Examining Suggested Accommodations for Emergent Bilinguals in Algebra Textbooks

Zandra de Araujo, Erin Smith, & Amy Dwiggins
University of Missouri

Ji Yeong I & Ricardo Martinez
Iowa State University

Cambio de Colores 2017 Conference - June 14-17, 2017

Research Questions

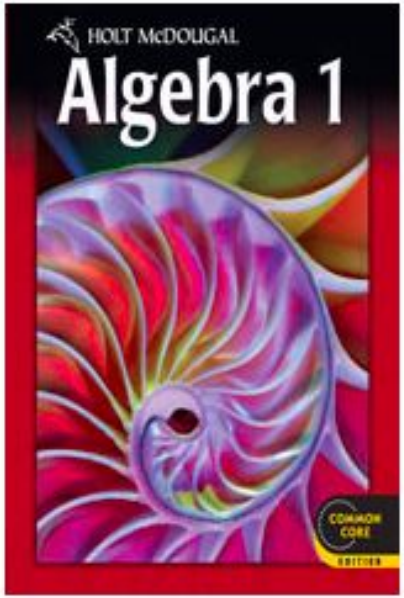
1. What do teacher guides of algebra textbooks recommend to facilitate mathematics learning for emergent bilinguals (EBs)?

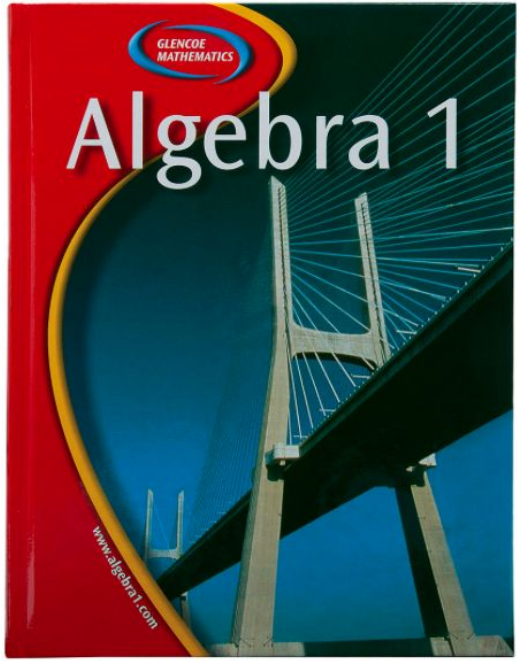
2. What assumptions guide these recommendations?

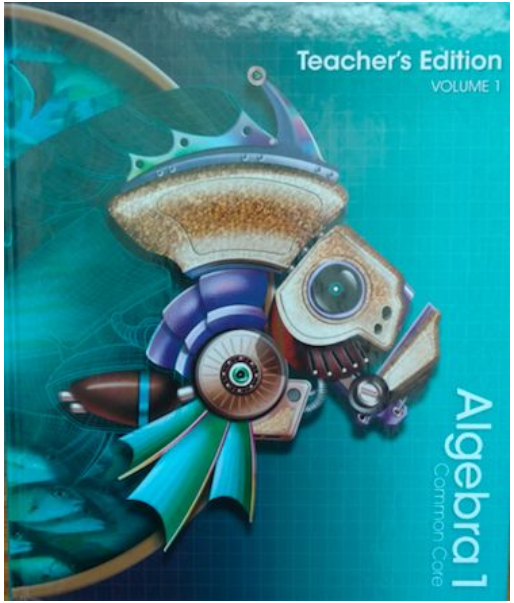
3. How do these recommendations align with research?

Method

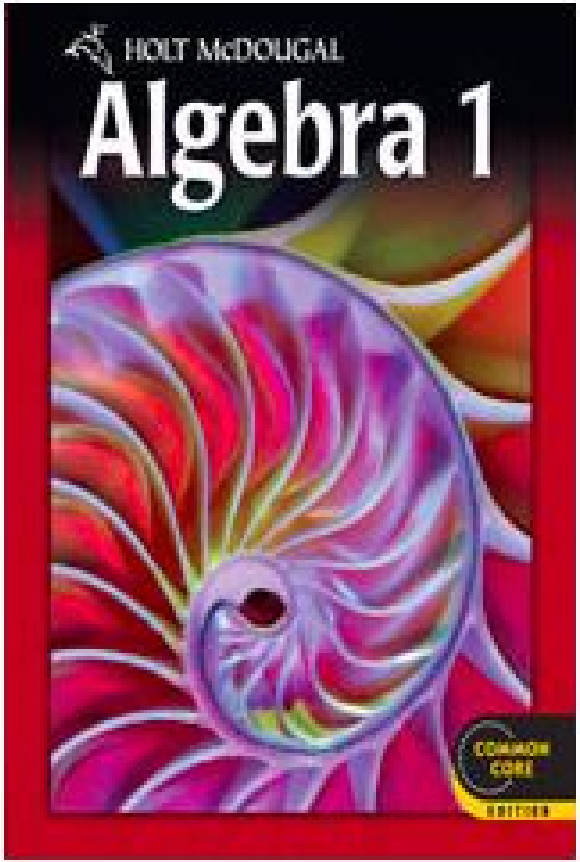
- 3 Algebra 1 Textbooks
- Identified EB Accommodations



