Inspire learning by doing

not factorable because it doesn't make a rectangle.

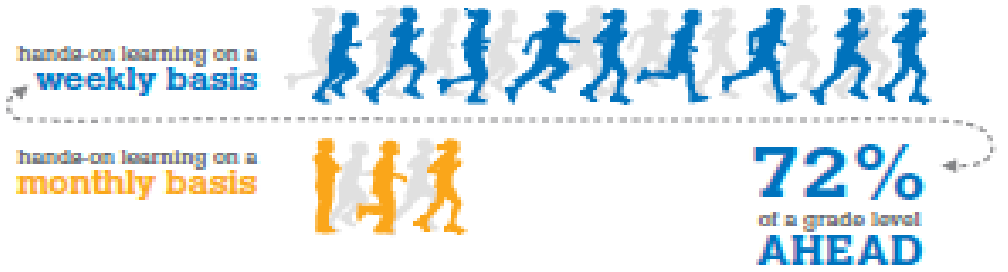
sticks out.

You have to put them together and try to make a rectangle if you make a rectangle then its factorable.

Algebra 1 students' written responses when asked about the factorability of $x^2 + 2x + 2$

"Each time one prematurely teaches achild something he could have discovered himself, that child is kept from inventing it and consequently from understanding it completely."

– Jean Piaget



When students are exposed to hands-on learning on a weekly basis rather than monthly basis, they prove to be 72% of a grade level ahead in mathematics.*

* How Teaching Matters: Bringing the classroom back into discussion of teacher quality. Princeton, NJ: Educational Testing Service.

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Fractions as Numbers! Beyond Part-Whole

