Helping Teachers Connect Assessing Numerical Proficiency and Classroom Instruction

Marilyn Burns
NCSM 2013
Tuesday, 11:15 AM – 12:15 PM
MRI
Math Reasoning Inventory

Find out what students really understand about math

Funded by the Bill & Melinda Gates Foundation
Find out what your students really understand about math

- Focus on how students think and reason
- Uncover students’ strategies, understandings, and misconceptions
- Learn how students respond to questions the Common Core expects all middle school students to answer successfully

Sign up for a FREE account and try it today!

SIGN UP FOR FREE  LEARN MORE

The Assessments

Math Reasoning Inventory (MRI) is an online formative assessment tool designed to make teachers’ classroom instruction more effective.

Learn More

The Reports

MRI instant reports can be used to inform instruction, monitor progress, identify students who would benefit from intervention, and communicate with parents.

Learn More

Reasoning Strategies

The MRI Interview reveals the strategies students use to reason with whole numbers, decimals, and fractions.

Learn more

“In just a few minutes, I was able to gain valuable awareness about my math students and adjust my lessons accordingly.”

— Diana Jones
Grade 6 Teacher
SLcusd, California
MRI asks questions that the Common Core expects all students entering middle school to be able to answer successfully.
Reasoning is the heart of MRI.
The *Interview* is the core of MRI.
• We ask . . .
• We listen . . .
• We learn . . .
Using MRI to support professional learning
Video Library

The Video Library includes more than 80 video clips of students answering MRI Interview questions. These are placed throughout the website to provide examples of various MRI features. To locate specific video clips, search by Interview Question or by Student.

Search Videos

Search by Interview Question | Select one

Natasha
Excerpt of Interview
06:49

Natasha
Compare 4/5, 0.503, and 0.7
00:22

Natasha
12.6 × 10
00:28

Natasha
20 days, 1.5 miles each day
01:43
Video Library

The Video Library includes more than 80 video clips of students answering MRI Interview questions. These are placed throughout the website to provide examples of various MRI features. To locate specific video clips, search by Interview Question or by Student.
Using MRI for Professional Learning

1. Embed video clips into classroom instruction.
2. Help teachers explore properties of operations.
3. Analyze student errors.
4. Use video clips to inform classroom instruction.
Using MRI for Professional Learning

1. Embed video clips into classroom instruction.
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4. Use video clips to inform classroom instruction.
99 + 17
99 + 17

Lauren,

99 + 10 = 109
99 + 17

Lauren

99 + 10 = 109
109 + 7 = 116
99 + 17

Lauren/Alessandra

99 + 10 = 109
109 + 7 = 116
99 + 17

Lauren / Alessandra

99 + 10 = 109
109 + 7 = 116

Jake
99 + 17

Lauren / Alessandra

99 + 10 = 109
109 + 7 = 116

Jake

9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
99 + 17

Lauren / Alessandra

99 + 10 = 109
109 + 7 = 116

Jake

9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7

The answer had to end in 6.
99 + 17

Lauren/Alessandra
99 + 10 = 109
109 + 7 = 116

Jake
9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7
The answer had to end in 6.
So I knew the answer had to be 116.
99 + 17

Lauren/Alessandra

99 + 10 = 109
109 + 7 = 116

Jake

9 plus any number is 1 less than the number you had.
(9 + 7 = 16)

6 is 1 less than the 7

The answer had to end in 6.
So I knew the answer had to be 116.

Eliane

9 + 7 = 16
99 + 17

Lauren/Alessandra
99 + 10 = 109
109 + 7 = 116

Jake
9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7
The answer had to end in 6.
So I knew the answer had to be 116.

Eliane
9 + 7 = 16
90 + 10 = 100
16 + 100 = 116
Jake

9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7
The answer had to end in 6.
So I knew the answer had to be 116.

Eliane

9 + 7 = 16
90 + 10 = 100
16 + 100 = 116

Lindsay

9 + 7 = 16
Jake

9 plus any number is 1 less than the number you had.

(9 + 7 = 16)

6 is 1 less than the 7

The answer had to end in 6.

So I knew the answer had to be 116.

Eliane

9 + 7 = 16
90 + 10 = 100
16 + 100 = 116

Lindsay

9 + 7 = 16
16 + 10 = 26
Jake

9 plus any number is 1 less than the number you had.
$(9 + 7 = 16)$

6 is 1 less than the 7

The answer had to end in 6.
So I knew the answer had to be 116.

Eliane

$9 + 7 = 16$
$90 + 10 = 100$
$160 + 100 = 266$

Lindsay

$9 + 7 = 16$
$16 + 10 = 26$
$26 + 90 = 116$
99 + 17

Lauren/Alessandra

99 + 10 = 109
109 + 7 = 116

Jake

9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7
The answer had to end in 6.
So I knew the answer had to be 116.

Eliane

9 + 7 = 16
90 + 10 = 100
16 + 100 = 116

Lindsay

9 + 7 = 16
16 + 10 = 26
90 + 26 = 116
99 + 17

Lauren/Alessandra
99 + 10 = 109
109 + 7 = 116

Dylan
100 + 17 = 117

Jake
9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7
The answer had to end in 6.
So I knew the answer had to be 116.

