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What Do We Do with the Kids Who "Aren't Ready" for Algebra?

E. Paul Goldenberg, June Mark, James Lynn, Martin Gartzman, Susan Hull

DRK-12 PI meeting, June 14, 2012

Agenda

- Setting the Context: “Double Period Algebra”
- District Algebra Supports Study (DASS)
- About *Transition to Algebra*
- About *Intensified Algebra*
- Q&A and Discussion

Context of High School Algebra

- Algebra seen as a “gateway” course
- Focus on all students succeeding in algebra
- Some students identified as needing additional support to succeed in algebra
- Maybe a greater challenge with *Common Core*
- Range of supports provided; additional instructional time common

District Algebra Supports Study (DASS)

- Better understand challenges district face in preparing *all* students for algebra
- Identify strategies and resources districts use to support struggling mathematics students
- Learn more about the specific needs of students
- Learn more about professional development needs for teachers who support these students

Transition to Algebra
DASS Research Questions

1. How are districts in the U.S. serving students who need support to succeed in Algebra 1?
   - What are strategies for identifying students that need support?
   - What resources and supports do districts provide?
2. What challenges do districts face to serve these students?
   - What supports do district leaders say students need?
   - What supports do they say teachers need?

DASS Methods

- Preliminary district leader interviews
  - Targeted range of districts by geography, size
- Survey of district leaders across the U.S.
  - Targeted districts with >25,000 students (N=315)
  - Targeted districts in MA >5,000 students (N=50)
  - Invited district math leader networks in MA, NY, OR, TX, WA
  - First administration from March 13-30, 2012
- Follow-up interviews with districts & schools

DASS Survey Sample Characteristics

- Number of respondents: 235
- Respondents' roles
  - 47% district math directors/supervisors
  - 32% district curriculum coordinators
- District locations (n=155)
  - 16% in NE (CT, MA, NY, PA)
  - 8% in MW (IA, IL, KS, MN, ND, NE, OH, WI)
  - 53% in S (AK, AL, DC, FL, GA, LA, MD, MS, NC, SC, TN, TX, VA, WV)
  - 23% in W (AZ, CA, CO, ID, NV, OR, UT, WA)

DASS Findings: Algebra Policies

- Vast majority (90%) say district has a graduation requirement related to Algebra 1 (n=186 respondents)
  - 47% say must pass course in Algebra 1
  - 29% say must complete multiple years of math, including Algebra 1
  - 23% say must take and/or pass an end-of-course (EOC) exam in algebra
  - 11% say must pass state assessment with algebra content

(n= 168 respondents)

DASS Findings: When Students Take Algebra 1

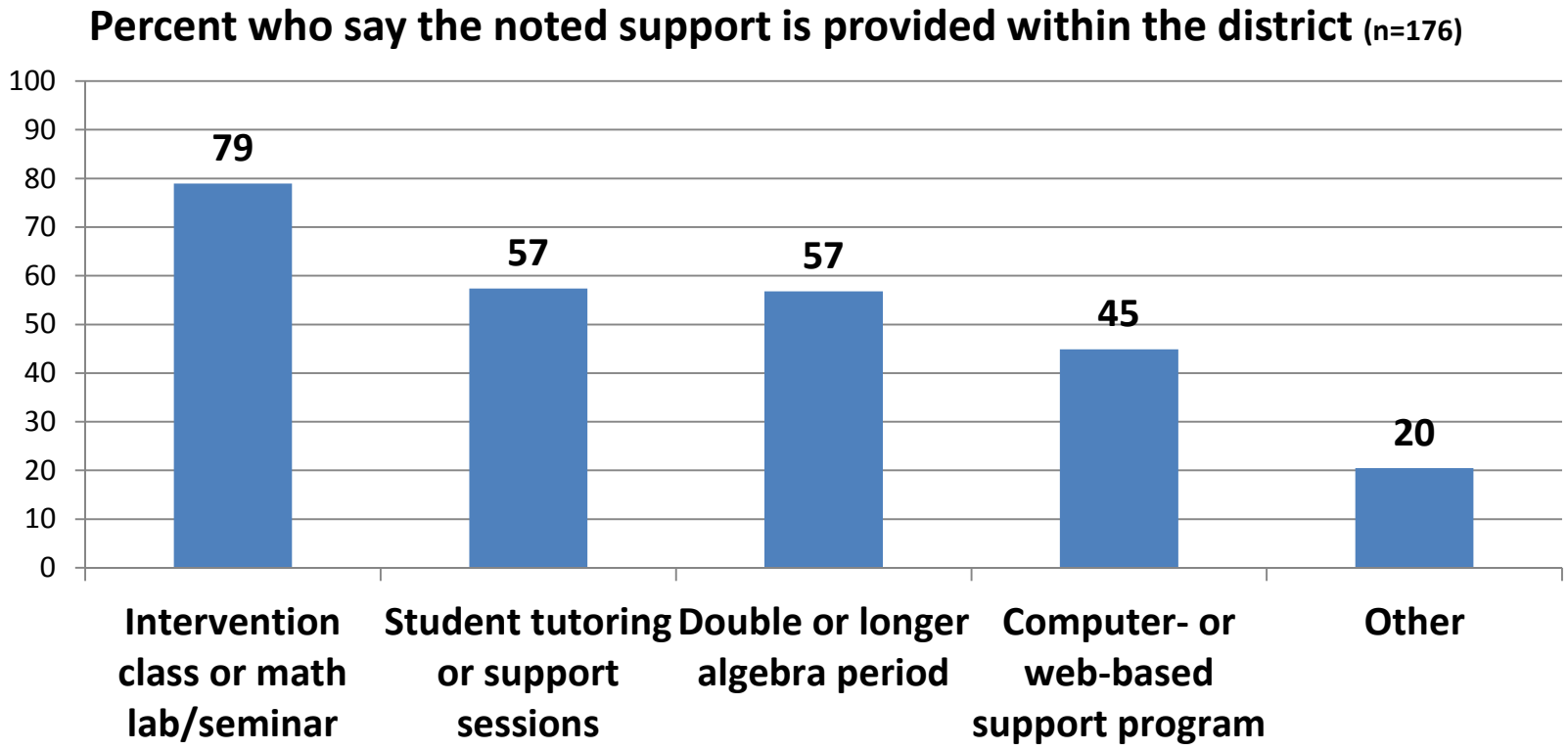
- Most students take Algebra 1 in 9th grade, and many do in 8th grade
  - 71% say over half of 9th graders take Algebra 1 (n=194)
  - 24% say over half of 8th graders do (n=192)
- Substantial proportions take Algebra 1 in 7th and 10th grades
  - 49% say 11-50% of 10th graders take Algebra 1 (n=164)
  - 26% say 11-50% of 7th graders do (n=162)

DASS Findings: Prevalence of Supports

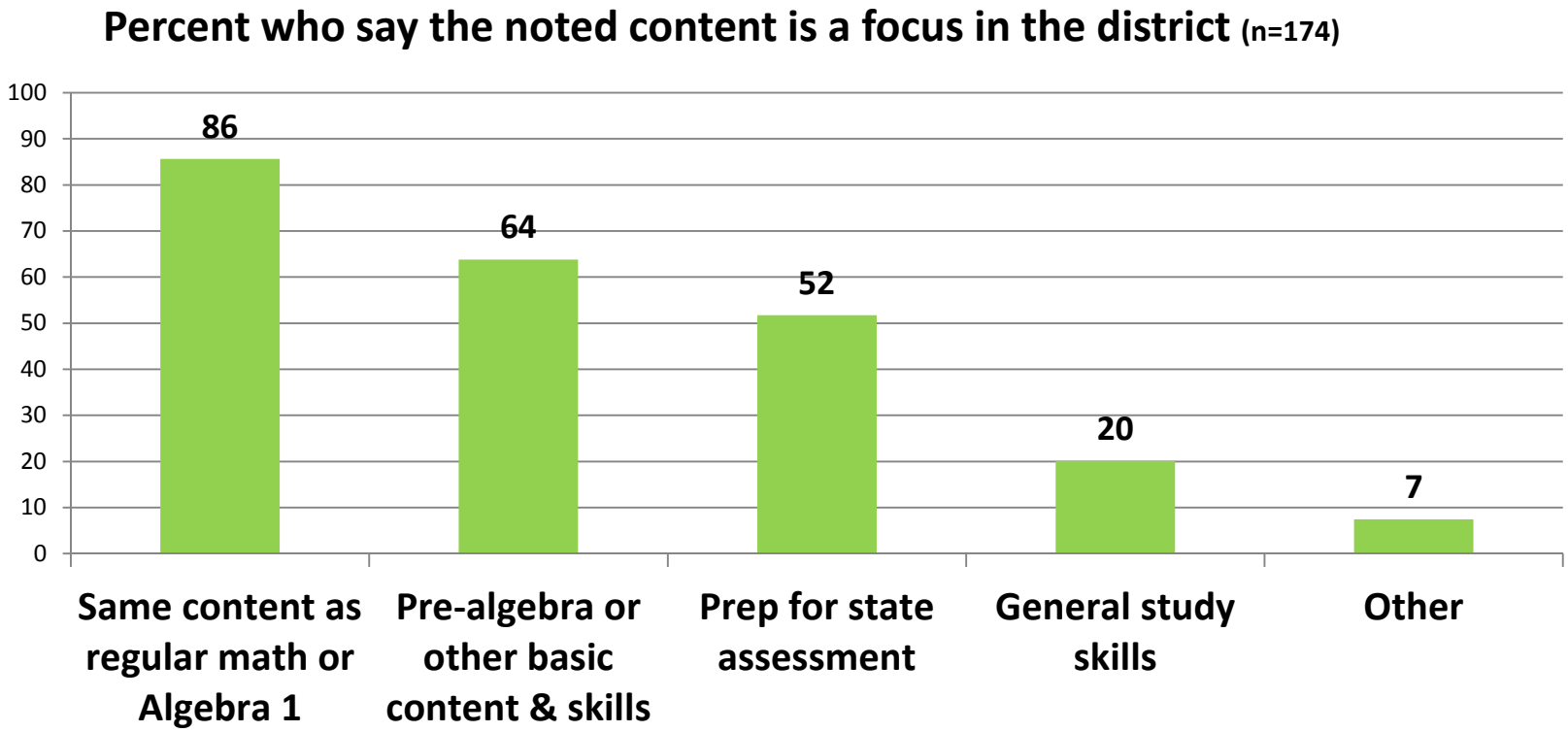
- Vast majority (92%) say district provides supports for struggling students in Algebra 1 (n=195)
- Most (75%) say a majority of students who need support receive it in 9th grade
  - 12% say a majority receive support in 8th grade (n=177)

DASS Findings: Types of Supports Provided

(At grade level when most receive supports)

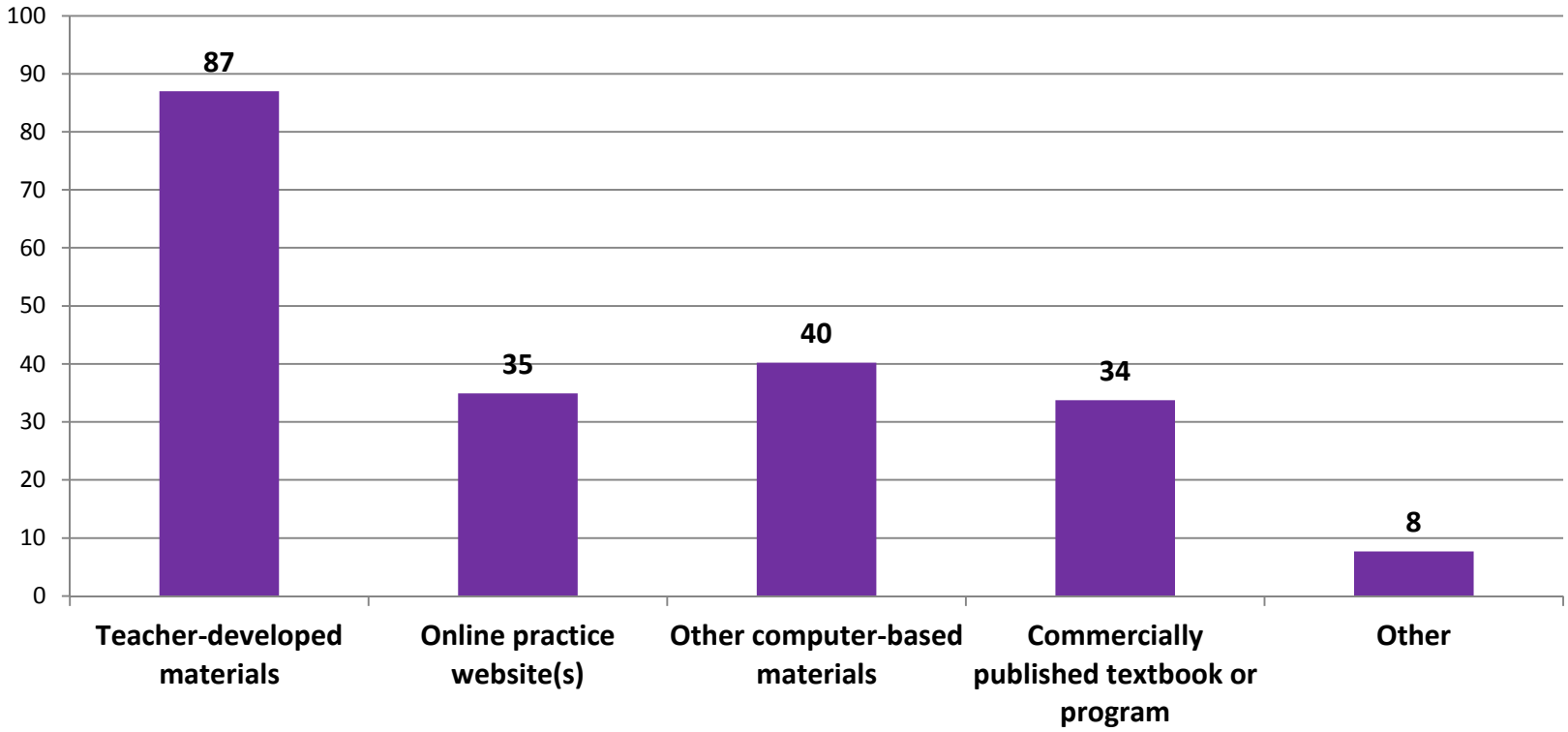


DASS Findings: Content of Supports



DASS Findings: Materials Used for Support

Percent who say the noted materials are used in the district (n=169)

