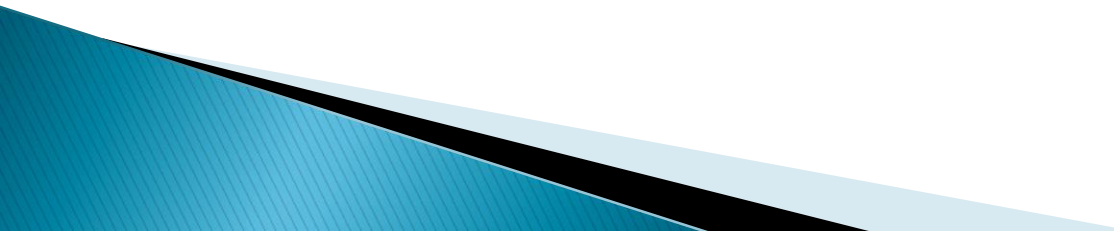


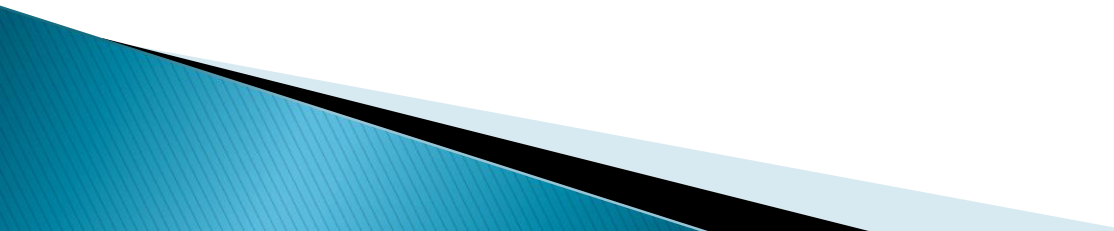
Increase your Students' Mathematical Communication with a Writing Checklist and Google Classroom

NCTM Annual Meeting 2017
Andrea Lohse
zentz_andrea@hotmail.com

Agenda

- ▶ Background
 - ▶ Writing Strategies
 - ▶ Writing Checklist
 - ▶ Implementation
 - ▶ Examples and Results
 - ▶ How to Adjust to your Classroom
- 

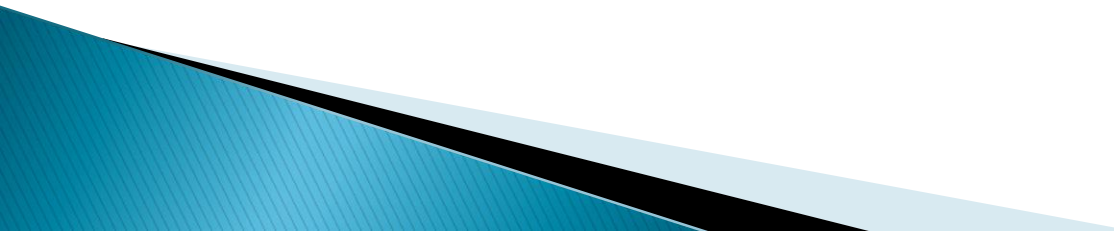
Background

- ▶ I teach 6th and 7th grade at a Title 1 school in Aurora, Colorado
 - ▶ 8 years of teaching experience
 - ▶ Action research study as part of my master's program at Ball State University
- 

Classroom Observations

- ▶ Students could
 - Find the correct answer
 - Show their computations
- ▶ But could not
 - Put their explanation into words
 - Justify their solution
 - Explain why they performed steps in their process

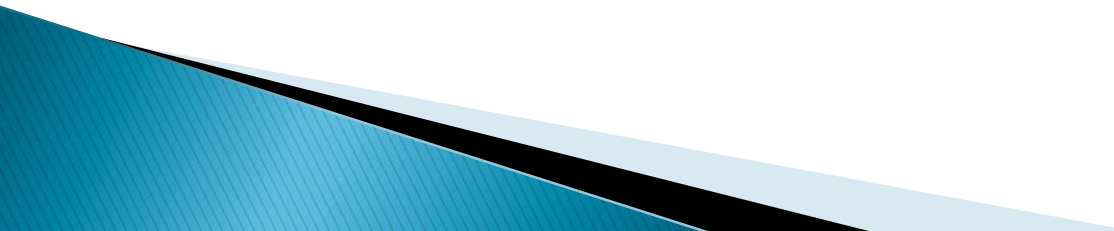
Why Write in Math?

