Improving Math and Literacy through Writing

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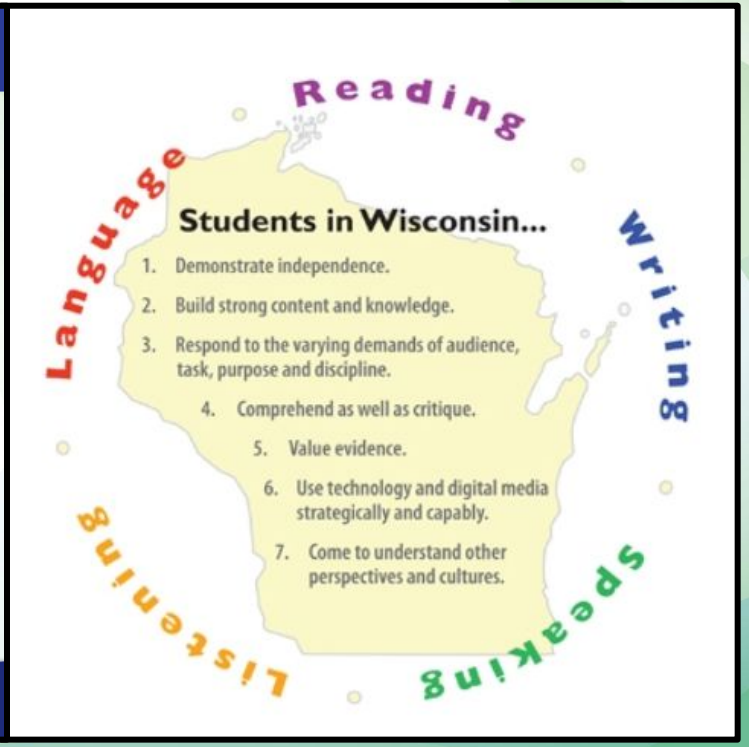
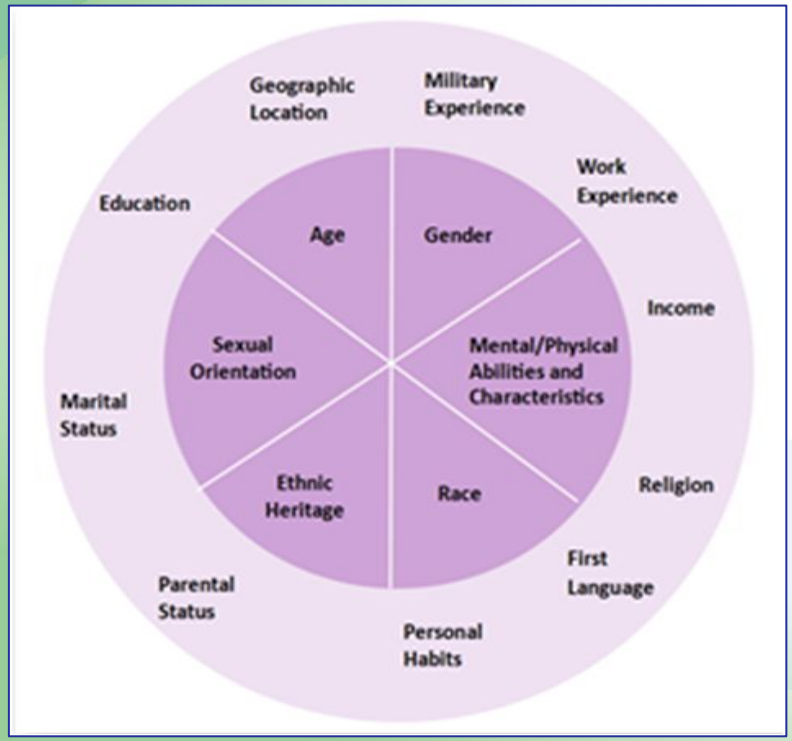
Response to Intervention

Wisconsin's Foundational Documents

English Language Arts



Culturally Responsive Practices



The National Writing Project and Carl Nagin state that "The emphasis on culture and identity has helped educators more effectively and sensitively teach children who are also English Language Learners. ELL studies from the last decade observe that learning a new language, in addition to being a grammatical task, also asks the student to take on a new identity (p. 28).

Production and Distribution of Writing

What are your beliefs about the teaching of writing?

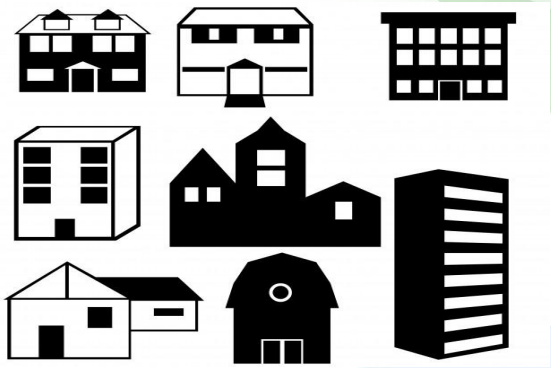
Characteristics of Effective Writing Instruction

- Require that all students write (Graham & Harris, 2011).
- Explicitly teach strategies for generating ideas, drafting, revising, and editing (Dawson, 2013; Graham & Harris, 2013; Graham & Perin, 2007).

