Content Reading Skills in Mathematics

Don Kapoor
University of Regina

Words and symbols are parts of the language of mathematics. If students cannot read mathematics with understanding, they will be handicapped whether they are reading to carry out a task, for information or enjoyment, or to further their academic knowledge.

Reading mathematics is not easy. To be able to read mathematics, children must acquire some special skills. While every teacher teaches reading, the mathematics teacher has the special responsibility of teaching children to read mathematics. The reader of mathematics must:

1. possess a specialized vocabulary.
2. know the meaning and various uses of special symbols.
3. follow notational agreements and abbreviations.
4. be aware of the sequence of steps recorded when computations are displayed.

General Guidelines for Reading Mathematics

Reading SLOWLY for DETAIL

Mathematics should be read slowly and carefully - usually more than once using paper and pencil. Often, students are not aware of this. As children develop their ability to read, they are encouraged to read as rapidly as they can. When reading stories, they seldom reread. In reading mathematics, however, speed is only a minor concern. Comprehension of every detail is so important that rereading is a highly recommended procedure.

Why is it necessary to read slowly and carefully and reread passages of mathematics? The answer lies in the compactness of the symbolism, the precise meaning of most items, and the need for the reader to reason and recall relevant and previously learned information. Reasons for using this technique should be discussed with children. They must be convinced of the need to reread.

Reading QUICKLY for an OVERVIEW

In various situations, it can be advisable to have children practice a reading technique called skimming. Skimming is rapid reading to obtain a general impression.

Skimming to preview. Skimming can be useful in previewing a chapter in a mathematics textbook. It can be done by examining the chapter title, the table of contents, and page titles. This should be done with the teacher, who points out the important topics coming up.

Previewing a printed mathematics lesson alerts students to the main ideas of the lesson, to new terms, new phrases, or new principles. These ideas are usually highlighted. Previewing may also help recall related knowledge or encourage a review of forgotten material.

Reprinted from the Saskatchewan Mathematics Teachers' Society Journal *with permission of the Society and the author.*

Skimming to review. Skimming may also be used to look back over a unit of study. Under the guidance of the teacher, children can rapidly read through section headings and page titles of material, noting the topics they have studied.

Skimming to understand the organizational pattern of a book. Skimming may be useful in helping children recognize the organizational pattern of their textbook. Most mathematics textbooks follow some organizational pattern. Ideas or algorithms are usually presented in one or two ways and are followed by exercises and problems.

In general, teachers should have children skim material before they begin slow and careful reading. These two general guidelines may appear somewhat contradictory as one advises rapid reading; the other a deliberate approach. However, there is no conflict when these guidelines are applied. Students should be instructed and helped to preview material rapidly and then to read and reread slowly and carefully, making sure they understand every line.

Students will not do these things naturally. It is your responsibility to help them see the wisdom of these guidelines and to provide practice in following them.

Reading Skills in Mathematics

There are several specific skills which are necessary in order to read mathematics efficiently. In some cases, these are extensions of the skills taught in language arts; in other cases, the skills are quite different. Teachers who are planning to help children learn to read the best book need to incorporate these skills into their instruction.

Knowledge of Vocabulary

Mathematics has its own vocabulary. While many mathematical terms are borrowed from everyday English, a reader of mathematics must be skilled in knowing both the *mathematical and everyday meanings of words.* Words have many meanings. Often there is a difference between the everyday meaning and the mathematical meaning of a word. See Table 1 on the following page for examples.

In order to teach the meaning of a word, a teacher should provide:

1. Examples of objects with reasons to which the term refers, examples of objects that have the property denoted by the term, or examples of actions the term signifies.
2. Nonexamples, explaining why the object is not an example of the term you are teaching.
3. Characterizations or conditions of the concept contained in the term or object.
4. Comparisons or contrasts of a word with related words.

Practice is essential in building a vocabulary. In teaching reading and in practice sessions, include discussions and exercises on using:

1. root words
2. prefixes
3. different phrases having the same meaning.

Some examples of *root words* are: Add serves as a root, or stem, for at least six mathematical terms (add, addition, adding, addend, additive, and adds). Measure, measuring, and measurement all share a common root, as do multiple, multiplier, multiply, and multiplication.