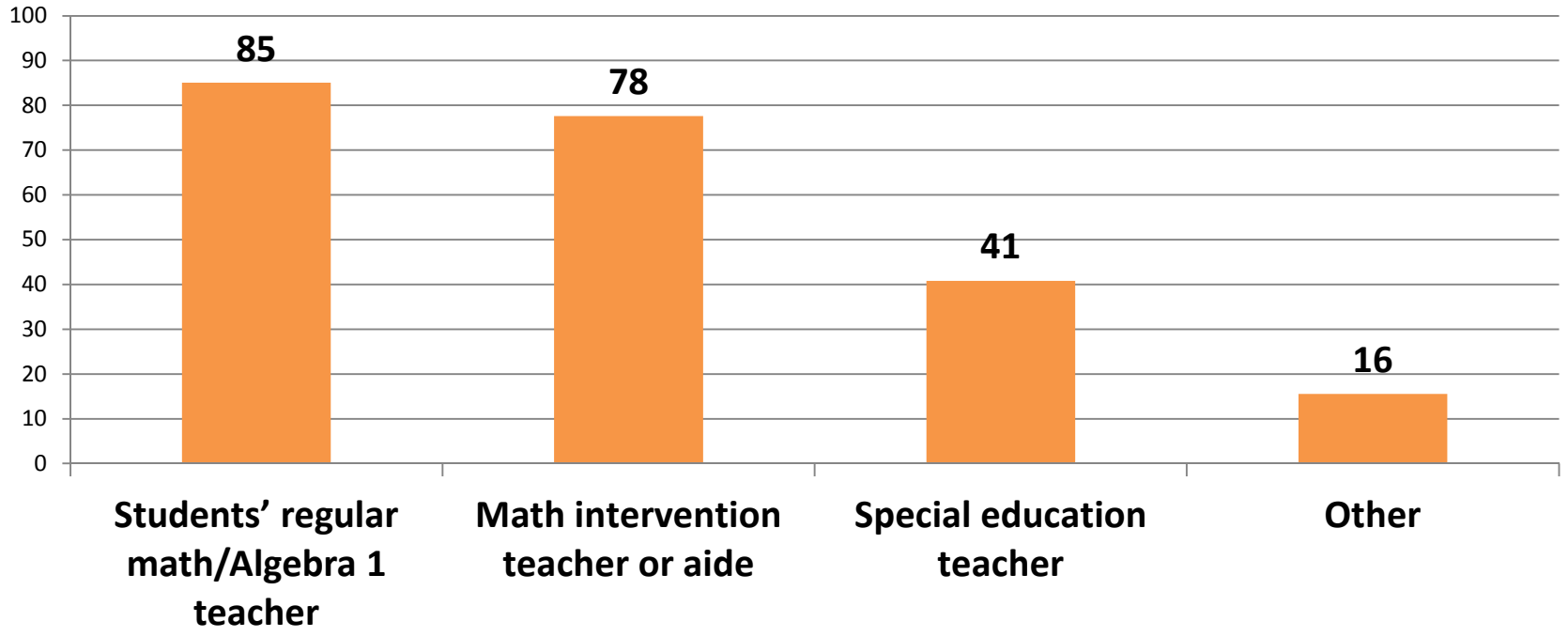


DASS Findings: Online/Computer Supports Cited

- Assessment and Learning in Knowledge Spaces (ALEKS)
- Khan Academy
- Plato Learning
- Compass Learning Odyssey Math
- Carnegie Learning Cognitive Tutor
- Study Island
- Math XL - Pearson
- Accelerated Math - Renaissance Learning
- I CAN Learn
- Apex Math
- USA Test Prep

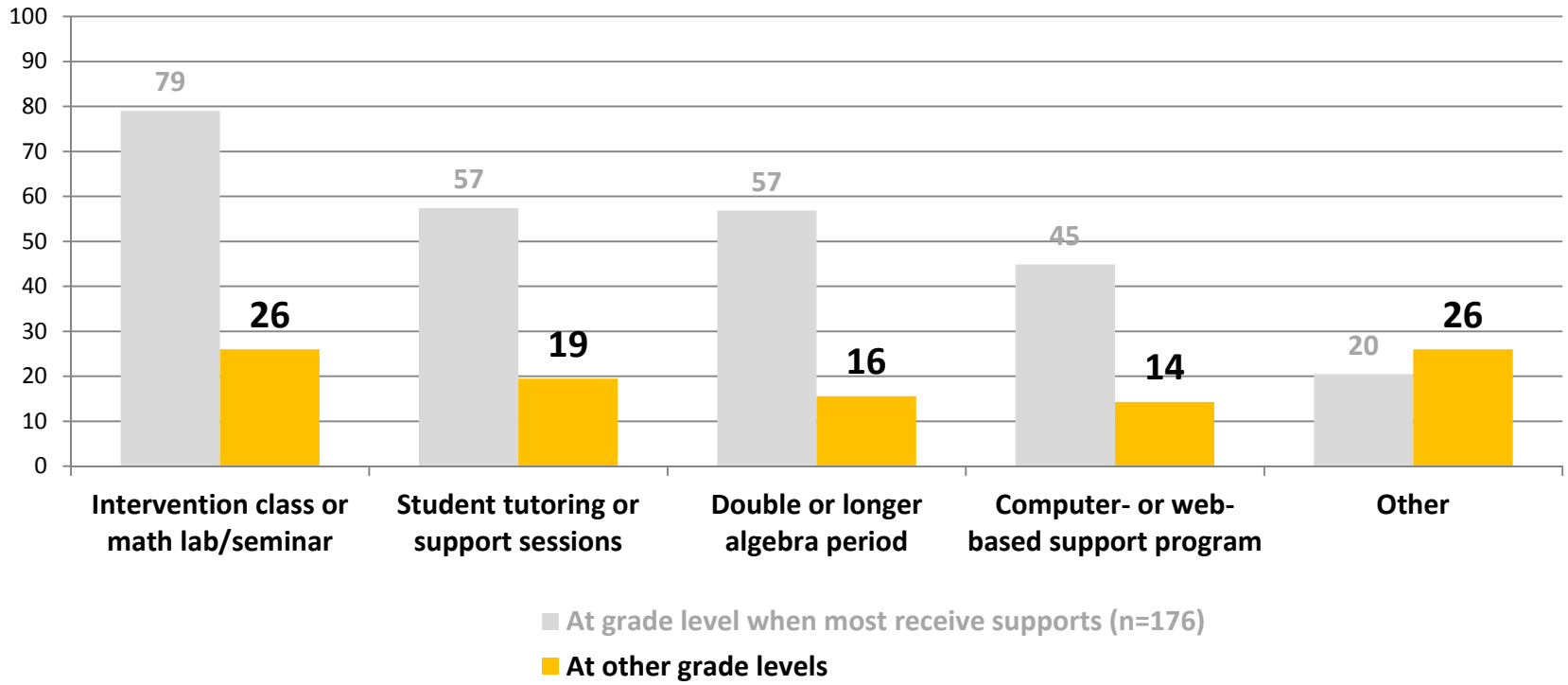
DASS Findings: Who Provides Support

Percent who say the noted people provide Algebra 1 support (n=174)



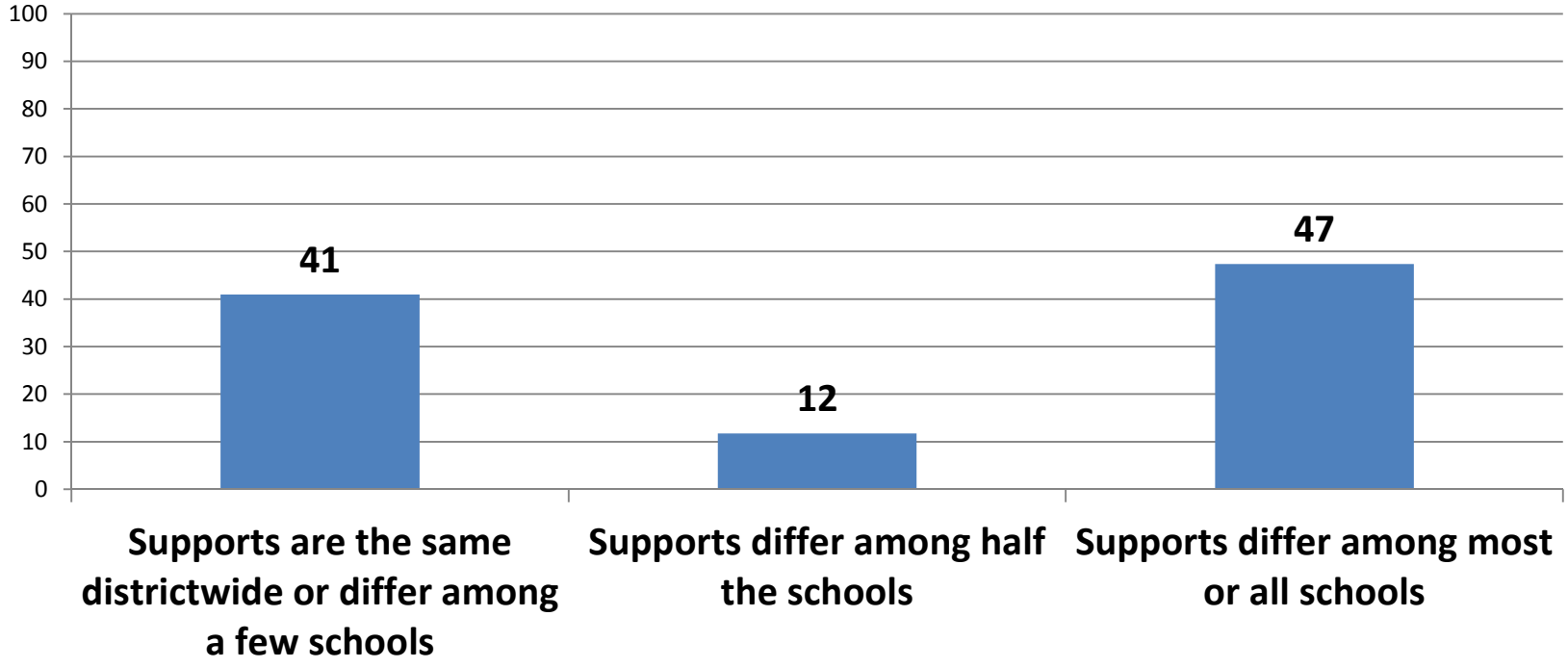
DASS Findings: Types of Supports Provided
(At other grade levels)

Percent who say the noted support is provided within the district (n=77)



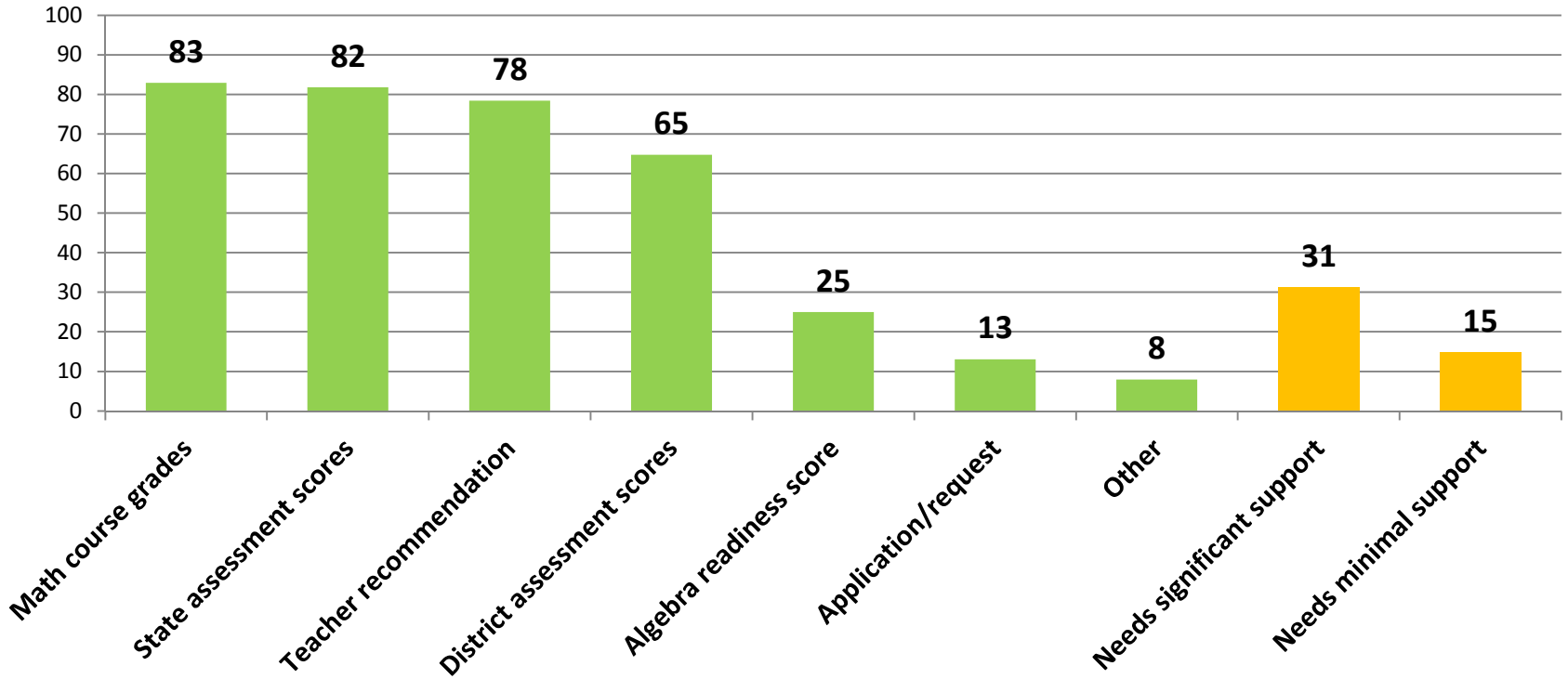
DASS Findings:
How Widely Supports Vary within Districts

Percent who choose each description for their district (n=171)



DASS Findings: Criteria Used to Identify Students for Support

Percent who say the criterion is used to identify students for support (n=176)



DASS Findings: Student Needs, Ranked

Percent who agree or strongly agree that each is a need among struggling students

1. Stronger number sense (100%)	**8. More real-world applications** (86%)
2. Deeper understanding of math concepts (99%)	**9. More individualized support** (84%)
3. Better understanding of fractions/rational numbers (98%)	**10. Better math instruction in early grades** (83%)
4. More opportunities for reasoning and sense-making (96%)	**11. More time to learn algebra** (82%)
5. Better attitudes toward learning math (91%)	**12. More practice with algebra** (81%)
6. Regular attendance (88%)	**13. Better Algebra 1 instruction** (77%)
7. Stronger number facts (88%)	**14. Better curriculum or instructional materials** (55%)