Eliane
9 + 7 = 16
90 + 10 = 100
16 + 100 = 116

0

Lindsay
9 + 7 = 16
16 + 10 = 26
90 + 26 = 116
99 + 17

Lauren / Alessandra
99 + 10 = 109
109 + 7 = 116

Jake
9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7.
The answer had to end in 6.
So I knew the answer had to be 116.

Dylan
100 + 17 = 117
117 - 1 = 116

Eliane
9 + 7 = 16
10 + 10 = 100
16 + 100 = 116

Lindsay
9 + 7 = 16
16 + 10 = 26
90 + 26 = 116

1. 90 + 17 = 107
2. 90 + 17 = 107
99 + 17

Lauren/Alessandra
99 + 10 = 109
109 + 7 = 116

Dylan
100 + 17 = 117
117 - 1 = 116

Jake
9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7
The answer had to end in 6.
So I knew the answer had to be 116.

Eliane
9 + 7 = 16
90 + 10 = 100
16 + 100 = 116

Lindsay
① 9 + 7 = 16
16 + 10 = 26
90 + 26 = 116
② 90 + 17 = 107
107 + 9 = 116
99 + 17

Lauren/Alesandra
99 + 10 = 109
109 + 7 = 116

Dylan
100 + 17 = 117
117 − 1 = 116

Caleb
99 is 1 less than 100.
17 − 1 = 16
99 + 1 = 100
100 + 16 = 116

Jake
9 plus any number is 1 less than the number you had.
(9 + 7 = 16)
6 is 1 less than the 7

The answer had to end in 6.
So I knew the answer had to be 116.

Eliane
9 + 7 = 16
90 + 10 = 100
160 + 100 = 260

Lindsay

1. 9 + 7 = 16
2. 90 + 17 = 107
3. 107 + 9 = 116
99 + 17

Alberto

Manuel

Dina

Amir
99 + 17

Lauren/Alessandra

99 + 10 = 109
109 + 7 = 116

Dylan
100 + 17 = 117
117 - 1 = 116

Caleb
99 is 1 less than 100.
17 - 1 = 16
99 + 1 = 100
100 + 16 = 116

Jake
9 plus any number is 1 less than the number you had.
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6 is 1 less than the 7.
The answer had to end in 6.
So I knew the answer had to be 116.

Eliane
9 + 7 = 16
90 + 10 = 100
16 + 100 = 116

Lindsay
① 9 + 7 = 16
16 + 10 = 26
90 + 26 = 116
② 90 + 17 = 107
107 + 9 = 116
99 + 17

Lauren/Alessandra
99 + 10 = 109
109 + 7 = 116

Jake
9 plus any number is 1 less than the number you had.
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The answer had to end in 6.
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Eliane
9 + 7 = 16
90 + 10 = 100
16 + 100 = 116

Dylan
100 + 17 = 117
117 - 1 = 116

Caleb
99 is 1 less than 100.
17 - 1 = 16
99 + 1 = 100
100 + 16 = 116

Lindsay
① 9 + 7 = 16
16 + 10 = 26
90 + 26 = 116
② 90 + 17 = 107
107 + 9 = 116
99 + 17

Lauren/Alessandra

99 + 10 = 109
109 + 7 = 116

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99 is 1 less than 100.
17 - 1 = 16
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16 + 100 = 116

Lindsay

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90 + 26 = 116

② 90 + 17 = 107
107 + 9 = 116
99 + 17

Lauren/Alessandra
99 + 10 = 109
109 + 7 = 116

Dylan
100 + 17 = 117
117 - 1 = 116

Caleb
99 is 1 less than 100.
10 - 1 = 16
99 + 1 = 100
100 + 16 = 116

Jake
9 plus any number is 1 less than the number you had.
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9 + 7 = 16
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② 107 + 9 = 116
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100 + 16 = 116

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107 + 9 = 116
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109 + 7 = 116

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100 + 17 = 117
117 - 1 = 116

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99 is 1 less than 100.
17 - 1 = 16
99 + 1 = 100
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   16 + 10 = 26
   90 + 26 = 116
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   107 + 9 = 116
99 + 17

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end in 6.
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answer had to be 116.

Dylan
100 + 17 = 117
117 - 1 = 116

Caleb
99 is 1 less than 100.
17 - 1 = 16
99 + 1 = 100
100 + 16 = 116

Eliane
9 + 7 = 16
90 + 10 = 100
160 + 100 = 116

Lindsay
(1) 9 + 7 = 16
16 + 10 = 26
90 + 26 = 116
(2) 90 + 17 = 107
107 + 9 = 116
99 + 17

Lauren/Alessandra
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117 − 1 = 116

Caleb
99 is 1 less than 100.
17 − 1 = 16
99 + 1 = 100
100 + 16 = 116

Lindsay
① 9 + 7 = 16
16 + 10 = 26
90 + 26 = 116
② 90 + 17 = 107
107 + 9 = 116
Using MRI for Professional Learning

1. Embed video clips into classroom instruction.
2. Help teachers explore properties of operations.
3. Analyze student errors.
4. Use video clips to inform classroom instruction.
1. **Question 7**

   What is 15 times 12?

   \[ 15 \times 12 = \]

2. **Answer**

   - Correct (180)
   - Incorrect
   - Self-corrected (180)
   - Did Not Answer

3. **Explanation**

   How did you figure out the answer?

