What Every School Leader Needs to Know About Strengthening Mathematics Instruction

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What a great time to be convening to worry about math!

- **Common Core State Standards**
- **Quality K-8 materials**
- **$5 billion with a STEM RttT tie-breaker**
- **A president who believes in science and data**
- **The beginning of the end of Algebra II**
- **A long overdue understanding that it's instruction, stupid!**

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Today's Goal

To engage you in thinking about (and then being willing and able to act on) the issues of more effective instruction, higher expectations and building a culture of professionalism among the teaching staff. That is, perspectives, understandings and strategies for providing effective instructional leadership in K-12 mathematics.

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Today's agenda

- Setting a context and providing a set of critical perspectives
- It's instruction, silly – the "listen-fors" and "look-fors" of effective instruction
- Our roles and shifting the culture toward greater transparency and collaboration

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My Process Agenda
(modeling good instruction)

- **Inform** (lots of ideas and food for thought)
- **Engage** (focused individual and group tasks)
- **Stimulate** (excite your sense of professionalism)
- **Challenge** (urge you to move from words to action)

5

Some data. What do you see?

	40	4
	10	2
	30	4

6

Predict some additional data

	40	**4**
	10	**2**
	30	**4**

7

How close were you?

	40	**4**
	10	**2**
	30	**4**
	20	**3**

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All the numbers – so?

	45	**4**
	25	**3**
	15	**2**
	40	**4**
	10	**2**
	30	**4**
	20	**3**

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A lot more information (where are you?)

Roller Coaster	45	4
Ferris Wheel	25	3
Bumper Cars	15	2
Rocket Ride	40	4
Merry-go-Round	10	2
Water Slide	30	4
Fun House	20	3

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Fill in the blanks

Ride	???	???
Roller Coaster	45	4
Ferris Wheel	25	3
Bumper Cars	15	2
Rocket Ride	40	4
Merry-go-Round	10	2
Water Slide	30	4
Fun House	20	3

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At this point, it's almost anticlimactic!

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The amusement park

Ride	Time	Tickets
Roller Coaster	45	4
Ferris Wheel	25	3
Bumper Cars	15	2
Rocket Ride	40	4
Merry-go-Round	10	2
Water Slide	30	4
Fun House	20	3

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The Amusement Park

The 4th and 2nd graders in your school are going on a trip to the Amusement Park. Each 4th grader is going to be a buddy to a 2nd grader.

Your buddy for the trip has never been to an amusement park before. Your buddy want to go on as many different rides as possible. However, there may not be enough time to go on every ride and you may not have enough tickets to go on every ride.

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The bus will drop you off at 10:00 a.m. and pick you up at 1:00 p.m. Each student will get 20 tickets for rides.

Use the information in the chart to write a letter to your buddy and create a plan for a fun day at the amusement park for you and your buddy.

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Why do you think I started with this task?

- Standards don't teach, teachers teach
- It's the translation of the words into tasks and instruction and assessments that really matter
- Processes are as important as content
- We need to give kids (and ourselves) a reason to care
- Difficult, unlikely, to do alone!!!

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Part 1

Contexts and Perspectives

(glimpses at the what, why and how of what we do)

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Opening Gambit

Your knowledge, experience, insights, creativity, energy and expertise are desperately needed to significantly improve the knowledge and capacity of the nation's teachers of mathematics.

(If you don't feed inadequate…..)

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The Math Leader's Field of Activity

The heart of ensuring instructional quality and producing high levels of student achievement includes four key elements:

- A coherent and aligned **curriculum** that includes a set of grade level content expectations, appropriate print and electronic instructional materials, with a pacing guide that links the content standards, the materials and the calendar;
- High levels of **instructional effectiveness**, guided by a common vision of effective teaching of mathematics and supported by deliberate planning, reflection and attention to the details of effective practice;
- A set of aligned benchmark and summative **assessments** that allow for monitoring of student, teacher and school accomplishment at the unit/chapter and grade/course levels; and
- **Professional growth** within a **professional culture** of dignity, transparency, collaboration and support.

