Improving Math and Literacy through Writing

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Response to Intervention
Wisconsin’s Foundational Documents

English Language Arts

**Wisconsin’s Vision for English Language Arts**

- English Language Arts is an integrated discipline
- English Language Arts instruction builds an understanding of the human experience

- Literacy is an evolving concept, and becoming literate is a lifelong learning process
- Critical thinking and problem solving, communication, collaboration, and creativity are aspects of effective English Language Arts instruction and attributes of WI graduates
- Literacy, language and meaning are socially constructed and are enhanced by multiple perspectives

**Students in Wisconsin...**
1. Demonstrate independence.
2. Build strong content and knowledge.
3. Respond to the varying demands of audience, task, purpose and discipline.
4. Comprehend as well as critique.
5. Value evidence.
6. Use technology and digital media strategically and capably.
7. Come to understand other perspectives and cultures.
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)
Constructing (and more gathering)
Constructing
Finishing and Presenting
What is “text” in Mathematics?

Standards for Mathematical Practice

Incorporating Writing in Mathematics
Incorporating Writing into Mathematics Instruction

<table>
<thead>
<tr>
<th>The Writing Process in Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish the purpose for writing in math class.</td>
</tr>
<tr>
<td>Encourage students to use words, numbers, and, if they like, pictures to provide as much information as possible to explain their thinking.</td>
</tr>
<tr>
<td>Post useful mathematics vocabulary.</td>
</tr>
<tr>
<td>Have students share their writing in pairs or small groups for feedback.</td>
</tr>
</tbody>
</table>

Burns, “Writing in Math”, Educational Leadership, October 2004
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 and 6 to the Writing Process
Standards for Mathematical Practice #1

Problem Solving

Mathematically proficient students can...

- Identify and Execute
- Understand and Connect
- Explain
- Check for Accuracy
- Analyze
- Evaluate
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.
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

Standards for Mathematical Practice #1

Persevering
Mathematically Proficient students can...

- **EXPLAIN** the problem to themselves.
- **ORGANIZE** information...
- **MONITOR** their work
- **ASK** themselves/others, “Does this make sense?”
- **CHANGE** their plan based on responses from others
- **CHECK** Is my answer correct?
- **EVALUATE** What worked/didn’t work?

Standard for Mathematical Practice #1

**Use Writing to Explain**

**Use Writing to Monitor Student Work**

**Use Writing to Evaluate/Check Work**
Standards for Mathematical Practice #6

Understand Symbols
Precise Explanations
Communicate Clearly
Calculate Accurately
Use Definitions and Vocabulary
Teachers who are developing students’ capacity to "attend to precision" focus on clarity and accuracy of process and outcome in problem solving.
Connecting Practices to Writing

Mathematically Proficient students can...

- **USE** correct math vocabulary with clear definitions
  (Revising and Editing Writing)

- **UNDERSTAND** the meaning of symbols

- **DETERMINE** labels from context of a given problem
  (Interpreting from Writing)

- **INTERPRET** correct units of measure from context

- **ENSURE** and appropriately **DISPLAY** calculations and solution paths are accurate and efficient
  (Visualizing the Writing)

Standard for Mathematical Practice #6
For the above situation, answer the following questions.

● Describe how the block pattern is changing from one case to the next.

● What would case 100 look like? How many blocks would it have? How do you know?

● What does case 0 look like? How do you know?
Writing 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

<table>
<thead>
<tr>
<th>How else could you have ...?</th>
<th>How are these ____________ the same?</th>
</tr>
</thead>
<tbody>
<tr>
<td>How are these ____________ different?</td>
<td>About how long ...? (many, tall, wide, heavy, big, more, less, etc.)</td>
</tr>
<tr>
<td>What would you do if ...?</td>
<td>What would happen if ...?</td>
</tr>
<tr>
<td>What else could you have done?</td>
<td>If I do this, what will happen?</td>
</tr>
<tr>
<td>Is there any other way?</td>
<td>Why did you ...?</td>
</tr>
<tr>
<td></td>
<td>How did you ...?</td>
</tr>
</tbody>
</table>
More Prompts to Use for Writing in Mathematics

<table>
<thead>
<tr>
<th>Prompt</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>To help students share their representations....</td>
<td>Ask - Which way (e.g., picture, model, number, sentence) best shows what you know? Why?</td>
</tr>
<tr>
<td>To help students reflect on their work....</td>
<td>Ask - What were you thinking when you decided to use a certain strategy when solving your problem?</td>
</tr>
<tr>
<td>To help students make connections....</td>
<td>Ask - How is this like something you have done before?</td>
</tr>
<tr>
<td>To help students make predict or invent....</td>
<td>Ask - What decisions can you make from the pattern that you discovered?</td>
</tr>
</tbody>
</table>
**The Ice Cream Cone:**

You may or may not remember that the volume of a sphere is \(\frac{4}{3}\pi r^3\) and the volume of a cone is \(\frac{1}{3}\pi r^2h\). 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.

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**From "Sensible Mathematics" by Steve Leinwand (2012)**
The first thing our group did was draw a diagram of the problem as shown. Then we proceeded in figuring out how many seats per row and how many rows there would need to be, knowing that the length of the area made for the seats was 100m. We calculated this by looking at the required number of seats, which was 1000, and divided this by the length of one seat, which was 50cm. This gave us the number of seats per row.

Our next step was to find out how many seats per row we had. We knew that the number of seats per row would decrease as we rows went further away from the stage. We also know that the last row, we could have zero seats per row.

So we counted the outer most row to make sure that we hadn’t exceeded the seats per row. We subtracted the circumference of the outer part of the 15th row from the specified width of the seats. This gave us the total amount of seats in all four rows. So we divided the number by 4 to get the number of seats per row, which we ended up with 17 seats per row.
“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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