Designing Secondary Mathematics Programs for All Students

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Underlying Principle

- "*Everyone is good at mathematics because everyone can think. And mathematics is about thinking.*"
  - Yeap Ban Har, National Institute of Education, Singapore.
- Corollary 1: Strategies that attempt to remove thinking from learning are bound to fail in the long run.
- Corollary 2: When learning is effective, "getting the right answer" is but a small piece of the work.

Overview

- Key messages from Response to Intervention (RtI)
- Key messages from the CCSS for Mathematics
- Program considerations
- Implementation resources and suggestions
- Questions

Major Themes

- All students means ALL students
- The work is about improving instruction, which requires that teachers (all teachers) collaborate to reach more students more of the time
- Common messages among current initiatives
  - Common Core State Standards
  - Formative Assessment
  - Response to Intervention
  - School Turnaround
  - …

Questions for Georgia

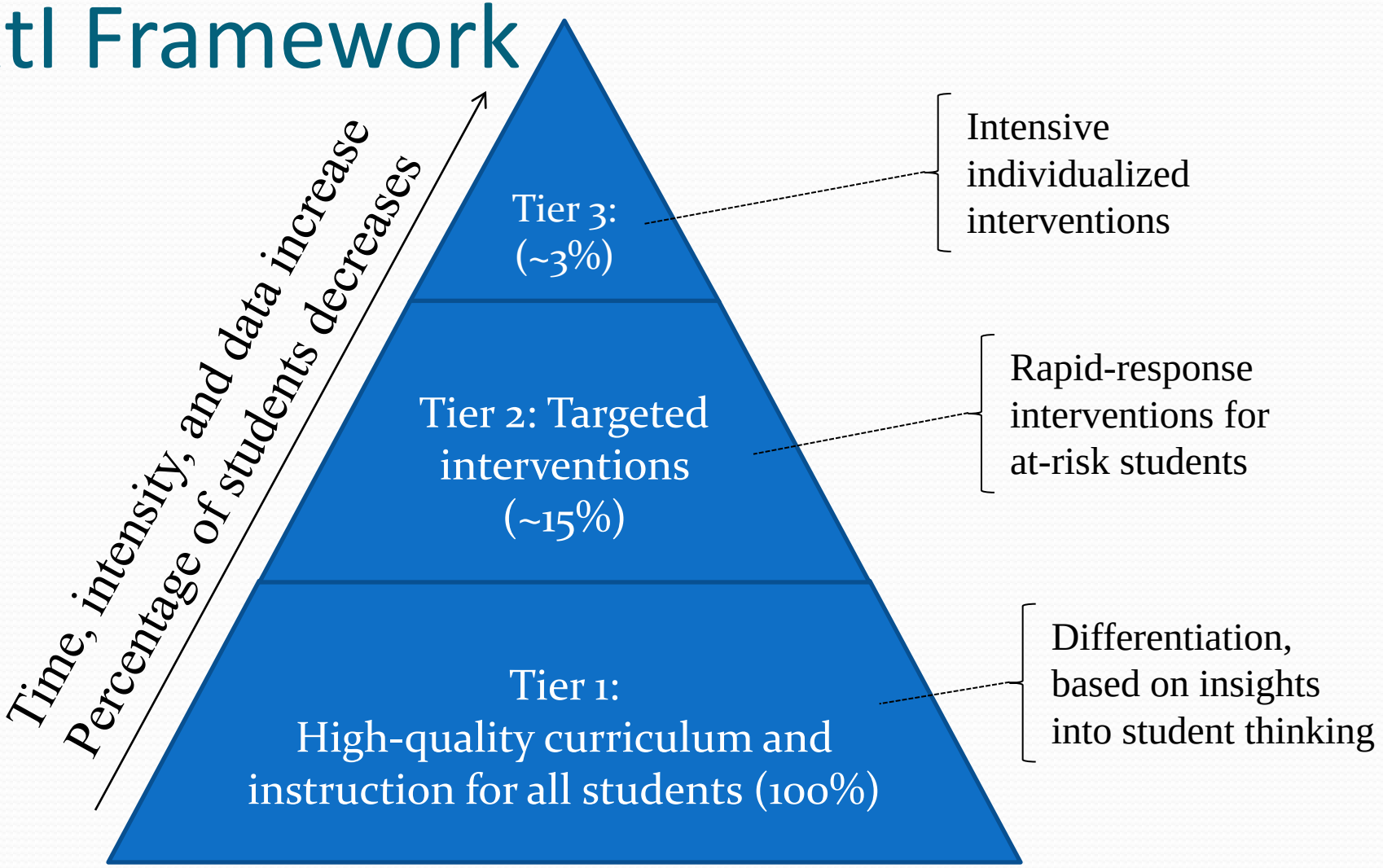
- The Georgia Performance Standards (GPS) anticipated many of the shifts embodied in the Common Core State Standards
- Which of the messages ring true for you because of your experience with GPS implementation?
- How might you help the nation through the transition to CCSS implementation?