DASS Findings: Teacher Needs, Ranked

Percent who agree or strongly agree that each is a need among teachers serving struggling Algebra 1 students

1. Knowledge of wider range of intervention strategies (93%)	**6. Better student diagnostic tools** (83%)
2. Time to coordinate support with other teachers (92%)	**7. Stronger pre-algebra teaching skills** (75%)
3. Stronger algebra teaching skills (89%)	**8. Stronger algebra knowledge** (72%)
4. More time to work with individual students (89%)	**9. Training in curriculum standards** (71%)
5. Training to assess and diagnose needs (89%)	**10. Stronger pre-algebra knowledge** (57%)

DASS Findings:
What Approaches Work Best (I)

- Additional instruction (45%) (n=92)
  - Extended time for algebra (22%)
  - Intervention course (12%)
  - Tutoring (9%)
  - Out-of-school/after-school support (8%)

DASS Findings:
What Approaches Work Best (II)

- Specific type or method of instruction (37%) (n=92)
  - Online or computer-based support (17%)
  - Individualized support (8%)
  - Use of diagnostic assessments (7%)
  - Small-group instruction (5%)
  - Specific classroom organization (e.g., workshop structure; flexible grouping; integrated classroom; co-teaching) (8%)

DASS Findings:
What Approaches Work Best (III)

- Content of support (24%) (n=92)
  - Remediation of basic skills (8%)
  - Presentation of alternate approaches (4%)
  - Review/reinforcement/re-teaching (3%)
  - Alignment with regular algebra class content (2%)
  - Focus on conceptual understanding (2%)
  - Pre-teaching (2%)
  - Other (specific curriculum; challenge rather than remediation) (5%)

DASS Findings:
What Approaches Work Best (IV)

- Support teacher characteristics (13%) (n=92)
  - Same teacher as in regular Algebra 1 (10%)
  - High quality/skilled (2%)
  - Holds specific beliefs and expectations of students (2%)
- Student characteristics (2%) (n=92)
  - Have basic skills in place (2%)
  - Motivated (1%)

DASS Findings: Summary

- Most districts require Algebra 1 and provide supports
- Support materials are most frequently "home-made," followed by computer-based
- District leaders' views of existing needs:
  - Student deficiencies are first; improved instruction is second
  - Teacher knowledge of interventions and coordination are first; stronger content knowledge is second
- Views of most successful approaches:
  - Additional instruction; more individualized support with regular math teacher; focus on remediation of basic skills

DASS Findings: Emerging Questions

- How do district leaders develop their understandings of student and teacher needs and required supports?
- What theories and factors influence the types of supports that districts provide?
- How do district supports vary among schools?
- What evidence exists about the effectiveness of current district supports?

DASS Next Steps

- In-depth district interviews targeting a range of support types (n=4 to 6)
- In-depth school interviews targeting a variety of approaches (n=3 to 4)
- Pursue additional survey responses:
  - ttalgebra.edc.org/algsupports

At your tables, please discuss…

- What are some issues, learnings, or needs related to algebra for underprepared or struggling students that have emerged in your work?

About Transition to Algebra

- NSF-funded R&D 4-year EDC project

- Year-long course concurrent with but not attached to Algebra 1
- Also being used in summer school and for pre-algebra

- "algebra intervention" (but with a twist)

A goal, a liberty, and an avoided pothole

- Goal:
- A liberty:
- Avoided pothole:

A goal, a liberty, and an avoided pothole

- Goal:
  Make kids as smart and intrepid as when they were five

- A liberty:

- Avoided pothole:

A goal, a liberty, and an avoided pothole

- Goal:
  Make kids as smart and intrepid as when they were five

- A liberty:
  We're not the algebra or pre-algebra course

- Avoided pothole:

A goal, a liberty, and an avoided pothole

- Goal:
  Make kids as smart and intrepid as when they were five

- A liberty:
  We're not the algebra or pre-algebra course

- Avoided pothole:
  Don't focus on potholes. There are too many to fill.

Habits of Mind approach

- Fast: *Prove* the kids can do more than they think

  (including succeed in first-year algebra)

- Focus on a *few* mathematical ways of thinking, mathematical habits of mind

- Use key topics as *contexts* for fostering these mathematical practices

Transition to Algebra Units

Some are the usual suspects

1. Language of Algebra
2. Geography of the Number Line
3. Distance and Sign
4. Area and Multiplication
5. Logic of Algebra
6. Geography of the Coordinate Plane
7. Thinking Things Through Thoroughly
8. Rational Expressions
9. Equations, Inequalities, and Graphs
10. Un-Multiplying: Factoring and Division
11. Radicals and Exponents
12. *<needs a better name>*

Transition to Algebra Units

"Common sense," Habits of Mind, logic, Math Practices, thinking

1. Language of Algebra
2. Geography of the Number Line
3. Distance and [illegible]
4. Area and Mul[illegible]plication
5. Logic of Algebra
6. Geography of the Coordinate Plane
7. Thinking Things Through Thoroughly
8. [illegible]tional Expressions
9. Eq[illegible]ations, Inequalities, and Graphs
10. [illegible]n-Multiplying: Factoring and Division
11. Radicals and Exponents
12. *<needs a better name>*

Transition to Algebra Units

Centrality of puzzles

1. Language of Algebra
2. Geography of the Number Line
3. Distance and Sign
4. Area and Multiplication
5. Logic of Algebra
6. Geography of the Coordinate Plane
7. Thinking Things Through Thoroughly
8. Rational Expressions
9. Equations, Inequalities, and Graphs
10. Un-Multiplying: Factoring and Division
11. Radicals and Exponents
12. *<needs a better name>*

Everywhere

A number trick!

Moving right along…

Transition to Algebra: Building Language and Logic of Algebra

Words	Maria	Pictures
Think of a number.	7	
Add 5.	12	
Multiply by 2.	24	
Subtract 2.	22	
Divide by 2.	11	
Subtract your original number.	4	

Transition to Algebra: Building Language and Logic of Algebra

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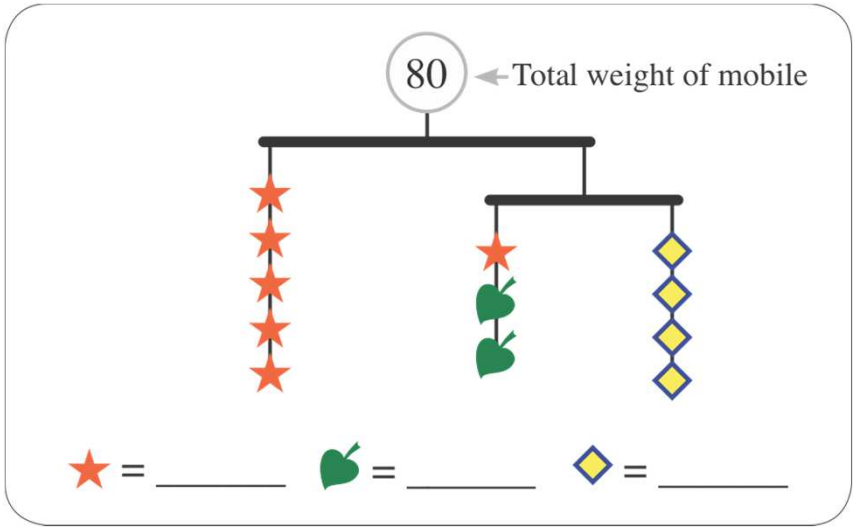
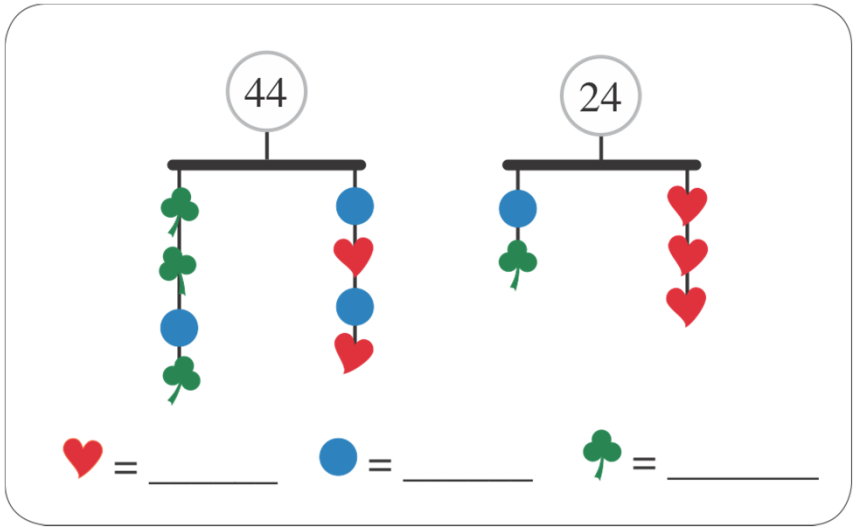
Subtract your original number.	4	

Transition to Algebra: Building Language and Logic of Algebra

Words	Maria	Pictures	Asher	Description of Pictures	Abbreviation
Think of a number.	7		3	bucket	b
Add 5.	12		8	bucket and 5 apples	$b + 5$
Multiply by 2.	24		16	2 buckets and 10 apples	$2b + 10$
Subtract 2.	22		14	2 buckets and 8 apples	$2b + 8$
Divide by 2.	11		7	bucket and 4 apples	$b + 4$
Subtract your original number.	4		4	4 apples	4

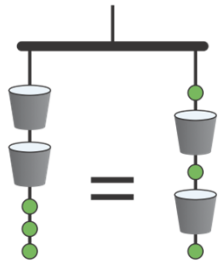
Mobile Puzzles



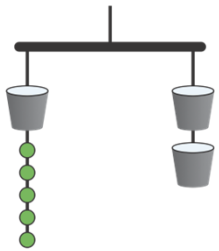


Making the logic of algebra explicit

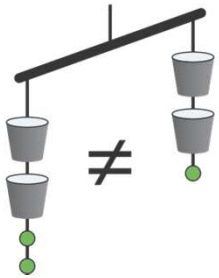
① This mobile *always balances*. Why?



② This mobile *only balances when* the buckets represent a certain number. What number makes it balance?

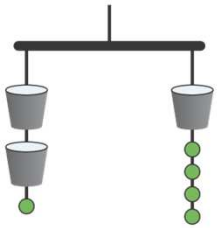


③ This mobile *never balances* no matter what number the bucket represents. Why?



④ Does this mobile balance *sometimes, always, or never?*

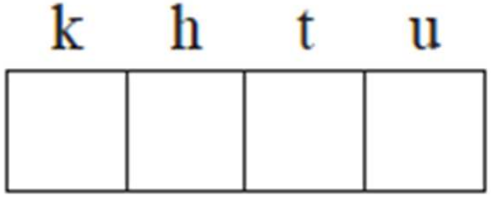
If sometimes, *when?*



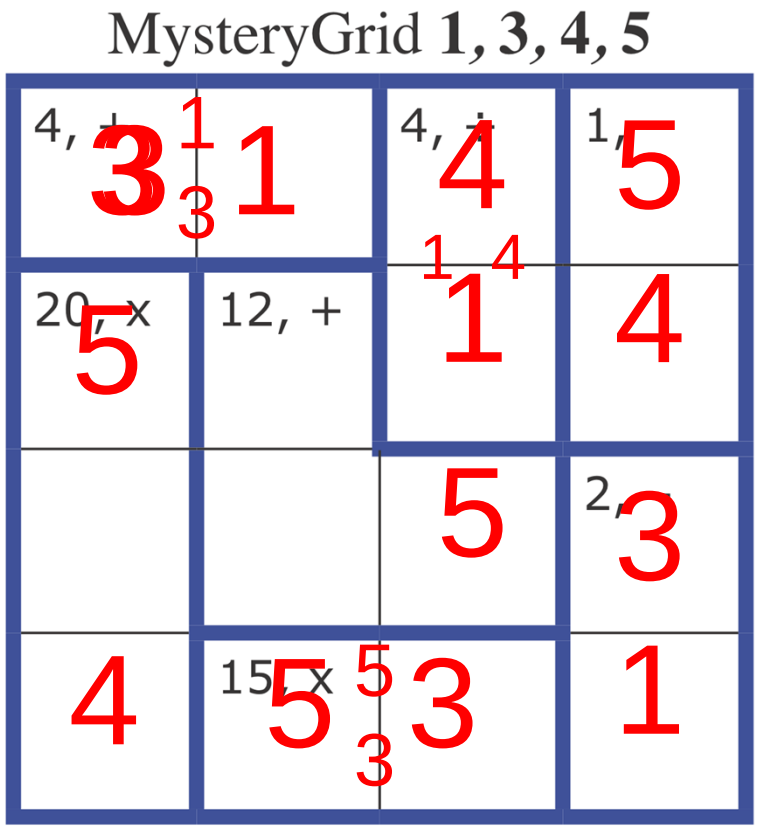
A puzzle to enjoy… I am a 4-digit number

Who Am I?

- The product of my digits is not 0.
- $tu = h$
- k is my only odd digit.
- $t + 1 = k$
- t is a square number.
- None of my digits are the same.
- I'm greater than 5000.

