learn mathematics

Why give students problems to solve?

- To learn mathematics.
- Answers are part of the process, they are not the product.
- The product is the student's mathematical knowledge and know-how.
- The 'correctness' of answers is also part of the process. Yes, an important part.

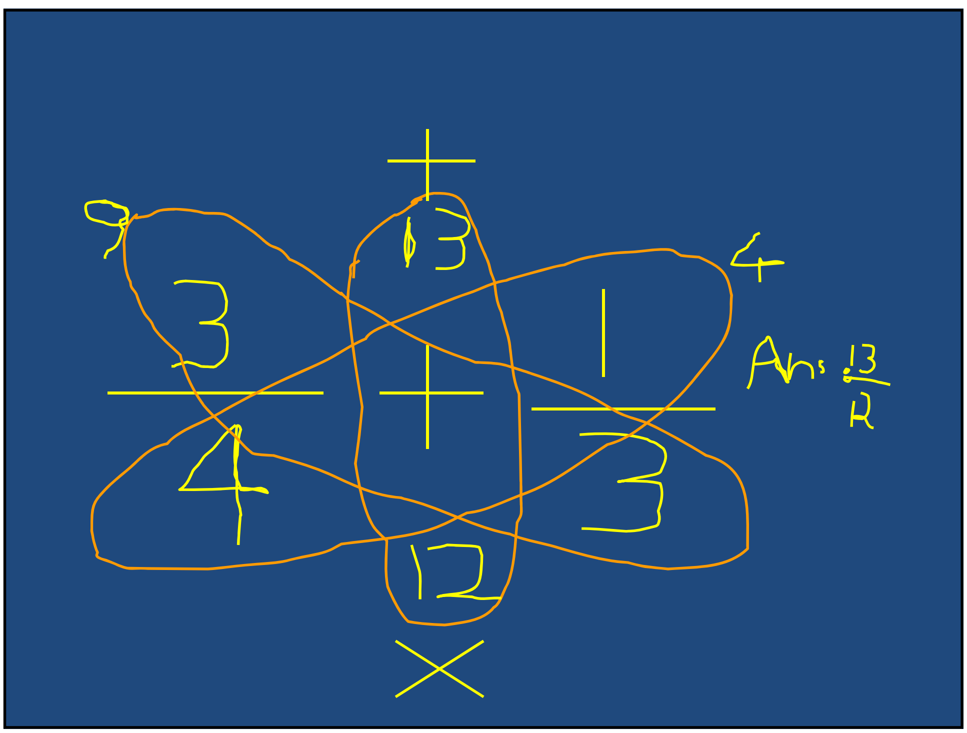
Answer getting vs. learning mathematics

- USA:
- **How can I teach my kids to get the answer to this problem?**

  Use mathematics they already know. Easy, reliable, works with bottom half, good for classroom management.
- Japanese:
- **How can I use this problem to teach the mathematics of this unit?**

Butterfly method

$$\frac{3}{4} + \frac{1}{3}$$



Problem from elementary to middle school

Jason runs 40 meters in 4.5 seconds.

Three kinds of questions can be answered

Jason ran 40 meters in 4.5 seconds

- How far in a given time
- How long it takes to go a given distance
- How fast is it going
- *Understanding how these three questions are related mathematically is is central to the understanding of proportionality called for by CCSS in 6th and 7th grade, and to prepare for the start of algebra in 8th.*

Acceleration to catch up

Differences among students

- The first response, in the classroom: make different ways of thinking students' bring to the lesson visible to all
- Use 3 or 4 different ways of thinking that students explain as starting points for paths to grade level mathematics target
- All students travel all paths: robust, clarifying, language developing

Cycles

- Problem by problem
- Daily
- Within unit
- Within semester
- Annual

Daily cycle

I. Social processes to learn other's "ways of thinking" naturally travels progression from earlier ways of thinking to grade level ways of thinking.
II. Inside each grade level problem, a window back into the progression from earlier grades. Work through the window, don't quit on the grade level.
III. Embedded tutoring
IV. Hints and scaffolding from teacher
V. Hints and scaffolding from program
VI. Homework help

Within Unit

I. Progression of problems
II. Progression of lessons
III. Rhythm from intuitively accessible contexts that scaffold thinking to mathematically precise, abstract and general. Learning to use mathematics as a reasoning tool.
IV. Small group “guided mathematics” for a day or 2 every week or 2, after a cycle of lessons. Students identified through the windshield of their actual work…finish what you start.

Beyond the classroom interventions

I. Most important and needed by most is help with the assigned work of the course. This includes homework help and study help. Should be available on much larger scale than we are used to. Open access to whomever wants it as well as assigned. Lower the social cost.