(What, how, how well and with what support to do it better)

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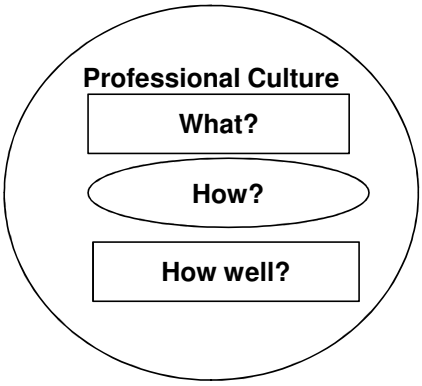

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But….as we need to acknowledge, too often:

- **Our curriculum is stale,**
- **Our instruction is underperforming,**
- **Our assessments are mediocre, and**
- **Our professional development is essentially useless!**

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BUT…Great News

- **Our curriculum is stale – enter CCSSM**
- **Our instruction is underperforming,**
- **Our assessments are mediocre – enter SBAC/PARCC**
- **Our professional development is essentially useless!**

Welcome to a far more simplified world.

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The Math Leader's Reduced Field of Activity
(in the CCSS Era)

The heart of ensuring instructional quality and producing high levels of student achievement includes four key elements:

- A coherent and aligned **curriculum** that includes a set of grade level content expectations, appropriate print and electronic instructional materials, with a pacing guide that links the content standards, the materials and the calendar;
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- A set of aligned benchmark and summative **assessments** that allow for monitoring of student, teacher and school accomplishment at the unit/chapter and grade/course levels; and
- **Professional growth** within a **professional culture** of dignity, transparency, collaboration and support.

(What, **how**, how well and **with what support to do it better**)

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WHY BOTHER?

(in case there is any doubt)

Here are 5 opening perspectives on why teacher effectiveness is indispensable

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1. Where we fit on the food chain

Economic security and social well-being

↑ ↑ ↑

Innovation and productivity

↑ ↑ ↑

Human capital and equity of opportunity

↑ ↑ ↑

High quality education (literacy, MATH, science)

↑ ↑ ↑

Daily classroom math instruction

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2) Let's be clear:

We're being asked to do what has never been done before:

Make math work for nearly ALL kids and get nearly ALL kids ready for college.

There is no existence proof, no road map, and it's not widely believed to be possible.

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3) Let's be even clearer:

And because there is no other way to serve a much broader proportion of students:

We're therefore being asked to teach in distinctly different ways.

Again, there is no existence proof, we don't agree on what "different" mean, nor how we bring it to scale.

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4) Another perspective:

Most teachers practice their craft behind closed doors, minimally aware of what their colleagues are doing, usually unobserved and under supported. Far too often, teachers' frames of reference are how they were taught, not how their colleagues are teaching. Common problems are too often solved individually rather than by seeking cooperative and collaborative solutions to shared concerns.

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5) The key things we know

People won't do what they can't envision,

People can't do what they don't understand,

People can't do well what isn't practiced,

But practice without feedback results in little change, and

Work without collaboration is not sustaining.

Ergo: Our job, as leader, at its core, is to help people envision, understand, practice, receive feedback and collaborate.

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Comments?
Questions?

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Part 2

So it's instruction, silly!

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from Everybody Counts

Virtually all young children like mathematics. They do mathematics naturally, discovering patterns and making conjectures based on observation. Natural curiosity is a powerful teacher, especially for mathematics….

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Unfortunately, as children become socialized by school and society, they begin to view mathematics as a rigid system of externally dictated rules governed by standards of accuracy, speed, and memory. Their view of mathematics shifts gradually from enthusiasm to apprehension, from confidence to fear. Eventually, most students leave mathematics under duress, convinced that only geniuses can learn it.

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So…the problem is:

If we continue to do what we've always done….

We'll continue to get what we've always gotten.

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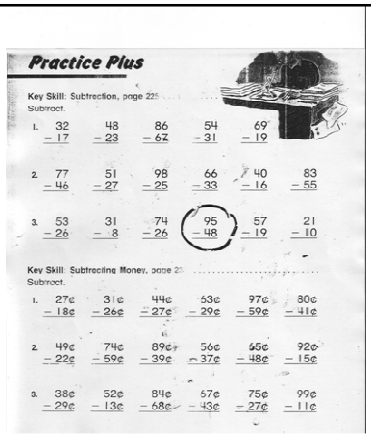

Practice Plus

Key Skill: Subtraction, page 225
Subtract.

1.	32 − 17	48 − 23	86 − 62	54 − 31	69 − 19	
2.	77 − 46	51 − 27	98 − 25	66 − 33	40 − 16	83 − 55
3.	53 − 26	31 − 8	74 − 26	95 − 48	57 − 19	21 − 10

Key Skill: Subtracting Money, page 2
Subtract.

