

# CONTENT-RICH LITERACY IN MATHEMATICS

## WHAT IS MATHEMATICAL LITERACY

The idea of students being “math literate” is not a new one. Researchers and professional organizations have advocated for mathematical literacy standards for more than twenty years (NRC, 2001; NCTM, 2000; Pugalee, 1999). Why? One only need look at national assessments in math. On national tests, nearly two-thirds of fourth graders and almost three-fourths of eighth graders are not proficient in math (NAEP, 2019). A 2013 National Assessment of Educational Progress (NAEP) item analysis indicated more than half of fourth graders could not accurately read the temperature on a thermometer and three-fourths of fourth graders could not solve a simple word problem (Green, 2014). A shift from a traditional pedagogy of math is needed. Oklahoma has incorporated the research of the National Council of Teachers of Mathematics (NCTM, n.d.) and the Five Mathematical Proficiencies of the National Research Council (NRC, 2001) to address the needs of Oklahoma math students. Oklahoma Academic Standards for Mathematics identify seven actions and processes for students to become math literate. They are: 1) develop a deep and flexible conceptual understanding, 2) develop accurate and appropriate procedural fluency, 3) develop problem-solving strategies, 4) develop mathematical reasoning, 5) develop a productive mathematical disposition, 6) develop the ability to make conjectures, models, and generalize, and 7) develop the ability to communicate mathematically (OAS, 2016, p. 7). Mathematics mastery cannot be separated from literacy skills—reading, writing, speaking, and listening. In today’s information-heavy and data-driven society, literacy skills equal life skills (Wendt, 2013).

## WRITING MATHEMATICALLY

Writing is the process in which students write their thoughts in a logical and coherent fashion (Ming, 2012). Math teachers sometimes experience a phenomenon where students can ace a test but then not be able to explain their reasoning of how they arrived at the answers. More writing in the classroom is an attempt to solve this dilemma.

What does writing mathematically look like? It is the ability for students to create drawings, pictures, tables, graphs, or other visual representations of mathematical concepts. It is the ability to explain and write problem-solving methods and justifications of processes and it is the ability to reflect upon their learning (Haltiwanger & Simpson, 2013). Writing also encourages students to use academic vocabulary appropriately and concisely. Ming (2012) suggests having students write poetry to explain math

concepts, create paragraphs about the procedures or solutions to problems, and keep a notebook for strategies, vocabulary, and reflection of what they learned (p.215).

Initially, students may need support in writing mathematically. Sentence stems, sentence frames, and graphic organizers offer tools for students who find it difficult to express their ideas in writing.

## **READING MATHEMATICALLY**

Reading mathematically is somewhat different from basic reading comprehension. Research has shown that math text contains more concepts per sentence and paragraph than other forms of text (Kenney et al., 2005). Students must be able not only to comprehend the vocabulary and reading itself, but also transform this information into mathematical symbols and processes. One literacy strategy that has been found useful is the K-W-H-L chart as a pre-reading intervention (Phillips et al., 2009). First, students identify words that they may not know in the text and the teacher facilitates understanding of the unknown or unfamiliar words. Students then read the text and jot down what they do know (K), what they are trying to find out (W), and how (H) they might arrive at a solution. Several research studies point to the use of “think alouds” when reading math text. The teacher thinks aloud how he or she might approach and solve a mathematical text or problem. Students are encouraged to use the “think aloud” model whenever they are trying to solve a mathematical text or problem (Ming, 2012; Phillips et al., 2009).

Students often see math as isolated and somewhat removed from the real world. How do we use math in real life? Bringing relevant text, charts, and tables into the classroom is an important step in making real world connections. Interpreting sales flyers and discount coupons, analyzing the sports section or the stock market of a newspaper, balancing a real or online checkbook, determining distance, cost, and timetables for travel are just a few examples of using applicable mathematical text.

## **MATH LITERACY IS COMMUNICATIVE & COLLABORATIVE**

Communication is a tool that helps students develop their mathematical understandings (Pugalee, 2001). Students need to discuss math to clarify their thinking, build upon their math reasoning, and generalize their knowledge to new situations.

Mathematical literacy involves students working, conversing, and collaborating with peers.

Collaboration occurs when students work together to solve a problem or achieve a goal (Ming, 2012).

This requires a dramatic shift in the classroom from an “I, We, You” pattern to a more student-centered

one. In an “I, We, You” classroom, the teacher demonstrates a new procedure or topic [I]; the teacher and the students work sample problems together [We]; and students work through similar problems on their own [You]. In a math literate classroom, the shift is to a “You, Ya’ll, We” pattern. Individually students are given a problem or real-world situation to struggle with [You]; students actively share and collaborate with peers to discuss their potential solutions and then come to a consensus [Ya’ll]; students discuss and share as a class their possible solutions [We] (Green, 2014). Inherent in group work, math literacy assumes that students may have differing perspectives to solve a problem or achieve a goal which actively encourages a variety of solutions.

One instructional strategy that supports collaboration is *word problem roulette* (Haltiwanger & Simpson, 2013, p. 492). Students work in heterogeneous groups of no more than four to solve a word problem. They discuss the problem together and reach a consensus on a possible solution. The students then break down the solution into at least four steps and each student takes a turn writing one step toward solving the problem. This strategy encourages students to think aloud, to analyze the best problem-solving approach, and to reach a consensus with their peers. Another collaborative, problem-solving strategy is progressive jigsaw. Students work together in a group to develop a process for solving a problem. Then two representatives from each group move to a new group and discuss their process or approach with the new group. The group determines whether this new information supports solving the problem and should be considered. This progression continues until the ideas of all groups are shared and diffused throughout the class.

## CONCLUSION

Math literacy expands beyond the confines of computational skills to more reliance on real-world application and math sense making (Green, 2014). An adult workforce needs citizens who can adapt to new technologies, identify problems, reason through those problems, and communicate their findings mathematically. This continues to be the goal and the challenge.

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