   - Used standard algorithm to multiply
   - Broke 15 and/or 12 into parts and then multiplied (e.g., 15 x 10 and then 15 x 2)
   - Changed to an easier problem, 30 x 6, by doubling and halving
   - Gave other reasonable explanation
   - Guessed, did not explain, or gave faulty explanation

   Notes:

   [Record student response]
15 \times 12
Common Core Connection

Grade 4

Number and Operations in Base Ten

Use place value understanding and properties of operations to perform multi-digit arithmetic.

**CCSS.Math.Content.4.NBT.B.5** Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations.
Common Core Connection

Grade 5

Operations & Algebraic Thinking

Write and interpret numerical expressions.

**CCSS.Math.Content.5.OA.A.1** Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.

**CCSS.Math.Content.5.OA.A.2** Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. *For example, express the calculation “add 8 and 7, then multiply by 2” as 2 × (8 + 7). Recognize that 3 × (18932 + 921) is three times as large as 18932 + 921, without having to calculate the indicated sum or product.*
Common Core Connection

Grade 6
Expressions & Equations
Apply and extend previous understandings of arithmetic to algebraic expressions.

**CCSS.Math.Content.6.EE.A.3** Apply the properties of operations to generate equivalent expressions. *For example, apply the distributive property to the expression* $3(2 + x)$ *to produce the equivalent expression* $6 + 3x$; *apply the distributive property to the expression* $24x + 18y$ *to produce the equivalent expression* $6(4x + 3y)$; *apply properties of operations to* $y + y + y$ *to produce the equivalent expression* $3y$. 
Distributive Property of Multiplication over Addition
15 x 12

Monica

Malcolm

Alberto
Monica: 15 x 12

“I did 15 times 10 and it was 150. And then I did 15 times 2 which is 30. And it was . . . um . . . 180.”
Monica: 15 x 12

“I did 15 times 10 and it was 150.
And then I did 15 times 2 which is 30.
And it was . . . um . . . 180.”

\[
\begin{align*}
12 &= 10 + 2 \\
15 \times 10 &= 150 \\
15 \times 2 &= 30 \\
150 + 30 &= 180
\end{align*}
\]
Malcolm: 15 x 12

“I broke apart the 15 and did 10 plus 5. And then I did 10 times 12 which equals 120. And then I did 12 times 5 which equals 60. And then I added it all together and I got 180.”
Malcolm: 15 x 12

“I broke apart the 15 and did 10 plus 5. And then I did 10 times 12 which equals 120. And then I did 12 times 5 which equals 60. And then I added it all together and I got 180.”

\[
\begin{align*}
15 &= 10 + 5 \\
10 \times 12 &= 120 \\
12 \times 5 &= 60 \\
120 + 60 &= 180
\end{align*}
\]
Alberto: 15 x 12

“I did 12 times 12 is 144
And then I did 3 times 12 and I got 36
And then I did 144 plus 36.”
Alberto: 15 x 12

“I did 12 times 12 is 144
And then I did 3 times 12 and I got 36
And then I did 144 plus 36.”

15 = 12 + 3
12 x 12 = 144
3 x 12 = 36
144 + 36 = 180
15 x 12

Monica

(15 x 10) + (15 x 2) = 180

Malcolm

(10 x 12) + (12 x 5) = 180

Alberto

(12 x 12) + (3 x 12) = 180
Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.
Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. **Construct viable arguments** and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.
15 x 12

Monica

Malcolm

Alberto

Cecilia
Cecilia: 15 x 12

“First I’m breaking it into steps and I’m doing 5 times 2. I leave the zero here and I bring the 1 up here.

Then 2 times 1 is 2, plus 1 is 3, so that’s 30.

Put a zero. Five times 1 is 5, and then 1 x 1 is 1.

So then the answer is 180.”
Cecilia: 15 x 12

“First I’m breaking it into steps and I’m doing 5 times 2. I leave the zero here and I bring the 1 up here.

Then 2 times 1 is 2, plus 1 is 3, so that’s 30.

Put a zero. Five times 1 is 5, and then 1 x 1 is 1.

So then the answer is 180.”
Common Core Connection

Grade 5

Number and Operations in Base Ten

Perform operations with multi-digit whole numbers and with decimals to hundredths.

CCSS.Math.Content.5.NBT.B.5 Fluently multiply multi-digit whole numbers using the standard algorithm.
Common Core Recommendation:

... a “balanced combination of procedures and understanding.”

Common Core Caution:

... “students who lack understanding of a topic may rely on procedures too heavily.”
Molly ran 1.5 miles each day for 20 days. How many miles did she run altogether?
Molly Problem

Molly ran 1.5 miles each day for 20 days. How many miles did she run altogether?
Common Core Connection

Grade 5

Number and Operations in Base Ten

Perform operations with multi-digit whole numbers and with decimals to hundredths.