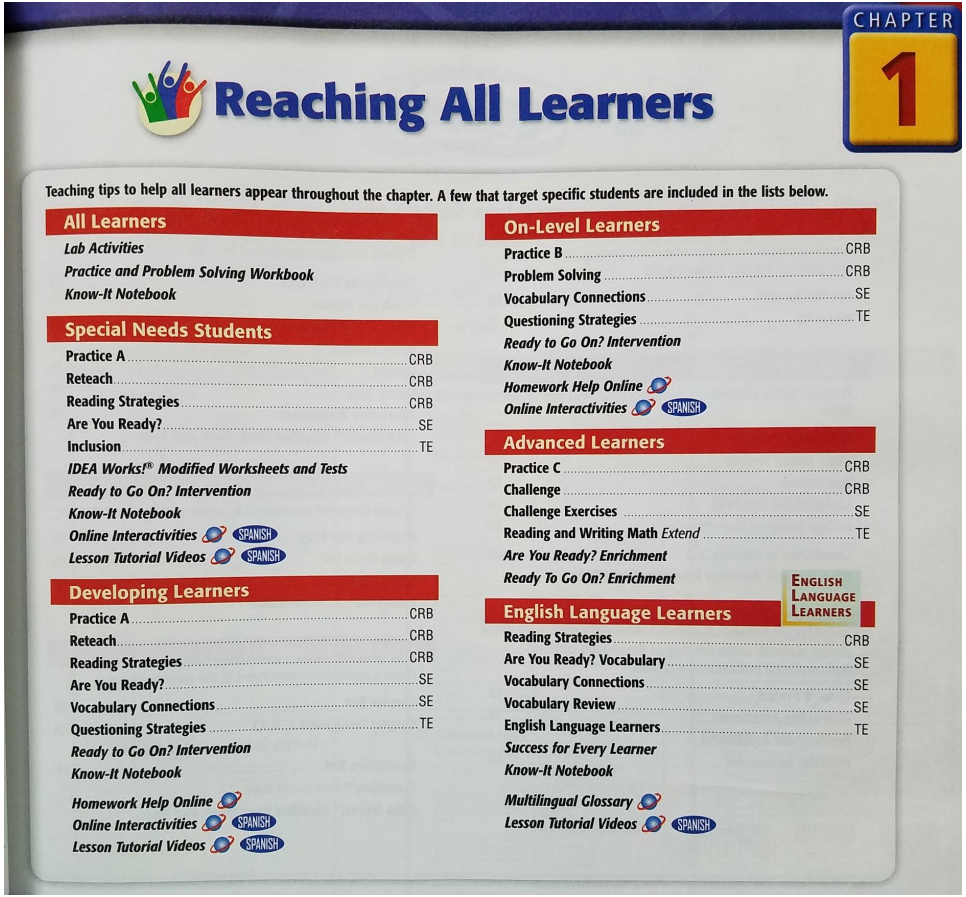




Holt McDougal (2012)



Holt McDougal (2012)



CHAPTER 1

Reaching All Learners

Teaching tips to help all learners appear throughout the chapter. A few that target specific students are included in the lists below.

All Learners

Lab Activities
Practice and Problem Solving Workbook
Know-It Notebook

Special Needs Students

Practice A ..... CRB
Reteach ..... CRB
Reading Strategies ..... CRB
Are You Ready? ..... SE
Inclusion ..... TE
IDEA Works!® Modified Worksheets and Tests
Ready to Go On? Intervention
Know-It Notebook
Online Interactivities SPANISH
Lesson Tutorial Videos SPANISH

Developing Learners

Practice A ..... CRB
Reteach ..... CRB
Reading Strategies ..... CRB
Are You Ready? ..... SE
Vocabulary Connections ..... SE
Questioning Strategies ..... TE
Ready to Go On? Intervention
Know-It Notebook
Homework Help Online
Online Interactivities SPANISH
Lesson Tutorial Videos SPANISH

On-Level Learners

Practice B ..... CRB
Problem Solving ..... CRB
Vocabulary Connections ..... SE
Questioning Strategies ..... TE
Ready to Go On? Intervention
Know-It Notebook
Homework Help Online
Online Interactivities SPANISH

Advanced Learners

Practice C ..... CRB
Challenge ..... CRB
Challenge Exercises ..... SE
Reading and Writing Math *Extend* ..... TE
Are You Ready? Enrichment
Ready To Go On? Enrichment

English Language Learners

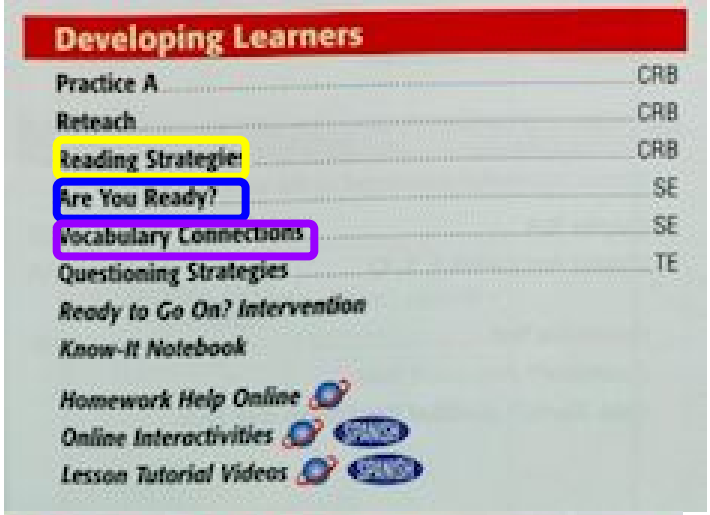
ENGLISH LANGUAGE LEARNERS

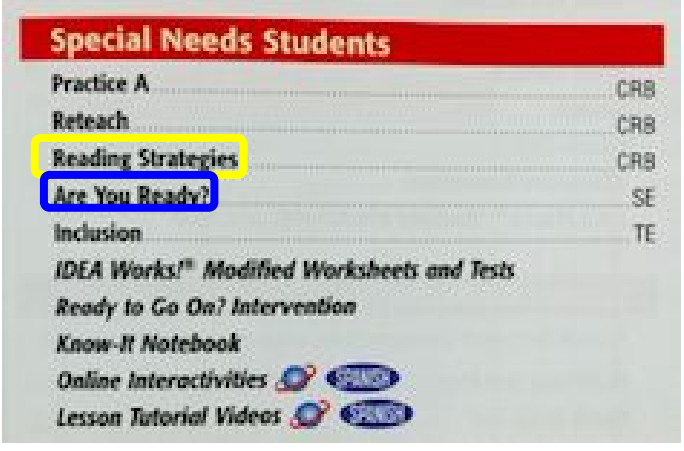
Reading Strategies ..... CRB
Are You Ready? Vocabulary ..... SE
Vocabulary Connections ..... SE
Vocabulary Review ..... SE
English Language Learners ..... TE
Success for Every Learner
Know-It Notebook
Multilingual Glossary
Lesson Tutorial Videos SPANISH

Differentiation for EBs aligned with Special Needs and Developing Learners

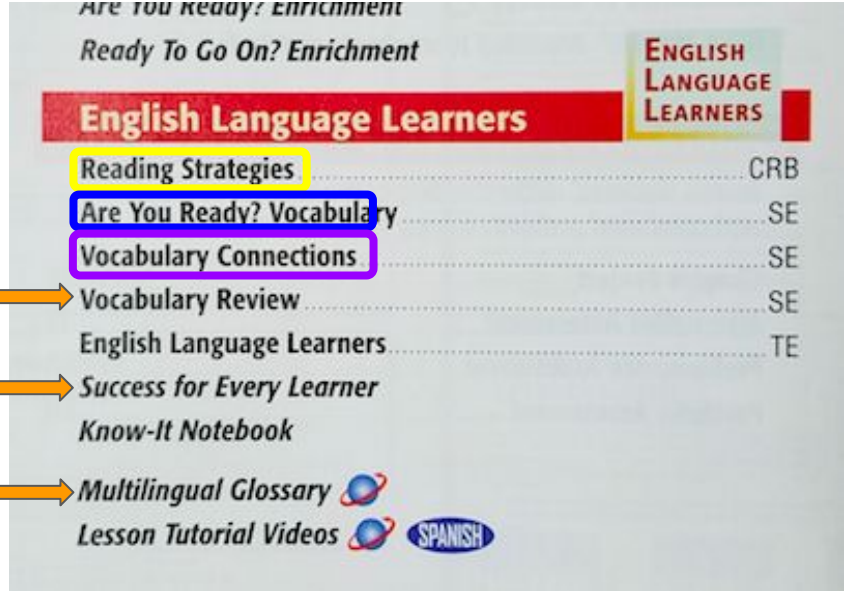
Holt McDougal (2012)

