Bringing Math Circle Ideas Into Classrooms

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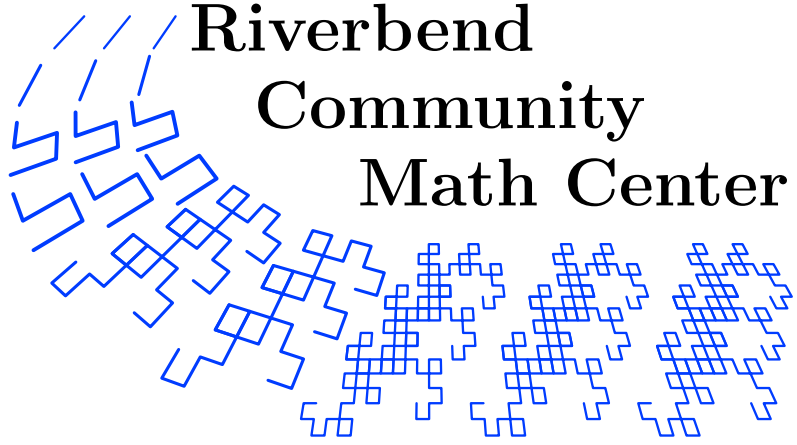

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Common Core State Standards

- Slated for implementation in most states by 2014
- Place an emphasis on critical thinking
- Students first work with computational skills concretely, then develop flexible approaches, and only later memorize facts and algorithms
- Middle and High School curriculum should involve much more modeling and proofs

Critical Concepts Needing Support in Grades K – 2

Flexible operations with (and decomposition of) numbers

- Nim Games
- Function Machines
- Dots and Boxes (James Tanton)
- Discussing alternative ways to produce a given number
- Figurate numbers
- Pascal's Triangle

Critical Concepts Needing Support in Grades K – 2

Authentic use of geometric vocabulary, with emphasis on attributes

- Greeps and Limadroops (*Math for Girls and Other Problem Solvers*)
- "What shapes can you fold?"
- Possible and impossible triangles

Critical Concepts Needing Support in Grades K – 2

Autonomous problem solving

- Fermi Questions
- Euler trails

Logic games and puzzles **(Enrichment)**

- Voting Theory
- Liar puzzles, et cetera
- Map Coloring

Critical Concepts Needing Support in Grades 3 – 5

Meaning, applications, and flexible use of basic operations

- Nim Games
- Function Machines
- Four 4s Challenge
- Polyhedron Families
- Combinatorial problems
- Modular Arithmetic, Sona Designs, and the Euclidean Algorithm
- Fermi Questions

Critical Concepts Needing Support in Grades 3 – 5

Conceptual transition to computational algorithms

- Dots and Boxes (James Tanton)
- Alien Math (Bases)
- How did the Incan Yupana (abacus) Work?
- Grid Power (Tatiana Shubin)

Critical Concepts Needing Support in Grades 3 – 5

Problem solving requiring rational number measurements

- Constructing a Fair Three-sided Die
- Plumbing Challenges
- Tootsie Pops Fermi Question

Critical Concepts Needing Support in Grades 3 – 5

Conceptual approaches to rational numbers

- Quilt fraction challenges
- Hundred grid challenges
- Ruler reasoning
- Hit the Target (Dennis Hodges and Jo Ellen Ramsey)
- Digits Fidgets (Sam Vandervelde)

Critical Concepts Needing Support in Grades 6 – 8

Understanding Number Systems
(Especially Rational, Irrational, and Complex Numbers)

- Rational Tangles (John Conway / Tom Davis)
- Continued Fractions
- The Pythagoreans and the Proof that $\sqrt{2}$ is Irrational
- Cantorian Set Theory
- Complex numbers and geometric transformations
- Group Theory / Braid Groups
- Mad Veterinarian (Josh Zucker)

Critical Concepts Needing Support in Grades 6 – 8

Algebraic Modeling (especially involving rates, ratios, and slope)

- Popularity Modeling
- Predator Prey Models
- Zombie Models (SIR Models)
- Complex Dynamics / Fractals

Topics for High School Students

- Modeling
- Complex Dynamics / Fractals
- Origami Constructions (Humiaki Huzita / Margherita Beloch / Helena Verrill / Tom Hull)
- Fuchsian Groups and Teichmuller Theory
- The Orbit Stabilizer Theorem / Counting Cube Vertex Colorings
- Magic Pancakes (Sue VanHattum)
- Pythagorean Triples
- What is i^i?