Key Messages from Response to Intervention

What Is RtI?

- RtI is about establishing a school-wide system for allocating instructional resources where they are needed
  - Give all students access to the regular curriculum AND provide differentiated instruction and support
  - Some students are 15 minutes behind; others are years behind
  - Labels are less important than providing additional instruction where it is needed
  - RtI integrates regular and special education
    - Students with disabilities are in every tier

RtI Framework



What Is Not RtI?

- RtI is not a package
- RtI is neither tracking nor homogeneous grouping
  - RtI is *not* about providing different instruction to different groups of students, based on adult judgments about what students cannot do
- When it comes to mathematical thinking, any group of 2 or more students is heterogeneous
- And perhaps you have encountered students who seemed to be heterogeneous all by themselves

Effective Instructional Strategies (Tier 1)

- Problem-based learning
  - Rich problems can motivate concepts and skills
  - To learn problem solving, students must be given opportunities to solve (and struggle with) problems
- Differentiation *within* a task
  - Alternative to differentiation *by* task
  - Given a rich mathematical task, students differentiate themselves
  - Then teachers (and intervention specialists) provide whatever support students need (without giving too much away)

Effective Instructional Strategies (Tier 2)

- **What instructional strategies are effective in helping students with difficulties in mathematics?**
  - The use of structured peer-assisted learning activities
  - Systematic and explicit instruction using visual representations
  - Modifying instruction based on data from formative assessment of students (such as classroom discussions or quizzes)
  - Providing opportunities for students to think aloud while they work

Source: Research Brief from the National Council of Teachers of Mathematics. Available at http://www.nctm.org/news/content.aspx?id=8468

Key Messages from the CCSS for Mathematics

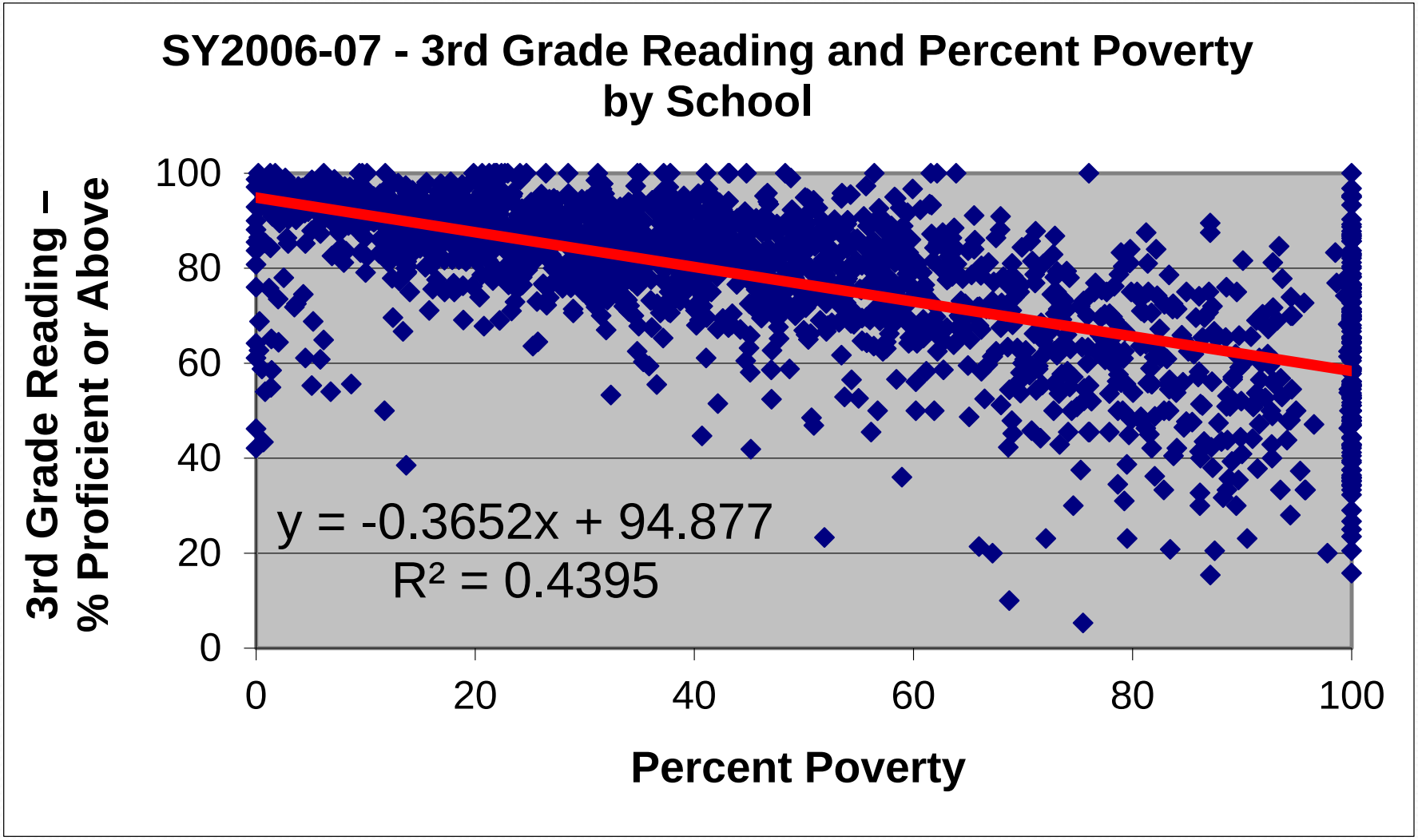
What's New with the CCSS?