- ▶ SMP 3 and NCTM Process Standards emphasize communication
 - ▶ Student benefits
 - Depth of knowledge
 - Essential skill
 - ▶ Teacher benefits
 - Formative assessment
 - Tailor lessons
 - Give feedback
- 

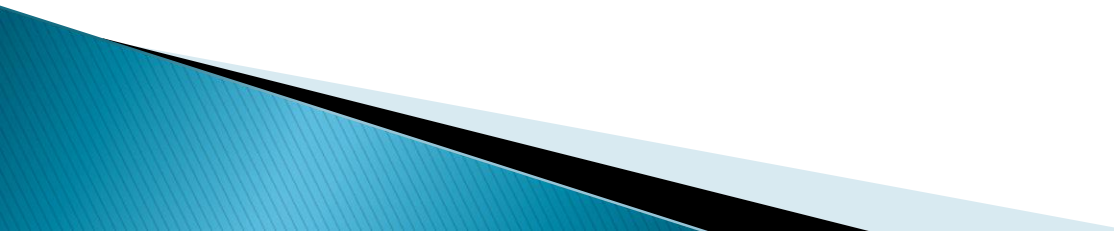
Writing Strategy – Prompts

- ▶ Choose prompts that can
 - Be solved in various ways
 - Use different representations
 - Require students to justify their solution
- ▶ This gives the opportunity for students to
 - Take ownership over their work
 - Justify their thinking to peers
 - Show their process clearly

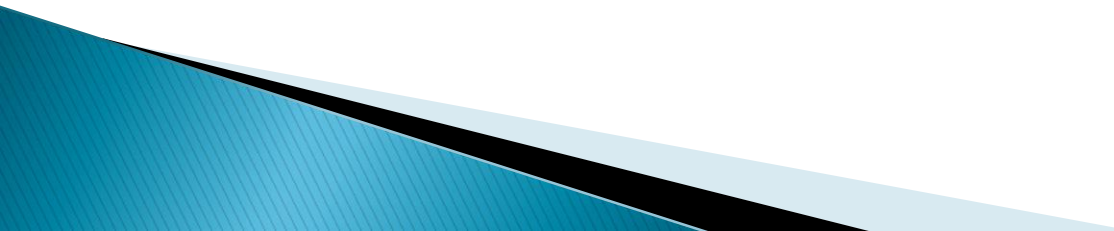
Writing Strategy – Discourse

- ▶ Most students find talking easier than writing
 - ▶ Fully understand solution strategy
 - ▶ Ask and answer questions
 - ▶ Generate different strategies
- 

Writing Strategy – Feedback

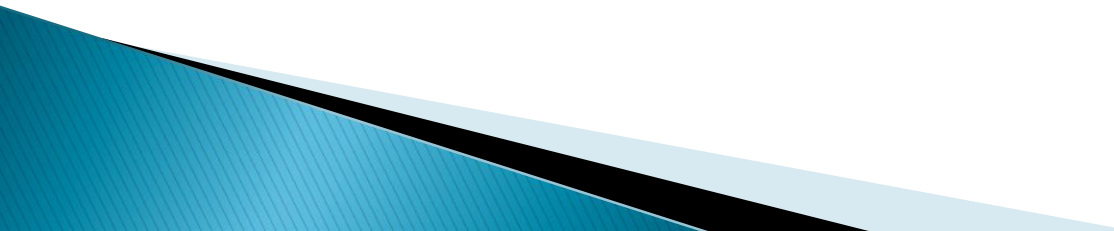
- ▶ Google Classroom
 - Students can write and submit work
 - Can be accessed and edited anywhere
 - Timely feedback
 - Work is archived
 - ▶ Forms of Feedback
 - Model grading process with anonymous work
 - Comments on individual Google Docs
 - Whole class announcements
- 

Writing Checklist

- ▶ Three overarching components that focus on the elements of good mathematical writing
 1. Correct Answer
 2. Correct Mathematical Reasoning
 3. Complete Explanation
 - ▶ Student friendly
 - Self, peer, and teacher assessment
 - 11 yes or no questions
- 

