Fostering Deep Comprehension in the Math Classroom

In the last module, you read about the importance of text complexity in creating truly literate students who are ready to live and work in the 21st century. Critical to reading complex texts, of course, is student understanding of these texts. Students “must show a steadily growing ability to discern more from and make fuller use of text, including making an increasing number of connections among ideas and between texts, considering a wider range of textual evidence, and becoming more sensitive to inconsistencies, ambiguities, and poor reasoning in texts” (Common Core State Standards Initiative, 2010, p. 8).

Literacy in Mathematics: Reading

Reading in mathematics poses unique issues that are not encountered in other subject areas. For example, in other subjects, students can read and comprehend texts by reading left to right. In math, though, students must read from left to right, from right to left, vertically, and sometimes diagonally. In addition, mathematical texts are often very dense, containing several abstract concepts and important vocabulary in compact sections. Unlike in other texts, math concepts are rarely repeated or explained in alternative contexts (Barton and Heidema, 2002).

Mathematics also requires students to decode not only words but numbers and symbols. And, as students progress toward more complex math concepts, those symbols begin to represent multiple functions. For example, the minus sign in an equation represents subtraction, but later in math the same symbol can represent a negative number. Therefore, the role of the math teacher as a reading teacher becomes critical to student success in mathematics.
**Common Core State Standards: Reading**

As previously noted, the reading standards address English language arts, history/social studies, science, and technical subjects but not mathematics specifically. Because most K-5 teachers cover all core academic subjects in their classrooms, they may have greater latitude when blending reading into their math lessons.

How math teachers in grades 6-12 bring reading skills out may vary more widely. For example, a math teacher co-teaching with an English language arts teacher may decide to approach the reading standards through an ELA framework. Math teachers who do not co-teach may start with the CCSS for Math practice standards (or their school or district’s reading and literacy initiatives) when deciding how to blend reading into their classes. In this course, we will often use the standards for science and technical subjects in our discussions because 6-12 math teachers may find these most relevant to their classroom needs.

Regardless of the approach, there is no doubt that the CCSS places a great emphasis on the engagement with informational texts in various content areas. As you consider the reading standards, focus especially on how these standards will apply to the kinds of texts that students will read in your classroom.

According to the CCSS, comprehension of all types of texts includes four different domains:

- The ability to determine **key ideas and details**:
  - what is clearly stated versus what is inferred
  - textual evidence that supports conclusions
  - analysis of people, events, and ideas
• An understanding of the **craft and structure**:  
  - word choice and tone—connotative, literal, and figurative  
  - analysis of structure  
  - point of view and style

• The **integration of knowledge and ideas** in various content formats:  
  - evaluate content from diverse media  
  - evaluation of arguments and reasoning  
  - comparison of texts

• A **wide range of reading and text complexity**, including literary and informational texts

The Common Core State Standards break these four domains down into clear and usable grade-level standards. For example, the reading standards for literacy in science and technical subjects include “key ideas and details” standards, in which students read closely to determine what the text says explicitly and to make logical inferences from it, as well as cite specific textual evidence when writing and speaking to support conclusions drawn from the text.

Here’s an example of the same basic “key ideas and details” standard written for grade 5 and the middle and high school grade-level spans. Notice how the standard—which is focused on analyzing how and why ideas develop and interact over a course of text—develops through the grades. In grade 5, students explain relationships or interactions between ideas or concepts in the text. By grades 11 and 12, students are following complex, multistep procedures to take measurements or perform technical tasks and analyzing results based on explanations in the text.
A Comprehension Focus

Before teachers can get down to the nitty-gritty of using comprehension strategies in the classroom, they need to think about the overall environment in their class. Is it conducive to successful comprehension for all students? In their article “Reading Comprehension: What Works” (1994, p. 65), authors Linda G. Fielding and P. David Pearson suggest four components to any successful comprehension instruction:

- **Ample amounts of reading time**—Students need to practice reading, and they need to be engaged in what they are reading. As they read, they gain knowledge.

- **Comprehension strategies**—Teachers cannot assume that students will understand what they read. Instead, teachers should provide (and model for) students with specific strategies that will help them before, during, and after their reading. (See below for specific strategies.)

- **Peer and collaborative learning**—Students rarely learn best in isolation. In more cooperative learning activities, students build community and learn about a text through other people’s thinking processes.

- **Discussion with teachers and peers**—Comprehension is aided in group discussions, particularly when the teacher does not control the discussion or force an interpretation of a text (p. 65).
Text Structure and Math

The content structure of math texts is very different from other texts that students read. In *Teaching Reading in Mathematics* (2002), authors Mary Lee Barton and Clare Heidema identify some of the most common text types or patterns that students encounter in math (p. 26-27):

- **Expositions**—explanations of concepts, methods, vocabulary, rules, etc.
- **Instructions**—descriptions of how to perform a task; despite seeming straightforward to teachers, these can often be problem areas for students who do not understand how to read instruction patterns.
- **Exercises and examples**—simple and complex problems, including computation.
- **Peripheral writing**—various introductions, observations, rhetorical questions, or other information that students read as they move through a text.
- **Signals**—text features such as headings, subheadings, bullets, arrows, and so on.

It is important that math teachers recognize that students can comprehend math text better when they understand the organization and the presentation of the text. Researchers identify two basic types of writing found in mathematical texts: demonstrations and word problems. Textbooks use demonstration writing to walk students through processes and concepts, which are often accompanied by an example illustrating the written text.