- Common across 45+ states
- Internationally benchmarked standards
- Focus, coherence, and rigor
- College and career readiness for all
- And all students means ALL students

College and Career Readiness

- College and career readiness involves mathematics at the level of Algebra 2 or its equivalent (A2E)
- All students need proficiency in A2E for
  - Many careers, with or without college
  - Informed citizenship
  - Individual empowerment
- High school mathematics should open doors
  - But adult decisions often close doors for students
  - After students complete A2E, they have choices
- But not your parents' Algebra 2

Who Can Interpret This?



A Real-World Problem

- Over the weekend, I was gathering sticks from my lawn, bundling them in each hand. When both hands became full, I found that by using both hands for a single bundle, I could gather quite a few more sticks. Why? What relationship should I expect between the quantities of sticks gatherable by the two methods?

Sketch of Solution

- The capacity to gather sticks depends on the cross-sectional area of the circles made by my fingers. That area varies with the square of circumference. So two hands together have four times the capacity of one hand, or two times the capacity of both hands separately.
- *Note: With algebra, we can prove this more precisely*.

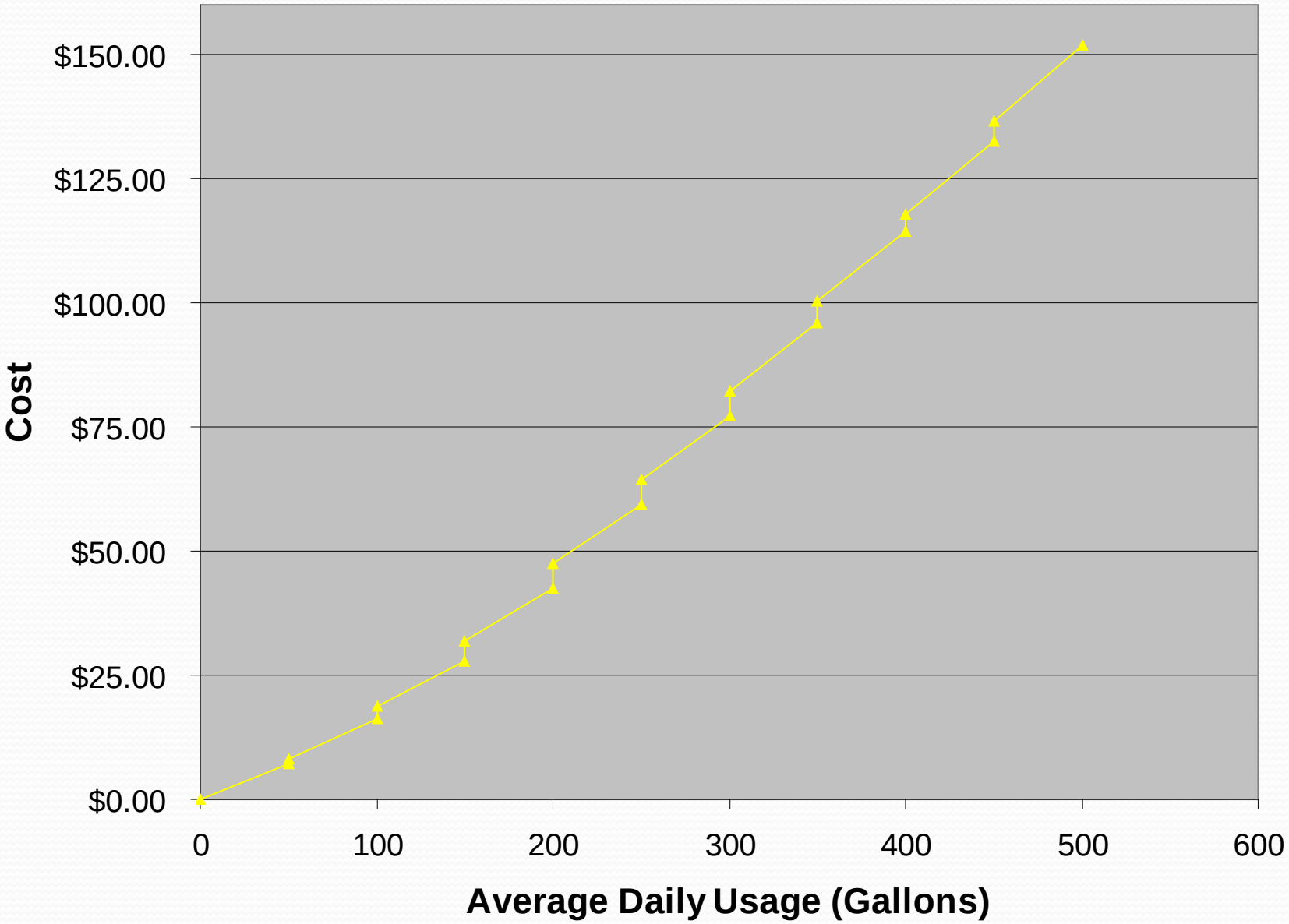
Washington Suburban Sanitary Commission

Rate Schedule, July 1, 2008

Average Daily Consumption (Gallons/Day)	Water Rate Per 1,000 Gallons	Sewer Rate Per 1,000 Gallons	Combined Rate Per 1,000 Gallons
0-49	$1.97	$2.77	$4.74
50 - 99	2.21	3.22	5.43
100 - 149	2.42	3.79	6.21
150 - 199	2.71	4.36	7.07
200 - 249	3.17	4.76	7.93
250 - 299	3.43	5.14	8.57
300 - 349	3.63	5.50	9.13
350 - 399	3.79	5.75	9.54
400 - 449	3.94	5.88	9.82
…	…	…	…