Focus on reading strategies and vocabulary





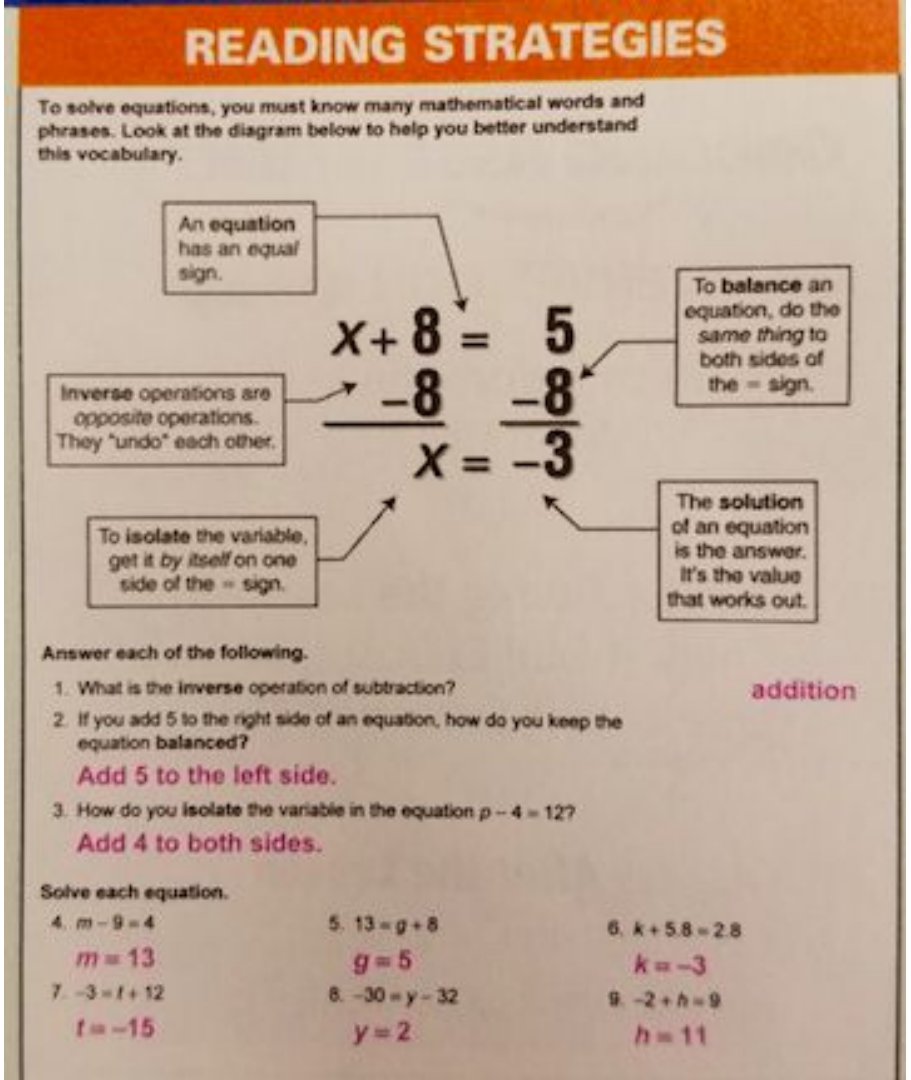
Only listed for EBs



Holt McDougal (2012)

Focus on reading strategies and vocabulary

Exercises targeted for EBs have low cognitive demand.



READING STRATEGIES

To solve equations, you must know many mathematical words and phrases. Look at the diagram below to help you better understand this vocabulary.

An **equation** has an *equal* sign.

To **balance** an equation, do the *same thing* to both sides of the = sign.

$$\begin{array}{rcl} x + 8 & = & 5 \\ -8 & & -8 \\ \hline x & = & -3 \end{array}$$

Inverse operations are *opposite* operations. They "undo" each other.

To **isolate** the variable, get it *by itself* on one side of the = sign.

The **solution** of an equation is the answer. It's the value that works out.

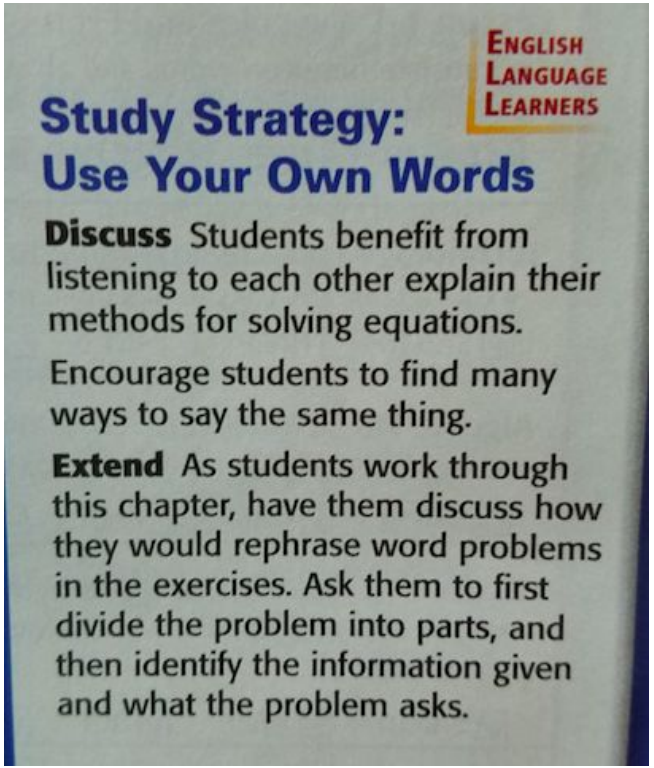
Answer each of the following.

1. What is the **inverse** operation of subtraction? addition
2. If you add 5 to the right side of an equation, how do you keep the equation **balanced?**
   Add 5 to the left side.
3. How do you **isolate** the variable in the equation $p - 4 = 12$?
   Add 4 to both sides.

Solve each equation.