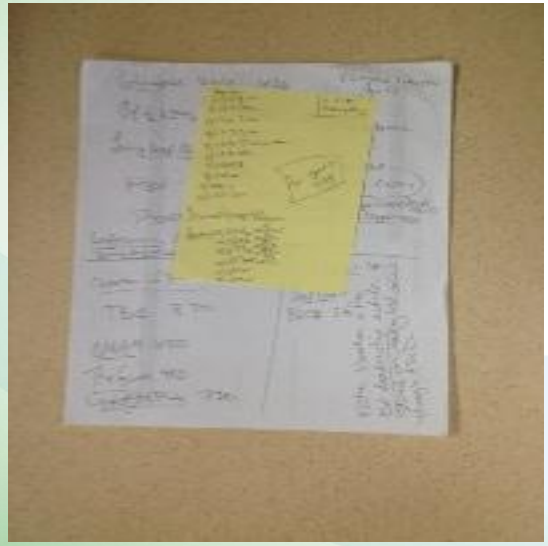
Characteristics of Effective Writing Instruction

- Beginning
- Visualizing
- Gathering
- Constructing
- Finishing
- Presenting

(Burke, 2008)



Beginning and Visualizing



Turn research into practice with IRA journals

Step-by-step instructions for accessing IRA journals online

The Reading Teacher
November 2014
Vol. 68, No. 3

Journal of Adolescent & Adult Literacy
November 2014
Vol. 58, No. 3

Reading Research Quarterly
Oct / Nov / Dec 2014
Vol. 49, No. 4

Gathering

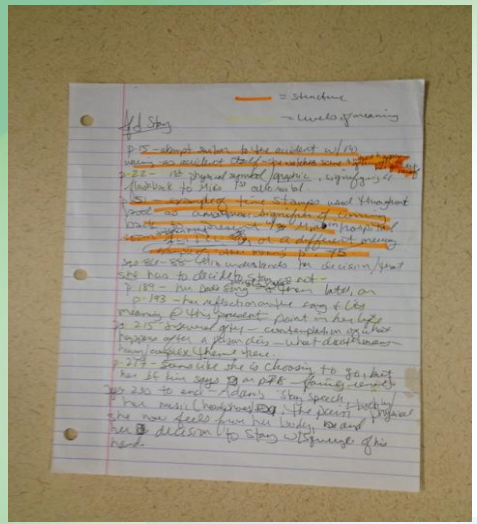
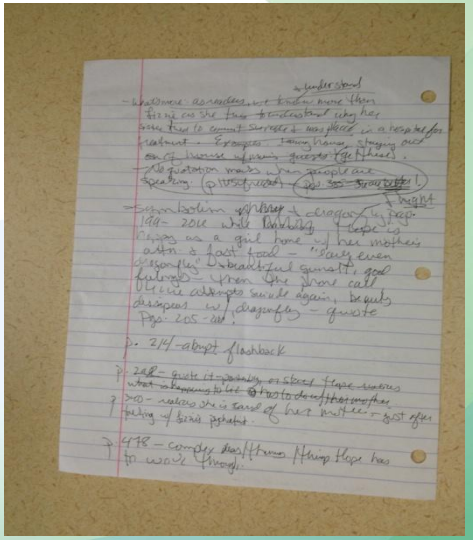
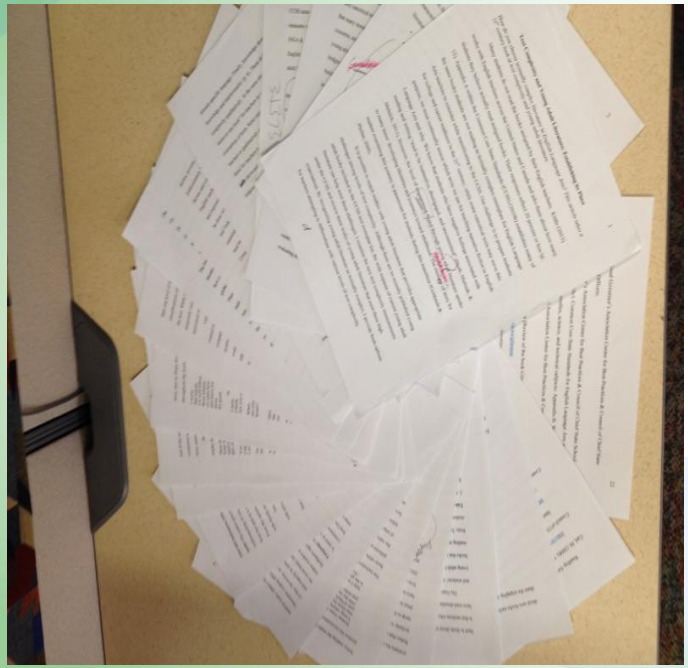
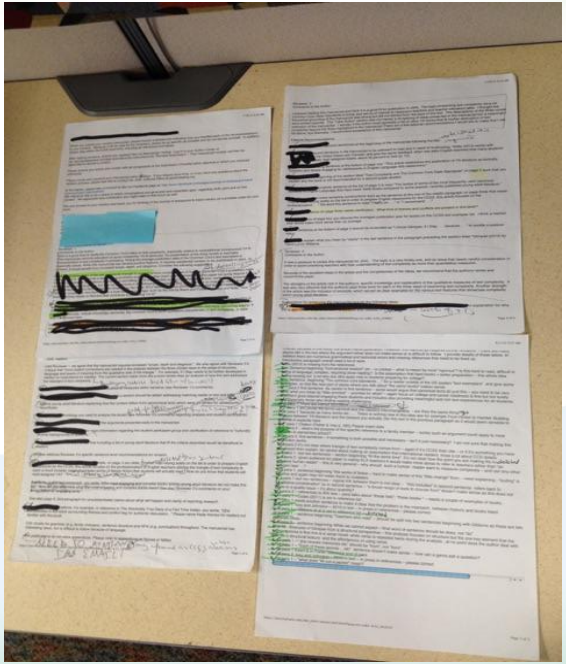