1.	27¢ − 18¢	31¢ − 26¢	44¢ − 27¢	53¢ − 29¢	97¢ − 59¢	80¢ − 41¢
2.	49¢ − 22¢	74¢ − 59¢	89¢ − 39¢	56¢ − 37¢	65¢ − 48¢	92¢ − 15¢
3.	38¢ − 29¢	52¢ − 13¢	81¢ − 68¢	57¢ − 43¢	75¢ − 27¢	99¢ − 11¢

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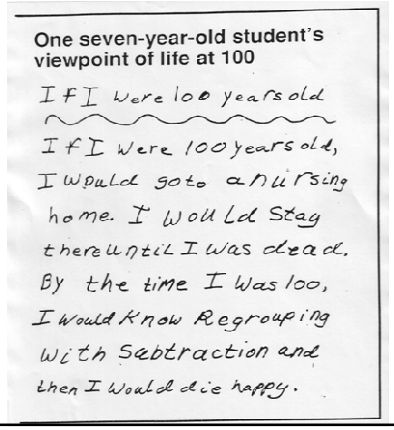

One seven-year-old student's viewpoint of life at 100

If I were 100 years old

If I were 100 years old, I would go to a nursing home. I would stay there until I was dead. By the time I was 100, I would know Regrouping with Subtraction and then I would die happy.

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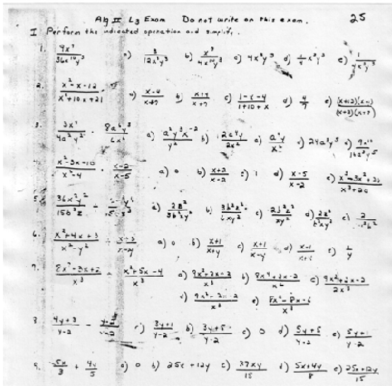

Alg II L3 Exam Do not write on this exam. 25

I Perform the indicated operation and simplify.

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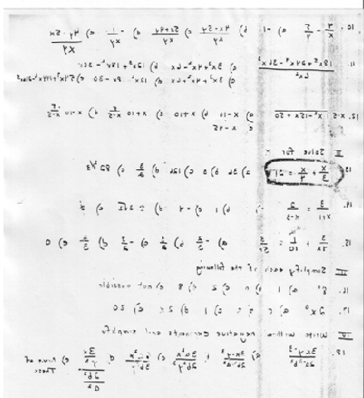

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II Solve for x

III Simplify each of the following

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Algebra:

The intense study of the last three letters of the alphabet

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So what have we gotten?

- Mountains of math anxiety
- Tons of mathematical illiteracy
- Mediocre test scores
- HS programs that barely work for more than half of the kids
- Gobs of remediation and intervention
- A slew of criticism

Not a pretty picture!

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If however…..

What we've always done is no longer acceptable, then…

We have no choice but to change some of what we do and some of how we do it.

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"The kind of learning that will be required of teachers has been described as *transformative* (involving sweeping changes in deeply held beliefs, knowledge, and habits of practice) as opposed to *additive* (involving the addition of new skills to an existing repertoire). Teachers of mathematics cannot successfully develop their students' reasoning and communication skills in ways called for by the new reforms simply by using manipulatives in their classrooms, by putting four students together at a table, or by asking a few additional open-ended questions…..

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Rather, they must thoroughly overhaul their thinking about what it means to know and understand mathematics, the kinds of tasks in which their students should be engaged, and finally, their own role in the classroom."

NCTM – Practice-Based Professional Development for Teachers of Mathematics

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What we know:

- They forget – so we need to more deliberately review;
- They see it differently – so we need to accommodate multiple representations;
- They approach it differently – so we need to elicit, value and celebrate alternative approaches;
- They give ridiculous answers – so we need to focus on number sense and estimation;
- They don't understand the vocabulary – so we need to build language rich classrooms;
- They ask why do we need to know this – so we need to embed the math in contexts.

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So it's instruction, silly!

Research, classroom observations and common sense provide a great deal of guidance about instructional practices that make significant differences in student achievement. These practices can be found in high-performing classrooms and schools at all levels and all across the country. Effective teachers make the question "Why?" a classroom mantra to support a culture of reasoning and justification. Teachers incorporate daily, cumulative review of skills and concepts into instruction. Lessons are deliberately planned and skillfully employ alternative approaches and multiple representations—including pictures and concrete materials—as part of explanations and answers. Teachers rely on relevant contexts to engage their students' interest and use questions to stimulate thinking and to create language-rich mathematics classrooms.

