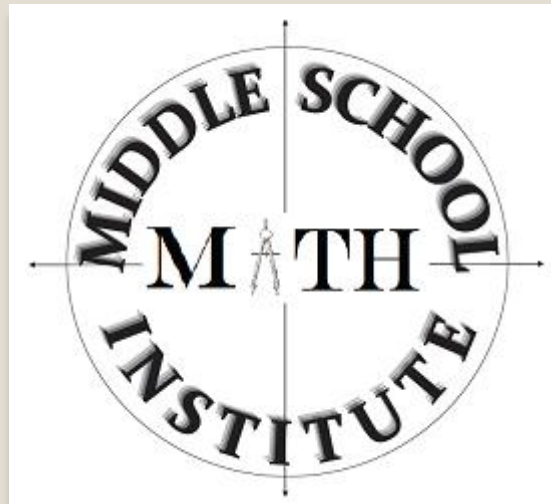


Middle School Mathematics Institute



WWW.MSMI-MN.ORG
ALLISON COATES, DIRECTOR



MSMI: Building the Bridge to Algebra



For Teachers

We provide professional development institutes for middle school teachers focused on mathematics knowledge for the courses they teach.

For Schools

We provide guidance to schools on how to create and adapt middle school math curricula that bridge the gap from exploration of arithmetic in K-3 to mastery of algebra 1 in grade 8/9.

For Parents

We provide parent education on:

- The foundations for algebra: what your students needs to know
- What math is required for college bound
- What math is required for STEM careers
- How to evaluate a school's math program



MSMI 2011: Fractions



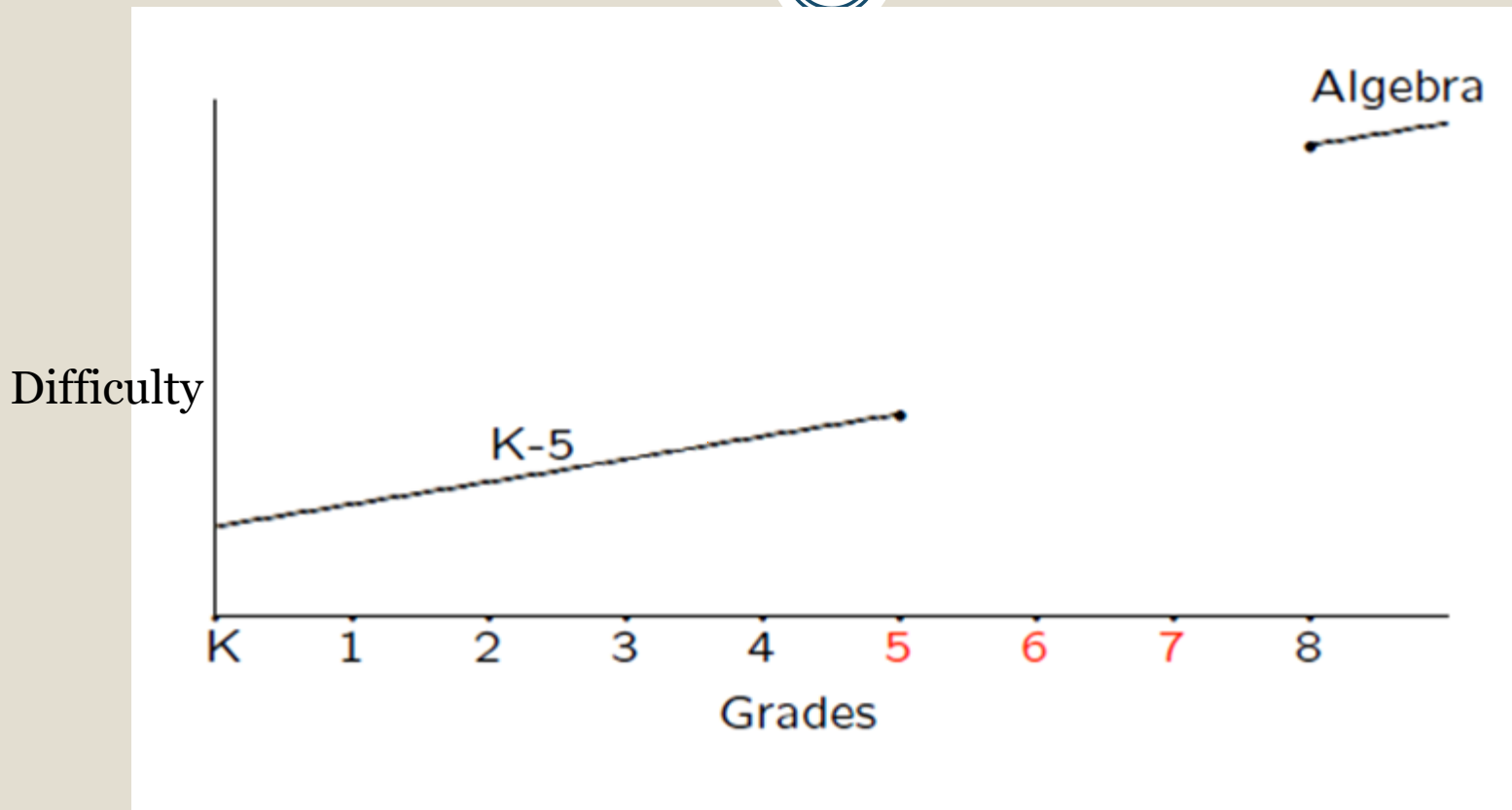
MASTERY

CONCEPTUAL
UNDERSTANDING

PROCEDURAL
FLUENCY



Where does the problem begin?