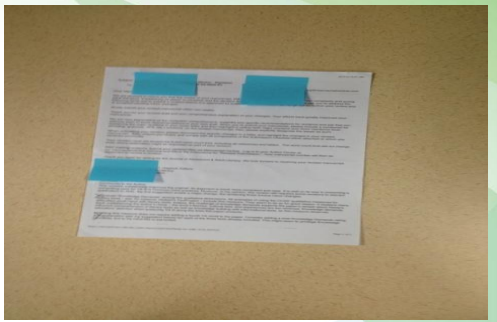
Photo Credit: Jonathan Singer

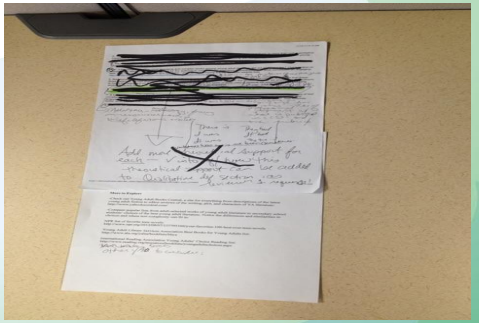


Constructing (and more gathering)

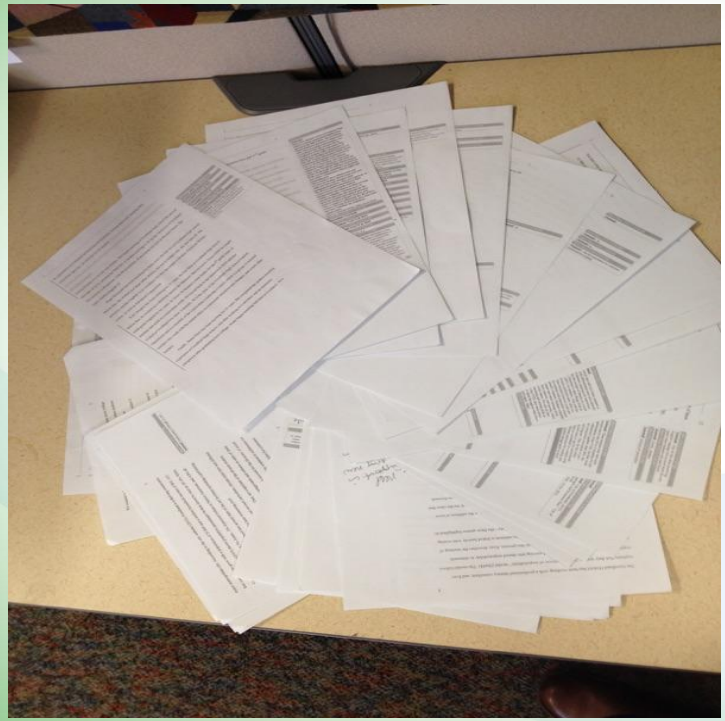


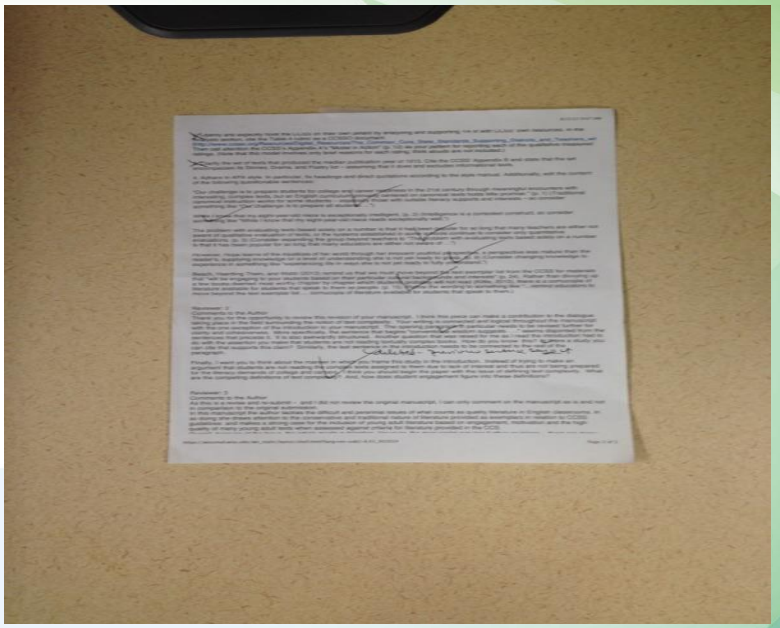






Constructing





Finishing and Presenting

dpi.wi.gov/wisconsin-writes

WISCONSIN Writes

Writing as Part of a Math Classroom

What is “text” in Mathematics?