Time

- Slow down for learning, thinking and language
  - The press of time against the scope and depth of curriculum
  - The press of time against the engagement, language processing and cognition of ELLs
  - The press of time against instruction in two languages
  - Time for teachers to learn, to think, to give feedback to students

Mathematical Practices Standards

1. Make sense of complex 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.

College and Career Readiness Standards for Mathematics

Expertise and Character

- Development of expertise from novice to apprentice to expert
  - Schoolwide enterprise: school leadership
  - Department wide enterprise: department taking responsibility
- The Content of their mathematical Character
  - Develop character

motivation

Mathematical practices develop character: the pluck and persistence needed to learn difficult content. We need a classroom culture that focuses on learning…a try, try again culture. We need a culture of patience while the children learn, not impatience for the right answer. Patience, not haste and hurry, is the character of mathematics and of learning.

5x8 Evidence-Gathering Card

Principle	Student Vital Behaviors
Logic connects sentences *Practices 1, 2, 3, 6*	Students ***say a second sentence*** (spontaneously or prompted by the teacher or another student) to explain their thinking and connect it to their first sentence.
Reasoning develops when students develop viable arguments *Practices 1, 2, 3, 6, 7, 8*	Students ***talk about each other's thinking*** (not just their own).
Students write explanations *Practices 1, 2, 3, 4*	Student work includes revisions, especially ***revised explanations*** and justifications.
Academic success depends on academic language *Practices 3, 6*	Students use ***academic language*** in their explanations and discussions (spontaneously and/or prompted by the teacher or other students.)
ELLs produce language *Practices 1, 2, 3, 6*	***English learners get time***, encouragement, and support – from other students and/or teacher – in using academic language in English or in their home language. Students are familiar with, and take advantage of language support scaffolds such as sentence frames, multiple choice oral responses, and reference to diagrams and other representations.
Believing (that you can get better at math by learning) motivates	***Do students believe that they can learn to be good at math*** by learning more math, by working hard, and persevering to make sense of problems? Or do students think they cannot change how good at math they are?
Equity (The foundation for the above)	***Which students are participating***? (e.g. boys more than girls, the same few students, ELL and special ed students?) Are they volunteering? Called on to do math? Talking about math in their group? Off task? **All students ask math questions.**

OAKLAND UNIFIED SCHOOL DISTRICT
Community Schools, Thriving Students

V.5 2-6-12
Your input welcome: TeamMath@ousd.k12.ca.us

Students say a second sentence

Why is this important?

Why would a student say a second sentence?

- Someone is listening…really
- There is more to say
- Think pair share

Why does that answer makes sense?
Why does multiplying make sense?
Show me with a diagram?

Work in pairs

Who gets to say second sentences?

- Shyness
- Language
- Reasoning is the subject of the lesson
- Rule of thumb: half the period should be discourse among students about student reasoning
- Teacher role: prompt the productive struggle, intervene when students start quitting, motivate.

PRIOR KNOWLEDGE

- Knowledge IS a representation, and in mathematics the representations use social, academic and specialized language.
- Specialized mathematical language includes symbolic expressions, tables, graphs, diagrams as well as special phrases and terms.
- “Let x be a number > 0, …”
- “Sonia has waited three times as long as Mr. Ryan promised. .”

What is learning?

- Integrating new knowledge with prior knowledge; explicit work with prior knowledge; prior knowledge varies across 25 students in a class; this variety is key to the solution, it is not the problem.
- Thinking in a way you haven’t thought before: thinking like someone else; like another student. Understand the way others think.

16 ÷ 3 = []

Show 15 ÷ 3 = []

1. As a multiplication problem
2. Equal groups of things
3. An array (rows and columns of dots)
4. Area model
5. In the multiplication table
6. Make up a word problem

Show 15 ÷ 3 = []

1. As a multiplication problem (3 x [ ] = 15)
2. Equal groups of things: 3 groups of how many make 15?
3. An array (3 rows, ? columns of 3 make 15?)
4. Area model: a rectangle has one side = 3 and an area of 15, what is the length of the other side?
5. In the multiplication table: find 15 in the 3 row
6. Make up a word problem

Show 16 ÷ 3 = []

1. As a multiplication problem
2. Equal groups of things
3. An array (rows and columns of dots)
4. Area model
5. In the multiplication table
6. Make up a word problem

Teach at the speed of learning

- Not faster
- More time per concept
- More time per problem
- More time per student talking
- = less problems per lesson

Personlization

The tension: personal (unique) vs. standard (same)