American curricula are exploratory in K-5, while algebra in 8th requires procedural fluency and conceptual understanding of abstractions.



Slide: H. Wu

The Road to Algebra



- Elementary (K-3) math is about number sense for whole numbers.
 - It is about learning math facts, elementary operations, basic properties. It is exploratory in nature.
 - It can be understood by counting things (fingers, beads, inch marks.)
 - It is taught with manipulatives, games, memorization, and other concrete methods.

Good elementary math builds both procedural fluency (addition tables, multiplication tables) and conceptual understanding (what place value means, why it works.)



The Road to Algebra

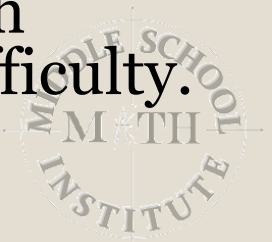


- Algebra, by contrast, is about abstraction: the ability to generalize based on rules, not examples.

-Consider all solutions of $2x - 3y = -7$. What properties does the set of all solutions of the equation possess?

Success in algebra requires mastery of
arithmetic,
laws of operations,
symbolic manipulation.

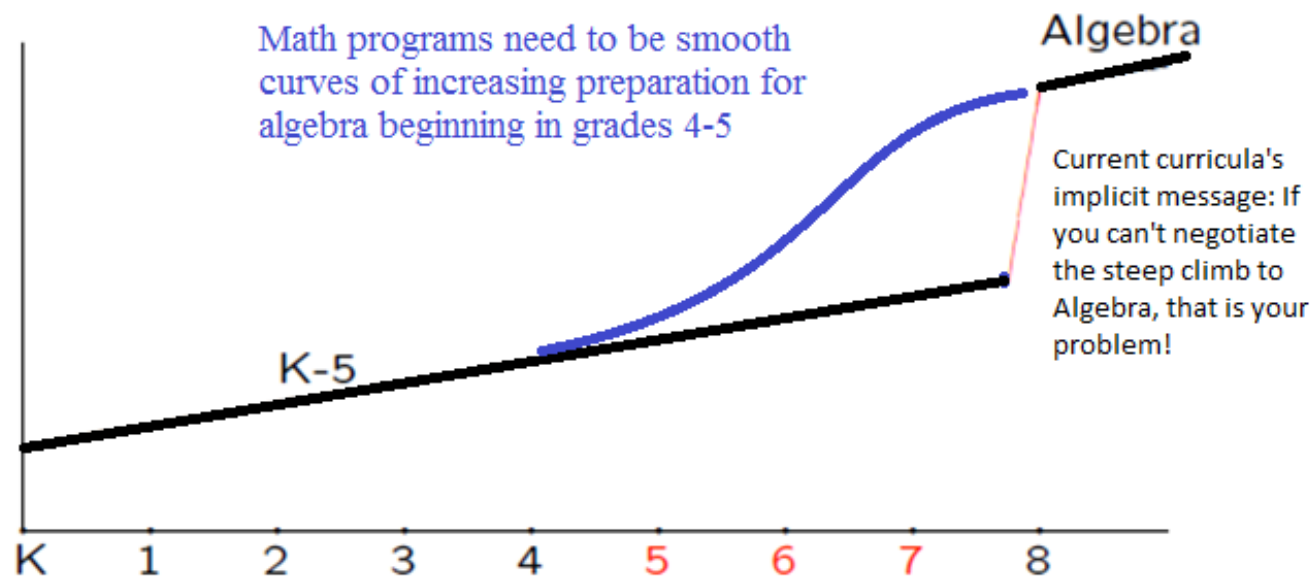
This is **difficult work!** We need a middle school math curriculum to help us build **gradually** up to this difficulty.



Preparation for Algebra must start by 4th grade.



Current middle school curricula do not bridge the gap, closing the door to success in Algebra by 4th grade.



Slide: H. Wu

Shallow Curriculum in Middle School



Current Middle School (grades 4-8) Textbooks provide:

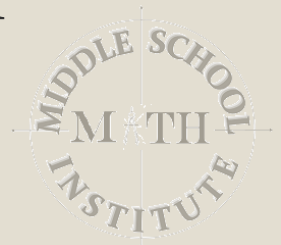
- No Coherence or Reasoning:
 - They “spiral” shallowly through too many topics, changing subjects often
 - Provide rules without reasons
- No Depth:
 - Avoid symbolic manipulation and abstraction
- No precision: They do not provide definitions for concepts such as fraction or decimal, and don’t distinguish between definitions and derived results.



