University of Colorado
Denver | Anschutz Medical Campus

Welcome to UCD's mini-STEM School:

The Challenges and Opportunities in Mathematics Teaching

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For A Start: An Example

- Please write down, or think about, a definition/meaning (fill in the blank): A fraction is _____

- Provide an example for your definition with 1/4 (include a picture)

- Let's share 2-3 responses

- We all learned: a fraction is a part of a whole (1/4 is one out of 4 equal parts)

- Let's see how this meaning may be applied to solving a problem
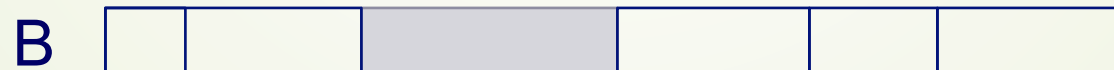
Problem Solving

Sticks A and B are exactly the same size.

The yellow part is exactly the size of the part above it in A.

What fraction is the shaded part of Stick A?

What fraction is the shaded part of Stick B?

Note: The shaded piece is not a part of Stick A, and it is one of 6 unequal parts of Stick B.

A

B

Mini-STEM Session Outline

- Example of challenges and opportunities (more to come)
- National Issue: Glenn Commission
- Session's focus
- Learn through hands-on activity
- A few, key challenges and opportunities
- Highly encouraging research findings
- Discussion (questions and more questions …)

Glenn Commission (2000)

It is abundantly clear from the evidence at hand that we are not doing the job that we should do—or can do—in teaching our children . . . Our children are falling behind; they are not "world-class learners" when it comes to mathematics and science.

The Commission has concluded that the most powerful instrument for change, and therefore the place to begin, lies at the very core of education—*with teaching itself*.

Focus

- Not on teachers (should be paid, certified), or on top-down curriculum/ standard mandates (at best – a good guide, misses how to accomplish those with diverse student populations)

- Focus on main professional goal: Teach math well so we promote student learning with understanding, problem solving

- Professional in:
  - Math content (goals for student learning, but not "one-size-fits-all")
  - Assesse students' available understanding
  - Capitalize on available understanding to engage students in learning activities (tasks) that change the known into the desired understanding

- Illustrate above three with fraction example
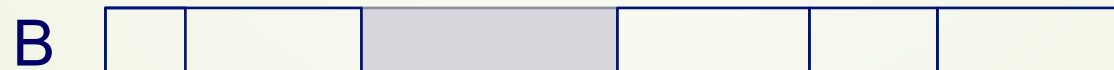
Recall Problem Solving

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A

B

Expend Math: French Fry Task

- Please do not do anything with the pieces of paper until task is explained

- Consider the yellow strip of paper as a French fry

- Use the white strips as a 'tool' in this activity

- Take a yellow piece (French fry); share it equally between two people
  - A few responses

- New rules (constraints): From now, you cannot fold the paper(s) or use rulers

- Take another French fry; share it equally among 3 people (can mark both)

- Intro - Repeat Strategy: (1) Estimate one person's piece, (2) repeat it n times, (3) compare to the given fry; go to step 1 while adjusting the estimate, etc.

- Shift to JavaBars: Work on 3, then shift to 4

Revised Definition (Unit Fraction)

- A unit fraction, 1/n (e.g., 1/3, 1/5, 1/12) is not just/mainly part of a whole

- A unit fraction is a unique quantity – a relation between two units
  - one unit is considered as a whole (One = 1)
  - the other fits within it n times – or the whole is n times as much as the piece

- For example, 1/4 is a quantity that the whole is 4 times as much of it
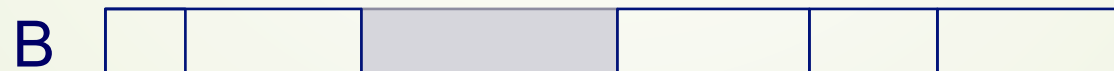
Solve Problem Anew

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Reflect on Our Example

- Supposed what you all do know (and capitalized on it)
  - Whole numbers as units made by repeating the unit of 1 so many times
  - Unit fraction as "one-out-of-so-many-equal-parts"
  - Accordingly, to make 1/2 you can/would fold the 'fry' (open to other solutions)
- Challenged your current understanding (Stick A – Stick B problem)
- Fostered learning of new idea (fraction as a relation) through activity:
  - First – activate/use what you do know
  - Second – constrain and promote novel link of known activities (don't start with whole but rather with one part – and iterate it)
  - Third – encourage reflection through well-chosen probing questions (shorter?)