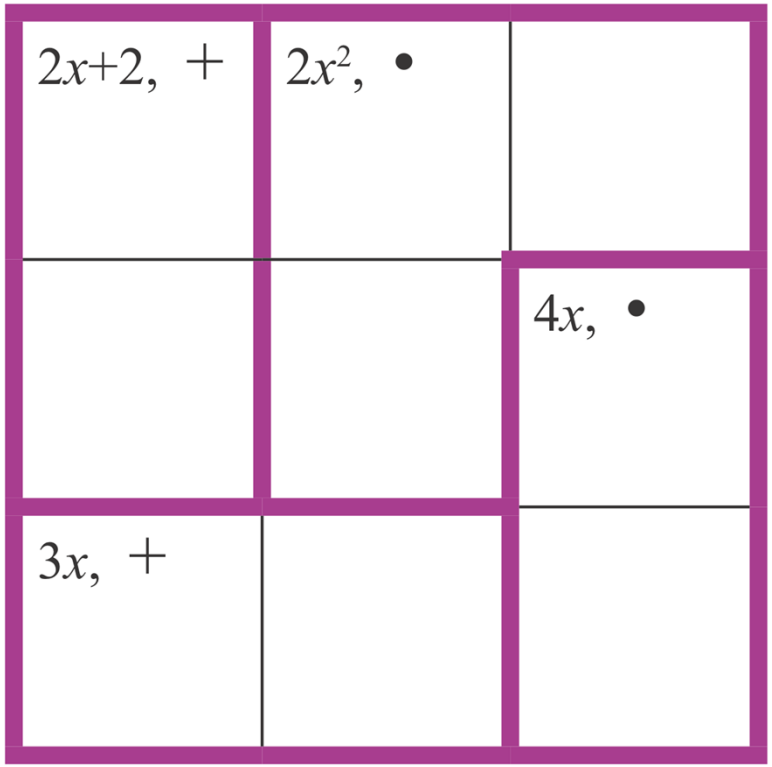


MysteryGrid Puzzles

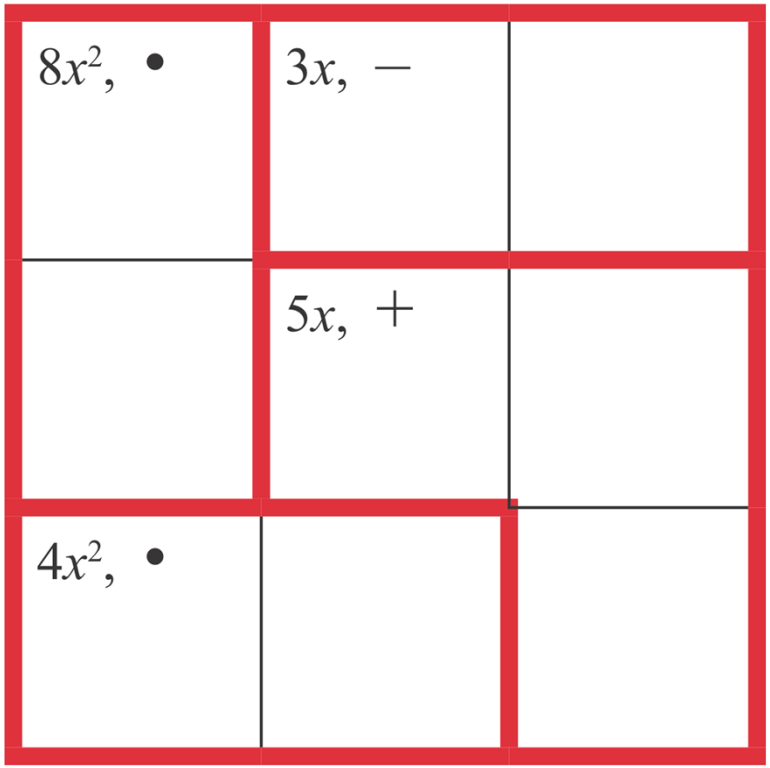


MysteryGrid Puzzles

MysteryGrid **2, *x*, 2*x***

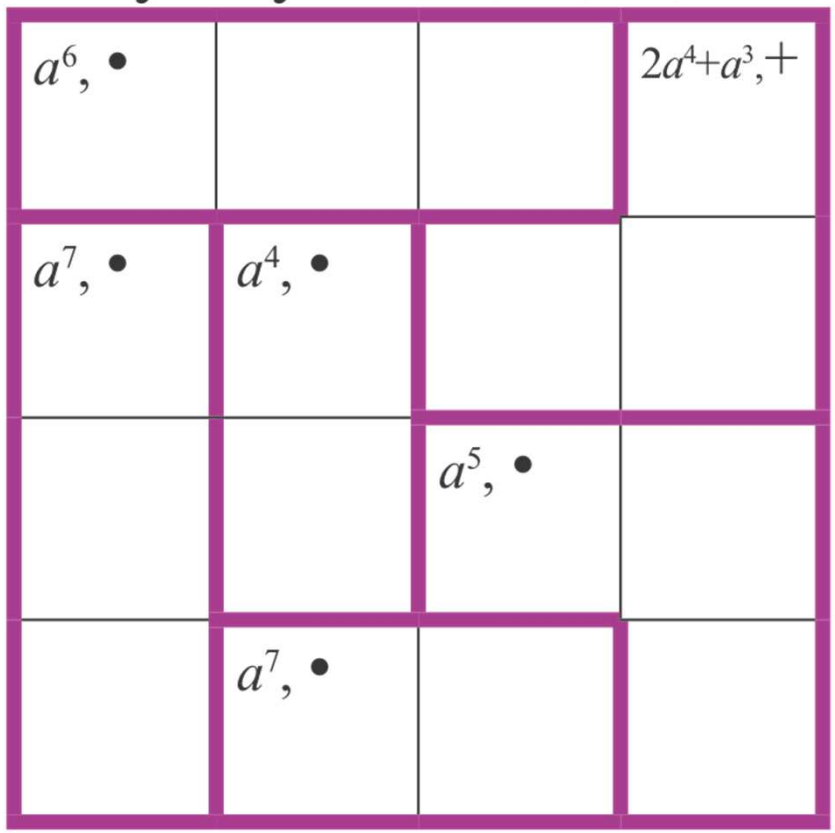


MysteryGrid ***x*, 2*x*, 4*x***



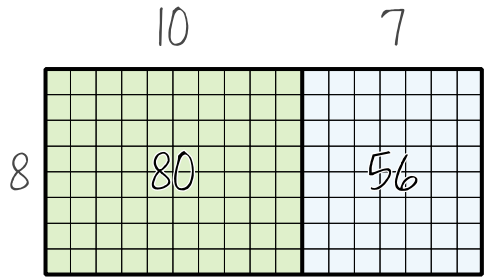
Exponents, too

MysteryGrid a, a^2, a^3, a^4



Area, multiplication, factoring, division

Area (contents) vs. Perimeter (boundary):



$8 \cdot 17 = 8(10 + 7) = 80 + 56 = 136$

Distributive property and division:

	x	5
y	xy	$5y$
3	$3x$	15

$$(x + 5)(y + 3) = xy + 8x + 15$$

$$\frac{xy + 8x + 15}{x + 5} = y + 3$$

PUZZLING factoring, division

	?	?
$3x$	$21xy$	?
4	?	32

Lesson Components

- Mental Mathematics
- Lesson Launch
- Student Problem Solving
- Puzzles
- Thinking Out Loud (student dialogues)
- Discussing Together (class discussion)
- Assessments
- Additional Practice

Transition to Algebra
Early research findings

- Class attrition close to 25%
- Class attendance irregular
- Individual student scores on a few comparable items rose significantly
- Levels of self-concept in mathematics increased significantly
- Levels of math anxiety decreased significantly

WHAT DO WE DO WITH THE KIDS WHO "AREN'T READY FOR ALGEBRA?"

Susan Hull, The Charles A. Dana Center at the University of Texas at Austin
Paul Goldenberg, Education Development Center
June Mark, Education Development Center
Marty Gartzman, University of Chicago
James Lynn, University of Illinois at Chicago

NSF DRK-12 PI MEETING
JUNE 2012

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at the University of Texas at Austin

PARTNERS AND SUPPORT

Partners

- Charles A. Dana Center, University of Texas at Austin
- University of Illinois at Chicago, Learning Sciences Research Institute
- Agile Mind
- 278 teachers at 127 schools with 13,028 students in 15 states

Project R & D Funding

- National Science Foundation
- Searle Fund of the Chicago Community Trust
- Bill and Melinda Gates Foundation
- Carnegie Corporation

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THE CHALLENGE:
STRUGGLING STUDENTS, RAMPED UP REQUIREMENTS

- Many more students now taking Algebra I are one or more grade levels behind in mathematics.
- Many struggling students are hindered by a lack of engagement and a lack of commitment to learning.
- Three years of mathematics beyond Algebra I are now required for high-school graduation in some states.
- Algebra I remains the most failed course in most districts.
- Curricula and teacher preparation have not kept pace with changing needs.

New approaches are needed to ensure underprepared students can get back on track to succeed in high school.

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INTENSIFIED ALGEBRA I PROJECT GOALS

1. Design and test a program of *intensification* – a systemic effort to address the contextual needs of students in learning *on-level content*
   (BUILD IT)

2. Develop supports for classroom implementation
   (MAKE IT DO-ABLE)

3. Develop structures for implementation at scale, particularly in urban districts
   (MAKE IT SCALE-ABLE)

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INTENSIFICATION

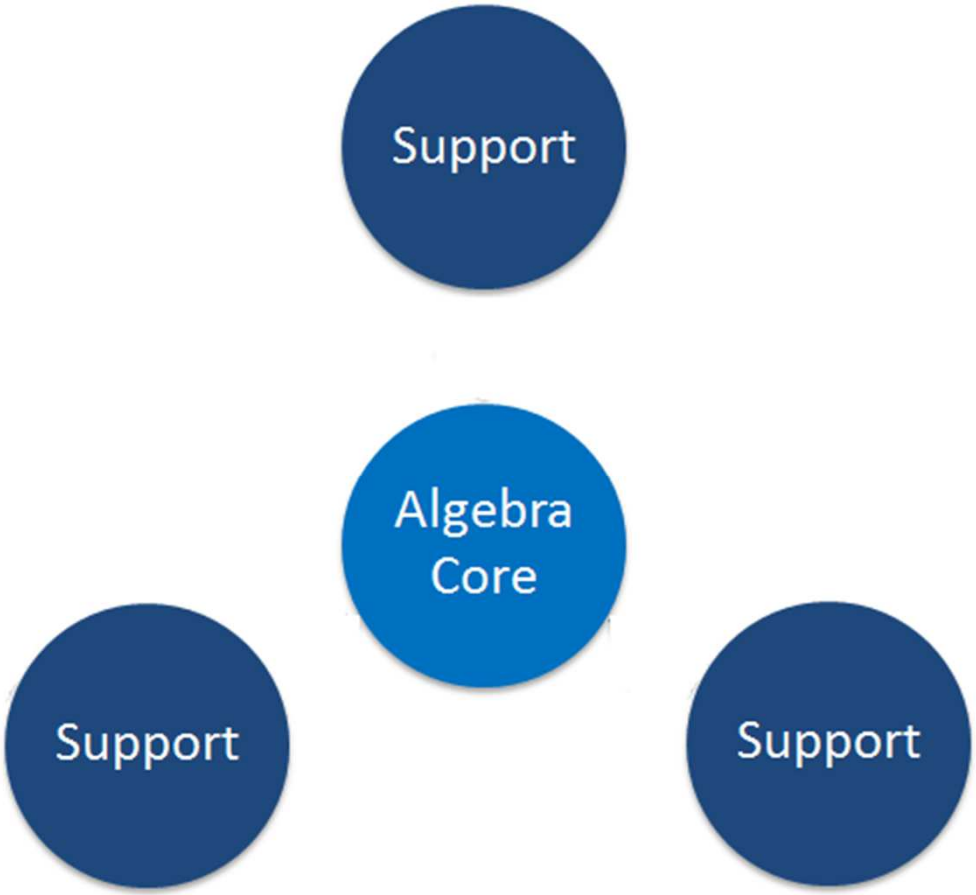
Intensification is a systemic effort to address the contextual needs of students in learning on-level content.

It may mean:

- Increasing the amount of time with content;
- Using a variety of pedagogical supports; and/or
- Developing students' socio-motivational well-being around the content.

It does **not** mean delaying rich mathematical experiences until students acquire "the basics."

ARCHITECTURES FOR INTENSIFICATION



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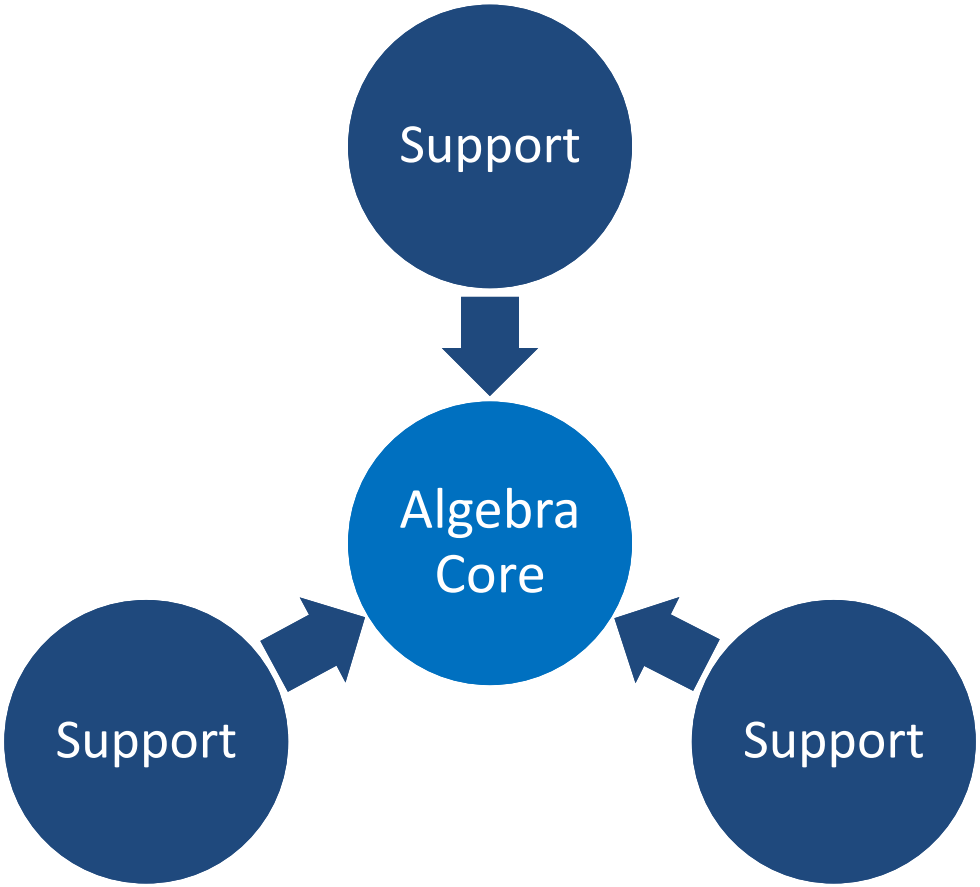