Roots can be important clues to the meaning of a word. Students are not always aware of this. A national study of seventh and eighth grade students revealed that 98 percent knew the meaning of sum, but only 17 percent knew the meaning of summation; 92 percent reported knowing the meaning

TABLE 1.
A List of Words in School Mathematics Having an "Everyday Meaning" and a "Mathematical Meaning"

acute	commute	lateral (area)	ray
add	compass	law	real (number)
alternate (interior angle)	complement	leg	right (angle)
altitude	concave	less	(square) root
angle(s)	cone	like (fractions)	round (off)
array	convex	lowest (terms)	row
associate	correspond	major (arc)	ruler
axes	count	map	scale (drawing)
balance	cross (product)	mean	second
bar	curve	minor (arc)	set
base	degree	mixed (number)	sign
between	distance	natural (number)	similar (figures)
borrowing	distribute	negative	simple (closed curve)
boundary	divide	odd	simple (form of fraction)
braces	element	opposite	solution
cancel	even	origin	space
cardinal	exterior	perfect (number)	square
carrying	face	place	term
casting (out nines)	factor	plane	twin (primes)
check	foot	plot	union
chord	greater	point	unit
clock (arithmetic)	intercept	power	volume
closed	interior	prime	yard
column	intersect	product	
common (denominator)	intersection	property	
	invert	radical	
	irrational	rational (number)	

of equal, but only 24 percent knew the meaning of equate.

Prefixes, too, play a role in the development of vocabulary. In school mathematics, the following prefixes are common:

bi-	binary, bisect, bisection
ex-	exterior, extract, extreme, expand, exponent
in-	interior, inscribe, incentre, internal, intersect
in-	infinite, inequality
mid-	middle, midpoint
non-	nonsimple, nonnegative, nonterminating, nonmetric, nonlinear
poly-	polygon, polyhedron
re-	rename, replace, regroup
trans-	transversal, transform, transitive, translate, translation
tri-	triple, trisect, tripod
un-	unequal, undefined, unknown, unlimited, unlike

Prefixes behave much like roots and can be incorporated into practice sessions involving root words.

In addition to helping children with roots and prefixes, you should also alert them to different forms of the same terms or phrases. The following set of terms or phrases - associative, associative principle, associative law, associativity - mean

essentially the same thing. Similar sets of terms and phrases can be constructed for commutative, distributive, and transitive.

Knowledge of Symbols

Symbols are the shorthand of mathematics. Children learn the meaning of symbols and their pronunciation by means of explanation, demonstration, advice, and usage. Many mathematical symbols are used in more than one way. See Tables 2 and 3 for different uses and pronunciations. Since the use of symbols is extensive and complex, students need a great deal of practice using and recognizing them.

TABLE 2.
A List of Symbols Used in School Mathematics

0 1 2 3 4 5 6 7 8 9 10

\+ − × ÷ · :

< > ≤ ≥ = ≠

% ° $ *d* ′ ″

I II III IV V VI VII VIII IX X

Δ π → ↔

TABLE 3.
Different Uses and Pronunciations of Symbols

Different uses of "3":

3, 34, 342, 2^3, p_3, 25.3

Different uses of "−":

-4, $\frac{3}{2}$, $18-12$, $-\frac{4}{2}$, $\overline{AB}$, $.24634\overline{}$

Different uses of ".":

$.333\ldots$, $\pi \doteq 3\frac{1}{7}$, $3 \cdot 5$

Note also how 3, −, and · can all be used together:

$3 \cdot 3$, $-3 \cdot 3$, $3-3$, -3.3, $\frac{1}{3}$, b^3

Special Reading Problems

There are several reasons why computations are difficult to read. The first has to do with eye movement. See Table 4 for examples. Eye movement in reading a computation is seldom left to right. Children have to learn many different eye movement sequences - practically one for each different algorithm. Teachers must demonstrate the order for an algorithm and get students to practice following it.

Reading Graphs and Tables

Learning how to read a graph or table is an essential skill in reading mathematics and in reading periodicals, newspapers, and other printed material. Although tables and graphs can take many forms, reading them is easier if done in two steps. First, have the students skim the table or graph for the topic. Have them identify all the categories reported. Let them obtain a general impression. Then, ask for a detailed study.

Reading Word Problems

Word problems, whether they are simple applications of previously learned computational procedures or challenging *mind benders*, are an important part of a mathematics program. Problems must be read and understood before they can be worked. Children should follow the two general guidelines discussed earlier. Once they can do this, then they can move on to the algorithm needed to solve the problem. Discussion of George Poly's four phases of problem solving can be a useful exercise for setting up and solving the problem.