What we will NOT do in MSMI2011:



- We will not teach rote procedures, nor ask you to teach by rote.
- We will not “memorize and discard” it.
- We will not ask you to do any math that depends on anything we haven’t presented.
- We will not use vague or indefinite descriptions of mathematical concepts.

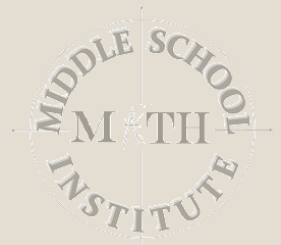


What we will do in MSMI2011:



We will become comfortable with definitions and know them:

- ✦ Definitions are NOT interpretations, analogies or personalities. They are grounding for everything else.
- Knowing a definition isn't rote learning.
- Yes, we will learn the defns to automaticity, but we will not use them blindly or unconnectedly.



What we will do in MSMI2011:



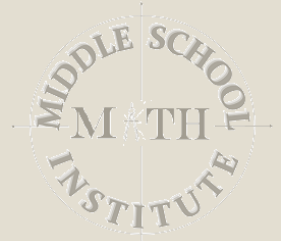
- We will ask you to use what we've presented, and **only** what we've presented, to derive results. **Everything** we need will be learnable from these definitions/facts alone.
- We will spend time **reasoning** about math rather than relying on formulas.
- We will gain mastery working with symbols.



What we will do in MSMI2011:



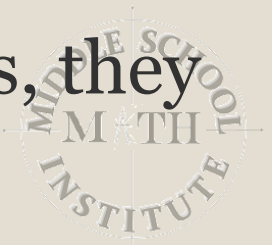
- We will be **ruthless** with ourselves. We will not allow ourselves to use any concept we've not explicitly been given. (And almost all textbooks violate this rule in almost every lesson on fractions.)
- In turn, we will be ruthless with ourselves when teaching: we will not allow ourselves to use any concept not explicitly given to our students.
- We will have empathy for our students.



Why we do this in MSMI2011:



- If you can reason from the definition, so can your students!
- Once students learn to reason, they stop having the perception that math is a game of hidden and unknown rules.
- Once they see the connections between arithmetic and fractions, fractions stop being scary and mysterious.
- Once symbols become familiar for fractions, they are less scary in algebra.



What will we learn about math?



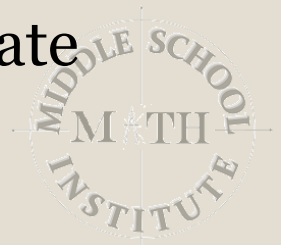
- Mathematics is coherent
 - The rules we learn for arithmetic **continue to apply** for fractions, decimals, real numbers and symbols.
- Mathematics makes sense intuitively
 - There are reasons why we perform the procedures we do. We don't have to “accept the validity”—we can prove it follows from what we know.
- Mathematics is precise
 - We have specific definitions for every mathematical object—no hand waving, no analogies. If we know the definition, we can derive what's true from it.



Y1 Syllabus



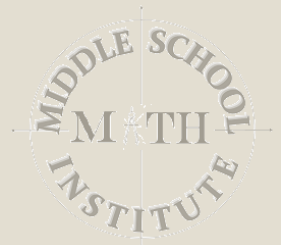
- **MONDAY:** Formal definitions of Fractions and Decimals, Equivalent Fractions and the Fundamental Fact of Fraction-Pairs
- **TUESDAY:** Equivalent Fractions Contd; Addition of Fractions and Decimals
- **WEDNESDAY:** Subtraction of Fractions; Introduction to Multiplication of Fractions
- **THURSDAY:** Multiplication of Fractions Contd.; Division of Fractions
- **FRIDAY:** Complex Fractions , Percent , Ratio and Rate



Daily Schedule



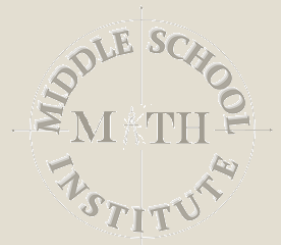
- 9:00 - 10:30 AM Lecture
- 10:45 - 11:30 AM Discussion
- 11:30 - 12:30 PM Lunch
- 12:30 - 2:00 PM Lecture
- 2:15 - 3:30 PM Discussion
- 3:30 - 4:30 PM Q&A



Common Core State Standards Initiative



- “The Common Core State Standards Initiative is a state-led effort coordinated by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO). The standards were developed in collaboration with teachers, school administrators, and experts, to provide a clear and consistent framework to prepare our children for college and the workforce.” (<http://www.corestandards.org/about-the-standards>)



Common Core State Standards Initiative



- “The K-5 standards ...provide detailed guidance to teachers on how to navigate their way through ...fractions, negative numbers, and geometry, and do so by maintaining a continuous progress from grade to grade.
- The standards stress not only procedural skill but also conceptual understanding, to make sure students are learning and absorbing the critical information they need to succeed at higher levels - rather than the current practices by which many students learn enough to get by on the next test, but forget it shortly thereafter, only to review again the following year.”
- Having built a strong foundation K-5, students can do hands on learning in geometry, algebra and probability and statistics. Students who have completed 7th grade and mastered the content and skills through the 7th grade will be well- prepared for algebra in grade 8.