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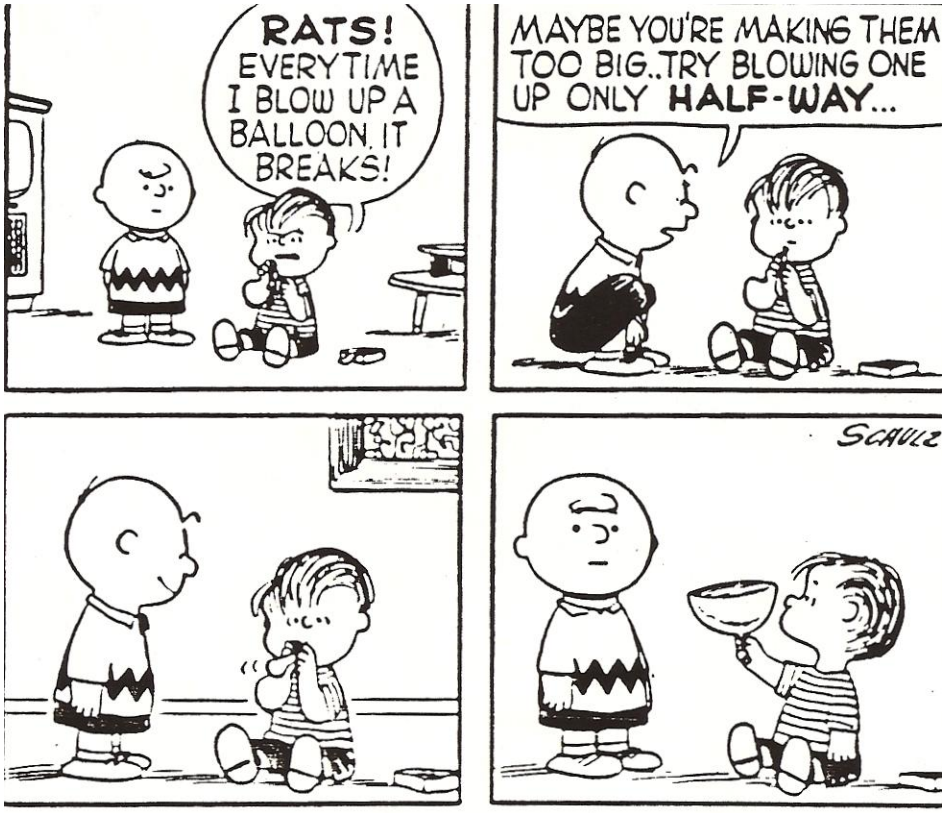
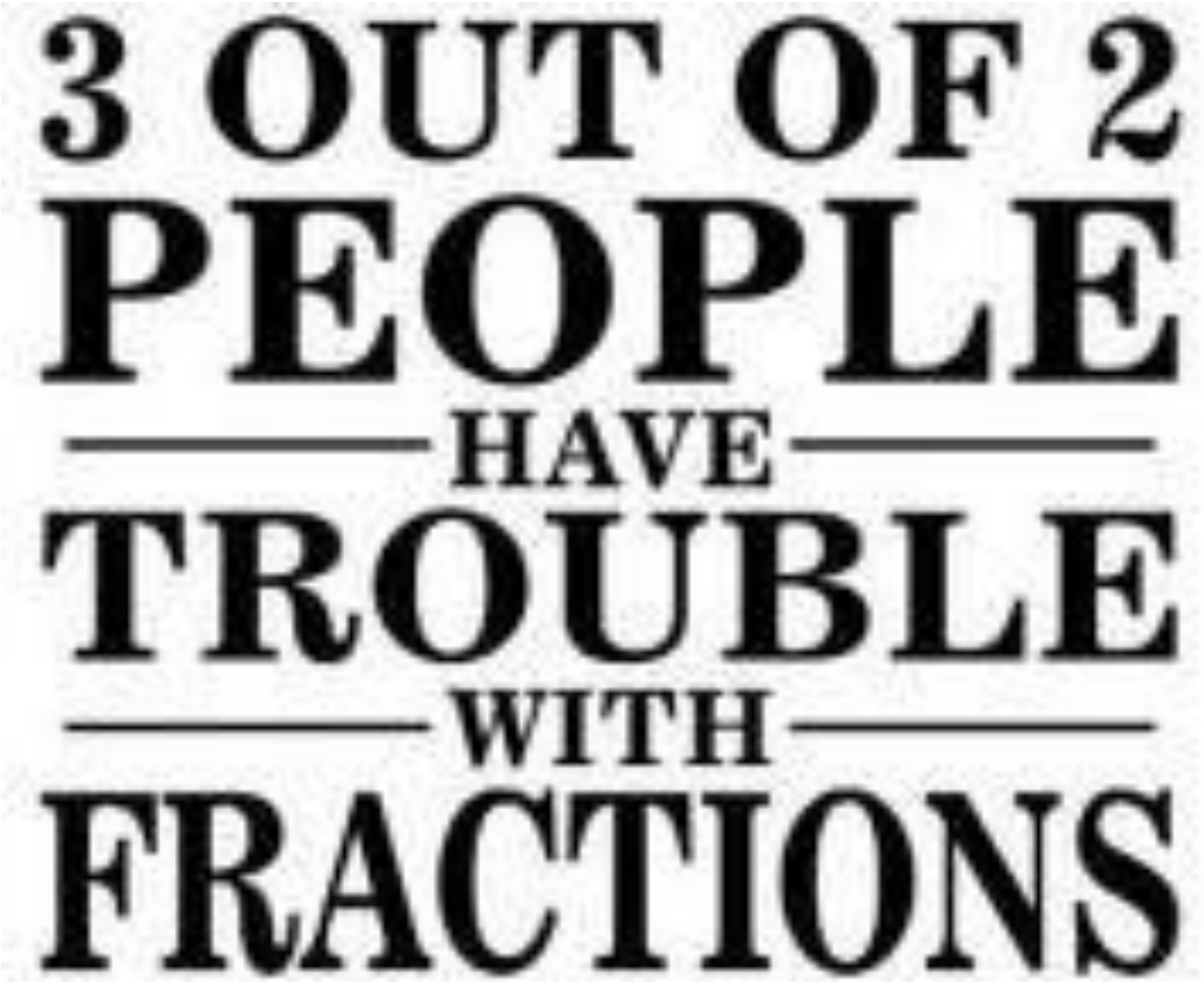
Fractions as Numbers???