**CCSS.Math.Content.5.NBT.B.7** Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.
Molly Problem

Molly ran 1.5 miles each day for 20 days. How many miles did she run altogether?

$$20 \times 1.5 = \_\_\_$$
Distributive Property of Multiplication over Addition
Sergio: Molly problem, 20 x 1.5

• Video clip from MRI
Sergio: Molly problem, 20 x 1.5

“I know that 20 times 1 is 20, so I put the 20 aside. And 20 times 5 is 100, and bloop it by one is just zero ... 10.0. So 20 plus 10 is 30.”
Sergio: Molly problem, 20 x 1.5

“I know that 20 times 1 is 20, so I put the 20 aside. And 20 times 5 is 100, and bloop it by one is just zero . . . 10.0. So 20 plus 10 is 30.”

20 x 1 = 20
20 x 5 = 100, so 20 x .5 is 10.0
20 + 10 = 30
Dina: Molly Problem, 20 x 1.5

• Video clip from MRI
Dina: Molly Problem, 20 x 1.5

“She would run 30 miles altogether. So I wouldn’t get confused, I did 10 days first. So it would be 15 miles for the 10 days. And then 15 miles times 2, for the other 10 days, would be 30.”
Dina: Molly Problem, 20 x 1.5

“She would run 30 miles altogether. So I wouldn’t get confused, I did 10 days first. So it would be 15 miles for the 10 days. And then 15 miles times 2, for the other 10 days, would be 30.”

10 x 1.5 = 15
15 x 2 = 30
Molly Problem, 20 x 1.5

<table>
<thead>
<tr>
<th>Sergio</th>
<th>Dina</th>
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</thead>
</table>

© 2010 Math Solutions
Molly Problem, 20 x 1.5

**Sergio**

\[
20 \times 1 = 20 \\
20 \times 0.5 = 10 \\
20 + 10 = 30 \\
1.5 = 1 + 0.5 \\
20 \times 1.5 = (20 \times 1) + (20 \times 0.5)
\]

**Dina**
# Molly Problem, 20 x 1.5

<table>
<thead>
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<th>Sergio</th>
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<tbody>
<tr>
<td>20 x 1 = 20</td>
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<td>20 x .5 = 10</td>
<td>15 x 2 = 30</td>
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<td>20 + 10 = 30</td>
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<td>1.5 = 1 + .5</td>
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<td>20 x 1.5 = (20 x 1) + (20 x .5)</td>
<td>20 = 2 x 10</td>
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<td>20 x 1.5 = 2 x (10 x 1.5)</td>
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Molly Problem, 20 x 1.5

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<th>Sergio</th>
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<td>20 x 1.5 = (20 x 1) + (20 x .5)</td>
<td>20 x 1.5 = 2 x (10 x 1.5)</td>
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Distributive Property of Multiplication over Addition
Molly Problem, 20 \times 1.5

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<tr>
<td>[20 \times 1.5 = (20 \times 1) + (20 \times .5)]</td>
<td>[20 \times 1.5 = 2 \times (10 \times 1.5)]</td>
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<tr>
<td><strong>Distributive Property of Multiplication over Addition</strong></td>
<td><strong>Associative Property</strong></td>
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Using MRI for Professional Learning

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2. Help teachers explore properties of numbers.
3. Analyze student errors.
4. Use video clips to inform classroom instruction.
15 \times 12

What were the two most common wrong answers?

??
What were the two most common wrong answers?

110 and 30
15 x 12

What were the two most common wrong answers?

110 and 30

(24% of all wrong answers)
12.6 \times 10
12.6 \times 10

What were the two most common wrong answers?
12.6 × 10

Jennifer

Craig

Luisa

Natasha
12.6 × 10

What were the two most common wrong answers?

120.6 and 12.60

(39% of all wrong answers)
12.6 \times 10

“The answer is 120 and 30 fifths.”

Grade 5 student
March 21, 2013
Malcolm X Elementary School
Berkeley, CA
12.6 \times 10

"The answer is 120 and 30 fifths."

12 \times 10 = 120

I changed .6 to 3/5

10 \times 3/5 = 30/5

So the answer is 120 and 30/5.
Most common wrong answers

• $100 - 18$

• $99 + 17$

• $3 - 1.9$
Most common wrong answers

• 100 – 18  [92, 81]

• 99 + 17  [106, 117]

• 3 – 1.9  [1.6 and 2.9]
Andres: 3 – 1.9

• Video from MRI
Andres: 3 – 1.9

“I figured it out because I put the 3 under the 9 and then I subtracted and that would give me 1 and 6 tenths.”

\[ 3 - 1.9 = 1.6 \]
Using MRI for Professional Learning

1. Embed video clips into classroom instruction.
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4. **Use video clips to inform classroom instruction.**
Common Core Connection

Grade 3

Number and Operations—Fractions

Develop understanding of fractions as numbers.

CCSS.Math.Content.3.NF.A.3 Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.
Common Core Connection

Grade 4
Number and Operations—Fractions
Extend understanding of fraction equivalence and ordering.

CCSS.Math.Content.4.NF.A.2 Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.
Which is greater, \( \frac{3}{8} \) or \( \frac{9}{16} \)?