Standards for Mathematical Practice

Incorporating Writing in Mathematics

Incorporating Writing into Mathematics Instruction

The Writing Process in Mathematics	
Establish the purpose for writing in math class.	Establish the audience.
Encourage students to use words, n bers, and, if the like, pictures to p vide as m information as pos to explain thin	Have students discuss their ideas befo e writing.
Post	Give in
Have small groups for feed	Use stu

Deeply understand mathematical concepts

Better understand the "Whys" of mathematics

Burns, "Writing in Math", *Educational Leadership*, October 2004

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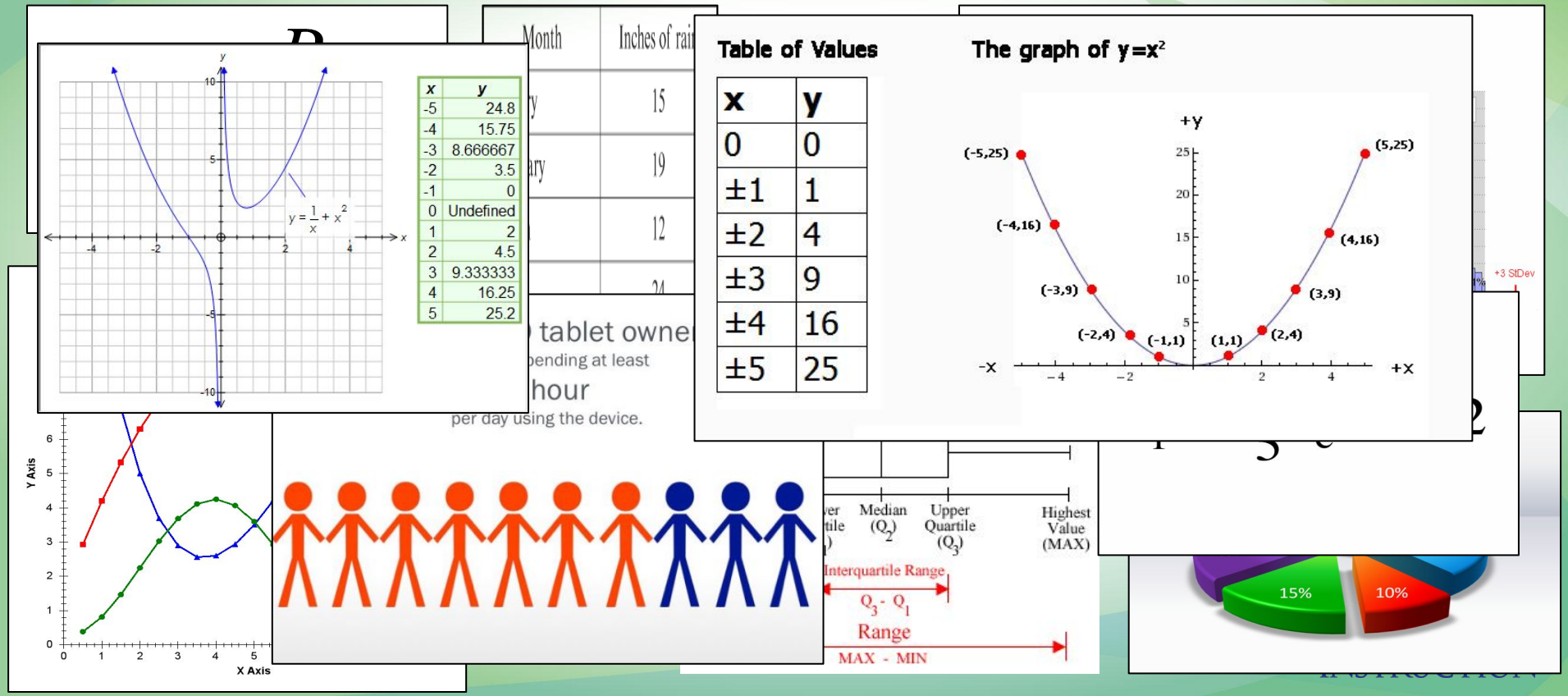
Wisconsin's Definition of 'Text'

A text is:

any communication – spoken, written, or visual – involving language

Text in Mathematics

A text is any communication – spoken, written, or visual - involving language



Standards for Mathematical Practice

"Habits of Mind" that lead to deeper understanding of mathematical concepts

Connect SMP 1 to the Writing Process

Students should be able to identify and execute a plan to solve a problem.