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Accordingly:

Some Practical Strategies for Raising Student Achievement Through Better Instruction

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Consider how we teach reading:
JANE WENT TO THE STORE.

- **Who went to the store?**
- **Where did Jane go?**
- **Why do you think Jane went to the store?**
- **Do you think it made sense for Jane to go to the store?**

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Now consider mathematics:
TAKE OUT YOUR HOMEWORK.

- **#1 19**
- **#2 37.5**
- **#3 185**

(No why? No how do you know? No who has a different answer?)

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Strategy #1

Adapt from what we know about reading

(incorporate literal, inferential, and evaluative comprehension to develop stronger neural connections)

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Number from 1 to 6

1. **What is 6 x 7?**
2. **What number is 1000 less than 18,294?**
3. **About how much is 32¢ and 29¢?**
4. **What is 1/10 of 450?**
5. **Draw a picture of 1 2/3**
6. **About how much do I weight in kg?**

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Number from 1 to 6

1. How much bigger is 9 than 5?
2. What number is the same as 5 tens and 7 ones?
3. What number is 10 less than 83?
4. Draw a four-sided figure and all of its diagonals.
5. About how long is this pen in centimeters?

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Strategy #2

Incorporate on-going cumulative review into instruction every day.

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Implementing Strategy #2

Almost no one masters something new after one or two lessons and one or two homework assignments. That is why one of the most effective strategies for fostering mastery and retention of critical skills is daily, cumulative review at the beginning of every lesson.

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On the way to school:

- A term of the day
- A picture of the day
- An estimate of the day
- A skill of the day
- A graph of the day
- A word problem of the day

55

Great
Take a deep breath!

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Tell me what you see.

73
63

57

Tell me what you see.

2 1/4

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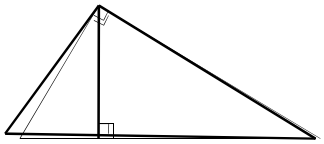
Tell the person sitting next to you five things you see.



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Strategy #3

Create a language rich classroom.

(Vocabulary, terms, answers, explanations)

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Implementing Strategy #3

Like all languages, mathematics must be encountered orally and in writing. Like all vocabulary, mathematical terms must be used again and again in context and linked to more familiar words until they become internalized.

Sum = both	Difference – bigger than
Area = covering	Quotient = sharing
Perimeter = border	Mg = grain of sand
Circumference = a belt	Surface area = skin

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Ready, set, picture…..

“three quarters”

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Why does this make a difference?
Consider the different ways of thinking about the same mathematics:

- **2 ½ + 1 ¾**
- **$2.50 + $1.75**
- **2 ½” + 1 ¾”**

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Ready, set, picture…..

20 centimeters

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Strategy #4

Draw pictures/
Create mental images/
Foster visualization

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The power of models and representations

- **Siti packs her clothes into a suitcase and it weighs 29 kg.**
- **Rahim packs his clothes into an identical suitcase and it weighs 11 kg.**
- **Siti's clothes are three times as heavy as Rahims.**
- **What is the mass of Rahim's clothes?**
- **What is the mass of the suitcase?**

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The old (only) way:

Let S = the weight of Siti's clothes
Let R = the weight of Rahim's clothes
Let X = the weight of the suitcase

S = 3R S + X = 29 R + X = 11

so by substitution: 3R + X = 29
and by subtraction: 2R = 18
so R = 9 and X = 2

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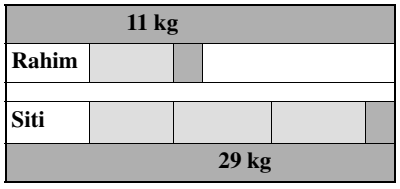
Or using a model:



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And next:

Look at the power of context

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Example 1:

Ready

Set

Find the difference: $10.00 - 4.59$

vs.

How much change do you get from $10 if your spend $4.59?

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Example 2:

$1.59 \overline{)\ 10.00}$

vs.

You have 10.00

Big Macs cost $1.59 each

So?

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Example 3:

$F = 4 (S – 65) + 10$

Find F when S = 81

Vs.

First I saw the blinking lights… then the officer informed me that:

The speeding fine here in Vermont is $4 for every mile per hour over the 65 mph limit plus a $10 handling fee.

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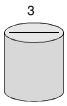
Putting it all together one way

Good morning class.

