Content-Area Literacy: Mathematics

By: Carol Lee and Anika Spratley (2009)

Of all the academic disciplines taught in middle and high school, the one we least expect to entail reading extended texts is in mathematics, but math texts present special literacy problems and challenges for young readers.

In this article:

Introduction

We expect students to face reading comprehension challenges in understanding word problems, for example, and to face some difficulties in understanding the texts and graphic illustrations in mathematics textbooks. But mathematics texts present special literacy problems and challenges for young readers.

The standards of the National Council of Teachers of Mathematics (NCTM) refer to mathematics as a language and a form of communication. These standards suggest using fictional literature that embodies mathematical ideas in the elementary school grades to help children make initial connections between mathematics and the real world. However, what these linkages might mean at the secondary school level remains unexplored.

Math textbooks

Most discussions on reading in mathematics in schools have focused on textbooks. Students are taught to identify the functions of prototypical sections of mathematics textbooks — general statements, use of bold print, definitions, examples, explanations, summaries, margin notes, diagrams — in order to know what kind of information they are reading to understand. Also, many studies employ generic reading strategies, supporting students in previewing, making prediction, re-reading and summarizing. These strategies are useful for tackling math textbooks, but do not necessarily help students to develop conceptual understanding, which comes only through repeated practice with problem solving.

There is no question that mathematics textbooks can serve as a significant barrier for students who are struggling readers. It is also true that students can learn mathematics procedures and concepts in the absence of understanding their textbooks, depending on how instruction is organized.

Some textbooks series explicitly emphasize reading. For example, the University of Chicago School Mathematics Project (UCSMP) organizes lessons to require independent reading in mathematics. On the website of their commercial publisher, UCMP offers the following explanation:

Q: Why is reading so important?

A: Studies have shown that students, in general, do not read traditional mathematics books. As a result, these students do not learn to become independent learners capable of acquiring mathematics outside of school when the need arises. UCSMP addresses this problem by making reading a regular part of each lesson and including questions that cover the reading. Here are some reasons for reading that teachers can give to students. You must read to succeed in future courses that use mathematics and in future jobs; because the reading will help you understand the uses of mathematics; because the reading tells you how the material from one lesson is related to other material in the book. (http://ucsmp.uchicago.edu/)

Paul Dowling conducted an examination of a variety of mathematics textbooks used in British schools. He distinguished texts routinely used in schools serving students from working class backgrounds and those in more elite schools, demonstrating that the textbooks used in more elite schools have a greater density of propositions and ground explanations with justifications based on disciplinary postulates, while the textbooks used in working class schools have less text and ground explanations in real world contexts rather than in the self-referential links to mathematical reasoning.

Researchers working on how to make math texts understandable recommend that students understand the logic of stipulated definitions, examine carefully how theorems and proofs are worked through in the examples to be sure they understand the underlying logic, use paper and pencil or calculators while they are reading to re-test and apply equations to their own examples. This is a unique and challenging process, involving a whole different logic from reading in other disciplines such as social science, history, and literature.

Mathematical language and logic

We should not underestimate the importance of our students being able to understand the language and logic of mathematics as captured in math textbooks. Without such understanding, advanced mathematics will simply not be accessible. Even if our young people do not intend to pursue careers in pure or applied mathematics or the various branches of science, taking three to four years of high school mathematics is associated with higher SAT and ACT scores for college admission and also better prepares students for college. Moreover, by successfully navigating high school mathematics courses young people will typically form a lifelong habit of reading newspaper and magazine articles that draw on mathematic evidence more critically, and this ability will help them to act as informed citizens.

John Allen Paulos, professor of mathematics at Temple University, has written widely about the impact of mathematical literacy for the public's understanding of a wide range of issues from

health to demographics, including how authors of newspaper and magazine articles can manipulate the numerical data they use to convince lay readers to support particular positions. In *A Mathematician Reads the Newspaper* (Paulos, 1996), Paulos examines newspaper articles on topics ranging from economics, business and social issues, to health and lifestyle issues, showing how readers can pose critical questions about the propositions and point of view in the articles by drawing on a basic background in the mathematics involved. Paulos also examines public discussions that use numerical data to create a sense of urgency about a particular issue, arguing that typical misunderstandings about probability often lead the public to assume that a set of outcomes or events are more probable than they actually are.

If, as a consequence of typical K-12 mathematics instruction, our high school graduates are able to develop core conceptual understanding *and* enjoy routine opportunities with support to read and critique a wide range of extended texts involving mathematical data, the types of mistaken reading assumptions Paulos cites will naturally become far less common.

There are existing projects that integrate reading in math classrooms. The Reading to Learn Mathematics Project involves helping students better comprehend the technical language, syntax and logic of math textbooks as well as learning to read a range of real life texts involving mathematics. The Project aligns reading in mathematics classrooms with inquiry-based instruction with the goals of helping students learn to think mathematically and to value both the aesthetics and the applicability of mathematics. The designers of this project have developed a series of functions of reading in the mathematics classroom (see the table below).

Categories of reading practices in a inquiry-oriented mathematics classroom

Category 1: Reading to make public

a. Reading to value students' meanings.
b. Reading to convey meaning.
c. Reading to get feedback.
d. Reading to make a presentation.
e. Reading to demonstrate one's thinking.

Category 2: Reading to comprehend

a. Reading generatively to make sense of text.
b. Reading to understand and follow directions.
c. Reading to make a decision.
d. Reading the teacher's comments to get the message.
e. Reading to make sense of graphic/visual text.
f. Reading critically and reflectively to make a decision that affects your life.
g. Reading with a focus to extract specific information.

Category 3: Reading to get an example

a. Reading a text to learn how to do something the text does.
b. Pointing to a text to show an example of something.

Category 4: Reading to generate something new

a. Reading to generate a reflective written response.
b. Reading to push something further.
c. Reading to spark an idea.
d. Reading a text representing individuals' thoughts to generate a shared text.
e. Reading to set the stage for the next activity.
f. Reading to revise a text.
g. Reading to generate an immediate response..

Category 5: Reading to remember

a. Reading reflective statements written on newsprint to value the meanings.
b. Reading to copy from the board.

Source: Siegel & Fonzi (1995, p. 644).

Just as there are good arguments regarding the inclusion of history and philosophy of science in the middle to high school science curriculum, there are also excellent reasons to call for the reading of extended texts in the history of mathematics. Reading a wide array of mathematics-centric and mathematics-related texts in the classroom can generate lifelong interest and support learning to reason mathematically.

Lee, C.D., Spratley, A. (2010). *Reading in the disciplines: The challenges of adolescent literacy*. New York, NY: Carnegie Corporation of New York.