Students should be able to analyze a solution path and modify the plan, if necessary.

Understand and connect learned mathematics to a real life problem or task.

Teachers who are developing students' capacity to "make sense of problems and persevere in solving them" develop ways of framing mathematical challenges that are clear and explicit, and then check in repeatedly with students to help them clarify their thinking and their process.

Standard for Mathematical Practice #1

Problem Solving and Persevering

Using Writing to Understand Math and Problem Solving Process

Persevering

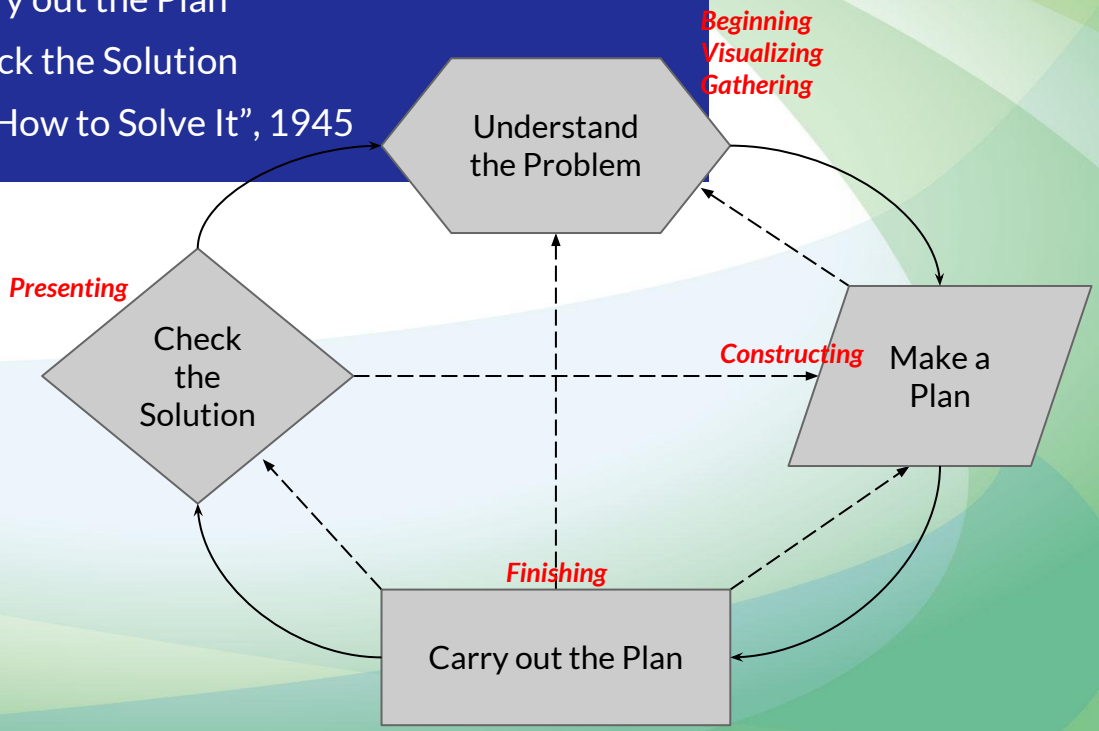
- Beginning
- Visualizing
- Gathering
- Constructing
- Finishing
- Presenting

(Burke, 2008)

George Polya's Problem Solving Technique

- Understand the Problem
- Make a Plan
- Carry out the Plan
- Check the Solution

Polya - "How to Solve It", 1945



Connecting Practices to Writing

Mathematically Proficient students can...

Standard for Mathematical Practice #1

- **EXPLAIN** the problem to themselves.
- **ORGANIZE** information…

Use Writing to Explain

- **MONITOR** their work
- **ASK** themselves/others, "Does this make sense?"
- **CHANGE** their plan based on responses from others

Use Writing to Monitor Student Work

- **CHECK** Is my answer correct?
- **EVALUATE** What worked/didn't work?