Today's objective: Find the surface area of right circular cylinders.

Open to page 384-5.

Example 1: S.A.= $2\pi rh + 2\pi r^2$



Find the surface area.

Page 385 1-19 odd

Putting it all together another way

Overheard in the ER as the sirens blare:

"Oh my, look at this next one. He's completely burned from head to toe."

"Not a problem, just order up 1000 square inches of skin from the graft bank."

You have two possible responses:

- **Oh good – that will be enough.**

OR

- **Oh god – we're in trouble.**

- **Which response, "oh good" or "oh god" is more appropriate?**
- **Explain your thinking.**
- **Assuming you are the patient, how much skin would you hope they ordered up?**
- **Show how you arrived at your answer and be prepared to defend it to the class.**

That is, instruction that:

- **Provides students with better access to the mathematics:**
  - Context
  - Technology
  - Materials
  - Collaboration
- **Enhances understanding of the mathematics:**
  - Alternative approaches
  - Multiple representations
  - Effective questioning

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In other words, math that:

- **Empowers, rather than sorts;**
- **Relates to students' own experiences;**
- **Is based on sense-making, not regurgitation; and**
- **Expects students to find solutions to problems, not just answers to exercises.**

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To recapitulate:

1. **Incorporate on-going cumulative review**
2. **Parallel literal to inferential to evaluative comprehension used in reading**
3. **Create a language-rich classroom**
4. **Draw pictures/create mental images**
5. **Embed the math in contexts/problems**

And always ask them "why?"

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Elements of a Vision

- **Effective mathematics instruction in thoughtfully planned.**
- **The heart of effective mathematics instruction is an emphasis on problem solving, reasoning and sense-making.**
- **Effective mathematics instruction balances and blends conceptual understanding and procedural skills.**
- **Effective mathematics instruction relies on alternative approaches and multiple representations.**

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Elements of a Vision (cont.)

- **Effective mathematics instruction uses contexts and connections to engage students and increase the relevance of what is being learned.**
- **Effective mathematics instruction provides frequent opportunities for students communicate their reasoning and engage in productive discourse.**
- **Effective mathematics instruction incorporates on-going cumulative review.**
- **Effective mathematics instruction maximizes time on task.**
- **Effective mathematics instruction employs technology to enhance learning.**

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Elements of a Vision (cont.)

- **Effective mathematics instruction gathers formative evidence of learning in every class.**
- **Effective mathematics instruction uses multiple forms of assessment and uses the results of this assessment to adjust instruction.**
- **Effective teachers of mathematics reflect on their teaching, individually and collaboratively, and make revisions to enhance student learning.**

(Is this what we see? Is this what we breath life into? Is this what we train to? Is this reflected in the materials we approve/recommend? Is this reflected in our assessments?) Why not?

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Interlude:

Questions

(What's not clear?)

and

Discussion

(What's disturbing you most?)

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Part 3

Building More Effective K-12 Mathematics Classes:

We All Have a Role to Play and the Culture Needs to Shift

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Once again:

People won't do what they can't envision,

People can't do what they don't understand,

People can't do well what isn't practiced,

But practice without feedback results in little change, and

Work without collaboration is not sustaining.

Ergo: Our job, as leader, at its core, is to help people envision, understand, practice, receive feedback and collaborate.

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Resulting in:

A Blueprint for Cultural Change

A curriculum, accessible resources, and minimal-cost strategies based on the "work of teaching"

A game plan for moving from good to very good and from very good to excellent

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The Curriculum:

- The mathematics we teach
- The teaching we conduct
- The technology and materials we use
- The learning we inculcate
- The equity we foster

Sound familiar?

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The Resources:

- Curriculum guides, frameworks and standards
- Textbooks, instructional materials
- Articles, readings
- Observations
- Demonstration classes
- Video tapes
- Web sites
- Student work, lesson artifacts
- Common finals and grade level CRTs
- Disaggregated test scores
- Buddies, colleagues

Notice the cost!