4. $m - 9 = 4$
   $m = 13$
5. $13 = g + 8$
   $g = 5$
6. $k + 5.8 = 2.8$
   $k = -3$
7. $-3 = t + 12$
   $t = -15$
8. $-30 = y - 32$
   $y = 2$
9. $-2 + h = 9$
   $h = 11$

Holt McDougal (2012)



ENGLISH LANGUAGE LEARNERS

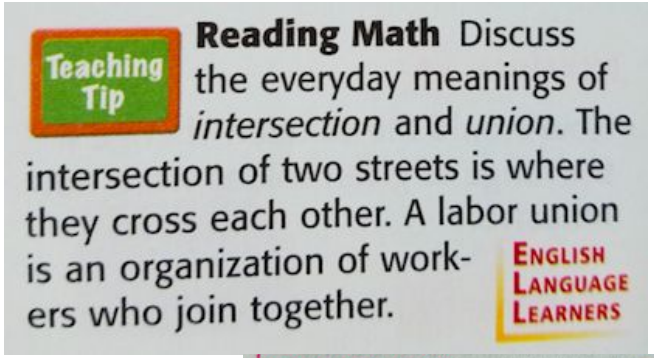
Study Strategy: Use Your Own Words

Discuss Students benefit from listening to each other explain their methods for solving equations.

Encourage students to find many ways to say the same thing.

Extend As students work through this chapter, have them discuss how they would rephrase word problems in the exercises. Ask them to first divide the problem into parts, and then identify the information given and what the problem asks.

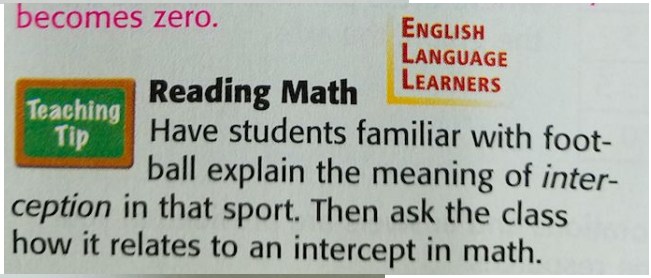
Teaching tips focus on "Reading Math"



Teaching Tip

Reading Math Discuss the everyday meanings of *intersection* and *union*. The intersection of two streets is where they cross each other. A labor union is an organization of workers who join together.

ENGLISH LANGUAGE LEARNERS

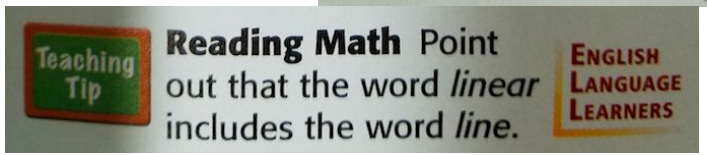


becomes zero.

ENGLISH LANGUAGE LEARNERS

Teaching Tip

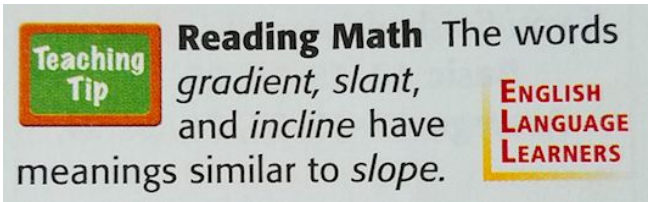
Reading Math Have students familiar with football explain the meaning of *interception* in that sport. Then ask the class how it relates to an intercept in math.



Teaching Tip

Reading Math Point out that the word *linear* includes the word *line*.

ENGLISH LANGUAGE LEARNERS

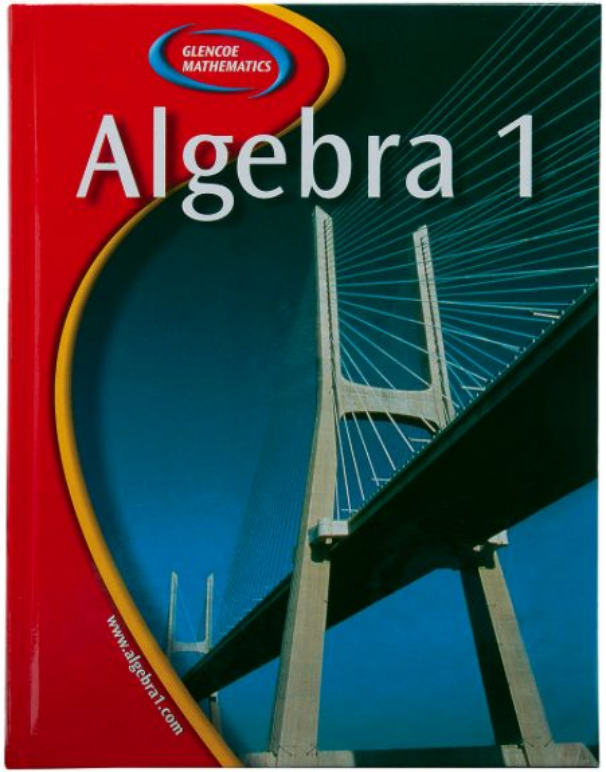


Teaching Tip

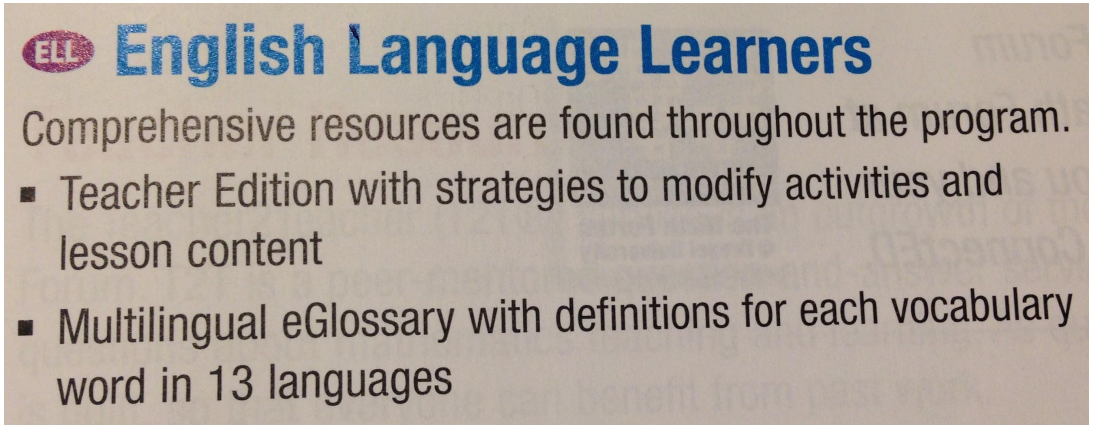
Reading Math The words *gradient, slant,* and *incline* have meanings similar to *slope*.