Challenges in Math Teaching

- **Knowing the math well** - number, multiplication, place-value, fractions, ratio/proportion, variable, function, relation among lengths/angles, etc.
  - Not "I am a 2nd or 11th grade teacher," but rather "I am a math teacher"
- **Knowing one's students' current understandings well** - research-based knowledge of developmentally appropriate learning trajectories
  - Most teachers do not seem to have access to this knowledge - nor can they use it mindfully (requires a huge shift in teachers theory of learning and math knowing)
- **Knowing how to constantly tailor tasks/activities** to both where students are and (b) the math intended for their learning
  - Curricular materials and standards, while important, cannot replace teachers' professional adaptation of tasks to students (currently, seem as if what actual students in one's classroom do know makes no difference)
- **Embracing the daily unknown** and thus celebrate learning (taking risks)

Opportunities in Math Teaching

- Spark never really turns off fully (think fireplace pilot); find ways to reignite – students and teachers alike rediscover math is exciting

- Persistent work with and support for teachers brings substantial change (countering years of exposure to different theories is hard-yet-possible)

- Addressing each of the challenges by fostering teacher professional growth is lengthy and not a straight line – but new ways benefit them and students
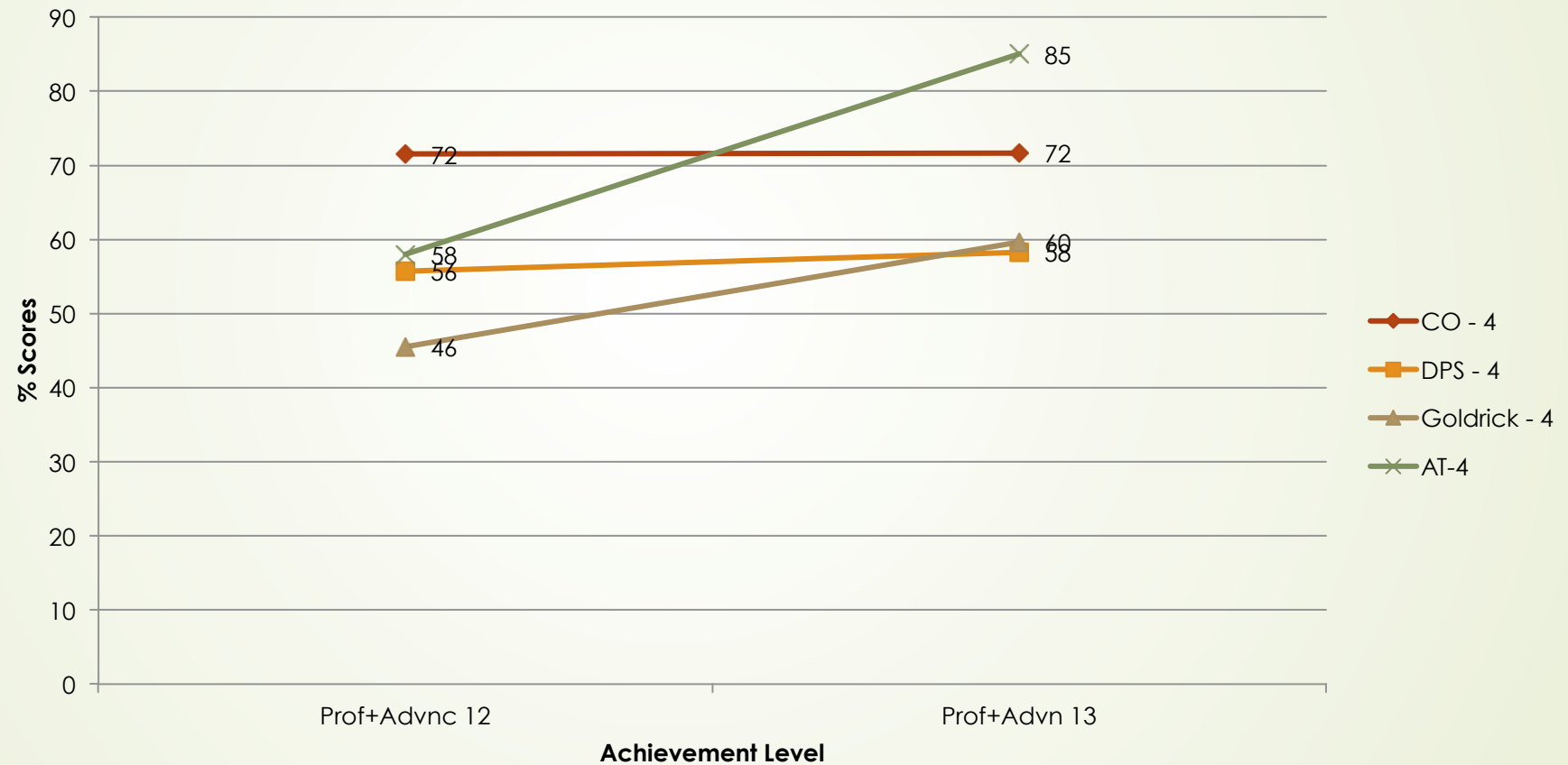
Encouraging Findings
(100% free/reduced lunch; 90% ELL)