Why Standards? Social Justice

- Main motive for standards
- Get good curriculum to all students
- Start each unit with the variety of thinking and knowledge students bring to it
- Close each unit with on-grade learning in the cluster of standards
- Some students will need extra time and attention beyond classtime

Standards are a peculiar genre

1. We write as though students have learned approximately 100% of what is in preceding standards. This is never even approximately true anywhere in the world.
2. Variety among students in what they bring to each day's lesson is the condition of teaching, not a breakdown in the system. We need to teach accordingly.
3. Tools for teachers…instructional and assessment…should help them manage the variety

New Leaders

Four levels of learning

I. Highest Standard: Understand well enough to explain to others
II. Good enough Standard: enough to learn the next related concepts
III. Low Standard: Can get the answers
IV. No Standard: Noise

Four levels of learning

The truth is triage, but all can prosper

I. Understand well enough to explain to others
   - As many as possible, at least 1/3

II. Good enough to learn the next related concepts
   - Most of the rest

III. Can get the answers
   - Sometimes we have to settle for low, but don't aim low

IV. Noise
   - Aimless

Different students learn at levels within same topic

I. Understand well enough to explain to others
   - An asset to the others, learn deeply by explaining

II. Good enough to learn the next related concepts
   - Ready to keep the momentum moving forward, a help to others and helped by others

III. Can get the answers
   - Can be elevated by embedded tutoring

IV. Noise
   - Embedded Tutoring can minimize

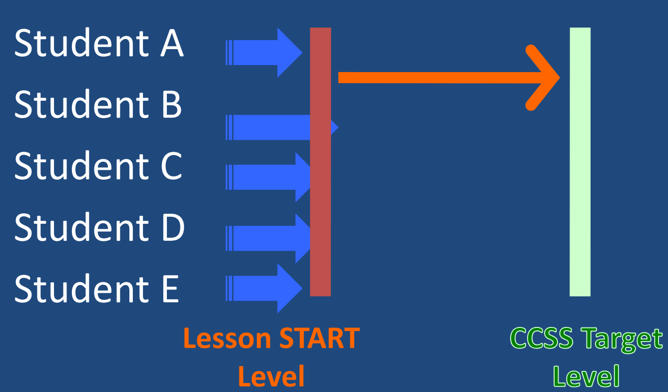
Walk into a classroom, you see this

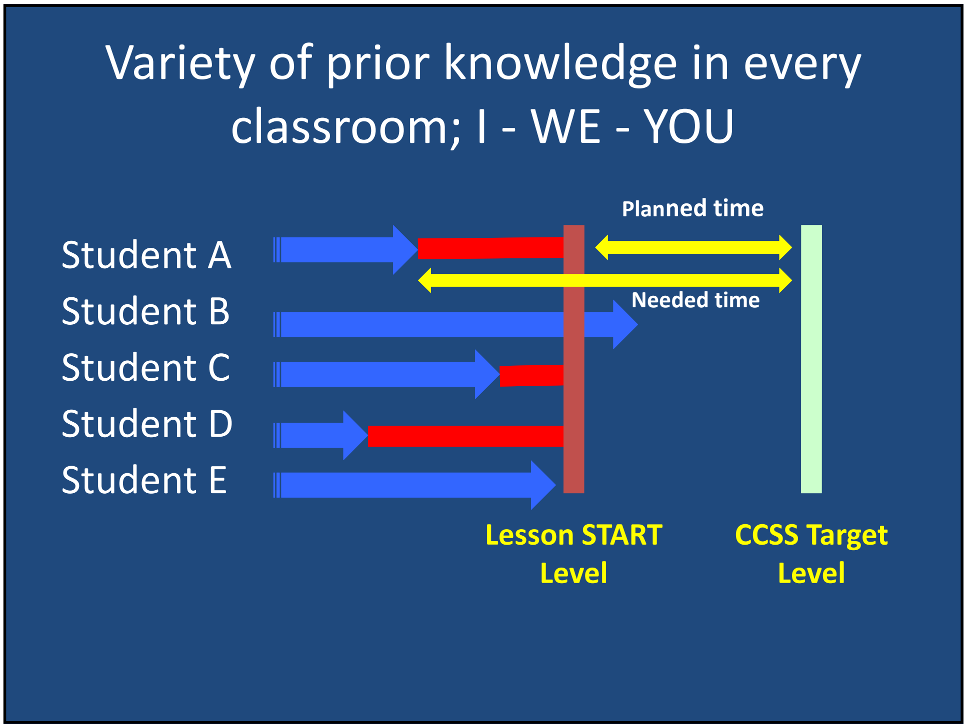
- Teacher says,
- "By the end of the chapter we are starting today, you will learn mathematics that makes solving this problem easy. Today, you can solve it with mathematics you already know. That will be harder than after you learn the mathematics of this chapter."
- What do you think will happen in the class? What do say to the teacher?