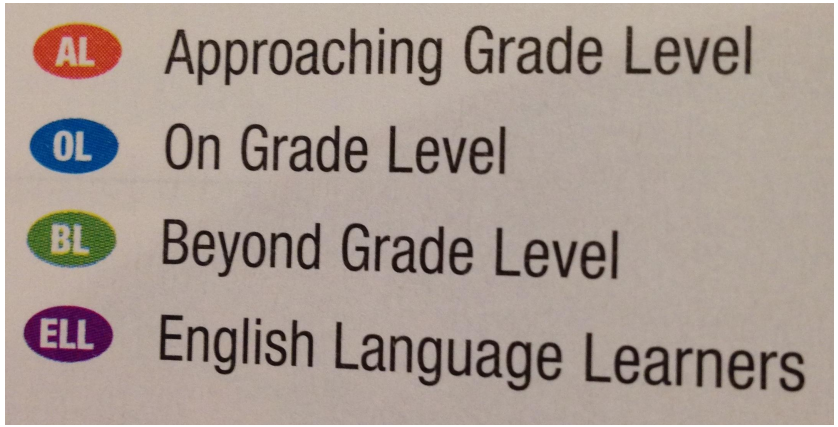
ENGLISH LANGUAGE LEARNERS

Glencoe/McGraw-Hill (2014)

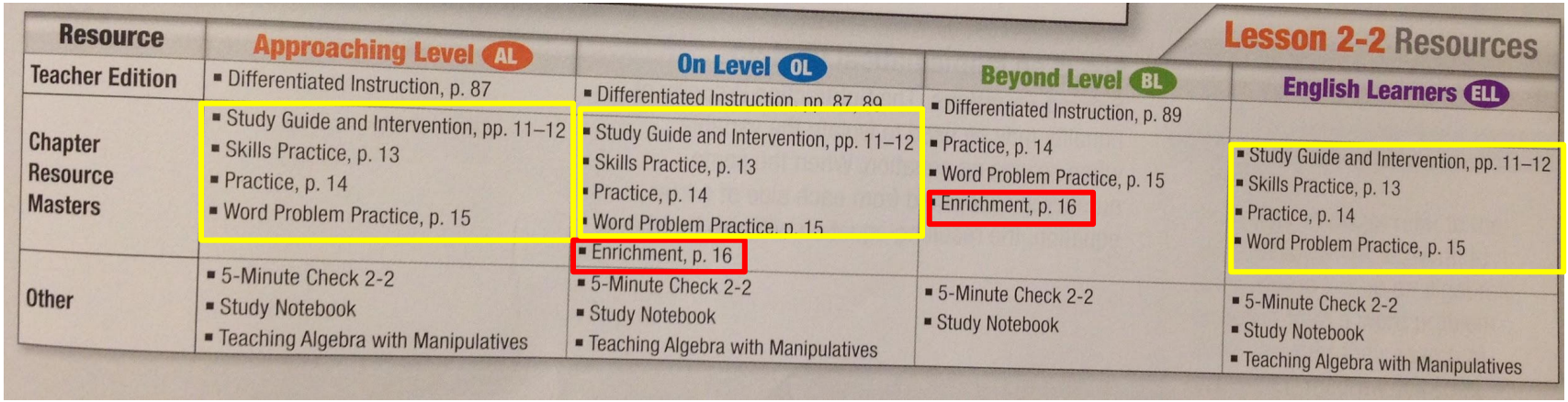


Glencoe/McGraw-Hill (2014)





Glencoe/McGraw-Hill (2014)



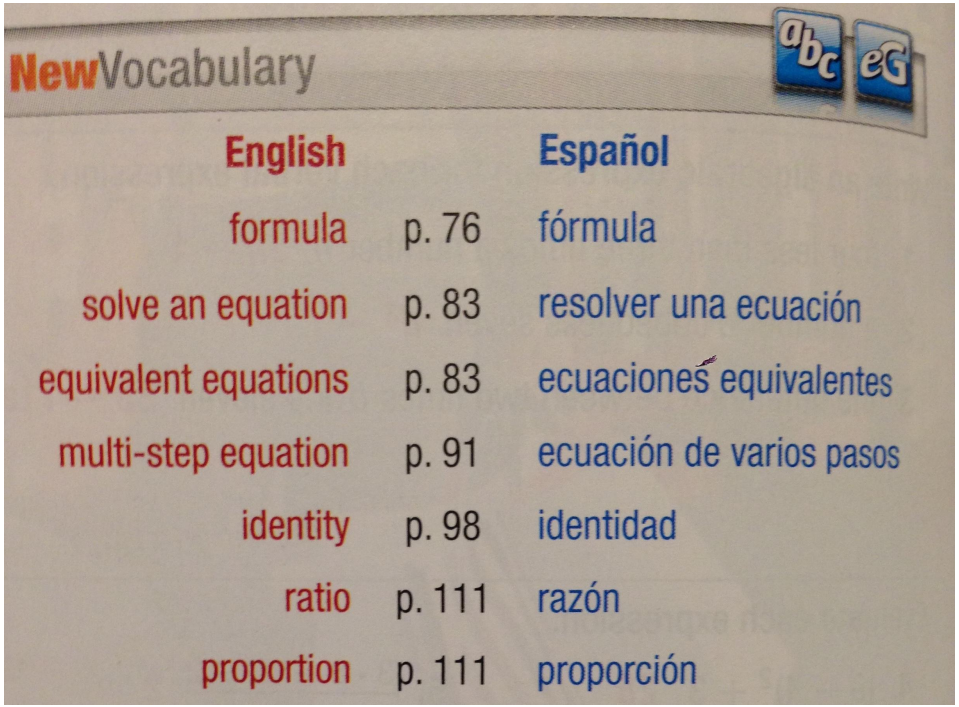
Lesson 2-2 Resources

Resource	Approaching Level AL	On Level OL	Beyond Level BL	English Learners ELL
Teacher Edition	▪ Differentiated Instruction, p. 87	▪ Differentiated Instruction, pp. 87, 89	▪ Differentiated Instruction, p. 89	
Chapter Resource Masters	▪ Study Guide and Intervention, pp. 11–12 ▪ Skills Practice, p. 13 ▪ Practice, p. 14 ▪ Word Problem Practice, p. 15	▪ Study Guide and Intervention, pp. 11–12 ▪ Skills Practice, p. 13 ▪ Practice, p. 14 ▪ Word Problem Practice, p. 15 ▪ Enrichment, p. 16	▪ Practice, p. 14 ▪ Word Problem Practice, p. 15 ▪ Enrichment, p. 16	▪ Study Guide and Intervention, pp. 11–12 ▪ Skills Practice, p. 13 ▪ Practice, p. 14 ▪ Word Problem Practice, p. 15
Other	▪ 5-Minute Check 2-2 ▪ Study Notebook ▪ Teaching Algebra with Manipulatives	▪ 5-Minute Check 2-2 ▪ Study Notebook ▪ Teaching Algebra with Manipulatives	▪ 5-Minute Check 2-2 ▪ Study Notebook	▪ 5-Minute Check 2-2 ▪ Study Notebook ▪ Teaching Algebra with Manipulatives

EB differentiation frequently aligned with Approaching Grade Level peers.