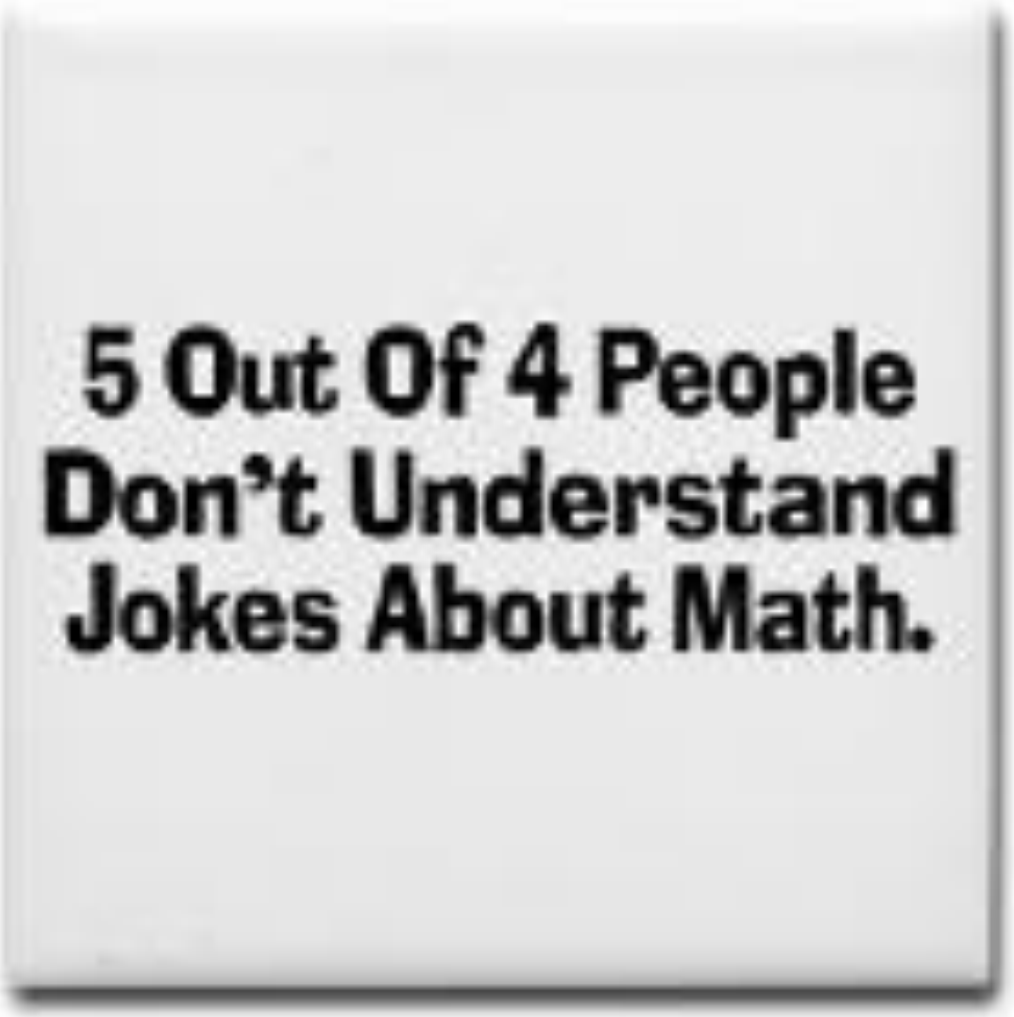
Fractions as Numbers???



Fractions as Numbers???



Fractions as Numbers???



Where Do We Stand?

- 2004 NAEP - 50% of 8th-graders could not order three fractions from least to greatest (NCTM, 2007)
- 2004 NAEP, only 35% of 17-year-olds correctly translated 0.029 as 29/1000 (Kloosterman, 2010)
- 2003 NAEP, 33% of 8th-graders could not find ¾ on a number line.
- 2009 NAEP, 52% of 4th-graders could not correctly identify 1 ¾ on a number line.
- 2009 NAEP, 42% of 4th-graders could not correctly identify a representation that shows equivalent fractions, e.g. ¾ is equivalent to 6/8.
- Conceptual understanding of fractions by students is weak.

Where Do We Stand?

- **If teachers struggle with fractions, students struggle with fractions**
  - Researchers have consistently found that teachers lack a deep conceptual understanding of fractions*
  - A study of elementary school teachers found that many could not solve computation problems involving fractions†
  - There is a direct connection to teachers' lack of conceptual understanding leading to teaching "algorithmically," by rote, or mechanically

* Hill, Rowan, and Ball, 2005—cited in IES Fractions Report
† Post, Harel, Behr, Lesh, 1988—cited in IES Fractions Report

Lack of Conceptual Understanding has several facets:

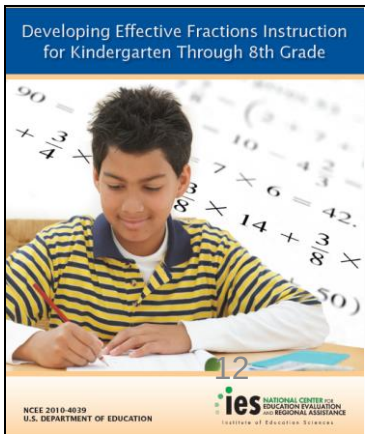
- Not viewing fractions as numbers at all, but rather as meaningless symbols that need to be manipulated in arbitrary ways to produce answers that satisfy a teacher .
- Focusing on numerators and denominators as separate numbers rather than thinking of the fraction as a single number.
- Confusing properties of fractions with those of whole numbers.