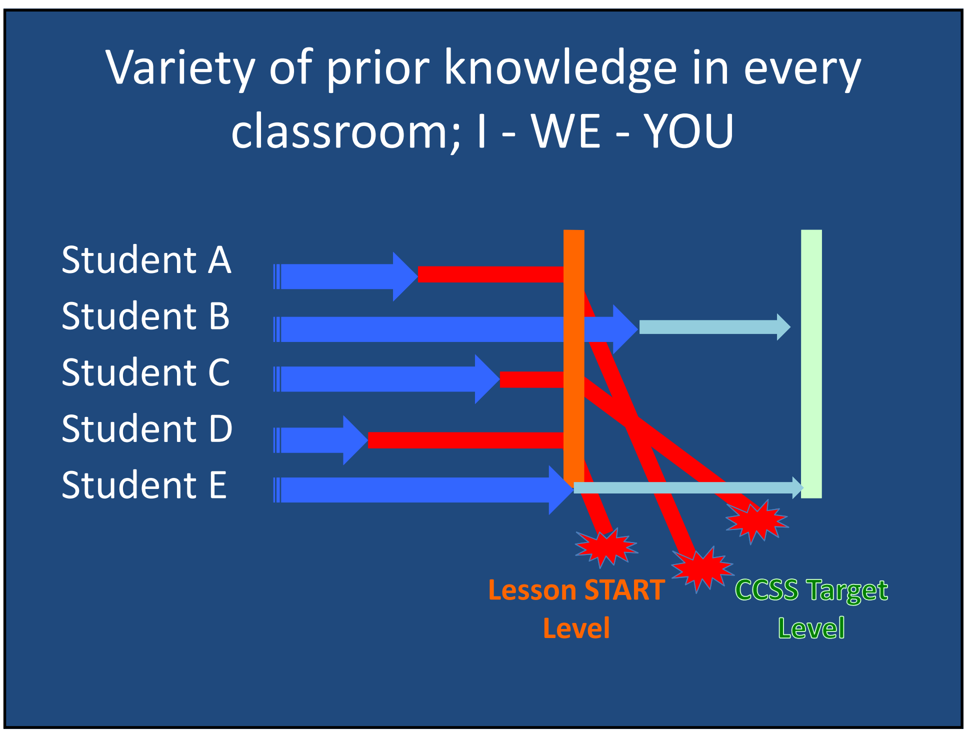
When the content of the lesson is dependent on prior mathematics knowledge

- "I – We – You" design breaks down for many students
- Because it ignores prior knowledge
- I – we – you designs are well suited for content that does not depend much on prior knowledge… new content or consolidation of content taught over previous 3 to 5 days

Minimum Variety of prior knowledge in every classroom; I - WE - YOU




Variety of prior knowledge in every classroom; I - WE - YOU
Planned time
Student A
Student B
Needed time
Student C
Student D
Student E
Lesson START Level
CCSS Target Level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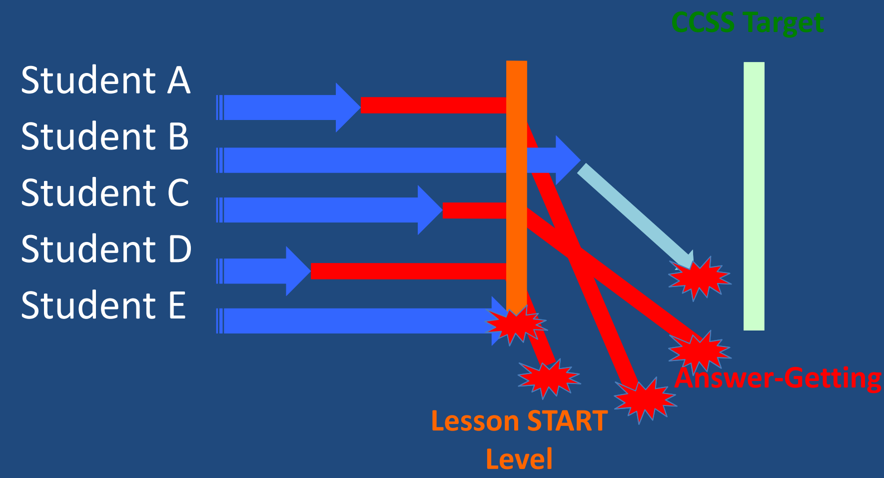
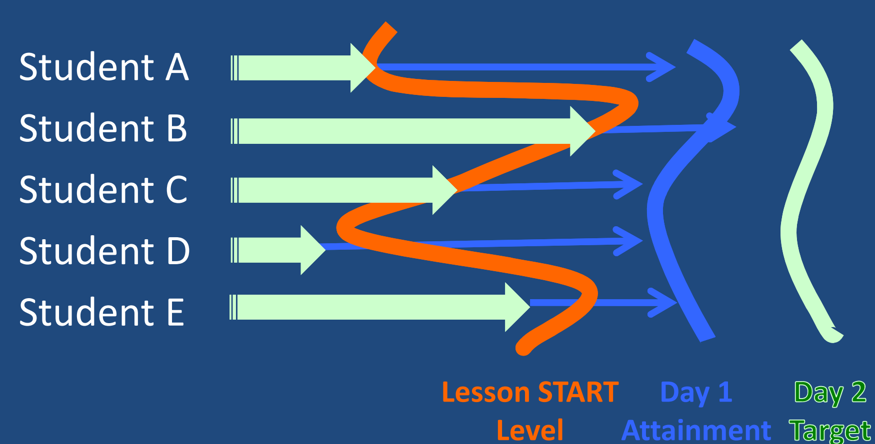