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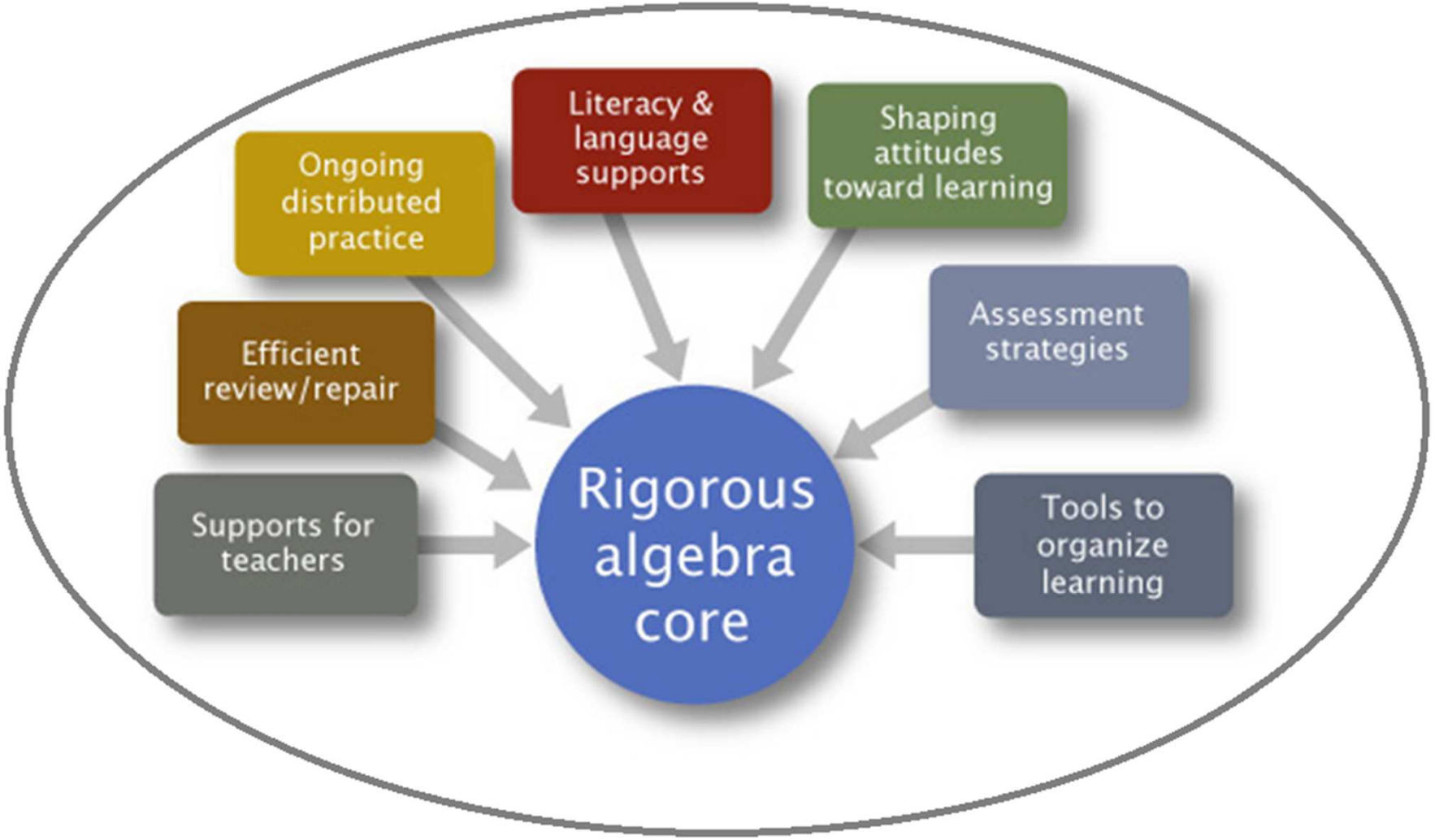
OUR INTENSIFICATION APPROACH: INTENSIFIED ALGEBRA I



OUR THEORY OF ACTION

Underprepared students need more time.

But more time alone is not enough…

Students need to complete a rigorous, high-school level Algebra I course that addresses foundational conceptual and skill weaknesses.

But it is not solely a mathematics scope and sequencing issue…

Struggling students need **time**, a **challenging curriculum**, and **cohesive, targeted supports and interventions.**

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INTENSIFIED ALGEBRA I GOALS

- Utilize an **asset-based approach** that builds on student strengths
- Make **learning and thinking explicit** through structure and routines
- **Engage students** in making meaning from learning experiences
- Ensure students experience success with **effective effort and persistence**

In one academic year, catch students up to their peers and equip them to be successful in Algebra I, and their future math courses

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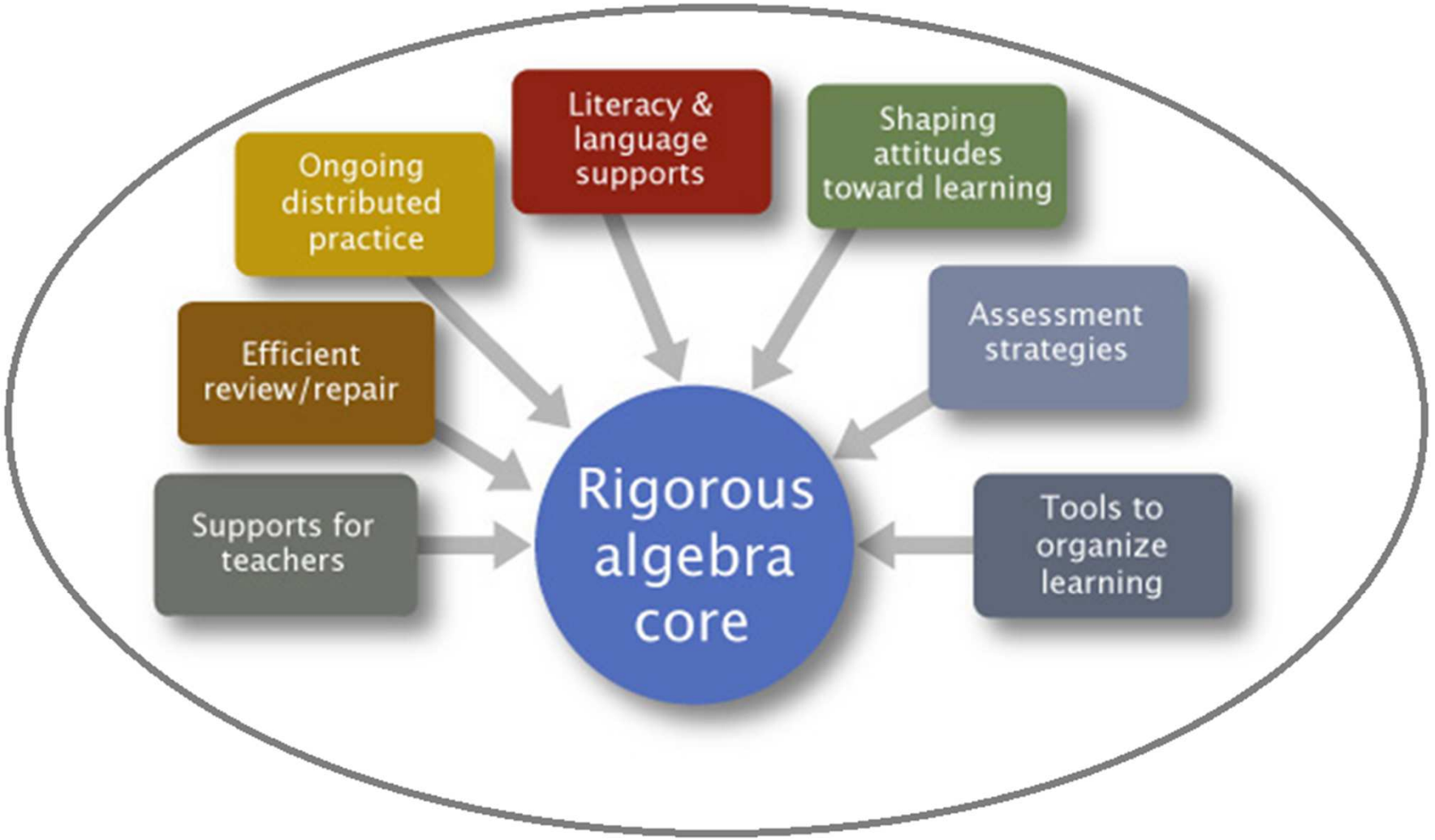
OUR INTENSIFICATION APPROACH: INTENSIFIED ALGEBRA I



COURSE DESIGN: DAILY LESSON STRUCTURE

Each daily lesson is designed for a 70-90-minute extended period. A typical lesson has these components:

- *Opener & Lesson preview* (5-10 min)
- *Core learning activity* (25-35 min)
- *Process homework* (10 min)
- *Consolidation activity* (20-25 min)
- *Wrap-up and introduce homework* (5 min)

WHAT RESEARCH TELLS US

- Providing **routines and structures** that help struggling learners organize critical mathematics content increases their learning (Deshler & Lenz).
- Accessing prior knowledge and **addressing students' misconceptions** increases learning (Swan & Bell, Burkhardt, Shell Centre).
- Engaging students with **challenging tasks** that involve **active meaning-making** increases learning (Horizon Research, Hiebert & Grouws).
- On-going cumulative **distributed practice** improves learning and retention (Rohrer, Mayfield).
- **Formative assessment** is a key intervention for improving student achievement (Black & Wiliam, Hiebert & Stigler).
- Promoting **learners' beliefs about their own intelligence** can increase their motivation and effort to learn mathematics (Dweck, Goode, Midgely, Aronson).

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INTENSIFICATION STRATEGY

Use of high cognitive-demand tasks

"Not all tasks are created equal, and different tasks will provoke different levels and kinds of student thinking."

—Stein, Smith, Henningsen, & Silver, 2000

"The level and kind of thinking in which students engage determines what they will learn."

—Hiebert et al., 1997

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HIGH-COGNITIVE DEMAND TASKS

LOW DEMAND

The formula to find the number of diagonals, ***d***, that can be drawn from one vertex in a polygon with ***n*** sides is, ***d = n - 3*** . Use the formula to find ***d*** when ***n*** is 6.

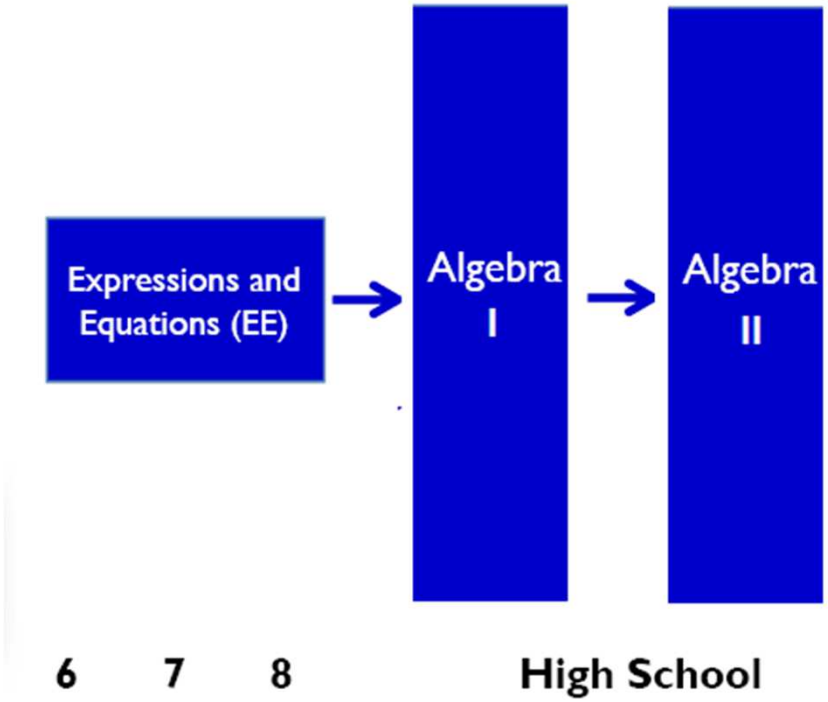
HIGH DEMAND

Find an algebraic rule to describe the relationship between the number of sides of a polygon, ***n***, and the number of diagonals that can be drawn from one vertex, ***d***.

Use ***n*** as the independent variable, and express your rule using function notation. Explain how you found the rule.

HIGHER LEARNING EXPECTIONS DEMANDED BY CCSS-M

The CCSS-M **content standards** increase learning expectations and require some re-ordering of algebra content.



The **Standards for Mathematical Practice** encourage the development of mindsets and habits that enhance student's mathematical proficiency. Students must:

- Make sense of problems and persevere in solving them;
- Reason abstractly and quantitatively;
- Use appropriate tools, including technology, strategically;
- Attend to precision;
- Construct viable arguments and assess the reasoning presented by others; and
- Model with mathematics.

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SUPPORTS FOR TEACHERS

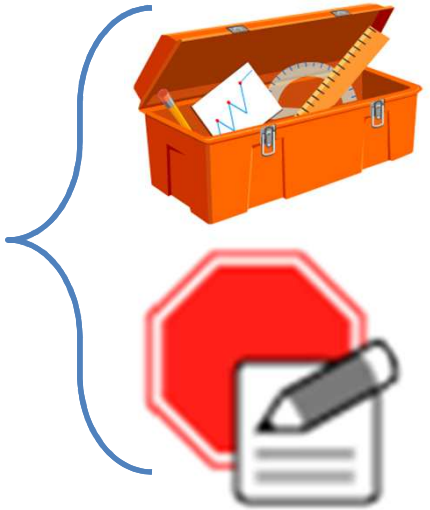
It’s not just the use of high-cognitive tasks.

Key questions for our program development:

- How can we support teachers to enact lessons in a way that promotes student understanding?
- How do we support teachers to reach every student, in every class, every day?

TEACHER ACTIONS THAT AFFECT COGNITIVE DEMAND

- Launch: Task set-up
- Investigate: Supporting students' exploration of the task
- Debrief: Orchestrating debriefing discussion



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INTENSIFICATION STRATEGY

Model of instruction to support inquiry and conceptual understanding

Launch → Investigate → Debrief

- Support for setting up problem and context
- Focus on maintaining the challenge for students

- Partners structure
- Support for predicting what students will do
- Questioning strategies

- Support for orchestrating discussion
- Emphasizing discourse
- Clarification of ideas

Maintain cognitive demand through all three parts of the model.

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SUPPORTING IMPLEMENTATION VIA DISCUSSION PROMPTS

Assessing Questions

- Clarify what the student has done and what the student understands about what they have done.

Advancing Questions

- Move students beyond their current thinking by pressing students to extend what they know to a new situation.