IES – Practice Guide - Fractions, 2010 (pp. 6-7)

What Success Looks Like

- **Developing Effective Fractions Instruction for K–8***
  - **Recommendation 1:** Build on students' informal understanding of sharing and proportionality to develop initial fraction concepts.
  - **Recommendation 2:** Help students recognize that fractions are numbers and that they expand the number system beyond whole numbers.
  - **Recommendation 3:** Help students understand why procedures for computations with fractions make sense.
  - **Recommendation 4:** Develop students' conceptual understanding of strategies for solving ratio, rate, and proportion problems, before introducing procedures.
  - **Recommendation 5:** Professional development programs should place a high priority on improving teachers' understanding of fractions and how to teach them.

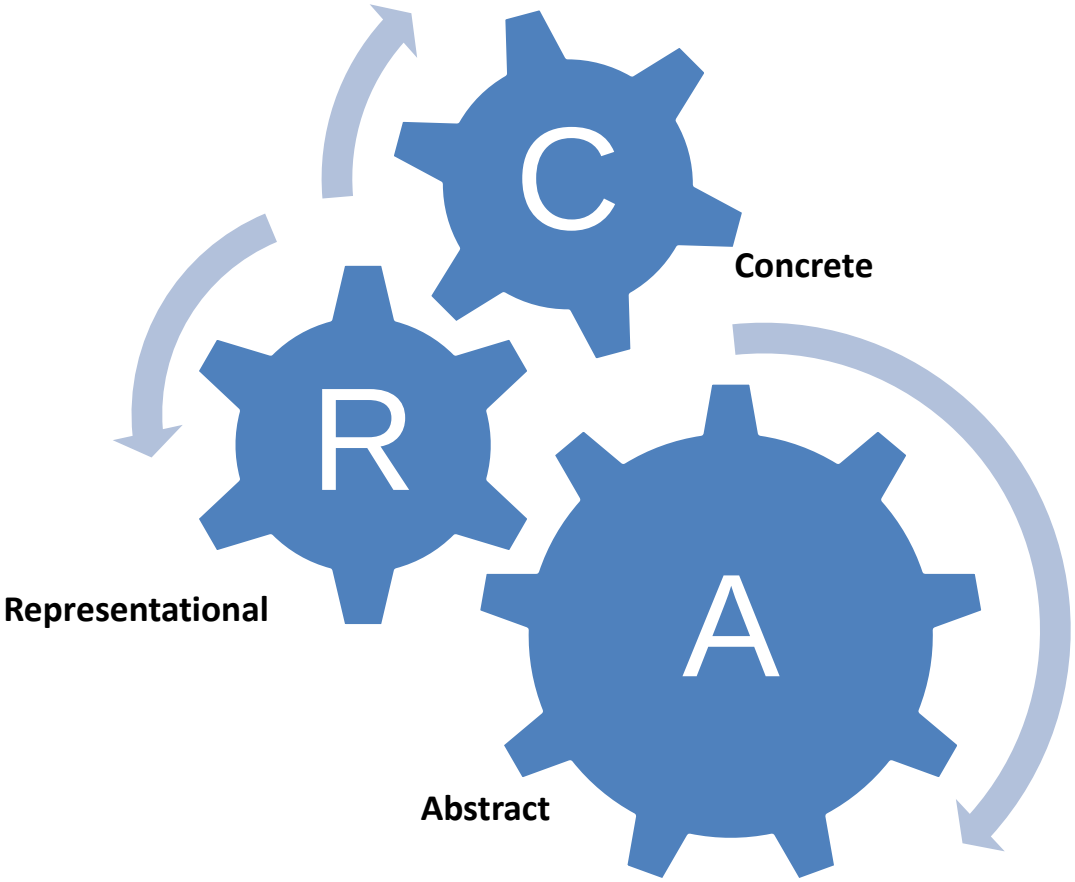
* Published by the Institute of Educational Sciences (IES) and What Works Clearinghouse (WWC), September 2010
http://ies.ed.gov/ncee/wwc/practiceguide.aspx?sid=15



Rigor

- Conceptual Understanding
- Fluency
- Application

Hands-On Learning Instructional Cycle



The Student

Rigor

- Conceptual Understanding
- Fluency
- Application

The Student

The Student

Prepare your students so that they will discover the concepts you wish to present – then it will be their mathematics and not yours.

Briefly, FINDERS KEEPERS is the most fundamental maxim in teaching school mathematics.

- Norm Gillespie

There must be far less telling by the teacher and more doing by the student.

- Piaget

Each time one prematurely teaches a child something he could have discovered himself, that child is kept from inventing it and consequently from understanding it completely.

- Piaget

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THANK YOU

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