Use Writing to Evaluate/Check Work

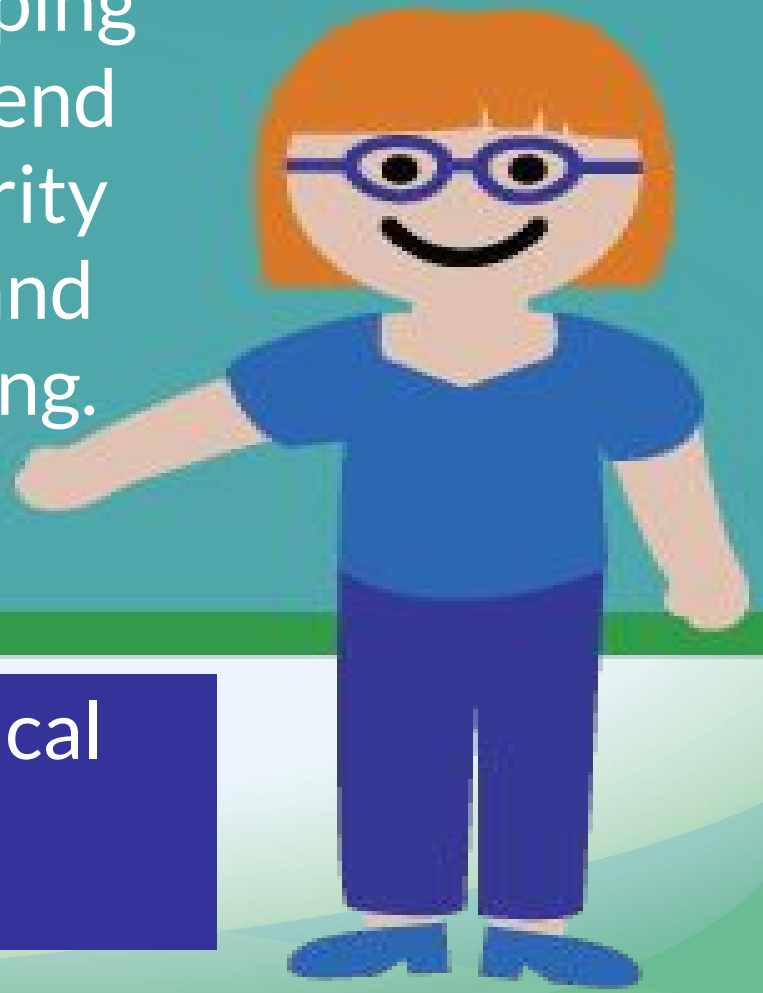
Standards for Mathematical Practice

"Habits of Mind" that lead to deeper understanding of mathematical concepts

Connect SMP 6 to the Writing Process

Students should not only be able to accurately solve a problem, but also use precise mathematical definitions and vocabulary to explain the meaning of the solution or solution paths.

Teachers who are developing students’ capacity to "attend to precision" focus on clarity and accuracy of process and outcome in problem solving.



Standard for Mathematical Practice #6

Attend to Precision

Connecting Practices to Writing

Mathematically Proficient students can...

Standard for Mathematical Practice #6

- **USE** correct math vocabulary with clear definitions

Revising and Editing Writing

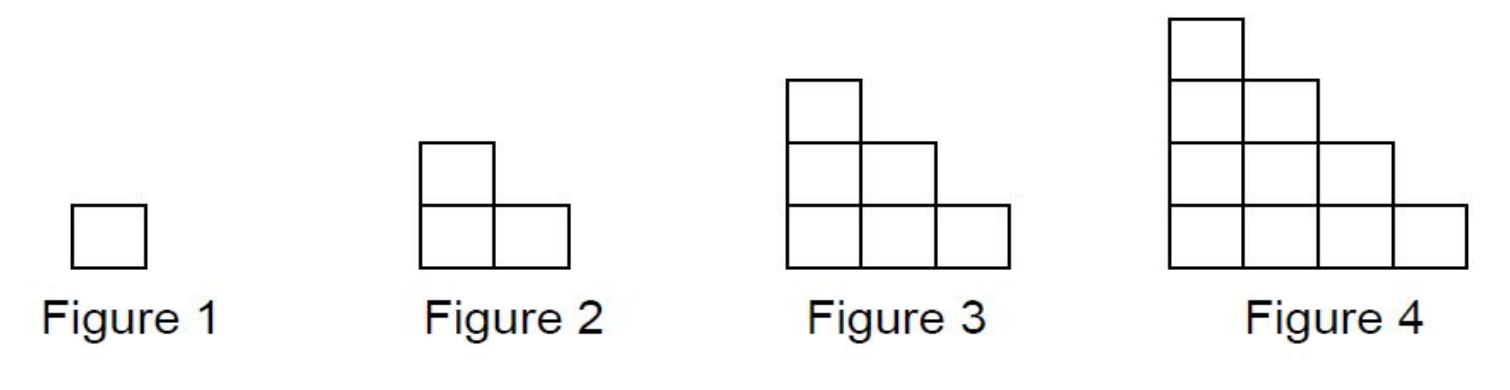
- **UNDERSTAND** the meaning of symbols
- **DETERMINE** labels from context of a given problem
- **INTERPRET** correct units of measure from context

Interpreting from Writing

- **ENSURE** and appropriately **DISPLAY** calculations and solution paths are accurate and efficient

Visualizing the Writing

Squares To Stairs



For the above situation, answer the following questions.

- Describe how you see the pattern growing?
- How many squares are in figure 10? **Write a convincing argument to prove your conclusion.**

  Make sure you justify your conclusions with evidence from the drawings.
- How many squares are in figure 55? **Explain how you know.**
- Can you use 190 squares to make a stair-like structure? Mathematically justify your answer.

Write about Text in Mathematics

Writing About Text (Graphs, Charts, Tables, and Equations) in Mathematics

Probe Vocabulary in Equation/Problem

- "Are we clear on the meaning of all of the words?"

Understanding the Problem:

- "Can you paraphrase the problem?"
- "Can you explain the meaning of the variables in the context of this problem?"
- "Can you explain the meaning of the numbers in the equation?"

Supporting Your Claim:

- "How did you solve this?"
- "Does your answer make sense?"
- "Is there another way to solve it?"