Lesson from *Teaching Arithmetic: Introducing Fractions*
Comparing Fractions
Comparing Fractions

\( \frac{3}{8} \quad \frac{9}{16} \)
Comparing Fractions

\[
\frac{3}{8} \quad \frac{9}{16}
\]

<table>
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<td>( \frac{1}{8} )</td>
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<tr>
<td>( \frac{1}{16} )</td>
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Comparing Fractions

\[ \frac{3}{8} \quad \frac{9}{16} \]

\[ \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \]
Comparing Fractions

\[ \frac{3}{8} \quad \frac{9}{16} \]
Comparing Fractions

\[ \frac{3}{8} \quad \frac{9}{16} \]

\[ \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \]

\[ \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \]
Comparing Fractions

\( \frac{3}{8} \quad \frac{9}{16} \)

\( \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \quad \) is equal to

\( \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \)

\( > \quad < \)
Comparing Fractions

\[ \frac{3}{8} \quad \frac{9}{16} \]

\[ = \quad > \quad \text{is equal to} \quad \text{is greater than} \]

\[ \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \]

\[ \frac{1}{8} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \]
Comparing Fractions

\[
\frac{3}{8} \quad \frac{9}{16}
\]

\[
\begin{array}{ccc}
\frac{1}{8} & \frac{1}{8} & \frac{1}{8} \\
\frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16}
\end{array}
\]

= is equal to
>
> is greater than
< is less than
Comparing Fractions

\( \frac{3}{8} < \frac{9}{16} \)

\( = \) is equal to
\( > \) is greater than
\( < \) is less than
Comparing Fractions

\[
\frac{3}{8} < \frac{9}{16}
\]

\[
\begin{array}{cccc}
\frac{1}{8} & \frac{1}{8} & \frac{1}{8} \\
\frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16}
\end{array}
\]

Sam

\[
\frac{2}{16} = \frac{1}{8}
\]
Comparing Fractions

\[ \frac{3}{8} < \frac{9}{16} \]

is equal to

\[ > \]

is greater than

\[ < \]

is less than

Sam

\[ \frac{2}{16} = \frac{1}{8} \]

\[ \frac{4}{16} = \frac{2}{8} \]
Comparing Fractions

\[
\frac{3}{8} < \frac{9}{16}
\]

\[
\begin{array}{cccc}
\frac{1}{8} & \frac{1}{8} & \frac{1}{8} \\
\frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16}
\end{array}
\]

\[=\]
\[\text{is equal to}\]
\[
> \]
\[\text{is greater than}\]
\[
< \]
\[\text{is less than}\]

Sam

\[
\frac{2}{16} = \frac{1}{8}
\]

\[
\frac{4}{16} = \frac{2}{8}
\]

4 more 16ths make \(\frac{3}{8}\)
Comparing Fractions

\[ \frac{3}{8} < \frac{9}{16} \]

\[ \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \]

\[ \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \]

\[ = \quad \text{is equal to} \]

\[ > \quad \text{is greater than} \]

\[ < \quad \text{is less than} \]

Sam

\[ \frac{2}{16} = \frac{1}{8} \]

\[ \frac{4}{16} = \frac{2}{8} \]

\[ \frac{6}{16} = \frac{3}{8} \]
Comparing Fractions

\[
\frac{3}{8} \lt \frac{9}{16}
\]

= is equal to

\[
\frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8}
\]

\[
\frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16}
\]

> is greater than

< is less than

Sam

\[
\frac{2}{16} = \frac{1}{8}
\]

\[
\frac{4}{16} = \frac{2}{8}
\]

\[
\frac{6}{16} = \frac{3}{8}
\]

\[
\frac{3}{8} \lt \frac{9}{16} \text{ because}
\]
Comparing Fractions

\[ \frac{3}{8} < \frac{9}{16} \]

\[ \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \]

\[ \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \]

Sam

\[ \frac{2}{16} = \frac{1}{8} \]

\[ \frac{4}{16} = \frac{2}{8} \]

\[ \frac{6}{16} = \frac{3}{8} \]

\[ \frac{3}{8} < \frac{9}{16} \text{ because } \frac{3}{8} = \frac{6}{16} \]

and \[ \frac{9}{16} \] is more.
Comparing Fractions

\[ \frac{3}{8} < \frac{9}{16} \]

is equal to

is greater than

is less than

Sam

\[ \frac{2}{16} = \frac{1}{8} \]

\[ \frac{4}{16} = \frac{2}{8} \]

\[ \frac{6}{16} = \frac{3}{8} \]

\[ \frac{3}{8} < \frac{9}{16} \] because \( \frac{3}{8} = \frac{6}{16} \) and \( \frac{9}{16} \) is more. It takes \( \frac{2}{16} \) to make \( \frac{1}{8} \).
Comparing Fractions

\[ \frac{3}{8} < \frac{9}{16} \]

\[ \frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \]

\[ \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \]

Sam

\[ \frac{2}{16} = \frac{1}{8} \]

\[ \frac{4}{16} = \frac{2}{8} \]

\[ \frac{6}{16} = \frac{3}{8} \]

\[ \frac{3}{8} < \frac{9}{16} \] because \( \frac{3}{8} = \frac{6}{16} \) and \( \frac{9}{16} \) is more. It takes \( \frac{2}{16} \) to make \( \frac{1}{8} \), so you need \( \frac{4}{16} \) for \( \frac{2}{8} \) and \( \frac{6}{16} \) for \( \frac{3}{8} \).
Comparing Fractions

\[
\frac{3}{8} < \frac{9}{16}
\]

is equal to

\[
> \quad <
\]

is greater than

is less than

\[
\frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \\
\frac{1}{16} \frac{1}{16} \frac{1}{16} \frac{1}{16} \frac{1}{16} \frac{1}{16} \\
\frac{1}{16} \frac{1}{16} \frac{1}{16} \frac{1}{16} \frac{1}{16} \frac{1}{16}
\]