The second kind of writing is word problems. Although in most texts the topic sentence is generally placed early in a paragraph, in word problems facts and details often appear at the beginning, and the topic sentence appears at the end (Barton and Heidema, 2002).
The unique writing style presented by word problems can best be introduced to students by using think-alouds. During a think-aloud, a teacher models her metacognitive process, explaining how she determined the question being asked, identifying which information is important and which is not, and determining which process or operation will help her find the solution.

**Pre-reading, During-reading, and Post-reading Stages**

Think about the reading process as having three different stages—pre-reading, during-reading, and post-reading. Each of these stages provides opportunities for students to engage with the text and deepen their comprehension of the subject matter. The following table defines the three stages of reading that math students should attend to:

<table>
<thead>
<tr>
<th>Stage 1: Pre-Reading</th>
<th>Stage 2: During-Reading</th>
<th>Stage 3: Post-Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students assess what prior experience they’ve had with similar problems or the content being taught, and then establish a purpose for reading.</td>
<td>Students determine their level of comprehension by visualizing, drawing a sketch and labeling key information, clarifying areas that are still confusing, and determining the best process to engage with the text.</td>
<td>Students work the problem and check their reasoning, by asking questions such as “What process did I use? Why did I choose that process? Was my reasoning correct?” They also share and compare their reasoning with someone else.</td>
</tr>
</tbody>
</table>

These simple strategies can assist students in comprehending math texts and can be easily implemented into any lesson plan. These strategies help students connect with the ideas presented in the text and support students in reading complex math text closely, with attention to detail. The skills they learn through these strategies will be invaluable not only in school, but later in life, as well.
Math Comprehension Strategies

Let’s take a look at a few specific comprehension strategies that require students to read actively. Remember to consider the type of text students are reading and the objective set for reading that text before choosing the strategy students will use.

K-N-W-S

After giving students a word problem, invite them to look carefully at the information before beginning to solve the problem. Students can work in groups to complete the K-N-W-S chart (such as the one below) and then discuss with their groups how they knew what to put in each column.

<table>
<thead>
<tr>
<th>K</th>
<th>N</th>
<th>W</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>What facts do I KNOW?</td>
<td>What Information is NOT needed?</td>
<td>WHAT does the problem ask me to find?</td>
<td>What STRATEGY will I use to solve the problem?</td>
</tr>
</tbody>
</table>

Anticipation Guide

An anticipation guide is a pre-reading activity that motivates students to anticipate or predict what is going to be happening in a text before they ever begin reading it. Teachers provide specific guiding statements that activate what students already know about the topic.

An anticipation guide can also help stimulate student interest in a topic. Before they read, students react to the various statements, develop a response, and prepare to defend their answers during a small-group or whole-class discussion. After a discussion, students can read the selection and find evidence to support their beliefs.
Here is an example of an anticipation guide for statistics (Barton and Heidema, p. 97).

<table>
<thead>
<tr>
<th>Anticipation Guide</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Directions:</strong> In the column labeled <em>Me</em>, place a check next to any statement with which you agree. After reading the text, compare your opinions about those statements with information in the text.</td>
<td></td>
</tr>
<tr>
<td>Me</td>
<td>Text</td>
</tr>
<tr>
<td>_____</td>
<td>_____</td>
</tr>
<tr>
<td>1. There are several kinds of averages for a set of data.</td>
<td>1. There are several kinds of averages for a set of data.</td>
</tr>
<tr>
<td>2. The mode is the middle number in a set of data.</td>
<td>2. The mode is the middle number in a set of data.</td>
</tr>
<tr>
<td>3. Range tells how far apart numbers are in a set of data.</td>
<td>3. Range tells how far apart numbers are in a set of data.</td>
</tr>
<tr>
<td>4. Outliers are always ignored.</td>
<td>4. Outliers are always ignored.</td>
</tr>
<tr>
<td>5. Averages are always given as percents.</td>
<td>5. Averages are always given as percents.</td>
</tr>
</tbody>
</table>

**SQ3R (Survey-Question-Read-Recite-Review)**

SQ3R is a strategy that spans all the stages of the reading process. After assigning a text passage, students do the following (with you modeling the step if they are not familiar with the strategy):

- **Survey**—Survey what you are about to read by considering the title, headings, illustrations, first paragraph, and last paragraph.
• **Question**—Develop a question that reflects the purpose of reading. Record other questions that arise during the survey step. A good place to start is to have students turn the subheadings into questions. Students may also pose questions regarding illustrations, diagrams, graphs, and so on. Write down unfamiliar vocabulary and find meanings.

• **Read**—As students read, they look for the answers to their questions. Record new questions that arise in response. Use context clues to help understand new vocabulary words.

• **Recite**—Without looking at the text, recall what it was about. Articulate answers to questions. Reread if necessary to answer questions.

• **Review**—Answer questions about the purpose for reading the text. Review written answers. Summarize the main information in the text through various means such as flow chart, graphic organizers, written summaries, or group discussion.

**SQRQCQ (Survey-Question-Read-Question-Compute-Question)**

This technique helps students analyze mathematical word problems.

• **Survey**—Survey the problem. Find and read the question sentence.

• **Question**—Ask yourself, “What is this problem asking me to find?”

• **Read**—Read the entire problem. Explain how to find which information is important and which is not.

• **Question**—Ask yourself which process you will use to solve the problem.

• **Compute/construct**—Work the problem by constructing a solution.

• **Question**—Review written answers. Ask yourself whether the process and answer seem correct, accurate, and reasonable.
There are a plethora of comprehension strategies from which to choose. The primary intention of the CCSS reading standards is to teach students to actively read a wide range of texts. Students should attend to the text as directed by the teacher, who asks text-based questions and requires students to identify evidence from the text to support their answers. As students learn to read closely and purposefully, they will become able to handle and comprehend increasingly more complex texts.