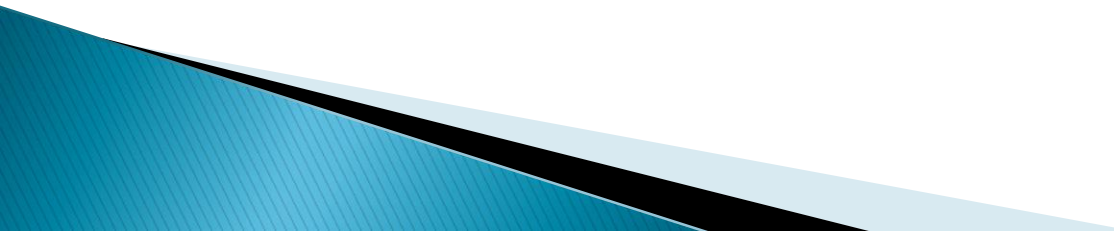
Component 1: Correct Answer

Did you...

- Get the correct answer?
 - Explain the meaning of the answer using units if necessary?
 - Make no computational errors?
 - Explain why you think your answer makes sense?
- 

Component 2: Correct Mathematical Reasoning

Did you...

- Use the correct vocabulary to describe your reasoning?
 - Specifically use the numbers in the problem?
 - Explain why you did each step?
- 

Component 3: Complete Explanation

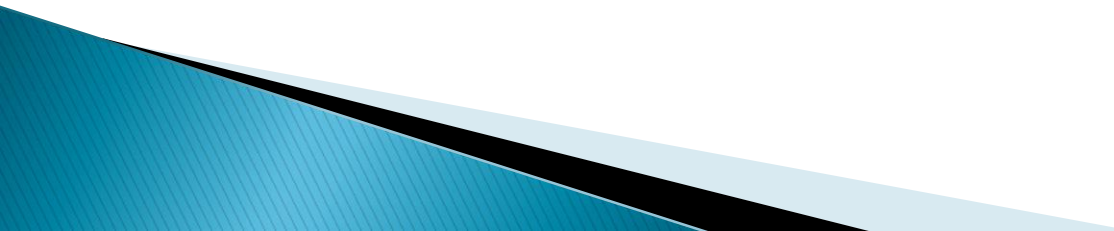
Did you...

- Restate the question?
- Use a logical progression in your explanation?
- Explain each step in your process?
- Fully explain the meaning of your diagrams, models, or pictures?

Implementation

- ▶ Unit on systems of equations
- ▶ Seventh grade advanced math course
- ▶ Access to Chromebooks

Example – Writing Prompt and Discourse

- ▶ Introductory prompt
 - ▶ Several methods to solve
 - Equations
 - Tables
 - Guess and Check
 - Graphs
 - ▶ Shared strategies
 - Emphasized questions on the checklist
 - ▶ Independent writing
- 

Example – Modeling Assessment

1. The first thing that you have to do is make a equation. I am going to use x and y for this equation. X means how much water the big pitcher can hold and y is how much the small pitcher can hold
2. The first equation I will make is $-y+x=2$.
3. The second equation is $2y+x=8$
4. Now that you have the equations you need to subtract them and you'll find out what y is.
5. So you do $x-x$ which is 0. Then you subtract the y s, $-y-2y=-3y$. After you do both of those then you subtract the 2 and the 8, which gives you -6.
6. This means that $-3y=-6$. So $y=2$.
7. Now you have to insert this into the equation to find out what x equals.
8. Since $y=2$, I'll put y into the first equation to get $-2+x=2$. I add 2 to both sides of the equation to get $x=4$.

*Explain each step in your process

*Explain why you did each step

*Explain the meaning of the answer using units

*Explain why your answer makes sense

0/3

Example – Individual Feedback

“Three apples and 4 bananas cost \$4.85. Three apples and ten bananas cost \$8.75. Find the cost for an apple.”

First, we need to label the variables so we can start the equation.

a=apple

b=banana

Second, we use our text clues so we can create our equations.

$$3a + 4b = 4.85$$

$$3a + 10b = 8.75$$

Third, we multiply so we can cancel out the other variable.

$$3a + 4b = 4.85 \quad (10) \quad \text{-----} \quad 30a + 40b = 48.5$$

$$3a + 10b = 8.75 \quad (4) \quad \text{-----} \quad 12a + 40b = 35$$

Fourth, we subtract so we can cancel out the variables.

$$30a + 40b = 48.5$$

$$-(12a + 40b = 35)$$

$$18a = 13.5$$

Fifth, we divide to find a.

$$18a = 13.5$$

$$\underline{\quad \quad} \quad \underline{\quad \quad}$$
$$a =$$



Andrea Lohse
Jan 25, 2016

Resolve

This should say "cost of an apple" and "cost of a banana"



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Jan 25, 2016

Resolve

What text clues did you use to write these?