Sam

\[
\frac{2}{16} = \frac{1}{8} \\
\frac{4}{16} = \frac{2}{8} \\
\frac{6}{16} = \frac{3}{8}
\]

\[
\frac{3}{8} < \frac{9}{16} \text{ because } \frac{3}{8} = \frac{6}{16} \text{ and } \frac{9}{16} \text{ is more. It takes } \\
\frac{2}{16} \text{ to make } \frac{1}{8}, \text{ so you need } \\
\frac{4}{16} \text{ for } \frac{2}{8} \text{ and } \frac{6}{16} \text{ for } \frac{3}{8}.
\]
Comparing Fractions

\[ \frac{3}{8} < \frac{9}{16} \]

is equal to

> is greater than

< is less than

Sam

\[ \frac{2}{16} = \frac{1}{8} \]
\[ \frac{4}{16} = \frac{2}{8} \]
\[ \frac{6}{16} = \frac{3}{8} \]

\[ \frac{3}{8} < \frac{9}{16} \text{ because } \frac{3}{8} = \frac{6}{16} \]
and \( \frac{9}{16} \) is more. It takes \( \frac{2}{16} \) to make \( \frac{1}{8} \), so you need \( \frac{4}{16} \) for \( \frac{2}{8} \) and \( \frac{6}{16} \) for \( \frac{3}{8} \).

Jennifer

\[ \frac{3}{8} < \frac{9}{16} \text{ because} \]
Comparing Fractions

\[
\frac{3}{8} < \frac{9}{16}
\]

\[
\frac{1}{8} \quad \frac{1}{8} \quad \frac{1}{8} \\
\frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16} \quad \frac{1}{16}
\]

\[
\frac{1}{2}
\]

Sam

\[
\frac{2}{16} = \frac{1}{8} \\
\frac{4}{16} = \frac{2}{8} \\
\frac{6}{16} = \frac{3}{8}
\]

\[
\frac{3}{8} < \frac{9}{16} \text{ because } \frac{3}{8} = \frac{6}{16} \text{ and } \frac{9}{16} \text{ is more. It takes } \\
\frac{2}{16} \text{ to make } \frac{1}{8} \text{, so you need } \\
\frac{4}{16} \text{ for } \frac{2}{8} \text{ and } \frac{6}{16} \text{ for } \frac{3}{8}.
\]

\[
\]

\[
\]

\[
\]

Jennifer

\[
\frac{3}{8} < \frac{9}{16} \text{ because } \\
\frac{9}{16} > \frac{1}{2} \text{ and } \\
\frac{3}{8} < \frac{1}{2}.
\]
Comparing Pairs

Write “>”, “<”, or “=” in between each pair to make a true statement.

1. \( \frac{1}{2} \) \( > \) \( \frac{3}{8} \) because \( \frac{4}{8} \) is \( \frac{1}{2} \) but since you only have \( \frac{3}{8} \), \( \frac{3}{8} \) is more.

2. \( \frac{3}{4} \) \( > \) \( \frac{5}{8} \)

3. \( \frac{3}{16} \) \( < \) \( \frac{1}{2} \)

4. \( \frac{1}{4} \) \( = \) \( \frac{2}{8} \)

5. \( \frac{7}{8} \) \( > \) \( \frac{12}{16} \)

6. \( \frac{1}{2} \) \( = \) \( \frac{2}{4} \)

7. \( \frac{5}{16} \) \( > \) \( \frac{1}{4} \) because \( \frac{4}{16} \) is \( \frac{1}{4} \) so you have \( \frac{1}{16} \) left so \( \frac{5}{16} \) is more than \( \frac{1}{4} \)

8. \( \frac{8}{16} \) \( = \) \( \frac{2}{4} \)

9. \( \frac{1}{4} \) \( > \) \( \frac{1}{8} \) you need \( \frac{3}{8} \) to make \( \frac{1}{4} \) but you only have \( \frac{1}{8} \), so then \( \frac{1}{4} \) is more than \( \frac{1}{8} \)

10. \( \frac{3}{4} \) \( > \) \( \frac{11}{16} \)

11. \( \frac{7}{16} \) \( = \) \( \frac{2}{8} \)

12. \( \frac{8}{15} \) \( > \) \( \frac{13}{30} \) \( = \) \( \frac{1}{2} \) is \( \frac{8}{16} \) but you only have \( \frac{3}{8} \), then \( \frac{8}{16} \) is more than \( \frac{3}{8} \)
Comparing Pairs

Write ‘>’, ‘<’, or ‘=’ in between each pair to make a true statement.