Smith, 2004

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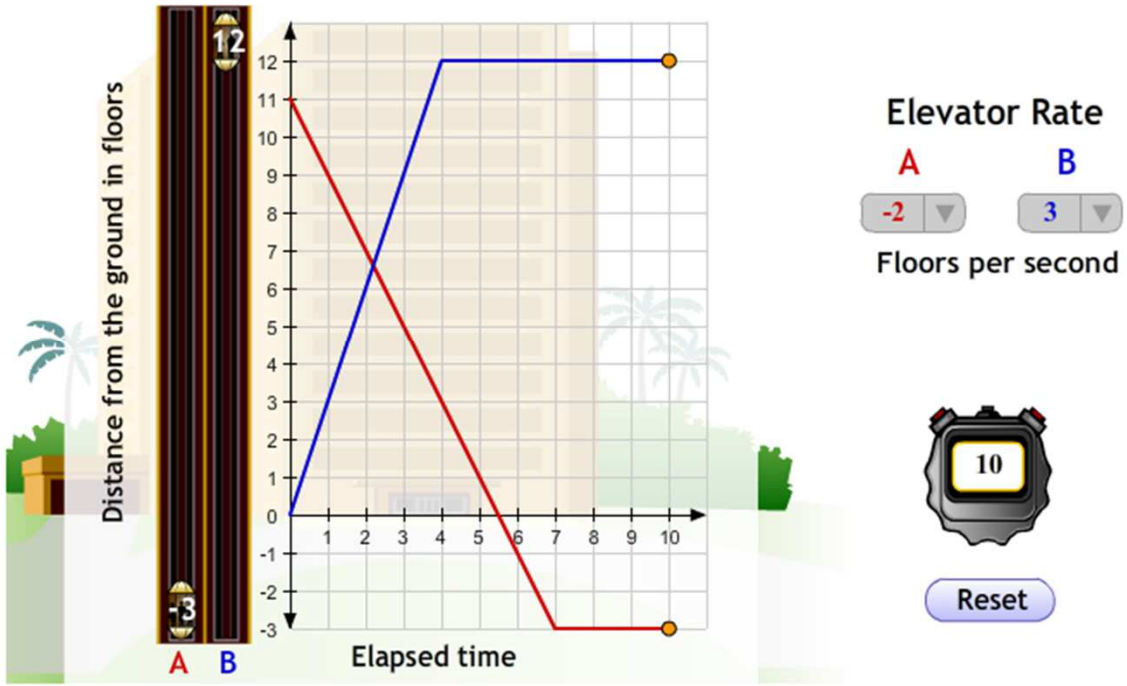
Now that you have completed the elevator problems, use the animation to check your graphs.



INTENSIFICATION STRATEGY

Leverage findings from literacy in the content areas

[T]he lack of reading-to-learn skills is behind much of poor student performance in the content areas.

Many students have not developed specific techniques to appreciate the nuances of the big ideas in the domains of knowledge. In short, for many learners the big ideas are invisible.

Gomez, *L.*, *& Gomez*, *K*. (*2007*). *Reading for learning*: Literacy supports for 21st century work. Phi Delta Kappan, *89*(3), 224–228.

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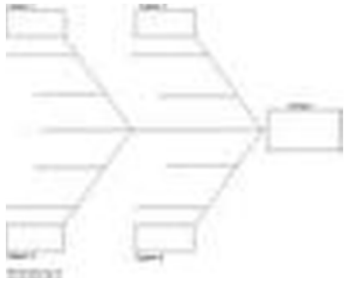
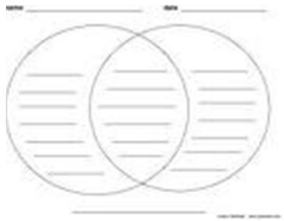
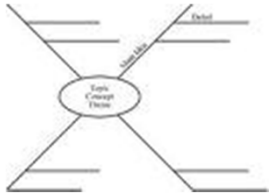
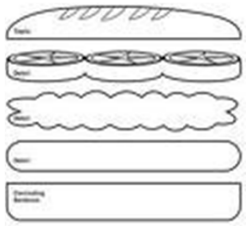
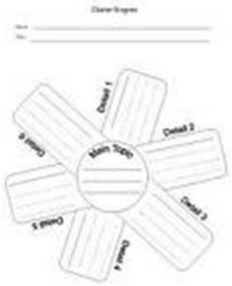
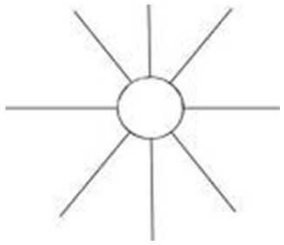
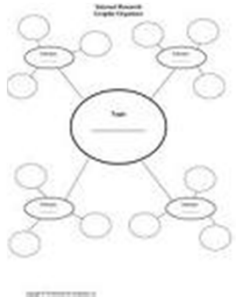
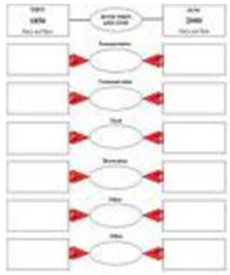
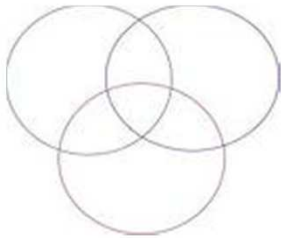
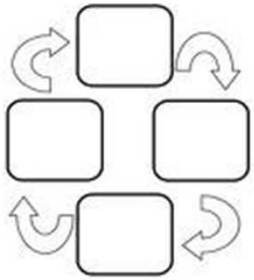
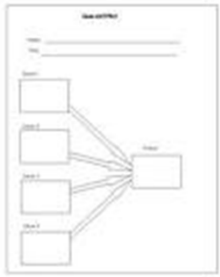
A MYRIAD OF GRAPHIC ORGANIZERS



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MATH JOURNAL EXAMPLE

- Based on your investigation, what conjectures can you make about **the relationship between algebraic and geometric solutions to systems of linear equations?** Complete the Math Journal to describe your conjectures.

ALGEBRAIC RESULT	WHAT DOES THE GRAPH LOOK LIKE?	WHAT MIGHT THIS TELL YOU ABOUT THE NUMBER OF SOLUTIONS FOR THE SYSTEM?
Answer includes one value for ***x*** and one value for ***y***.		
Equations simplify to a **false** equation containing only numbers (for example, 0 = 12).		
Equations simplify to a **true** equation containing only numbers (for example, 18 = 18).		

LANGUAGE NOTES

◀ 7.1 Rates and motion graphs ▶ ◀ 1 2 3 4 5 6 7 8 9 10 11 ▶

Core activity 1-2

In the *Opener* you considered a race car that traveled at a **speed** of 110 miles per hour. Mathematicians might also describe how fast a car is moving by discussing the car's **rate**.

Speed describes a change in distance relative to a change in time. At a faster speed, a race car covers more distance in a given amount of time. At a slower speed, the race car covers less distance in that time. A speed is always positive.

Rate describes a change in one measure relative to a change in another measure. A car's fuel consumption rate of 32 miles per gallon and an adult's resting heart rate of 78 beats per minute are examples of rates. A rate can also be negative. A temperature change of -3 degrees per hour is also an example of a rate.

Language note

Rate has several meanings. Sometimes, people call a price a rate: "That hotel charges a high **rate**."

The word **rate** is also used to compare things: "I would **rate** that movie higher than the one I saw yesterday."

In this topic, **rate** describes a change in distance relative to a change in time.

Use of learning routines

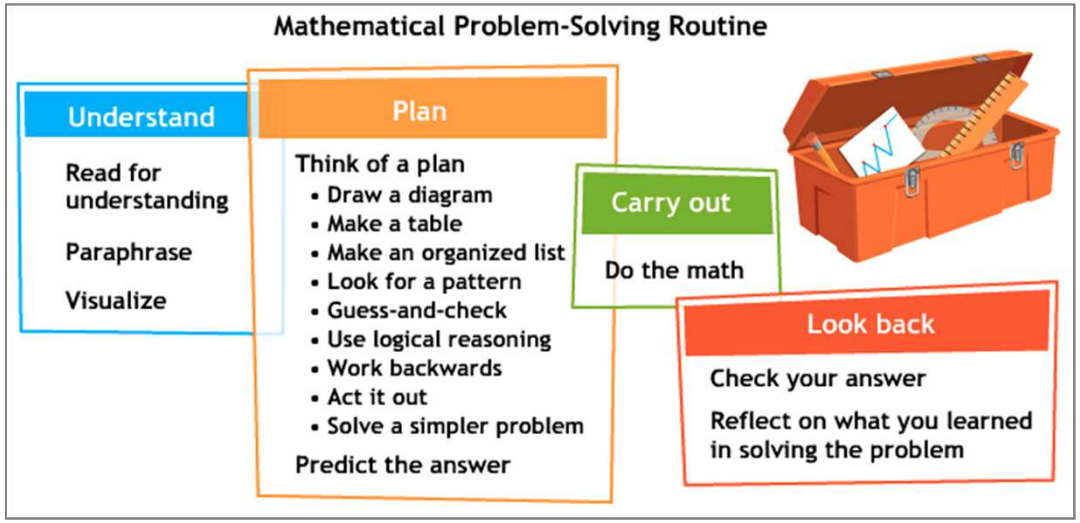
"Some students in school today don't see a connection between their efforts and school success, don't know what it is they need to practice, can't imagine themselves ever being 'academic,' and have never seen 'academics played.' . . .

A first step in helping students become full participants in the classroom is to ensure that all students value and understand the importance of learning and **learning rituals**."

Lenz, B.K., Deshler, D. (2004). *Teaching Content to All: Evidence-Based Practices in Middle and Secondary Schools*. Boston: Pearson Education, Inc.

TOOLS TO HELP STUDENTS ORGANIZE LEARNING

- Daily routines help students summarize learning and make connections within algebra
- Explicitly-taught problem solving strategies encourage persistence
- Embedded question prompts, structures, and scaffolding support students in organizing their work and developing ideas
- Tasks are designed to maximize time spent on meaningful work—not drill and kill



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RESPONSE TO INTERVENTION SUPPORTS

Intensified Algebra I supports instructional interventions for struggling students with:

- Attention to special education learning needs
- Data on assessment to inform instruction
- Review/repair strategies
- Motivational strategies based on psychological and other learning sciences research
- Re-engagement of learners through visual and multiple representations of mathematical ideas

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EMPOWERING STUDENTS IN THE LEARNING PROCESS

A routine for processing homework

1. With your partner

Compare your answers.

Compare how you solved the problem.

2. As a class

Your teacher will identify several problems to review as a class.

Participate in the whole-class discussion of the problems.

3. By yourself

● I understand all of the ideas in the homework.

▲ I understand some/most of the ideas.

■ I don't understand most of the ideas.

4. Finish

Place your corrected homework assignment in the IN side of the folder.

Remove any assignment on the OUT side of the folder.

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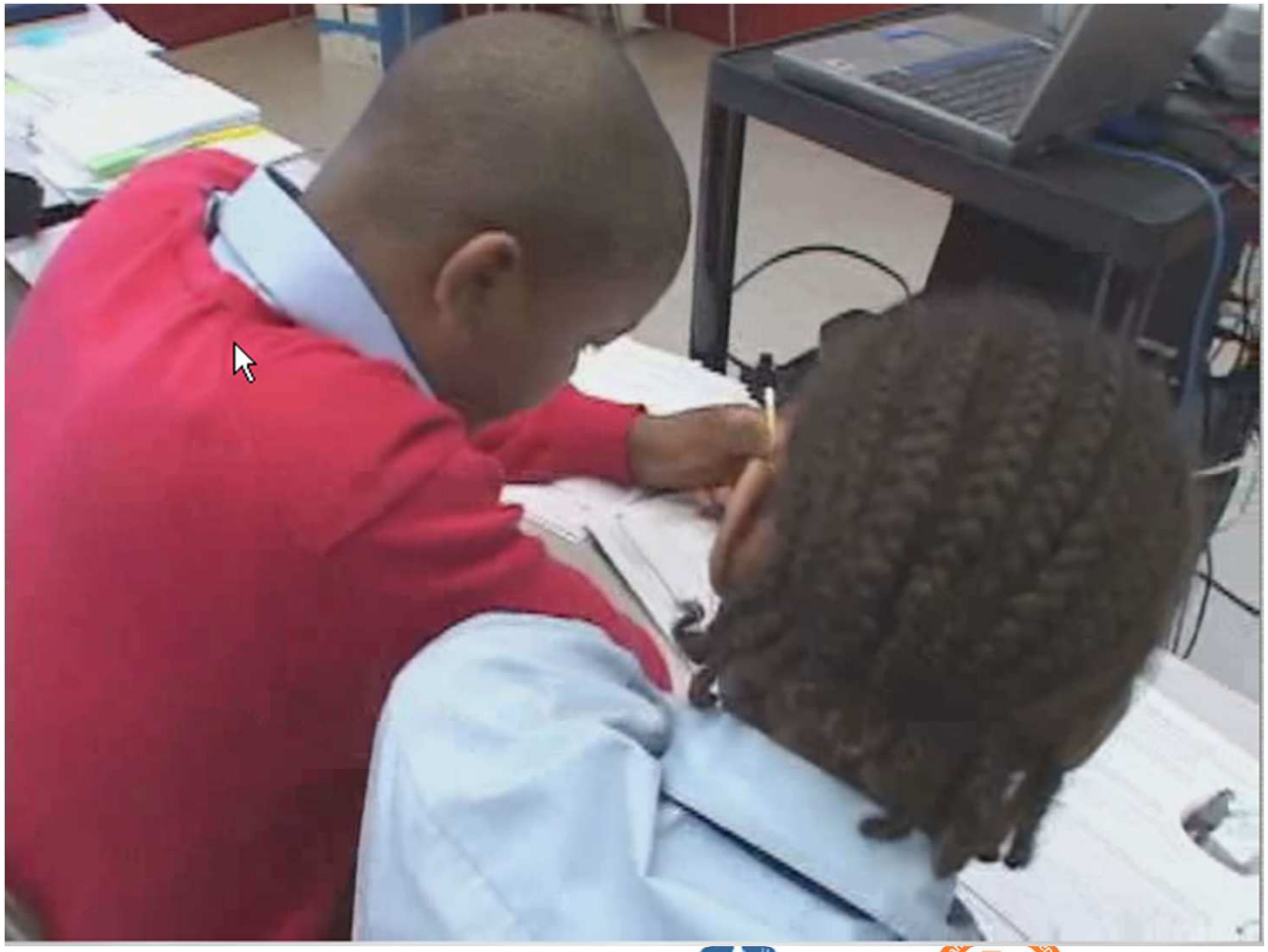
EXPLICIT TEACHING OF ROUTINES



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HELPING STUDENTS MAKE CONNECTIONS

◀ 15-Connecting solution methods ▶

◀ 1 2 3 4 5 6 7 8 9 10 11 12

Activity 15.5 **Wrap up and introduce homework**

15.1 Opener: Solving by factoring or other methods
Explore the connections and limits of solving by factoring

15.2 Graphing, factoring, and the quadratic formula
Compare and contrast three methods for solving quadratic equations

15.3 Process homework

15.4 Online assessment
Assess your understanding of key ideas and skills from this topic

15.5 Wrap up and introduce homework

Reflect on today's lesson and be prepared to share out with the class:

An important idea from today's lesson is ...