TCAP Scores 2012/2013 - Grade 3 Math
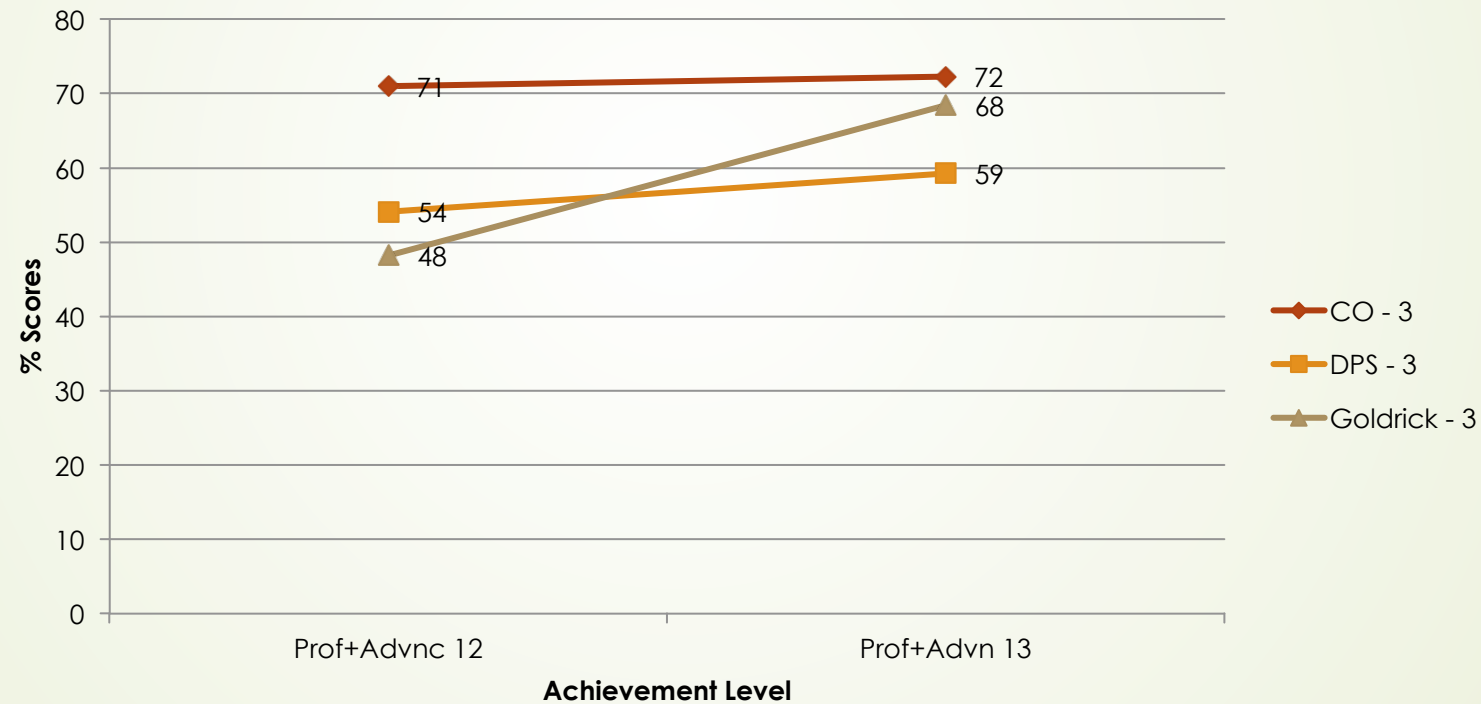
Encouraging Findings (cont.)

TCAP Scores 2012/2013 - Grade 4 Math

Encouraging Findings (cont.)
Brain Study (fMRI) – Number Comparison

	Pre (mili-sec)	Post (mili-sec)
Unit Fractions	1,176	912 (~30% faster)
Whole Numbers	937	760 (~25% faster)

Ron Tzur (UCD): Math Teaching - Challenges and Opportunities

3/16/16

Discussion – Questions & Answers

- We really do know how to bring a change
  - Current project, funded by National Science Foundation (4-year, $3M)
  - Aurora Public Schools (4-5), ~50 teachers
  - One year of professional development; one year of study
- My pondering: Can we (Denver, Colorado, US) recruit resources, stamina, and patience to bring it about ? ? ?
- Your questions: