**Promoting Critical Writing and Reflection**

When we write, we discover what we think. Writing is both a tool for and an outcome of learning. The Common Core State Standards for Writing emphasize writing in both ways. Writing is a way of “offering and supporting opinions, demonstrating understanding of the subjects they are studying, and conveying real and imagined experiences and events” (p. 18). Likewise, writing allows students to “develop the capacity to build knowledge on a subject through research projects and to respond analytically to literary and informational sources” (p. 18).

**Common Core State Standards: Writing**

According to the CCSS, strong and literate writing includes four different domains:

- **Various text types and purposes:**
  - clear arguments with supportive claims, logical reasoning, and ample evidence
  - informative/explanatory texts that convey complex ideas
  - narratives with rich details and clear sequencing

- **Production and distribution of writing:**
  - coherent writing that is appropriate to audience and purpose
  - planning, revising, editing, and rewriting process
  - use of technology to publish and collaborate

- **Use of research to build and present knowledge:**
  - research projects based on significant questions
  - use and analysis of research materials
evidence from literary or informational texts as support

- **A wide range of writing** over extended and short time frames

The Common Core State Standards provide standards that break down the four domains so that students are college and career ready in writing by the time they graduate.

As it does in the other knowledge strands, the Common Core State Standards alter the emphasis to critical thinking. In writing, this means an emphasis on logical argument and informative and explanatory writing. In math, this means writing arguments that are focused on discipline-specific content and writing informational texts that include the explanation of mathematical procedures. “The ability to write logical arguments based on substantive claims, sound reasoning, and relevant evidence is a cornerstone…with opinion writing—a basic form of argument—extending down into the earliest grades” (CCSSI, 2011). Research projects, both short and long, are also emphasized in order to promote written analysis and presentation.

**Strategies for Writing and Reflection in Math**

Mary Lee Barton and Clare Heidema consider the power of writing in mathematics in their book *Teaching Reading in Mathematics* (2002): “Writing activities can engage students in thinking about a concept and can help them examine more deeply the concept as they collect data or work with examples. Formulating explanations through writing helps students know if they really understand a concept. Writing can be used as a way to self-evaluate as students reflect on what they have learned” (p. 132).

As in all other subject areas, the CCSS emphasizes the importance of critical thinking. According to the CCSS for Mathematics (CCSSM), “one hallmark of mathematical understanding is the ability to justify, in a way appropriate to the
student’s mathematical maturity, why a particular mathematical statement is true or where a mathematical rule comes from” (CCSSI, 2011).

In particular, the standards for mathematical practice in the CCSS describe proficient math students as people who can “understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is” (CCSSI, 2011).

Writing is an essential tool in developing this kind of math proficiency. Some of the following strategies can help.

Written Explanations

Having students write explanations of math problems or processes in prose is one of the most basic and most important ways to foster students’ critical thinking skills. This can take a variety of forms:

- In word problems, ask students to explain their answers in detail, rather than coming up with a number only.
- Have students explain and illustrate two different approaches to solving a problem.
- Have students explain what strategy they used to solve a problem and why they chose this strategy.
• Have students explain why they came to a certain conclusion about a math problem or process.

Learning Logs

A learning log can be a powerful tool for helping students to think deeply in mathematics before, during, and after reading or learning. After assigning a topic, give students time to think about their response. Then give them time to write about the topic. Later, have students reread what they have written in their learning logs to reflect on how their ideas have stayed the same or changed.

Here are several examples of writing topics for learning logs:

<table>
<thead>
<tr>
<th>Before reading/learning</th>
<th>During reading/learning</th>
<th>After reading/learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe when you use algebra at home.</td>
<td>Write a story problem in which you need to calculate the area of a complicated space.</td>
<td>Explain how you would do this calculation in your head.</td>
</tr>
</tbody>
</table>

Another idea for a learning log is a “climbing and diving” activity in which students engage with a topic. In *Using Writing in Mathematics to Deepen Student Learning*, (2009) author Vicki Urquhart provides the following example of such an activity: “Following a unit on the area of polygons, students spend 10 minutes writing everything they learned, including formulas and descriptions. They then read over their writing and select one idea to explore further, such as why the formula to determine the area of a triangle works for all triangles, regardless of time. The second 10-minute writing allows them to justify their thinking or reflect on their understanding” (p. 12).
RAFT (Role-Audience-Format-Topic)

In the RAFT strategy, students use writing to apply concepts they have learned to new contexts. Using RAFT, students critically consider their role as a writer, the audience they are writing for, the various forms of writing, and the topic they will be writing about. RAFT writing prompts help students to consider multiple perspectives and purposes.

The RAFT writing strategy has four components that help students to digest information as both readers and writers:

- **Role** of the writer—Who are you as a writer? Are you a reporter? An observer? An eyewitness?

- **Audience**—Who are you writing for: teacher, classmates, abstract concepts, objects?

- **Format**—What form will your writing take: essay, article, letter, diary, instructions?

- **Topic**—What is the subject of the writing?

Brainstorm together or assign a topic based on concepts you want students to learn. Then have students think about RAFT and choose a role, an audience, a format, and a topic to respond to the text. For example, students who are studying the importance of functions might use RAFT as follows (Barton and Heidema, 2002, p. 140):

- **Role**—function

- **Audience**—relations

- **Format**—article

- **Topic**—argue the importance of functions
Reasons and Evidence Chart: Supporting a Claim

The CCSS emphasizes the importance of supporting a point of view or argument. To help students think about and organize their support, encourage them to use a chart like the following:

<table>
<thead>
<tr>
<th>Opinion or Argument:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reasons</td>
</tr>
</tbody>
</table>

A Note on Reflection

Although the Common Core State Standards do not target reflection as a specific knowledge area, reflection in all of the knowledge strands—reading, language, speaking and listening, and writing—promotes literacy in students. As students reflect, they make inferences and draw conclusions, revise their thinking, extend and refine their knowledge, and analyze information. Many of the approaches you have already learned in this course promote reflective thinking through all the reading stages, for example, pre-reading questions that ask students to make predictions, during-reading questions that ask students to consider their impressions before the reading is even completed, and post-reading questions that ask students to consider how their ideas may have changed after reading a text.

As you guide your students toward true literacy, consider how often you use reflective questions in your classroom. Are you too often asking factual questions? Are you accepting student answers without requiring support for them? Do you
encourage students to think on a metalevel about their own understanding by asking them to identify strategies that help them?