Look at tonight's homework:

Which activities from today's lesson prepare you to successfully complete the homework?

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INTENSIFICATION STRATEGY:
FIVE KEY FORMATIVE ASSESSMENT STRATEGIES

- Clarifying and understanding intentions and criteria for success
- Engineering effective classroom discussions that elicit evidence of learning
- Providing feedback that moves learning forward
- Activating students as instructional resources for each other
- Activating students as the owners of their own learning

…AND ONE BIG IDEA

- Use evidence about learning to adapt instruction to meet student needs

Wiliam, D. & Thompson, M. (2007). Integrating Assessment with Learning: What Will It Take to Make it Work? In Dwyer, C. A. (Ed.), *The Future of Assessment: Shaping, Teaching and Learning*. Mahwah, N. J.: Erlbaum.

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A ROUTINE FOR REVIEWING ASSESSMENTS

Activity 12.4 Review mid-unit assessment

Read your teacher's comments. If you don't understand a comment, ask your partner for help. Ask your teacher only if your partner can't help you.

- Green = I understand all of the ideas in the problem.
- Yellow = I understand some/most of the ideas.
- Red = I don't understand most of the ideas in the problem.

Correct the problems that you got wrong but now understand.

- Discuss and review only problems that either you or your partner got wrong.
- Correct remaining problems that you now understand.
- Check your corrections with your partner to make sure your answers are now correct.

- Place your corrected assessment in the IN side of the folder.
- Be ready to participate in a brief whole-class discussion of the assessment.

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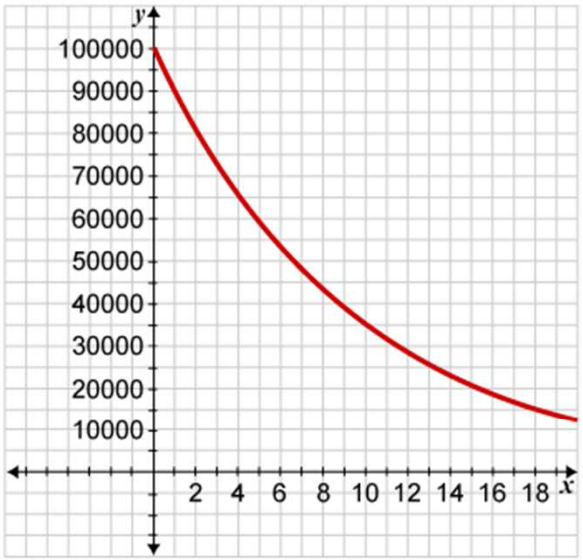
ONLINE ASSESSMENTS

Guided assessment

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Which scenario best fits the graph shown?



- The population of a town during the years after a large corporation put their headquarters there.
- The population of a town after the local automobile manufacturer closed the manufacturing plant.
- The repayment of a no-interest loan paid off at $1000 a year.
- The scoring average of a star basketball player in the years after a severe injury.

Hint | Submit Answer

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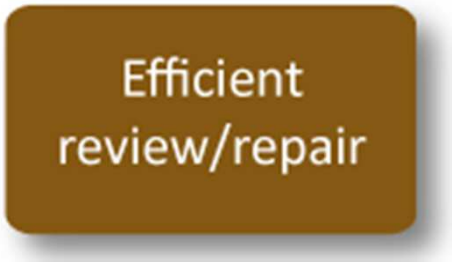
INTENSIFICATION STRATEGY



Correcting misconceptions versus remedial learning

A study by Alan Bell and Malcolm Swan found that students whose teachers addressed and corrected misconceptions, rather than simply using remedial measures, achieved and maintained higher long-term learning results.

Bell, A. & Swan, M. Some experiments in diagnostic teaching. *Educational Studies in Mathematics*, 24, pp. 115-137.

See also www.toolkitforchange.org

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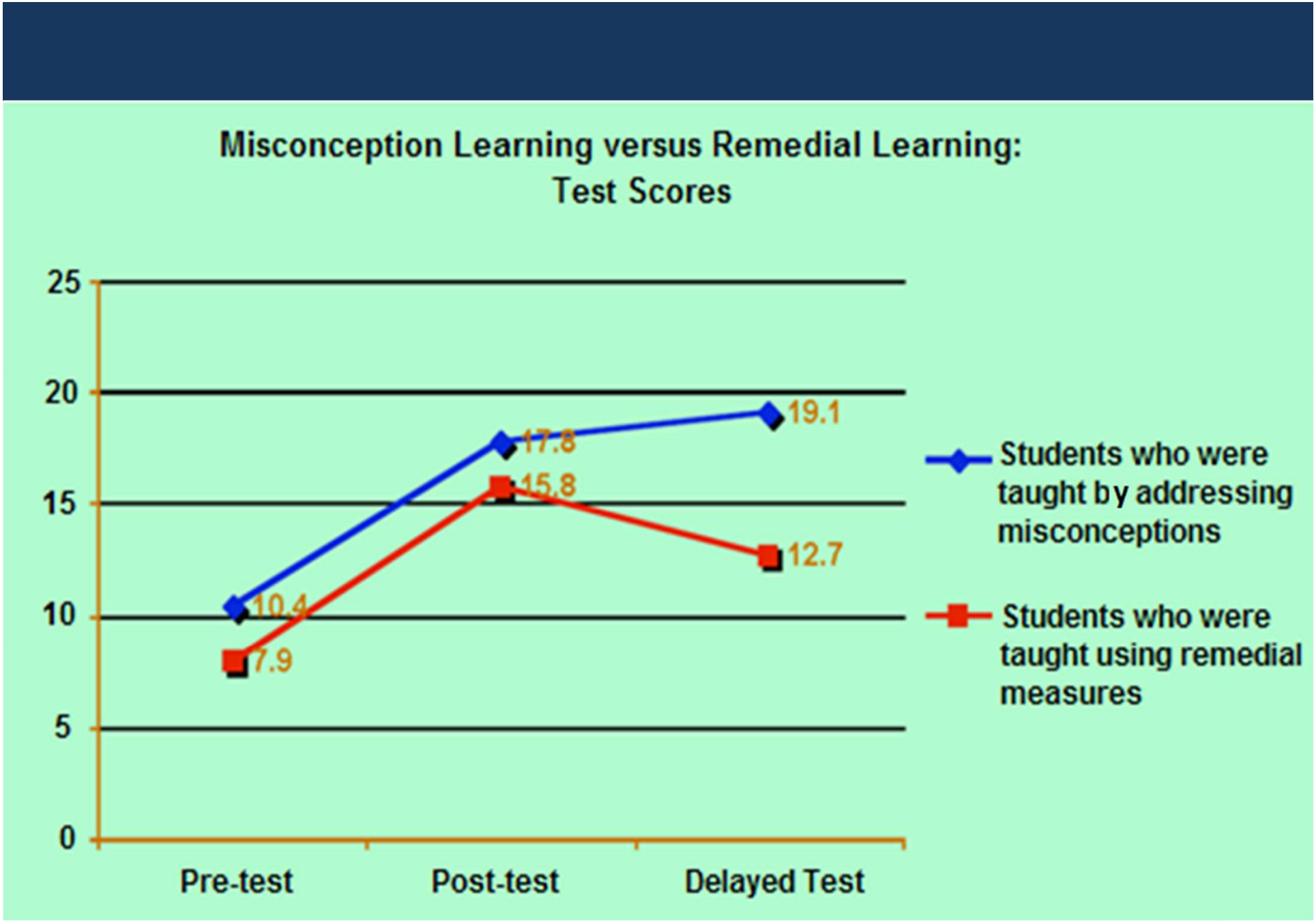

Misconception Learning versus Remedial Learning:
Test Scores
25
20
15
10
5
0
Pre-test
Post-test
Delayed Test
10.4
17.8
19.1
7.9
15.8
12.7
Students who were taught by addressing misconceptions
Students who were taught using remedial measures

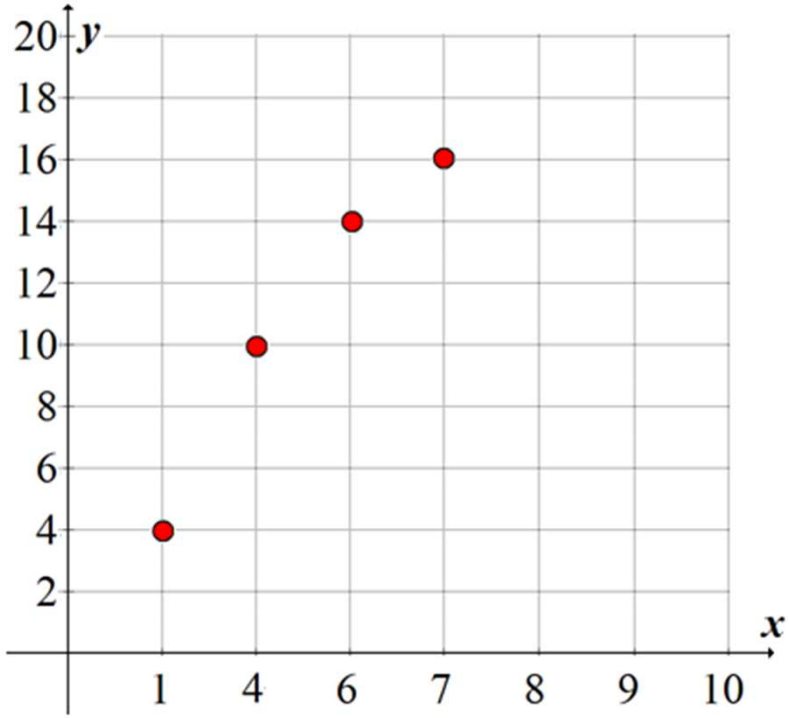
SURFACING AND REPAIRING MISCONCEPTIONS: USING WORKED EXAMPLES

1. Identify the mistake that was made in graphing the data in Table 1.

Table 1

x	y
1	4
4	10
6	14
7	16

Graph 1



2. Use the data in Table 1 to draw a correct graph.

A STRATEGY FOR EFFECTIVE REVIEW: DISTRIBUTED PRACTICE

Strong positive effects of spaced practice have been found in a wide variety of contexts. Carlous Caple summarized this body of research as follows:

> The spacing effect is an extremely robust and powerful phenomenon, and it has been repeatedly shown with many kinds of material. Spacing effects have been demonstrated in free recall, in cued recall of paired associations, in the recall of sentences, and in the recall of text material.… Also the effect of spaced study can be very long-lasting (Caple, 1996, p. 22).

Staying Sharp 12

Practicing algebra skills

1. The following points are on the graph of a particular line: $(-2,6)$, $(0,5)$, $(2,4)$, $(6,2)$, $(8,1)$, $(10,0)$, $(12,-1)$. What is the y-intercept of the line?

   Answer with supporting work:

2. Complete four rows of an x-y table for the following function: $y = 2x + 7$

x	y

Previewing upcoming learning

3. Bobby and Billy sit on one side of a seesaw.

   When their older brother, Adam, who weighs 110 pounds, sits on the other side, the seesaw tilts down on Adam's side. What can you conclude about Bobby and Billy's combined weight? What can you conclude about their individual weights?

   Answer with explanation

4. Adam sits on one side of a seesaw; his twin brothers sit on the other side; the seesaw is perfectly balanced. Then, the twins sit on one side and Mr. Howard and his dog sit on the other side; the scale again is perfectly balanced. What will happen if Adam sits on one side of the seesaw and Mr. Howard and his dog sit on the other?

   Answer with explanation:

Reviewing prealgebra skills

5. Polygon DEFGH is a regular pentagon. If the sum of all of the interior angles is $540°$, what is the measure of $\angle E$?

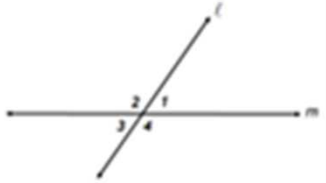
   Answer with supporting work:

6. In the diagram shown below, line ℓ intersects line m. If the measure of $\angle 1$ is $70°$, find:

   $m\angle 2 =$ ____

   $m\angle 3 =$ ____

   $m\angle 4 =$ ____



INTENSIFICATION STRATEGY

Social, motivational supports

Social, emotional, motivational supports help students develop:

- **Academic identities** as learners who recognize, value, and seek out high-quality education
- **Motivation** and commitment to high achievement
- **Skills** to help create and contribute to a learning community.

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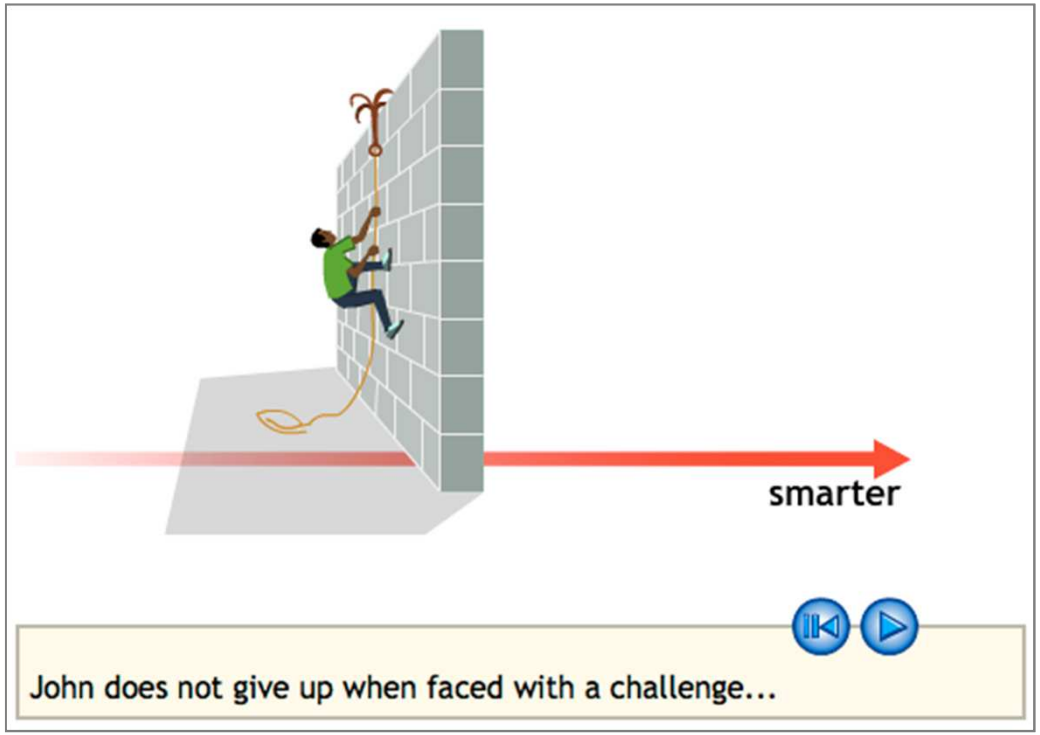
CHANGING STUDENTS' BELIEFS AND ATTITUDES

Ideas incorporated from social psychology:

- ***Malleable intelligence*** Intelligence can be shaped through actions and beliefs.
- ***Effective effort*** Getting better at something requires the right kind of effort.
- ***Attribution*** Success is not about luck.