EBs shut out of enrichment.

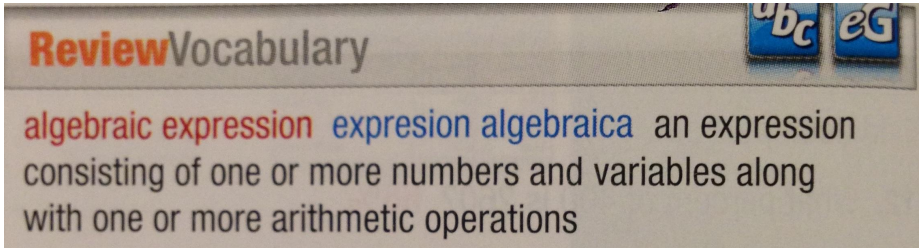
Glencoe/McGraw-Hill (2014)



New Vocabulary

English		Español
formula	p. 76	fórmula
solve an equation	p. 83	resolver una ecuación
equivalent equations	p. 83	ecuaciones equivalentes
multi-step equation	p. 91	ecuación de varios pasos
identity	p. 98	identidad
ratio	p. 111	razón
proportion	p. 111	proporción

Focus on
vocabulary terms



Review Vocabulary

algebraic expression expresion algebraica an expression consisting of one or more numbers and variables along with one or more arithmetic operations

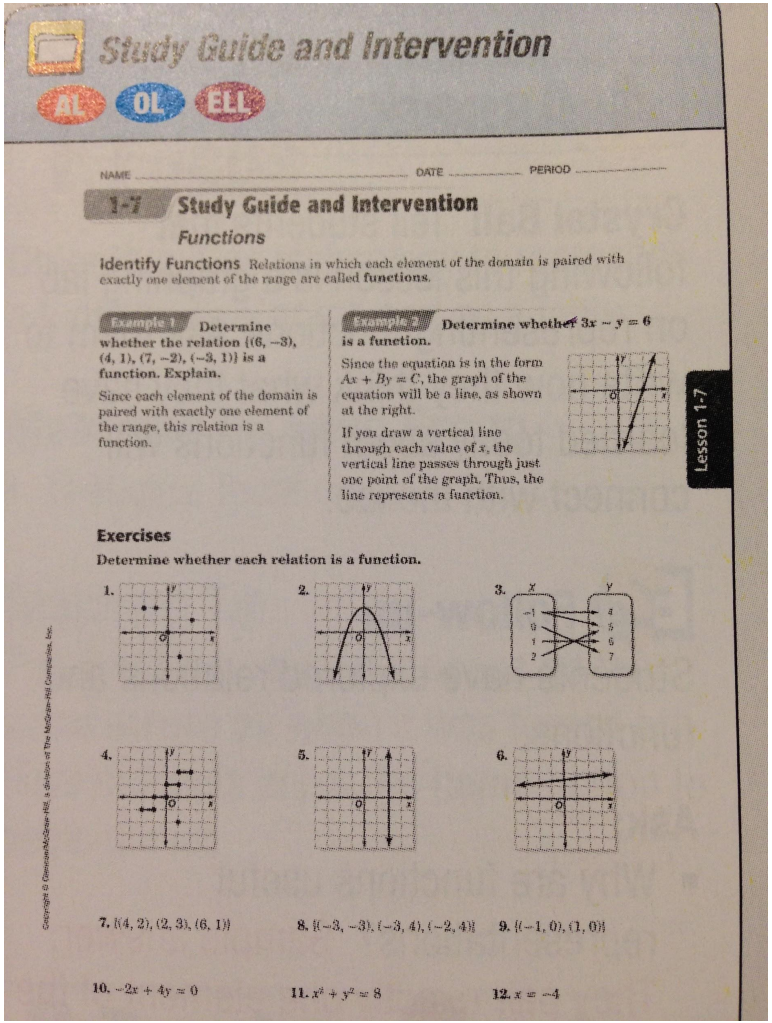
Glencoe/McGraw-Hill (2014)

DifferentiatedInstruction AL OL ELL

If you identify students who have trouble writing mathematical or verbal expressions,

Then pair them with other students as mentors for practicing these skills. The transition from verbal expressions to algebraic expressions is easier for some students than others.

EB differentiated exercises have low cognitive demand.



Study Guide and Intervention

AL OL ELL

NAME _____ DATE _____ PERIOD _____

1-7 Study Guide and Intervention

Functions

Identify Functions Relations in which each element of the domain is paired with exactly one element of the range are called **functions**.

Example 1 Determine whether the relation {(6, −3), (4, 1), (7, −2), (−3, 1)} is a function. Explain.

Since each element of the domain is paired with exactly one element of the range, this relation is a function.

Example 2 Determine whether $3x - y = 6$ is a function.

Since the equation is in the form $Ax + By = C$, the graph of the equation will be a line, as shown at the right.

If you draw a vertical line through each value of x, the vertical line passes through just one point of the graph. Thus, the line represents a function.

Lesson 1-7

Exercises

Determine whether each relation is a function.

1. 2. 3.

4. 5. 6.

7. {(4, 2), (2, 3), (6, 1)}

8. {(−3, −3), (−3, 4), (−2, 4)}

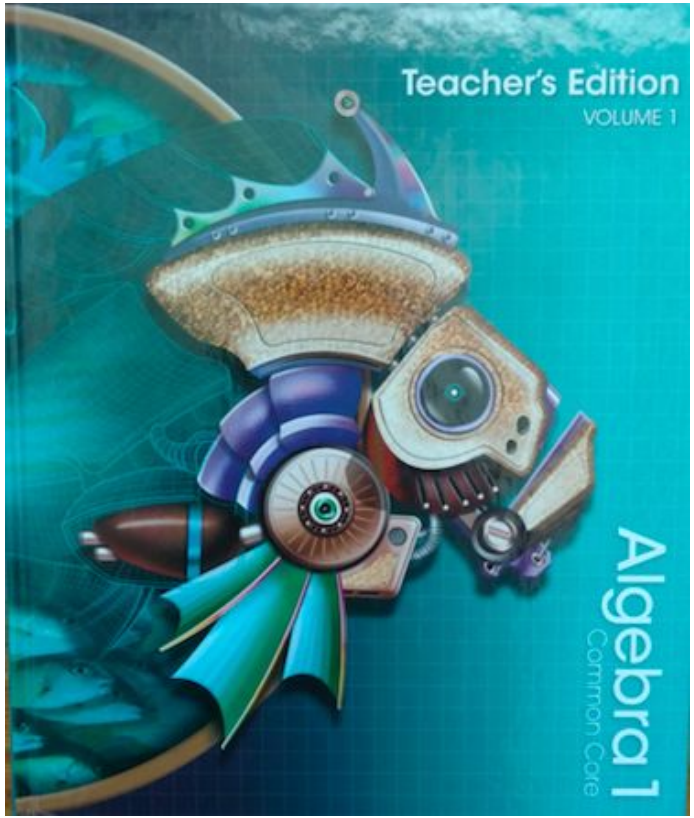
9. {(−1, 0), (1, 0)}

10. $-2x + 4y = 0$

11. $x^2 + y^2 = 8$

12. $x = -4$

Pearson (2014)

