Reading in Mathematics

by

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This article was first published in Teaching Mathematics, *Vol.4, No.4, May 1977, by the Mathematics Council of the NTA.*

Students, please answer the following questions: "Jane has 50 tomato plants. If she plants them in four rows, how many will there be in each row? Will there be any plants left over?" This is a common type question in elementary school math classes. Did you get 12 in each row and 2 left over? Yes, that was the answer in the teacher's book but it is not right! (The right answer is given later.)

One of the important areas of education considered by several school boards in the last couple of years in in-service workshops has been "Reading in the Content Areas." This has probably been because of the general complaint by teachers that "Johnny can't read" and as a result he seems to have trouble in other subject areas. The feeling seems to be that if reading is causing trouble in a particular subject, the teachers involved with that content area should make some attempt to teach the applicable reading skills.

Part of the problem, however, is that teachers in many subject areas have not had any formal training in teaching reading and as a result often feel insecure in dealing with it.

In this context, I will try to give a brief outline of general reading skills, the reading skills that relate in particular to mathematics, and discuss how some of these may be identified and used in the teaching of mathematics. I hope this attempt will help in some small way with the problem.

Developmental Reading Program

Most reading specialists agree that the following components are necessary for an effective developmental reading program:

1. development of the basic reading and study skills,
2. mastery of the specialized reading and study skills in the content subjects,

3. opportunity to do reading for purposeful development,
4. experience in reading for pleasure.

General Reading Skills

The general reading skills which have been identified as common to all academic subjects are:

1. reading for the main idea,
*2. knowledge of advanced and specialized vocabulary,
3. utilization of contextual clues for meaning,
4. proficiency in structural analysis,
*5. ability to adjust rate and technique to purpose,
*6. skill in analytical and critical reading.

The degree to which a skill is taught and the method of instruction used will vary from subject to subject. In the preceding paragraphs I have indicated (*) those areas where I feel we can do most in mathematics.

Reading Skills that Relate Specifically to Mathematics

1. Understanding the specialized vocabulary.
   (a) technical mathematical terms,
   (b) alphabetical, operational, grouping and relationship symbols,
   (c) roots, prefixes, and suffixes that aid in understanding mathematical terms,
   (d) also, common words that have special mathematical meanings.

2. Reading and interpreting verbal problems.
   (a) evolving procedures for problem solving,
   (b) distinguishing between the important and irrelevant information in problems,
   (c) apply graphic representations to problems.

3. Recognizing relationships.

4. Recognizing equations as expressive in a manner similar to sentences in regular prose writing.

5. Acquiring meaning from the statements of rules and definitions so that they may be used with understanding.

6. Organizing details and processes to find solutions.

7. Checking to verify solutions and/or to locate errors.

What implications do these reading skills have for us in the teaching of mathematics in the classroom?

1. Understanding the specialized vocabulary.

How much emphasis do we place on vocabulary development and what approaches do we take toward teaching it? Do we use roots of words in a meaningful way to show interrelationships between concepts? Is there enough consideration given to the distinct mathematical meaning of common words? What does a student really understand by: negative (especially if he is involved in photography), product (if he has been shopping the evening before), dividend (if his father is involved with stocks, et cetera), similarly with: complementary, scale, yard, set, partition; the list is endless.

There are obviously hundreds of technical terms within the total scope of the field of mathematics. If vocabulary study is conducted, in most cases, it will be with technical terms. Consider the terms a Grade 9 geometry student must have mastery of before he can attempt to understand: Jurgensen, p.56, Theorem 2-2: "If the exterior sides of two adjacent angles are opposite rays then the angles are supplementary." An understanding of the terminology of mathematics is essential for mastery. A few suggestions may prove helpful in teaching the mathematics vocabulary.

(a) Make few assumptions that the students are familiar with terms.

(b) Be sure all words are correctly pronounced and spelled.

Language accuracy should be given the same degree of importance as computational accuracy.

(c) Use specialized terms when called for.

(d) Test for growth in vocabulary, as well as reasoning and computation, regularly.

2. Reading and interpreting verbal problems.

This is the skill given most emphasis in the literature, but I feel it is the area in which mathematics teachers are strongest. Procedures have been evolved and used for attacking this kind of problem. A common procedure is the Ladder:

7. Check
6. Solution
5. Estimated
4. Processes
3. Given
2. Required
1. Read!

We can use verbal problems to determine other than numerical answers. There are many such problems that can prove useful in the mathematics and/or language arts classroom.

Consider as an example:

"Each spring the school held a marble shooting contest, with prizes for the winners. One of the rules for entering the contest was that each person must

have a minimum of 50 marbles. Jack, Harry, and Bill were three friends who wanted to enter. Jack had 75 marbles, Harry had 50 marbles, but Bill had only 40 marbles. The boys realized that one of them could not enter the contest. They decided to combine their marbles and share them equally to see if they would each have enough marbles to become contestants.