Source: http://www.wsscwater.com/service/rates.cfm

Monthly Water and Sewer Cost



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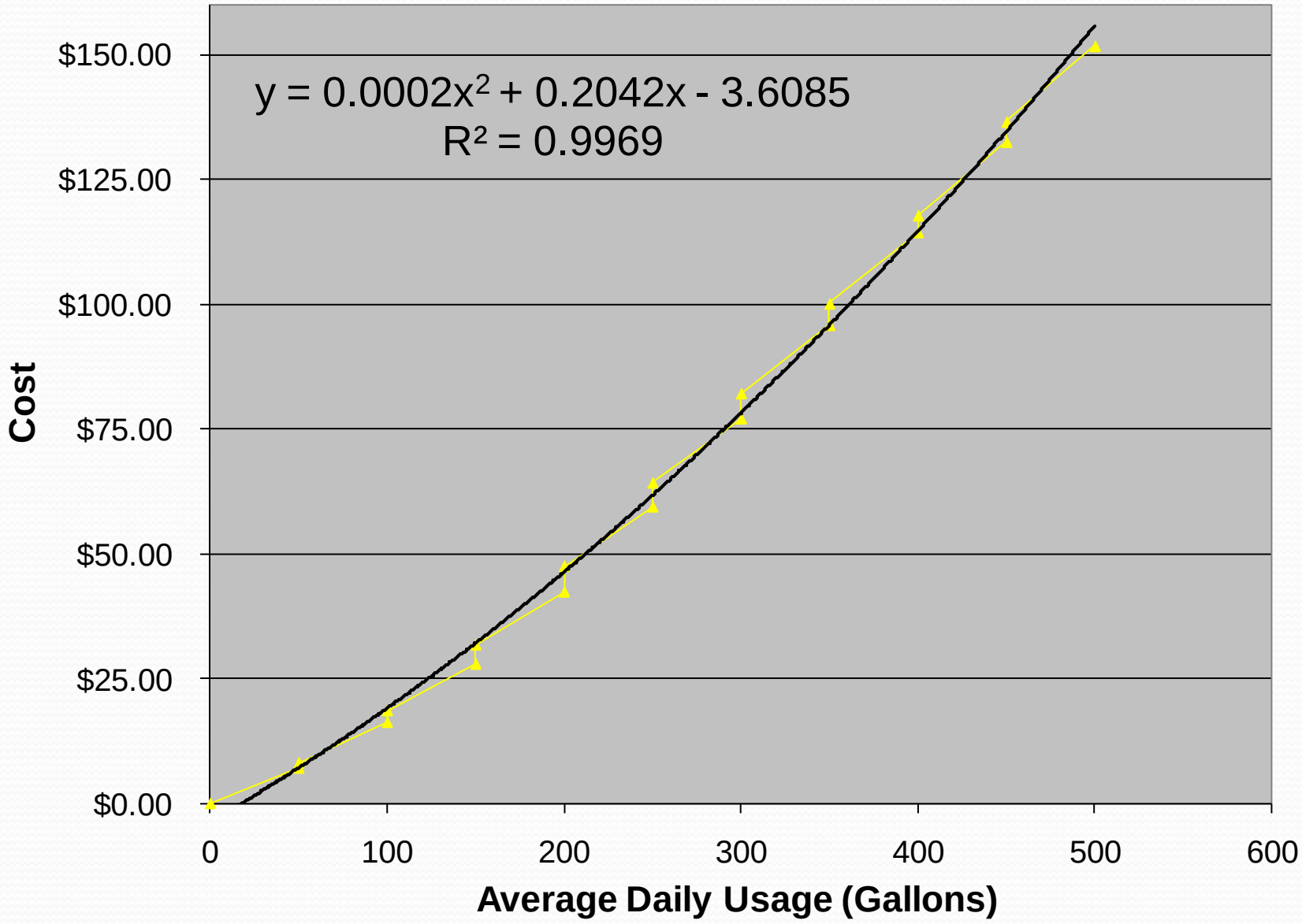

What Is Needed?

- Renewed curriculum and instruction
  - Especially across middle and high school, toward a rigorous, relevant, and accessible A2E
- Support for students are behind
  - To help them catch up

- The CCSS and the Model Pathways are foundational responses to these needs

Key Messages from Common Core State Standards

CCSS Principles

- **Focus**: focus strongly on key ideas, understandings, and skills in each grade and course
- **Coherence**: think across grades, and link to major topics in each grade
- **Rigor**: in major topics, pursue with equal intensity
  - conceptual understanding,
  - procedural skill and fluency, and
  - applications

CCSS Mathematical Practices

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

PARCC Task Types

TYPE I: *TASKS ASSESSING CONCEPTS, SKILLS AND PROCEDURES*	TYPE II: *TASKS ASSESSING EXPRESSING MATHEMATICAL REASONING*	TYPE III: *TASKS ASSESSING MODELING / APPLICATIONS*
• A balance of conceptual understanding, fluency, and application • Any or all mathematical practice standards • Machine scorable, innovative, computer-based formats • Included on the End of Year and Performance Based Assessment	• Written arguments, justifications, critique of reasoning, precision in mathematical statements • MP.3, MP.6 and other mathematical practice standards • A mix of innovative, machine scored and hand scored responses • Included on the Performance Based Assessment	• Modeling and application in a real-world context or scenario • MP.4 and other mathematical practice standards • A mix of innovative, machine scored and hand scored responses • Included on the Performance Based Assessment

Implementation Resources

Implementation Resources

- The Mathematics Frameworks from the Partnership for Readiness for College and Careers (PARCC)
- The draft Mathematics Content Specifications from the Smarter Balanced Assessment Consortium (SBAC)
- The Mathematics Assessment Project (MAP)
- The Illustrative Mathematics Project (IMP)
- Bill McCallum's Common Core Tools blog
  - Progressions documents
- Common Core videos from the Hunt Institute
- Phil Daro's SERP Institute videos
- Inside Mathematics website

An Example from MAP

Boomerangs

Phil and Cath make and sell boomerangs for a school event.
The money they raise will go to charity.