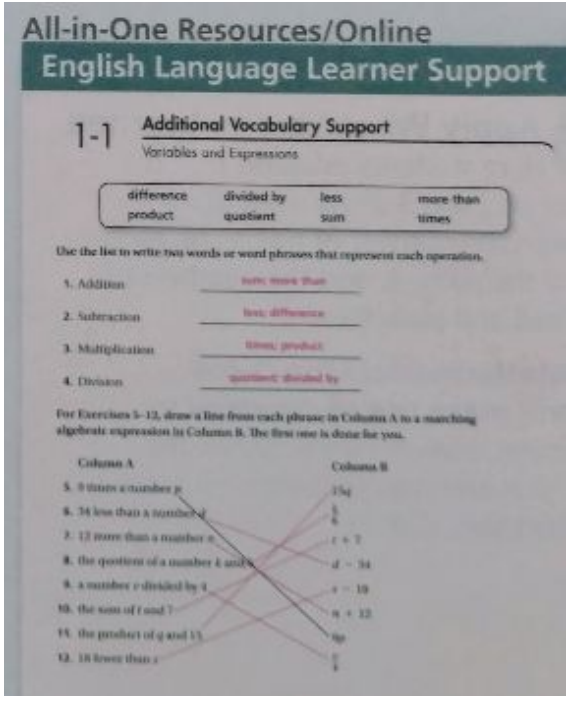


Pearson (2014)

Teaching Resources		Intervention	On-Level	Enrichment	ELL
Student Practice and Assessment Workbooks (Print and Online)	Student Companion *(in English and Spanish)*	√	√		√
	Practice and Problem Solving Workbook *(in English and Spanish)*	√	√	√	√
	Common Core Test Prep Workbook	√	√	√	√
All-In-One Teaching Resources (Print, Online, and DVD)	Think about a Plan Worksheet *(in English and Spanish)*	√	√	√	√
	Practice Form G *(in English and Spanish)*		√	√	
	Practice Form K *(in English and Spanish)*	√			√
	Standardized Test Prep Worksheet *(in English and Spanish)*	√	√	√	√
	Reteaching	√			√
	Enrichment		√	√	
	ELL Support	√			√
	Performance Tasks	√	√	√	√
	Chapter Projects	√	√	√	√
	Extra Practice *(per chapter)*	√	√	√	√
	Find the Errors!		√	√	
	Activities	√	√	√	√
	Games		√	√	
	Puzzles		√	√	
	Multilingual Handbook				√
	Teaching with TI Technology		√	√	

Pearson (2014)

EB Support - Helps students develop and reinforce mathematical vocabulary and key concepts


All-in-One Resources/Online

English Language Learner Support

1-1 Additional Vocabulary Support

Variables and Expressions

difference	divided by	less	more than
product	quotient	sum	times

Use the list to write two words or word phrases that represent each operation.

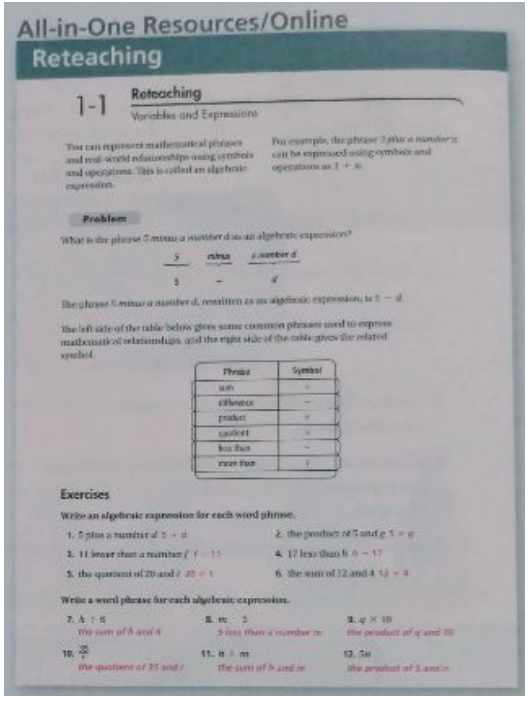
1. Addition
2. Subtraction
3. Multiplication
4. Division

For Exercises 5–12, draw a line from each phrase in Column A to a matching algebraic expression in Column B. The first one is done for you.

Column A

5. 9 times a number p
6. 34 less than a number d
7. 12 more than a number c
8. the quotient of a number k and 6
9. a number r divided by 4
10. the sum of t and 7
11. the product of q and 15
12. 18 fewer than x

Reteaching - Provides reteaching and practice exercises for the key lesson concepts. Use with struggling students or absent students.


All-in-One Resources/Online

Reteaching

1-1 Reteaching

Variables and Expressions

You can represent mathematical phrases and real-world relationships using symbols and operations. This is called an algebraic expression.

For example, the phrase *5 plus a number n* can be expressed using symbols and operations as $5 + n$.

Problem

What is the phrase *5 minus a number d* as an algebraic expression?

5	minus	a number d
5	−	d

The phrase *5 minus a number d*, rewritten as an algebraic expression, is $5 - d$.

The left side of the table below gives some common phrases used to express mathematical relationships, and the right side of the table gives the related symbol.

Phrase	Symbol
sum	+
difference	−
product	×
quotient	÷
less than	−
more than	+

Exercises

Write an algebraic expression for each word phrase.

1. 5 plus a number d $5 + d$
2. the product of 5 and g $5 \times g$
3. 11 fewer than a number f $f - 11$
4. 17 less than h $h - 17$
5. the quotient of 20 and t $20 \div t$
6. the sum of 12 and 4 $12 + 4$

Write a word phrase for each algebraic expression.

7. $h + 6$ the sum of h and 6
8. $m - 5$ 5 less than a number m
9. $q \times 10$ the product of q and 10
10. $\frac{25}{r}$ the quotient of 25 and r
11. $n + m$ the sum of n and m
12. $5n$ the product of 5 and n

Pearson (2014)

ELL Support

Connect to Prior Knowledge Review perfect squares. Write 1, 4, and 9 on the board. Ask students what they have in common. Then encourage students to guide you as you list more perfect squares on the board.