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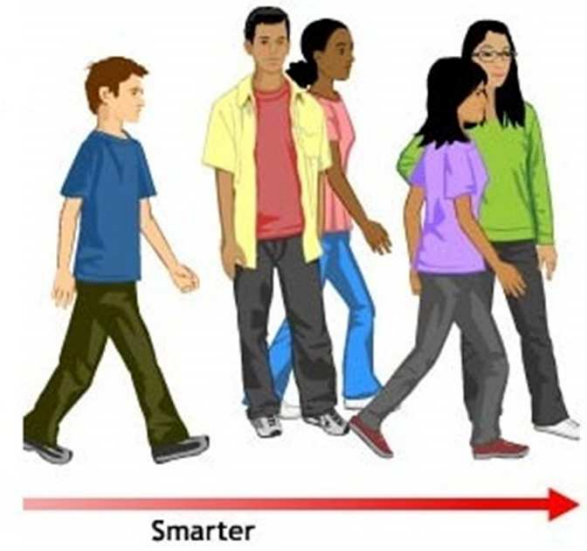
STUDENTS' BELIEFS ABOUT INTELLIGENCE IMPACT ACADEMIC ACHIEVEMENT

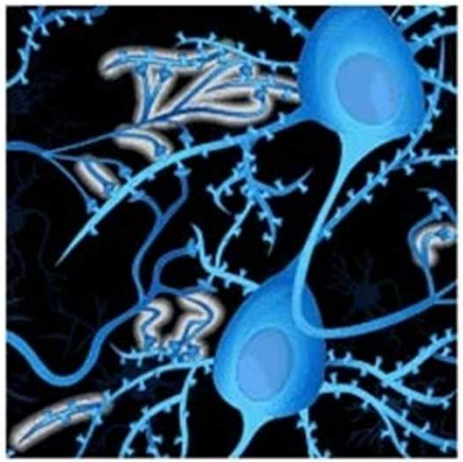
- **Fixed mindset:**
  - Avoid learning situations if they might make mistakes
  - Try to hide, rather than fix, mistakes or deficiencies
  - Decrease effort when confronted with challenge

- **Growth mindset:**
  - Work to correct mistakes and deficiencies
  - View effort as positive; increase effort when challenged

STUDENTS CAN DEVELOP GROWTH MINDSETS

- Explicit instruction about the brain, its function, and that intellectual development is the result of effort and learning has increased students' achievement in middle school mathematics.





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STUDENTS' BELIEFS ABOUT THEIR INTELLIGENCE AFFECT THEIR ACADEMIC ACHIEVEMET

When confronted with challenging school transitions or courses, students with growth mindsets outperform those with fixed mindsets, even when they enter with equal skills and knowledge.

Dweck, 2007

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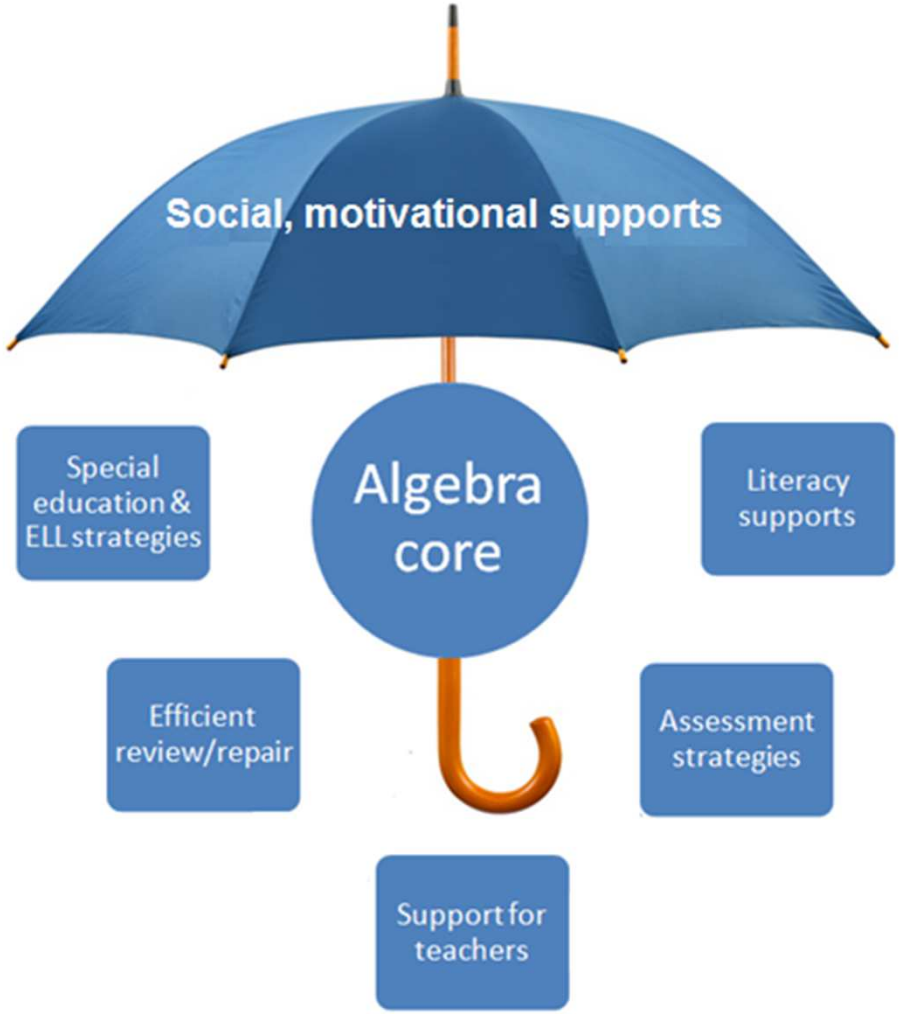
A VARIATION ON AN INTENSIFICATION MODEL



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INTENSIFIED ALGEBRA I: FINDINGS FROM EXTERNAL EVALUATION

Over 90% of teachers report that their students benefit mathematically in the following areas:

- Communicating mathematical ideas
- Developing a deeper conceptual learning of mathematics
- Developing problem solving skills
- Perseverance in solving mathematic problems
- Learning mathematics content
- Development of self-confidence in mathematical ability

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INTENSIFIED ALGEBRA I: FINDINGS FROM EXTERNAL EVALUATION

Teachers see student benefits in other important areas as well:

- Reading and writing skills
- Preparation for future math courses
- Acquisition of mathematics skills
- Positive attitudes and dispositions towards mathematics
- Positive work habits

FINDINGS FROM A SMALL-SCALE COMPARITIVE STUDY

Ethnic Background of Students

Ethnic Background	National Sample Comparison Students*	IA Students
White	69%	19%
African American	9%	23%
Hispanic	11%	53%
Asian	5%	5%
American Indian or Alaskan Native	3%	0%
Pacific Islander	1%	0%
Other	2%	0%

*The sample represents students that took a nationally normed algebra assessment.

FINDINGS FROM A SMALL-SCALE COMPARITIVE STUDY

Average Objective Percent Correct, Moderate Mastery Range and Percent Mastery from a Nationally-normed Algebra Assessment, vs. IA Average Objective Percent Correct

Objective	Item Numbers on nationally-normed assessment	Average Objective Percent Correct on nationally-normed assessment	Moderate Mastery Range on nationally-normed assessment	IA Average Objective Percent Correct
Solving Linear Equations, Inequalities	1,4,11,13, 16	47	31-57	61
Functions and Graphs	6,8,19,20,22,23,27, 31,32	36	21-44	58
Variables, Expressions, Formulas	3,7,10*,14,21	43	27-53	63
Graphing Linear Equations	5,9,15,17,26*	42	23-53	45
Quadratic Equations and Functions	2,25,28,30*	44	27-55	41
Geometry	12,18,24,29	38	27-43	41

*These items on the IA assessment do not match the national algebra assessment.

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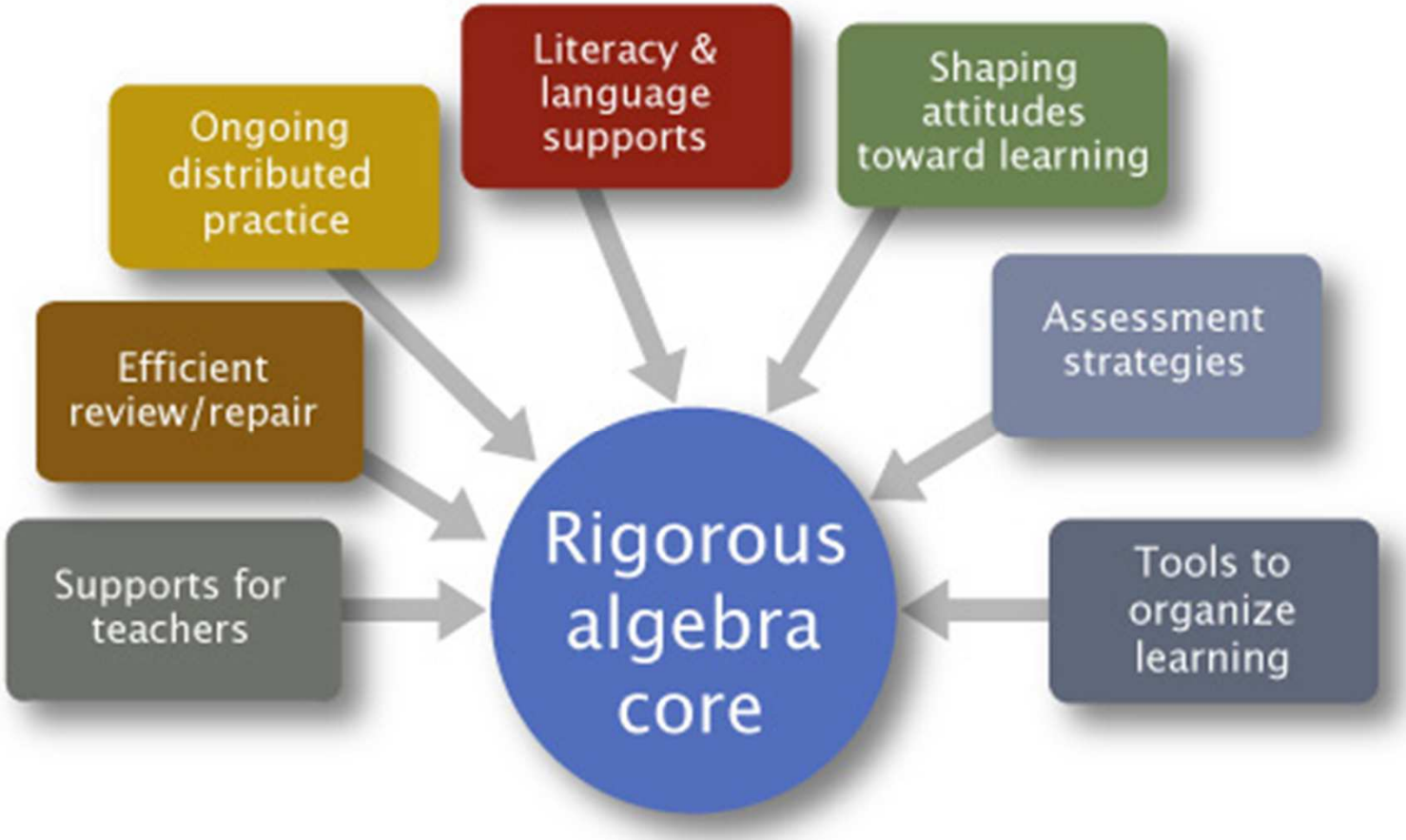
FINDINGS FROM A SMALL-SCALE COMPARITIVE STUDY

On items that involved solving linear equations and writing algebraic rules:

- IA students performed in the high mastery range on solving linear equations, functions and graphs, and variables, expressions and formulas.
- On individual items classified as “solving a linear equation,” students performed as well as the national sample.
- On items classified as “writing an algebraic rule,” students performed better than the national sample on 5 out 7 items.

OUR INTENSIFICATION APPROACH: INTENSIFIED ALGEBRA I



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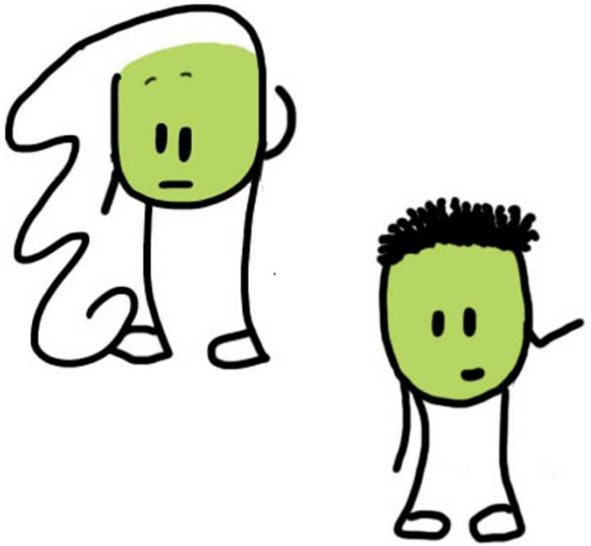
Q&A



[From the index cards], what questions do you have for the presenters?

At your tables, please discuss…

Consider the issues and needs discussed earlier raised by your own work in relation to the discussion of our two projects.

- What connections do you see?
- What other questions are raised, including, perhaps, ones related to CCSS-M?

Thank you!

- Transition to Algebra
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  - June Mark: jmark@edc.org
  - Paul Goldenberg: pgoldenberg@edc.org
- Intensified Algebra
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