1. \( \frac{1}{2} \) \( > \) \( \frac{3}{8} \) because \( \frac{4}{8} = \frac{1}{2} \) so \( \frac{3}{8} \) is \( \frac{1}{8} \) less.
2. \( \frac{3}{4} \) \( > \) \( \frac{5}{8} \)
3. \( \frac{3}{16} \) \( < \) \( \frac{1}{2} \)
4. \( \frac{1}{4} \) \( = \) \( \frac{2}{8} \)
5. \( \frac{7}{8} \) \( > \) \( \frac{12}{16} \)
6. \( \frac{1}{2} \) \( = \) \( \frac{2}{4} \) because \( \frac{1}{2} \) is \( \frac{1}{2} \) of \( \frac{2}{4} \)
7. \( \frac{5}{16} \) \( > \) \( \frac{1}{4} \)
8. \( \frac{8}{16} \) \( = \) \( \frac{2}{4} \)
9. \( \frac{1}{4} \) \( > \) \( \frac{1}{8} \) because it takes \( \frac{2}{8} \) to be \( \frac{1}{4} \) to \( \frac{1}{4} \).
10. \( \frac{3}{4} \) \( > \) \( \frac{11}{16} \)
11. \( \frac{8}{16} \) \( > \) \( \frac{3}{4} \)
12. \( \frac{1}{4} \) \( = \) \( \frac{2}{8} \) see number 9.
Question 1

Which is greater, 3/8 or 5/6?

Answer

- Correct (5/6)
- Incorrect
- Self-corrected (5/6)
- Did Not Answer

Explanation

- Converted to common denominators
- Compared to 1/2 or 50%, or 1 or 100% (e.g., 5/6 is more than 1/2 and 3/8 is less than 1/2)
- Explained that eighths are smaller than sixths and there are fewer eighths
- Converted to decimals or percents
- Gave other reasonable explanation
- Guessed, did not explain, or gave faulty explanation

Notes

record student response

End Interview
Which is greater, \( \frac{3}{8} \) or \( \frac{5}{6} \)?
Which is greater, 3/8 or 5/6?

Amir

Ernesto

Alberto
Amir: Which is greater, 3/8 or 5/6?

• Video from MRI
Amir: Which is greater, 3/8 or 5/6?

“I know that ... um ... well, 1/8 is 12 ½ percent and 1/6 is around 15 and 4/6 percent, it’s around there. So 3/8 is around 37 ½ percent. And I know that 4/6 is 66 2/3 percent. So 5/6 must be greater than 3/8.”
Ernesto: Which is greater, 3/8 or 5/6?

• Video from MRI
Ernesto: Which is greater, 3/8 or 5/6?

“Because 5/6 is almost a whole, if you add one more piece. And 3/8 needs a lot of pieces to get 1 whole.”
Alberto: Which is greater, 3/8 or 5/6?

• Video from MRI
Alberto: Which is greater, 3/8 or 5/6?

“‘Cause you just need 1 more to get to 6, and in this one you need 5 more.”

[Repeat after prompting] “You need 1 more sixth to get to 6, and 5 more eightths to get to 8 eighths.”
What Does the Data Tell?

• MRI K–5
Common Core Connection

Kindergarten

Number and Operations in Base Ten

Work with numbers 11–19 to gain foundations for place value.

CCSS.Math.Content.K.NBT.A.1 Compose and decompose numbers from 11 to 19 into ten ones and some further ones, e.g., by using objects or drawings, and record each composition or decomposition by a drawing or equation (such as 18 = 10 + 8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.
Common Core Connection

Grade 1

Number and Operations in Base Ten

Understand place value.

CCSS.Math.Content.1.NBT.B.2 Understand that the two digits of a two-digit number represent amounts of tens and ones.
Place Value
Place Value
Place Value
Place Value

• How many cubes are there altogether?
Place Value

• How many cubes are there altogether?
• If I take 6 cubes away, how many cubes will be left on the paper?
Place Value

- How many cubes are there altogether?
- If I take 6 cubes away, how many cubes will be left on the paper?
- If I take 10 cubes away, how many cubes will be left on the paper?
**Individual Report: Whole Numbers**

**MR, E**

**Interview**
Date Completed: 17-Nov-2011

<table>
<thead>
<tr>
<th>Category</th>
<th>Strategies or Understandings Demonstrated</th>
<th>Appropriate Strategies or Understandings Not Demonstrated</th>
</tr>
</thead>
</table>
| Adding and Subtracting Mentally | • Breaks numbers apart to add or subtract 100 – 18  
• Gives other reasonable explanation 1000 – 98  
• Uses standard algorithm to add or subtract 99 – 17 | • Uses addition to solve subtraction problems  
• Uses benchmark numbers to add or subtract |

| Multiplying and Dividing Mentally | • Uses known facts and place value to multiply or divide 7000 ÷ 70  
• Breaks numbers apart to multiply or divide 15 × 12  
• Gives other reasonable explanation 50 × 40  
• Guesses, does not explain, or gives faulty explanation Estimate 18 × 21 | • Uses benchmark numbers to make estimates |

| Applying Understanding         | • Uses distributive property 15 × 12  
20 × 15 = 300, 21 × 15 = ____ | • Models with mathematics to solve problems in context  
• Uses inverse relationship of addition and subtraction |