Writing Prompt About a Graph:

- "In your own words, how would you describe this graph?"

Inferencing Information from a Graph:

- "What conclusions can you obtain from the graph?"

Citing Textual Evidence from a Graph:

- "Use evidence from the graph to convince someone else of your conclusion?"

Writing Prompt about a Table:

- Write a story using the data from a table.

Write to Stimulate "Deep Thinking" about Mathematics

Stimulate thinking by asking open-ended questions

How else could you have …?	How are these _____ the same?
How are these _____ different?	About how long …? (many, tall, wide, heavy, big, more, less, etc.)
What would you do if …?	What would happen if …?
What else could you have done?	If I do this, what will happen?
Is there any other way?	Why did you …?
How did you …?	

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More Prompts to Use for Writing in Mathematics

To help students share their representations….	Ask - Which way (e.g., picture, model, number, sentence) best shows what you know? Why?
To help students reflect on their work….	Ask - What were you thinking when you decided to use a certain strategy when solving your problem?
To help students make connections….	Ask - How is this like something you have done before?
To help students make predict or invent….	Ask - What decisions can you make from the pattern that you discovered?

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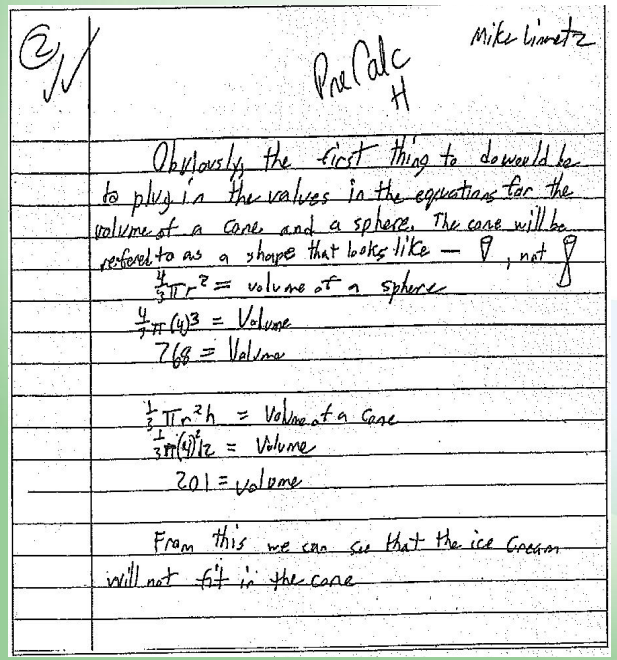
Student Samples

The Ice Cream Cone:
You may or may not remember that the volume of a sphere is 4/3 πr^3 and the volume of a cone is ⅓ $\pi r^2 h$. Consider the *Ben and Jerry's* ice cream sugar cone, 8 cm in diameter and 12 cm high, capped with an 8 cm in diameter sphere of deep, luscious decadent, rich, triple chocolate ice cream. If the ice cream melts completely, will the cone overflow or not? Explain your reasoning and show your work.



2

PreCalc H

Mike Linetz

Obviously the first thing to do would be to plug in the values in the equations for the volume of a cone and a sphere. The cone will be referred to as a shape that looks like —, not

$\frac{4}{3}\pi r^3$ = volume of a sphere

$\frac{4}{3}\pi(4)^3$ = Volume

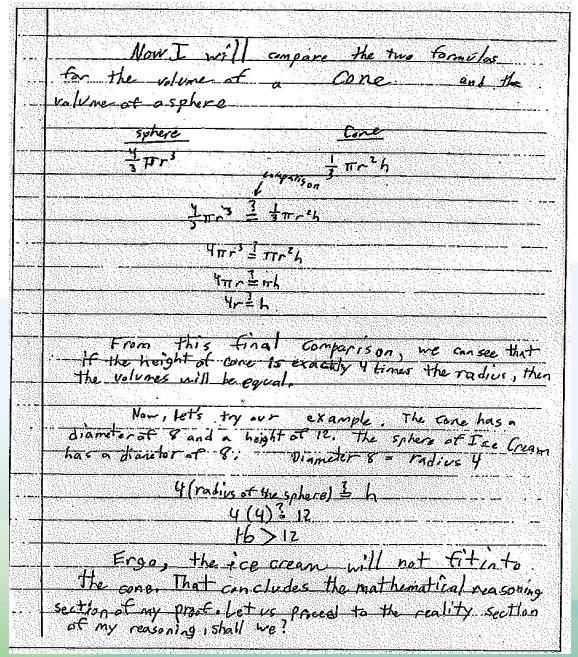
768 = Volume

$\frac{1}{3}\pi r^2 h$ = Volume of a Cone

$\frac{1}{3}\pi(4)^2 12$ = Volume

201 = volume

From this we can see that the ice cream will not fit in the cone



Now I will compare the two formulas for the volume of a cone and the volume of a sphere

sphere	Cone
$\frac{4}{3}\pi r^3$	$\frac{1}{3}\pi r^2 h$

comparison

$\frac{4}{3}\pi r^3 \stackrel{?}{=} \frac{1}{3}\pi r^2 h$

$4\pi r^3 \stackrel{?}{=} \pi r^2 h$

$4\pi r \stackrel{?}{=} \pi h$

$4r \stackrel{?}{=} h$

From this final comparison, we can see that if the height of cone is exactly 4 times the radius, then the volumes will be equal.

