HOW WE CAN HELP STUDENTS MAKE SENSE OF MATHEMATICS AND MATHEMATICAL PROBLEMS

Bill Crombie
Director of Professional Development
The Algebra Project
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Poll: Gauging Familiarity of Math Challenges

- How familiar with Math Challenges are you?
  - Very familiar
  - Somewhat familiar
  - Neither familiar nor unfamiliar
  - Somewhat unfamiliar
  - Not at all familiar

- How often do you use Math Challenges in your classrooms?
  - Often
  - Sometimes
  - Never

Tell me more about your experience
What are Math Challenges

- Tool that provides teachers, grade K-8, with high quality tasks that yield formative information about student understanding.

- With regular use, students receive regular exposure and experience engaging with high quality assessments.

- Aligns to Common Core State Standards.
Theory of Action (DRAFT)

Mathematics Challenge Components

- High-quality classroom tasks that:
  - Provide formative information about student understanding
  - Are aligned with the Common Core State Standards
  - Are curriculum independent
  - Use appropriate real-world situations and applications
  - Emphasize conceptual understanding, communication, and problem-solving and higher-order thinking skills

- Teaching and learning considerations provide guidance for moving student learning forward on each standard and task

- Scoring information, rubrics, and sample student work

- On-going monthly meetings supported by meeting agendas and guiding questions that help teachers to plan for the use of the assessments, adjust instruction based on elicited evidence, and trouble shoot with colleagues

Teacher Outcomes

- Content knowledge for teaching increases
- Teachers gather better quality evidence of student understanding
- Teachers facilitate/differentiate learning based on student needs

Student Outcomes

- Student engagement/time on task increases
- Increased perseverance (intrinsic motivation) in mathematics

Improved student learning of mathematical content
Anatomy of a math challenge

Six-Step Math Challenge Process

- **Planning**
  - Step 1: Review Math Challenge Meeting Protocol
  - Step 2: Review and solve Math Challenge prior to your PLC Meeting
  - Step 3: Hold PLC meeting and discuss responses to guiding questions on the Meeting Protocol

- **Implementation**
  - Step 4: Implement Math Challenge in classroom

- **Analysis and Reflection**
  - Step 5: Respond to guiding questions on the Analyzing Student Responses Protocol
  - Step 6: Complete Math Challenge Feedback Log
## List of Math Challenges

### Common Core Mathematics Challenges

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>Grade 6</th>
<th>Grade 8</th>
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</thead>
<tbody>
<tr>
<td>A Trip to Shape Town</td>
<td>A Map of Shape Town</td>
<td>Candy Fractions</td>
<td>At the Nature Center</td>
<td>Building Numbers</td>
<td>Biking with Fractions</td>
<td>Field Trip to the Zoo</td>
<td>Pythagorean Theorem</td>
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<tr>
<td>Boxes of Rocks</td>
<td>At the Nature Center</td>
<td>Quilt Squares</td>
<td>Everyday patterns in Algebra</td>
<td>Designing the Flag</td>
<td>Field Trip to the Zoo</td>
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<tr>
<td>The State Animals of Tennessee</td>
<td>Baking Up Fractions</td>
<td>The Pond and the Field</td>
<td>Field Trip to the Zoo</td>
<td>Everyday Patterns in Algebra</td>
<td>Next to Nothing</td>
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<tr>
<td>Cookies at the Bakery</td>
<td>Voting at the Zoo</td>
<td>School Garden in Order</td>
<td>Field Trip to the Zoo</td>
<td>Planning Coordinate City</td>
<td>The Quadrilateral Community</td>
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<tr>
<td>Field Trip to the Zoo</td>
<td>Shady Fractions</td>
<td>Rectangular Gardens</td>
<td>School Garden in Order</td>
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<tr>
<td>Pencil Measures</td>
<td>Tile Squares</td>
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<tr>
<td>What’s in Your Desk Drawer</td>
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</tbody>
</table>
1. Make sense of 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.
Make sense of problems and persevere in solving them.

1. Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. … Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
A Word Problem

There are 40 sheep and 20 goats on a ship. How old is the ship’s captain?

a) 60  
b) 20  
c) 800  
d) 2
Relational Understanding and Instrumental Understanding

- Instrumental Understanding
  “Rules without Reason”

- Relational Understanding
  The Meanings which make Sense of the Rule

Richard Skemp
A Mathematics Challenge:
Field Trip to the Zoo (Grade 6)
Standards

- Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- Summarize numerical data sets in relation to their context, such as by:
  - Reporting the number of observations.
  - Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.
Learning Cycle

- Try it
- Practice it
- Think about it
- Improve it
Experiential Learning Cycle

- Concrete Event
- Abstract Concept
- Application
- Reflection

- Piaget
- Lewin
- Kolb
5 Step Curricular Process

Concrete Event

Application

Reflection

Abstract Concept

- Picture
- People-Talk
- Feature Identification
- Feature -Talk
- Iconic Representation
- Symbolic Representation
5 Step Curricular Process

1. Concrete Event
2. Picture
3. People Talk
4. Feature Talk
5. Iconic & Abstract Symbolic Representation
Feature-Talk is a device to connect the ordinary discourse of students to the symbolic representations of mathematics.

Feature-Talk gives a voice to the sense-making that students are engaged in.

Feature-Talk is an explicit regimentation of ordinary discourse. It is how we express “these ideas” in mathematics.
Discussion

- What are some points you would like to discuss more?

- What are some issues that you are currently working on?
ETS is developing new elementary school Math Challenges.

ETS is conducting more research around effective ways for teachers to use Math Challenges. Please let us know if you are interested in participating in our research.

ETS is working on translating Math Challenges into different languages and creating an online version.
Resources

- Moses & Cobb, 2001. Radical Equations - Civil Rights from Mississippi to the Algebra Project, Beacon Press: Boston (pp. 120-122)
Web Resources

- The Algebra Project
  http://www.algewbra.org/

- The Young People’s Project:
  http://www.typp.org/

- http://www.algebra.org/curriculum
  You can register free and create a login. At present the site only contains the high school curriculum.