**Written Computation**
Date Completed: 17-Nov-2011

<table>
<thead>
<tr>
<th>Category</th>
<th>Demonstrated</th>
<th>Not Demonstrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computing Accurately with Paper and Pencil</td>
<td>5000 ÷ 328</td>
<td></td>
</tr>
<tr>
<td></td>
<td>842 × 35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3423 ÷ 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>275 ÷ 22</td>
<td></td>
</tr>
</tbody>
</table>
# Group Report: Whole Numbers

**All Students**

Start Date: 24-Feb-2013  
End Date: 24-Mar-2013

## Interview

**Students:** 25

<table>
<thead>
<tr>
<th>Category</th>
<th>Consistently Demonstrated (75–100% of Students)</th>
<th>Often Demonstrated (50–74% of Students)</th>
<th>Sometime Demonstrated (25–49% of Students)</th>
<th>Rarely Demonstrated (0–24% of Students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adding and Subtracting Mentally</td>
<td></td>
<td>Breaks numbers apart to add or subtract (72%)</td>
<td>Uses benchmark numbers to add or subtract (36%)</td>
<td>Counts by 1s (6%)</td>
</tr>
<tr>
<td>Multiplying and Dividing Mentally</td>
<td>Uses known facts and place value to multiply or divide (80%)</td>
<td></td>
<td>Uses benchmark numbers to multiply or divide (36%)</td>
<td>Uses standard algorithm to multiply or divide (12%)</td>
</tr>
<tr>
<td>Applying Understanding</td>
<td>Uses inverse relationship of addition and subtraction (88%)</td>
<td>Uses distributive property (68%)</td>
<td>Models with mathematics to solve problems in context (36%)</td>
<td>Figures exact answer when asked to estimate (4%)</td>
</tr>
</tbody>
</table>

## Written Computation

**Students:** 25

<table>
<thead>
<tr>
<th>Category</th>
<th>75–100% of Students</th>
<th>50–74% of Students</th>
<th>25–45% of Students</th>
<th>0–24% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computing Accurately with Paper and Pencil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5000 - 328 (80%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>842 x 36 (84%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3423 - 6 (60%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>275 x 22 (52%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Item Analysis: Whole Numbers

#### Period 1
Start Date: 30-Sep-2011  
End Date: 28-Oct-2011

**Legend**
- ✅ Appropriate for the numbers at hand
- ❌ Not Appropriate for the numbers at hand

#### Interview
Students: 7

<table>
<thead>
<tr>
<th>Question</th>
<th>Correct / Self-corrected</th>
<th>Incorrect</th>
<th>Did Not Answer</th>
<th>Strategies Used by Students Who Gave Correct Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1060 - 988</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>✅ Uses addition to solve subtraction problems (6/7)</td>
</tr>
<tr>
<td>2 99 + 17</td>
<td>43%</td>
<td>57%</td>
<td>0%</td>
<td>✅ Breaks numbers apart to add or subtract (1/3)</td>
</tr>
<tr>
<td>3 100 - 18</td>
<td>57%</td>
<td>29%</td>
<td>14%</td>
<td>✅ Uses standard algorithm to add or subtract (2/3)</td>
</tr>
<tr>
<td>4 15 + ___ = 200</td>
<td>71%</td>
<td>14%</td>
<td>14%</td>
<td>✅ Breaks numbers into parts to add or subtract (4/5)</td>
</tr>
<tr>
<td>5 20 × 15 = 300, 21 × 10 = ___</td>
<td>0%</td>
<td>43%</td>
<td>57%</td>
<td>No correct answers given</td>
</tr>
<tr>
<td>6 50 × 40</td>
<td>43%</td>
<td>57%</td>
<td>0%</td>
<td>✅ Uses known facts and place value to multiply or divide (3/3)</td>
</tr>
<tr>
<td>7 15 × 12</td>
<td>29%</td>
<td>43%</td>
<td>29%</td>
<td>✅ Uses standard algorithm to multiply or divide (2/2)</td>
</tr>
<tr>
<td>8 7000 ÷ 70</td>
<td>57%</td>
<td>14%</td>
<td>29%</td>
<td>✅ Uses known facts and place value to multiply or divide (4/4)</td>
</tr>
<tr>
<td>9 Estimate 18 × 21</td>
<td>57%</td>
<td>43%</td>
<td>0%</td>
<td>✅ Relates to benchmark number to make estimates (1/4)</td>
</tr>
<tr>
<td>10 295 students, 25 on each bus</td>
<td>0%</td>
<td>43%</td>
<td>57%</td>
<td>No correct answers given</td>
</tr>
</tbody>
</table>

#### Written Computation
Students: 7

<table>
<thead>
<tr>
<th>Question</th>
<th>Correct / Self-corrected</th>
<th>Incorrect</th>
<th>Did Not Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 5000 - 328</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>2 842 × 25</td>
<td>57%</td>
<td>29%</td>
<td>14%</td>
</tr>
<tr>
<td>3 3423 ÷ 6</td>
<td>71%</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
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What Does the Data Tell?

• MRI K–5
• Mental reasoning should be integral to math instruction
What Does the Data Tell?

• MRI K–5
• Mental reasoning should be integral to math instruction
• Intervention is needed for students who need to catch up
Find out what your students really understand about math

- Focus on how students think and reason
- Uncover students' strategies, understandings, and misconceptions
- Learn how students respond to questions the Common Core expects all middle school students to answer successfully

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