Use Manipulatives Model to students how to use grid paper to show a trinomial is a perfect square. One unit on the grid paper is "1", two vertical units is x, and a 2×2 square unit is x^2. $4x^2 + 4x + 1$ can be arranged into a perfect square. Challenge students to arrange other trinomials into squares and write the factors.

ELL Support

Use Graphic Organizers Tell students to make a 3-column KWL table. The columns are labeled "Know", "Want to Know", and "Learned". In the first column, have students write a declarative sentence about each of the following words: number, quantity, variable, expression, and algebra. In the second column, have them write a question about each word. After the lesson, ask students to write what they have learned about each word in the third column.

Give the students this example to help them get started:
K: 3, 4, and 5 are numbers.
W: What is the biggest number?

After the lesson, give the students this example to help them get started on the "Learned" column:
L: An unknown number can be shown by a letter.

Looking across books....

Emergent Bilinguals

Assumptions in Teacher's Guides	Recommendations from Research

Emergent Bilinguals

Assumptions in Teacher's Guides	Recommendations from Research
● Can't handle challenging mathematics tasks (i.e., enrichment) ● Require remediation ● Can't engage in reasoning and sense-making	

Emergent Bilinguals

Assumptions in Teacher's Guides	Recommendations from Research
● Can't handle challenging mathematics tasks (i.e., enrichment) ● Require remediation ● Can't engage in reasoning and sense-making	
● Shouldn't be expected to engage in productive mathematical communication ● Lack mathematical vocabulary	

Emergent Bilinguals

Assumptions in Teacher's Guides	Recommendations from Research
• Can't handle challenging mathematics tasks (i.e., enrichment) • Require remediation • Can't engage in reasoning and sense-making	
• Shouldn't be expected to engage in productive mathematical communication • Lack mathematical vocabulary	
• Are fluent in L1	

Emergent Bilinguals

Assumptions in Teacher's Guides	Recommendations from Research
• Can't handle challenging mathematics tasks (i.e., enrichment) • Require remediation • Can't engage in reasoning and sense-making	• Provide challenging mathematics tasks • Provide resources as needed (including challenge)
• Shouldn't be expected to engage in productive mathematical communication • Lack mathematical vocabulary	
• Are fluent in L1	

Emergent Bilinguals

Assumptions in Teacher's Guides	Recommendations from Research
• Can't handle challenging mathematics tasks (i.e., enrichment) • Require remediation • Can't engage in reasoning and sense-making	• Provide challenging mathematics tasks • Provide resources as needed (including challenge)
• Shouldn't be expected to engage in productive mathematical communication • Lack mathematical vocabulary	• Focus on academic *language* • Develop vocabulary through mathematical activity (don't frontload)
• Are fluent in L1	

Emergent Bilinguals

Assumptions in Teacher's Guides	Recommendations from Research
• Can't handle challenging mathematics tasks (i.e., enrichment) • Require remediation • Can't engage in reasoning and sense-making	• Provide challenging mathematics tasks • Provide resources as needed (including challenge)
• Shouldn't be expected to engage in productive mathematical communication • Lack mathematical vocabulary	• Focus on academic *language* • Develop vocabulary through mathematical activity (don't frontload)
• Are fluent in L1	• Allow EBs to use their first language as a resource • Allow students to collaborate with others of the same language

Teachers

Assumptions in Teacher's Guides	Realities

Teachers

Assumptions in Teacher's Guides	Realities
● Have multiple EBs with shared L1	

Teachers

Assumptions in Teacher's Guides	Realities
● Have multiple EBs with shared L1	
● Know how to group students productively	

Teachers

Assumptions in Teacher's Guides	Realities
● Have multiple EBs with shared L1	
● Know how to group students productively	
● Know how to support academic language development	

Teachers

Assumptions in Teacher's Guides	Realities
● Have multiple EBs with shared L1	
● Know how to group students productively	
● Know how to support academic language development	
● Have time to seek out numerous resources outside of the textbook	

Teachers

Assumptions in Teacher's Guides	Realities
● Have multiple EBs with shared L1	● Number of EBs varies greatly by school/classroom ● Most teachers do teach EBs
● Know how to group students productively	
● Know how to support academic language development	
● Have time to seek out numerous resources outside of the textbook	

Teachers

Assumptions in Teacher's Guides	Realities
● Have multiple EBs with shared L1	● Number of EBs varies greatly by school/classroom ● Most teachers do teach EBs
● Know how to group students productively	● Grouping students needs to be considered carefully
● Know how to support academic language development	
● Have time to seek out numerous resources outside of the textbook	

Teachers

Assumptions in Teacher's Guides	Realities
● Have multiple EBs with shared L1	● Number of EBs varies greatly by school/classroom ● Most teachers do teach EBs
● Know how to group students productively	● Grouping students needs to be considered carefully
● Know how to support academic language development	● Additional professional learning is needed for strategies to support academic language development
● Have time to seek out numerous resources outside of the textbook	

Teachers

Assumptions in Teacher's Guides	Realities
● Have multiple EBs with shared L1	● Number of EBs varies greatly by school/classroom ● Most teachers do teach EBs
● Know how to group students productively	● Grouping students needs to be considered carefully
● Know how to support academic language development	● Additional professional learning is needed for strategies to support academic language development
● Have time to seek out numerous resources outside of the textbook	● Teachers have limited planning time and limited access to resources

Implications

Implications

- Teachers need further support to teach mathematics with EBs

Implications

- Teachers need further support to teach mathematics with EBs
- Teachers must be critical users of materials intended to accommodate EBs

Implications

- Teachers need further support to teach mathematics with EBs
- Teachers must be critical users of materials intended to accommodate EBs
- EBs must be given opportunities to engage in the mathematical practices

Implications

- Teachers need further support to teach mathematics with EBs
- Teachers must be critical users of materials intended to accommodate EBs
- EBs must be given opportunities to engage in the mathematical practices
- Teacher’s guides are an inadequate substitute for professional development

Implications

- Teachers need further support to teach mathematics with EBs
- Teachers must be critical users of materials intended to accommodate EBs
- EBs must be given opportunities to engage in the mathematical practices
- Teacher’s guides are an inadequate substitute for professional development
- Textbooks should move away from a deficit-perspective of EBs

Implications

- Teachers need further support to teach mathematics with EBs
- Teachers must be critical users of materials intended to accommodate EBs
- EBs must be given opportunities to engage in the mathematical practices
- Teacher's guides are an inadequate substitute for professional development
- Textbooks should move away from a deficit-perspective of EBs
- Teacher educators must provide teachers with resources and strategies that align with research

Questions?

Zandra de Araujo (dearaujoz@missouri.edu), Erin Smith (emsxh3@mail.missouri.edu), Amy Dwiggins (add39c@mail.missouri.edu)