They plan to make them in two sizes: small and large.

Phil will carve them from wood.
The small boomerang takes 2 hours to carve and the large one takes 3 hours to carve.
Phil has a total of 24 hours available for carving.

Cath will decorate them.
She only has time to decorate 10 boomerangs of either size.

The small boomerang will make $8 for charity.
The large boomerang will make $10 for charity.
They want to make as much money for charity as they can.

How many small and large boomerangs should they make?

How much money will they then make?

Alex's solution

Phil can only make 12 small or 8 large boomerangs in 24 hours

12 small makes $96

8 large makes $80

Cath only has time to make 10, so $96 is impossible.

She could make 10 small boomerangs which will make $80.

So she either makes 8 large or 10 small boomerangs

and makes $80.

CCSS Mathematical Practices

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Implementation Suggestions

CCSSM and Acceleration

- The CCSSM represent significant curricular acceleration in grades K-8
  - Much Algebra 1, Geometry, and Statistics are in the middle grades
  - Many "accelerated" programs will no longer be ahead
  - The CCSS for Grade 8 is a reasonable, internationally benchmarked response to "Algebra for all" in grade 8
- Accelerating large percentages of students much beyond the CCSS for K-8 is probably unwise
- The CCSSM for high school include much advanced content and much new content for all students
  - Most students will need three years in high school to complete CCSS
- *So we need to rethink mathematics, grades 6-12*

For large and medium schools

Math Programs for All Students

- Main pathway completing the CCSS in grade 11
  - Rather than Prealgebra in grade 9, provide support for *all* students to reach these standards
  - Provide alternatives to Precalculus for seniors
- Alternative pathway completing the CCSS in grade 10, allowing for AP Calculus in grade 12
  - Determine where "compacting" should happen
- Flexibility for the small numbers of students who are eager for still more mathematics
  - Align with gifted education policies
  - Expect PSEO during senior year

For small schools

Math Programs for All Students

- Main pathway completing the CCSS in grade 11
  - Rather than Prealgebra in grade 9, Provide support for *all* students to reach these standards
  - Employ distance learning for seniors
- Flexibility for students who are eager for still more mathematics
  - Employ acceleration on a case-by-case basis, driven by interest, emphasizing depth of learning
  - Employ distance learning as appropriate
  - Attend to gifted education policies

Research-Based Principles

- Implementation matters
  - Variation within a model is greater than the variation between models
  - Adoption of standards, programs, or textbooks merely opens the door
- High-quality professional development
  - Focuses on the content the teachers are teaching
  - Draws on curricular materials teachers are using
  - Involves analyzing student work
  - Takes time

Maintain Focus and Coherence

- Implementation plans may miss the point
  - Readers might not see focus and coherence
  - Strategies may be counterproductive
- The goal is coherence in curriculum, instruction, and learning
  - Standards are taken as atoms, but the power is in the bonds (Jason Zimba)
  - Think in chapters, not lessons (Phil Daro)

Tips for Implementation

1. Get to know the CCSS
   - Use the critical areas of focus
   - Take a progressions view
2. Lead with the mathematical practices
   - With the content you are teaching now
3. Work collectively
   - You do not need to invent it all yourself
4. Involve administrators and parents
5. Take some transitional steps
   - Changes you can make soon

Tips for Implementation

6. Build support structures for students who are behind
7. Design programs for *all students*, driven by progressions, not course names
8. Require focus and coherence in district initiatives and professional development offerings
9. Document your implementation
   - Treat your implementation work as action research
10. Take a deep breath … and prepare for a long haul
    - Improving instruction and building new systems takes time

Questions

Implementation Questions for You

- Can we empower teachers to make necessary changes?
  - Curriculum, instruction, support, programs, …
- Can we get the incentives right?
  - So that teachers will regularly work together to reach more students more of the time
  - So that we all learn from and with our best teachers
- Can we bring mathematics leadership to the decision-making table?
  - So that school-improvement efforts focus on long-term improvements not short-term fixes

Questions for Georgia

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