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Jan 25, 2016

Resolve

Which variable?



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Jan 25, 2016

Resolve

State what variable you're canceling out

Example – Student Use of Feedback

2. The first equation I will make is $-y+x=2$. I wrote this equation because a large minus a small pitcher is 2 cups. I switched the variables so that they will line up with my second equation below.
3. The second equation is $2y+x=8$ I wrote this equation since 2 small and 1 large pitcher added together equals 8 cups.
4. Now that you have the equations you need to subtract them to eliminate x and you'll find out what y is.
5. So you do $x-x$ which is 0. Then you subtract the y s, $-y-2y=-3y$. After you do both of those then you subtract the 2 and the 8, which gives you -6.
6. This means that $-3y=-6$. So $y=2$ by dividing both sides of the equation by -3.
7. Now you have to insert this into the equation to find out what x equals.
8. Since $y=2$, I'll put y into the first equation to get $-2+x=2$. I add 2 to both sides of the equation to get $x=4$.
9. Since $y=2$ and $x=4$, this means a large pitcher holds 4 cups and a small pitcher holds 2 cups.
10. I know I'm right because two small pitchers (4 cups) and a large pitcher (4 cups) equals 8 cups and one large (4 cups) minus a small pitcher (2 cups) equals two cups of water.

Example – Class Feedback



Andrea Lohse
Jan 7, 2016 (Edited Jan 8, 2016)



Due Jan 8, 2016

Explain How to Graph a Line from Standard Form

14
DONE

0
NOT DONE



Explain How to Graph a Line in Standard Form
Google Docs

Each student will get a copy

Andrea Lohse Jan 11, 2016

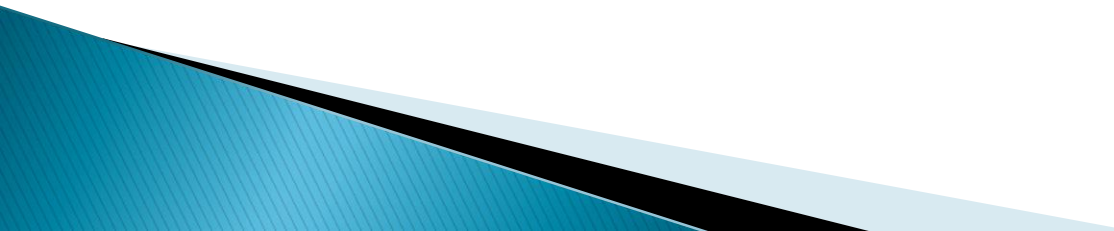
Here is an exemplary response for you to compare your work. Great job, Danya!

To graph $4x - 6y = 12$, you should find the x-intercept and the y-intercept. First let's find the x-intercept. We should set y to equal 0, $y = 0$. The 0 cancels out the $-6y$ because 0 times -6 equals 0. Now we are left with $4x = 12$, now we divide 4 by $4x$ and 12 by 4 (what we do to one side happens to the other). We want to do that to get x by itself so we can get the x-intercept. So $12/4 = 3$, now we are left with $x = 3$. So the x-intercept is 3.

Now let's find the y-intercept. We set x to equal 0, $x = 0$. The 0 cancels out the $4x$ because 0 times 4 equals 0. Now we are left with $-6y = 12$, now we divide $-6y$ by -6 and 12 by -6 (what we do to one side happens to the other). We want to do that to get y by itself so we can get the

y-intercept. So $12/-6 = -2$, now we are left with $y = -2$. So the y-intercept is -2.