1. What does the word combine mean in this problem?
2. What does the word minimum mean in this problem?
3. Could a person enter the contest if he had fewer than 50 marbles?
4. Could a person enter the contest if he had more than 50 marbles?
5. After combining their marbles, what was the total number the boys had?
6. How many marbles did each boy have after they shared the marbles?
7. Which boy lost the most marbles by sharing them?
8. Which boy gained the most marbles by sharing them?
9. Could all three boys enter the contest?
10. Do you think these boys were good friends. Why or why not?

There are still some who feel, however, that Johnny cannot read so we will omit this topic. It is when this approach is duplicated intermittently or completely through the system from primary to high school that we as mathematics teachers have failed to do our part in the total education process!

3. Acquiring meaning from the statements of rules and definitions so that they may be used with understanding.

How often are students required to memorize a statement as compared to the number of times they are encouraged to write it out in their own language? How much discussion is generally involved with new rules and definitions? Do we have time to do this, some ask? Can we afford not to? Perhaps consideration might be given to the idea that a longer time spent in introducing these ideas might actually shorten the time needed later when they are to be used, and more importantly, that students would have a better understanding in dealing with the problems related to the rules and definitions.

Along a similar line, I would suggest that you look at the other specific study skills and ask how you are dealing with these. If you have not been aware of these specific skills, maybe some consideration might be given to them in your future teaching of mathematics.

It was stated previously, in the outline of general reading skills, that the degree to which a skill is taught and the method of instruction used will vary from subject to subject. Three of these (2, 5, 6) were indicated as of particular significance in mathematics. The first of these (2. Knowledge of advanced and specialized vocabulary) has already been dealt with.

Of importance also is - 5. The ability to adjust rate and technique to purpose. We should make a point of emphasizing this aspect of reading mathematics. It is obvious to us, as teachers, that in reading mathematics material a very

careful, deliberate, and often slow approach must be taken. This may not, however, be obvious to the student. Do we spend time in teaching Johnny "how" to read the material we assign? The value of slow, careful reading should be emphasized. When a student has an incorrect answer to a problem, the reteaching is often directed toward the relationships between the numbers involved (and many times it should be), but how much consideration is given to the student's understanding of what he has read?

The following is an example taken from ESM Book 6, p.80: "When the product of two whole numbers is 36, we say that each of the numbers is a factor of 36. You have learned that the product divided by one factor gives the other factor."

Although this is a simple statement to us as mathematics teachers, when read by a Grade 6 student, especially without the mathematical reading approach, it may be quite complex.

The last - 6. Skill in analytical and critical reading - is an area of importance, to which generally very little consideration has been given. How, you might ask, can we aid in critical reading in mathematics? Are students encouraged to look for imprecise statements, or for that matter, is it even mentioned to them? As an example of the imprecise statement, reread the first paragraph in this article!

This problem was written to reinforce understanding of division of whole numbers with a remainder. Therefore, any reader would know that he should have a remainder since the entire lesson deals with remainders. However, a critical reader would immediately answer that there would be no remainder, since the statement says Jane plants them (all 50) in four rows. If she plants them, there will not be any left over. Yet the teacher's answer sheet showed a remainder of two in the correct solution. The good reader will also penalize himself if he does not assume that Jane planted an "equal number" of tomato plants in each of the four rows, although there is no good reason to believe that all rows had an equal number of plants. Therefore, the answer to the question of how many will be in each row can be "one or more." The writer probably intended that the problem read:

> Jane has 50 tomato plants. If she plants an equal number of them in each of four rows, how many plants will there be in each row? How many will be left over, if any?

The student must now divide 50 by four and should arrive at the correct solution of 12 plants in each row with 2 plants left over.

We should point out to students various situations like these and you will soon find they will be reading their mathematics problems very critically!

The story is told of a school teacher who decided upon due reflection to give full credit to a pupil for his answer to an arithmetic problem.

Question: If your father sold fifteen hundred bushels of grain for $2.00 per bushel, what would he get?

Answer: A new car.

From the foregoing, one can see the importance of asking accurate questions.

Even when we ask accurate questions, however, we should be prepared for unexpected answers, as the following conversation indicates:

Teacher: How old were you on your last birthday?

Junior: Seven, ma'am!

Teacher: How old will you be on your next birthday?

Junior: Nine, ma'am!

Teacher: Nonsense, if you were seven on your last birthday, how can you be nine on your next birthday?

Junior: I'm eight today!

To quote from the writing of a one-time teaching colleague: "The fact that each content field requires specific reading skills uniquely related to the discourse of that field implies that each subject teacher must assume direct responsibility for developing those skills pertinent to his particular area of instruction. It is apparent that if students are to pursue effectively their content area subjects, provision must be made for developing those reading skills and abilities which are essential for adequate comprehension within each particular area of instruction. The fact that proficiency in one subject is not necessarily predictive of success in another subject presents further evidence to support the necessity for teaching applicable reading skills within each content area."