You - we – I designs better for content that depends on prior knowledge



Acceleration, catching up and moving on

Structure time in cycles

Acceleration to AP

- CCSS starts algebra I content in grade 8
- Finishes algebra I in HS
- Acceleration = learning the same content faster, NOT skipping content
- No skip-able grades in CCSS
- 3 years compressed to 2 is learning 50% faster
- 2 years compressed to 1 is 100% faster

How do these two fraction items differ?

I. 4/5 is closer to 1 than 5/4. Show why this is true on the number line.

II. Which is closer to 1?
a) 5/4
b) 4/5
c) ¾
d) 7/10

With your partner, discuss ***how these items differ***. What do they demand from students?

Language, mathematics and EL

Attend to precision

Precision and Imperfect Language Mathematical Practice standard 6

- Imperfect language is valuable and can express precise reasoning and ideas
- Making language more precise is a social and mathematical process; it should be a recurring focus of class discussion
- Use imperfect language to express reasoning and then making the language and reasoning more precise together
- Perfect teaching is unnecessary, imperfect works fine with patience and an interest in each student's thinking

Precision

The process of making language precise IS the process we want students to engage in.

The process usually begins with imprecise language, often alternative imprecise language

Definition settles arguments in mathematics

- imprecise language could be using the same word with different meanings,
- the work is making the meanings explicit
- and then recognizing the difference
- and then specifying a common meaning
- testing definitions with a variety of examples is a very useful process…does the definition decide whether the example is an example of the defined term? if the definition does not decide, it needs to be made more precise.

Reference and correspondence

- another useful process is making references and correspondences explicit; for example, labeling the parts of a diagram so the quantities the parts refer to are explicit; writing the units…inches, pounds….;

Represent relationships explicitly

- another process is representing relationships in diagrams.
- Expressions represent relationships in concise way

Language Differences and Content

- How knowledge, cognition and language are threads in a single fabric of learning,
  - Inadvertent ways system unravels this fabric: silos, assessment, classification of students, instruction
- Practices linked to discipline reasoning expressed in language and multiple representations
- Access to content courses
- Don't leave out ELLs from Progression in text complexity and teaching for understanding

Discussions

- How can increased discussion from CCSS benefit Ells, rather than left out
- Communicative stamina needed, builds intellectual stamina:
- How do we teach teachers to lead, manage discussions?

Old State Standard

Students perform calculations and solve problems involving addition, subtraction, and simple multiplication and division of fractions and decimals:

2.3 Solve simple problems, including ones arising in concrete situations, involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less), and express answers in the simplest form.

Use equivalent fractions as a strategy to add and subtract fractions.

1. Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, 2/3 + 5/4 = 8/12 + 15/12 = 23/12. (In general, a/b + c/d = (ad + bc)/bd.)*

Old Boxes

- People are the next step
- If people just swap out the old standards and put the new CCSS in the old boxes
  - into old systems and procedures
  - into the old relationships
  - Into old instructional materials formats
  - Into old assessment tools,
- Then nothing will change, and perhaps nothing will

Three major design principles, based on evidence:

- –**Focus**
- –**Coherence**
- –**Rigor**

Explain how 2 second rule works

- Rule of thumb for safe following distance when driving:

  Count the seconds from when the car in front of you passes a sign to when your car passes the sign. It should be two seconds to be safe.

- Explain, using a diagram, how this rule works for different speeds. For example, what distance will the following distance be at 30 compared to 60 miles an hour.