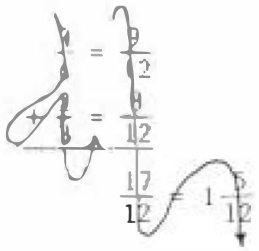
Diagnosing Mathematics Reading Problems

One way to measure a child's ability to read mathematics is to test his

TABLE 4.
Reading Computational Exercises

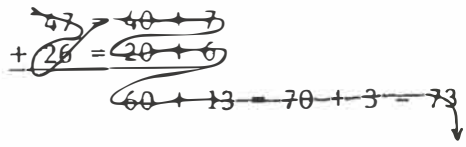
$$\begin{array}{r} \frac{3}{4} = \frac{9}{12} \\ +\ \frac{2}{3} = \frac{8}{12} \\ \hline \frac{17}{12} = 1\frac{5}{12} \end{array}$$

COULD BE READ:



$$\begin{array}{r} 47 = 40 + 7 \\ +\ 26 = 20 + 6 \\ \hline 60 + 13 = 70 + 3 = 73 \end{array}$$

COULD BE READ:



or her knowledge of the mathematical terms and symbols he or she reads. Most textbooks or teachers' guides contain vocabulary lists for this purpose at the end of each unit of study. Another method is to periodically complete a reading ability checklist on each child. This can be done by observing a child read a selected passage and respond to directions in the passage, and by talking with the child about that material that has been read. The following sample items might serve as a guide to compiling the checklist.

Basic Techniques:

1. Usually skims a passage and obtains a valid general impression of the main topic.
2. Is able to skim a passage and obtain a valid general impression of the main topic.
3. Reads at an appropriate pace for the difficulty of the material and his/her ability to understand.
4. Usually rereads material to ensure understanding.
5. Is aware of the need for skimming, careful reading, and rereading.

General Skills:

1. Realizes terms can have mathematical and nonmathematical meanings.
2. Can give a valid explanation of the mathematical term being read.
3. Can use the meaning of the roots and prefixes previously studied to explain the meaning of a term.
4. Can pronounce terms being read.
5. Can pronounce names given to symbols being used.
6. Can relate words and symbols to a picture in a given situation.

Special Skills:

1. Computations
   (a) Can read an algorithm in the proper order.
   (b) Can relate a given algorithm to a previously understood and more detailed algorithm or to the manipulation of real or pictorial objects.
2. Graphs
   (a) Can skim a graph to obtain the topic, main categories, elements in each category, and the general relationship expressed in the graph.
   (b) Can extract details from a graph.
3. Word Problems
   (a) Skims a problem to obtain a general impression, then reads and rereads the problem.

(b) Can restate a given problem in own words and identify the question to be answered.

Reading as a Teaching Technique

A primary reason why children have difficulty reading mathematics is that reading is rarely taught or utilized in mathematics classes. Children quickly learn that the most efficient way to study mathematics is to listen carefully, watch the teacher work sample problems, then go directly to the problems in the text and work through them in the same way. They see no need to develop reading skills until it is too late. If we are to change this, we must make reading the mathematics text a frequent part of in-class and out-of-class activities. We must strive to teach children skills they need to read mathematics, and we must make sure these skills are used.

Some suggested activities are:

1. Have students read the mathematics book aloud in class. Pick a page from the textbook that gives a clear explanation of the topic you want to teach. Have the students skim and state their general impression. Then have the students take turns reading portions of the page aloud. When graphs, tables, examples, pictures, or other explanatory material are referred to in the text, examine them carefully. Encourage the reader and the other students to pay attention by asking questions.
2. Have stuents read the text silently and begin working the assignment. While the students are reading and beginning to do the assignment, you should be available to answer questions. Use this time to ascertain which students have difficulty reading silently and what their specific problems are.
3. Give a homework assignment in which students learn by reading how to do the work. This procedure should be used only after students are doing well on the assignments. Make sure the students understand that they read first and work the problems afterward.

Dr. Kapoor, professor of education at the University of Regina, is currently on sabbatical leave. He serves as editor for the Saskatchewan Mathematics Teachers' Society Journal.

REFERENCES

Barney, L. "Problems Associated with the Reading of Arithmetic." The Arithmetic Teacher 19 (1972): 131-33.

Feeman, G.F. "Reading and Mathematics." The Arithmetic Teacher 20 (1973): 523-29.

Hater, M.A; R.B. Kane; and M.A. Byrne. "Building Reading Skills in the Mathematics Class." The Arithmetic Teacher 21 (1974): 662-68.

Kane, R.B.; M.A. Byrne; and M.A. Hater. Helping Children Read Mathematics. New York: American Book Co., 1974.

McKillip, Cooney, et al. Mathematics Instruction in the Elementary Grades. Glenview, Ill.: Silver Burdett Company, 1978.