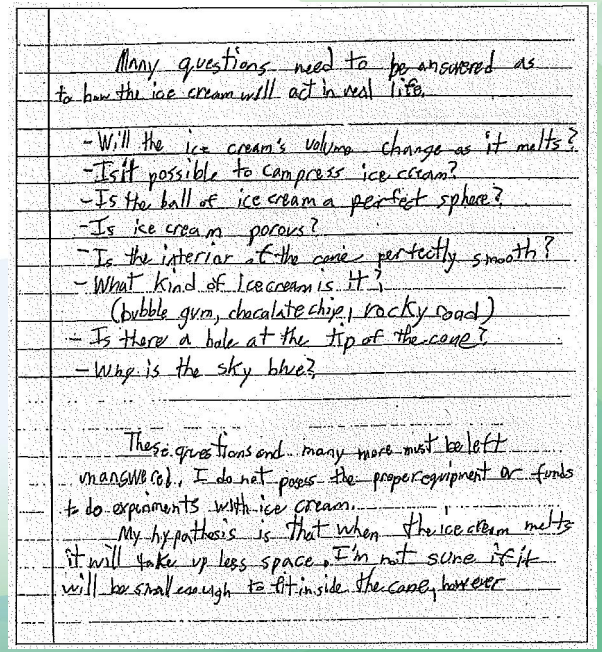
Now, let's try our example. The cone has a diameter of 8 and a height of 12. The sphere of Ice Cream has a diameter of 8. Diameter 8 = Radius 4

4 (radius of the sphere) $\stackrel{?}{=}$ h

$4(4) \stackrel{?}{=} 12$

$16 > 12$

Ergo, the ice cream will not fit into the cone. That concludes the mathematical reasoning section of my proof. Let us proceed to the reality section of my reasoning, shall we?



Many questions need to be answered as to how the ice cream will act in real life.

- Will the ice cream's volume change as it melts?
- Is it possible to compress ice cream?
- Is the ball of ice cream a perfect sphere?
- Is ice cream porous?
- Is the interior of the cone perfectly smooth?
- What kind of ice cream is it? (bubble gum, chocolate chip, rocky road)
- Is there a hole at the tip of the cone?
- Why is the sky blue?

These questions and many more must be left unanswered. I do not possess the proper equipment or funds to do experiments with ice cream.

My hypothesis is that when the ice cream melts it will take up less space. I'm not sure if it will be small enough to fit inside the cone, however

From "Sensible Mathematics" by Steve Leinwand (2012)

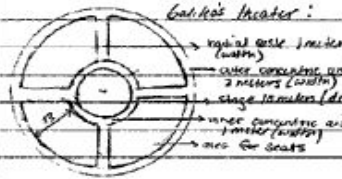
Student Sample

note: The figures on this page are not drawn to scale.

Discussion!

The first thing our group did was draw a diagram of the problem as we saw it.

Galileo's theater:

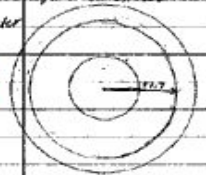


we proceeded in figuring out how many seats per row and how many rows! we needed knowing that our goal for number of seats was 1000, and the specification was no more than 30 seats in a row.

First, we tackled the question of how many sets of 4 rows we could fit into our plan for the theater. We took the length of the area made for the seats (13) and divided by .9 meters (90 cm - the required depth of seats). We got 14.$\overline{44}$ sets of rows. Now, .$\overline{44}$ could be a row, so we just made the outer most concentric aisle 2.4 meters. This made the length to fit the sets of rows 12.6 which when divided by .9 is exactly 14.

Our next task was to find out how many seats per row we had. We know that the number of seats per row would increase as the rows were further + further away from the stage. We also know that the most seats, we could have per row was 30. So we checked the outer most row to make sure that we hadn't exceeded 30 seats per row. We calculated the circumference of the outer part of the 13th set of rows

Galileo's theater



$2(17.7)\pi$ = circumference = 111.21238

Then we subtracted 4 from this number (the approximate width of the 4 radial aisles). To this number, we divided by .6m (60 cms → the specified width of the seats. This gave us the total amount of seats in all four rows, so we rounded the number (you can't have .8 of a seat) and divided by 4 (to get the number of seats per row). We ended up with 44 seats per row.

Mathematical Process

Calculations and Interpretations

Characteristics of Effective Writing Instruction

"Writing has to be learned in school very much the same way that it is practiced outside of school. This means that the writer has a reason to write, an intended audience, and control of subject and form. It also means that composing is staged across various phases of rumination, investigation, consultation with others, drafting, feedback, revision, and perfecting."

-James Moffett

Production and Distribution of Writing

Revisit your beliefs about the teaching of writing...

Resources

DPI ELA

http://dpi.wi.gov/ela

DPI Math

http://dpi.wi.gov/math

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