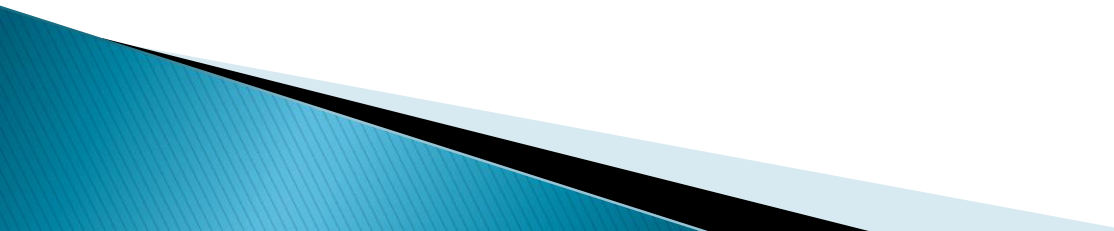
Results

- ▶ Improved writing skills
 - Justification of solution
 - Why steps were performed
 - ▶ Better comprehension
 - Test average increased 8%
 - Checking answers
 - Writing equations from word problems
 - ▶ Developed appreciation for writing in math
- 

Survey Results – Student Comments

- ▶ “I think that the unit we just did with writing was very effective for me and others too because it taught us how to explain what we are doing and know exactly every single step and why we did things in the process of solving an equation.”

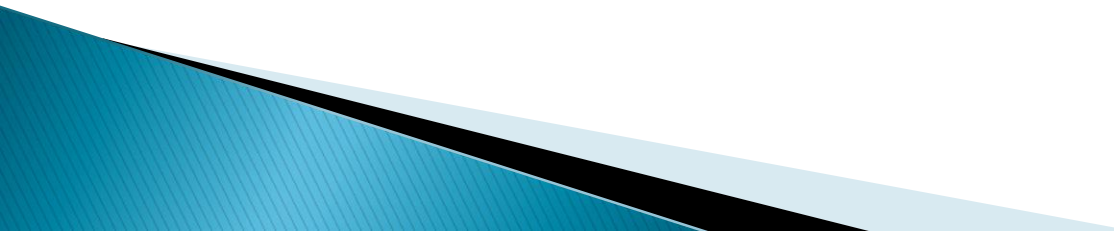
Survey Results – Student Comments

- ▶ “I like how you were specific when you graded our writing.”
 - ▶ “Feedback did help me because I got to know what I need to improve on and what I am forgetting, and if I do something like this again I will be a lot better and know what I need to do.”
- 

Key Insights

- ▶ Student insights
 - More in-depth knowledge of content
 - Good mathematical writing expectations
- ▶ Teacher insights
 - Timely feedback
 - Consistent implementation
 - Strengths and misconceptions
 - Tailored lessons and feedback

How to Adjust the Writing Checklist – Content Area

- ▶ Did you explain each step...
 - In solving your equation?
 - In making your graph?
 - ▶ Did you explain why your answer makes sense...
 - Using inverse operations?
 - Using the given information?
- 

How to Adjust the Writing Checklist – Age Group

- ▶ Did you say what your answer means instead of just stating a number?
- ▶ Did you write your explanation so a stranger could follow it?

Example of a Modified Checklist – Linear Equations

▶ **Correct Answer**

Did you...

- Explain why you think your equation is correct using the values given in the problem?

▶ **Correct Mathematical Reasoning**

Did you...

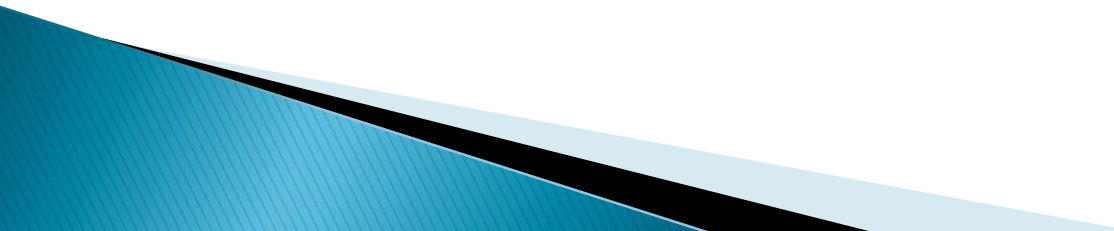
- Use the correct vocabulary such as slope, rate of change, initial value, etc.?

▶ **Complete Explanation**

Did you...

- Explain each step you used to find the slope and y-intercept?

Since My Research Study

- ▶ Modified checklist
 - ▶ Gradual implementation
 - ▶ Mastery of the checklist before peer assessments
- 

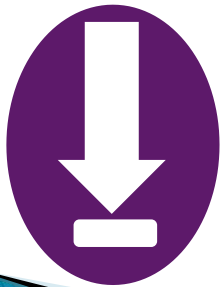


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