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The potential structures

- Structured and focused department meetings
- Before school breakfast sessions
- Common planning time – by grade and by department
- Pizza and beer/wine after school sessions
- Released time 1 p.m. to 4 p.m. sessions
- Hiring substitutes to release teachers for classroom visits
- Coach or principal teaching one or more classes to free up teacher to visit colleagues
- After school sessions with teacher who visited, teacher who was visited and the principal and/or coach to debrief
- Summer workshops
- Department seminars

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Strategies for the mathematics 1:

1. Conduct annual collegial discussions for each grade and each course:
   - What works, what doesn't work?
   - What math, what order, what's skipped, what's supplemented?
   - What's expected, not expected?
   - What's on the common final/grade level CRT?
   - What gets recorded in a written action plan
2. Conduct periodic mathematics strand or topic discussions (algebra, fractions, statistics):
   - What works, what doesn't work
   - Appropriate/inappropriate course/grade placement and overlaps
3. Baby/bath water discussions and decisions about specific topics
   - What's still important, what's no longer important?
   - Do I care if my own kids can do this?

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Strategies for the mathematics 2:

4. Common readings and focused discussions to truly build communities of learners:
   - To what degree are we already addressing the issue or issues raised in this article?
   - In what ways are we not addressing all or part of this issue?
   - What are the reasons that we are not addressing this issue?
   - What steps can we take to make improvements and narrow the gap between what we are currently doing and what we should be doing?
5. Collectively and collaboratively give teachers permission to adjust the curriculum on the assumption that they own the curriculum to a greater degree than most assume.

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Strategies for strengthening the teaching:

1. Use classroom visits to broaden perspectives and stimulate discussions
   - Typical and demonstration classes
   - Building a sense of we're all in this together and face common problems
2. The "roll the videotape strategy"….
   - Our own lessons
   - Annenberg tapes (www.learner.org)
   - NCTM Reflections lessons (www.nctm.org/reflections)
3. Collaboratively craft powerful lessons (www.nctm.org/illuminations and www.mathforum.com)
4. Here's the data, what's the math and what questions best elicit the math?

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Strategies for increasing the learning:

1. Analyze student work
   - Look at what my kids did!
   - What does work like this tell us we ought to do?
2. Review of common finals/grade level CRTs data
3. What's on the test? or examining the truism that "what we assess and how we assess communicates what we value"
   - Types of items/tasks/questions
   - Content and processes measured
   - Contexts, complexity, appropriateness, memorization required
4. Annual action planning sessions:
   - What are we doing well?
   - What can we do to expand what is working?
   - What are we not doing as well?
   - What can we do to improve what is not working as well?

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Strategies for reaching more students:

1. "What do the data tell us?" sessions
2. "What do the videotapes tell us" sessions
   - Compare and contrast two higher level classes/courses with two lower level classes/courses
3. Policy implication discussions
   - Algebra 1 placement
   - Grouping by reading levels
   - Heterogeneous grouping mandates
   - Pull-out programs

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Strategies to tie it all together:

1. Use faculty, grade-level and department meetings as opportunities to inform, stimulate, challenge and grow by adapting the "faculty seminar" model
2. Implement intensive induction procedures, processes and traditions
3. Cultivate and assign topic resource people
4. Appoint course committees – what, how, how well
5. Conduct annual math nights

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Okay: Your turn

So, which ones can't you do?

(A discussion to debunk the inevitable "yeah, buts")

95

The obstacles to change

- Fear of change
- Unwillingness to change
- Fear of failure
- Lack of confidence
- Insufficient time
- Lack of leadership
- Lack of support
- Yeah, but…. (no money, too hard, won't work, already tried it, kids don't care, they won't let us)

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The only antidotes I've ever seen work

- Sharing
- Supporting
- Risk-taking

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To recapitulate: Share "Practice-based professional interaction"

- Professional development/interaction that is situated in practice and built around "samples of authentic practice."
- Professional development/interaction that employs materials taken from real classrooms and provide opportunities for critique, inquiry, and investigation.
- Professional development/interaction that focuses on the "work of teaching" and is drawn from:
  - mathematical tasks
  - episodes of teaching
  - illuminations of students' thinking

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To recapitulate: Support
The mindsets upon which to start

- We're all in this together
- People can't do what they can't envision. People won't do what they don't understand. Therefore, colleagues help each other envision and understand.
- Can't know it all – need differentiation and team-work
- Professional sharing is part of my job.
- Professional growth (admitting we need to grow) is a core aspect of being a professional

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To recapitulate: Take Risks

It all comes down to taking risks

- While "nothing ventured, nothing gained" is an apt aphorism for so much of life, "nothing risked, nothing failed" is a much more apt descriptor of what we do in school.
- Follow in the footsteps of the heroes about whom we so proudly teach, and TAKE SOME RISKS

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Thank you.

Now go forth and start shifting YOUR school culture toward greater collegial interaction and collective growth.

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