Vocabulary Considerations for Teaching Mathematics

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The importance of rich and meaningful vocabulary knowledge when developing concepts is well documented and widely accepted by classroom teachers; vocabulary provides access to concepts. Because mathematics material is so difficult to read, "with more concepts per word, per sentence, and per paragraph than any other area" (Schell, 1982, p. 544), it is particularly crucial to emphasize vocabulary instruction in this content area.

Necessary Vocabulary for Developing Mathematical Concepts

The vocabulary that teachers should teach to help students develop mathematical concepts can be classified into four categories: technical, subtechnical, general, and symbolic.

Technical Vocabulary. Those words generally viewed as mathematical terminology are called technical vocabulary. Technical terms convey mathematical concepts that are difficult, if not impossible, to express in everyday language. Each technical term (e.g., integer, quadrilateral) has only one meaning, which is specific to mathematics. Because these terms are encountered only in mathematical contexts, and are themselves often defined with other technical terms, they are difficult to learn and remember; learning a technical vocabulary is comparable to learning a foreign language.

Subtechnical Vocabulary. Subtechnical terms have more than one meaning; these meanings vary from one content area to another or from a content area to everyday experience. Learners may know and be able to use one or more meanings for a subtechnical term, but may not necessarily know its specific mathematical meaning. Because of their multiple meanings (e.g., the volume of a cube, the volume control on the television set, the volume of world trade), these terms can be especially difficult to conceptualize. Some subtechnical terms have multiple meanings even within a mathematical context (e.g., degrees of temperature, degrees of an angle), thereby creating additional conceptual problems. Because of this nature, subtechnical terms may be even harder to learn and remember than technical terms.

General Vocabulary. Students encounter general vocabulary words in everyday language and in their usual reading experiences. Most elementary mathematics textbooks use a general vocabulary, although these words are not likely to be taught in reading class. One 1966 study found that even if students were taught all the words presented in seven different reading series at the primary level, they would be exposed to only about half the words included in mathematics textbooks for the same levels (Stauffer, 1966). Recent research indicates the problem still exists. Panchyshyn and Monroe (1992) found that more than half of the words included in elementary mathematics textbooks were not among those most frequently used in children's reading materials. A mandate for developing general vocabulary in mathematics becomes evident when these and similar findings are considered.

Symbolic Vocabulary. Symbolic vocabulary, viewed by some to be the real vocabulary of mathematics, presents its own special problems. Most reading ma-
terial uses only alphabet symbols. In mathematics, however, the reader needs to recognize not only the alphabet, but also numerous nonalphabet symbols. Numerals, the most common math symbols, represent numbers, which are themselves so highly abstract that even mathematicians find them difficult to define! In addition, a given numeral can be used to convey many different meanings. For instance, consider the numeral 2 in the following numerical contexts:

52 23 4 \( \frac{1}{2} \) 2/3 \( \text{m}^2 \)

The 2 conveys a different, and highly abstract, meaning in each context. Furthermore, the numerical expression itself can be read in different ways—42 can be read as “four squared,” “four to the second power,” etc. Adding to the potential for confusion, the same meaning can be conveyed by different symbols. Consider how learners must refocus their thinking when division is presented as \( \frac{4}{2} \), 2 \( \times \) \( \frac{1}{2} \) = 4, or 4/2.

Abbreviations, also classified as symbolic vocabulary, can create more confusion. Possibly no other subject area uses as many abbreviations, and many abbreviations are formed in irregular ways. Abbreviations such as \( \text{lb.} \) for pound and \( \text{ft.} \) for either foot or feet, which can also be expressed as the symbol ‘\( \text{lb} \)', as in 4'11", are especially confusing. Capps and Gage (1987) called attention to these and other problems with mathematical symbols and observed that it is “small wonder that children have difficulty” (p. 5) understanding them.

Planning and Implementing Vocabulary Instruction in Mathematics

Planning vocabulary instruction for concept development in mathematics is not an easy task. Teachers’ editions of basal mathematics series are only beginning to offer ideas and activities for developing and extending technical, subtechnical and symbolic vocabulary. General vocabulary, which may comprise the greatest number of unknown words, is usually ignored completely. Furthermore, these textbooks often fail to describe concepts adequately, thereby making teaching even more difficult.

How, then, should a teacher of elementary mathematics plan and implement vocabulary instruction for concept development? Most elementary teachers already have a repertoire of skills that they can use; the methodology and activities they have developed for teaching vocabulary in other areas can be just as appropriate for the mathematics lesson. Each type of vocabulary—technical, subtechnical, general and symbolic—must be considered when planning a specific lesson, but that should not affect the instructional strategy. Decisions regarding an instructional strategy should be based on teachers’ knowledge of

1) One way to start is by using concrete experiences with manipulatives to develop a concept. Guide oral language development as students work with the manipulatives. For example, cover rectangular regions with square tiles (or crackers or square pieces of paper) and discuss the concept of area before asking students to tackle the concept in their mathematics textbooks.

2) Examine the textbook lesson carefully ahead of time to identify terms that will be new for the students. Select a few key terms (technical or subtechnical) that can serve as organizers for the concepts to be taught. Also, be prepared to provide help concerning any symbols and general vocabulary that may create reading problems.

A lesson on adding two-digit whole numbers, for example, may require explanation or review of \( \text{addend, sum and equal} \). Although the symbols + and = should already be familiar, these concepts may need to be extended. Some of the general vocabulary words used in the textbook’s introductory example may be unfamiliar and will require special attention.

3) Teach and extend vocabulary in relation to students’ real-world experiences. Students enjoy finding examples of geometric shapes in their homes, en route to school and in their classrooms. Remind them of how breakfast cereal is packaged in rectangular boxes, or how stop signs are octagonal. When teaching fractions, express terms like “one-sixth” or “one-eighth” as slices of pizza, and use egg cartons to illustrate relationships among halves, fourths, thirds, sixths and twelfths.

4) Students who do not have enough relevant prior experiences with concepts need prereading activities, such as brainstorming and semantic mapping, to encourage discussion. For instance, ask the
class to brainstorm all known definitions of the word
*degree*: degrees of latitude and longitude, degrees of
temperature, degrees in an angle, a college degree, etc.
Then select and develop the definition that applies to
the concept being taught.

Semantic mapping is also useful when introducing a
new topic, as it "helps to activate and expand prior
knowledge; it also helps students learn new words"
(Johnson & Johnson, 1986, p. 625). The following
skeleton semantic map can be used when introduc-
ing a unit on measurement to 3rd-graders. Active
classroom discussion will encourage students to
provide labels for the categories given, include addi-
tional items and categories, and discuss relations-
ships among the concepts.

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5) Take time to teach the "little" words in math-
ematics class. Even words such as *a* and *the*
can be confusing. In the whole number system, the
only possibility for a number between 7 and 9 is 8; many
different possibilities are available, however, for
the same interval when working with fractions (e.g., 7 \( \frac{1}{4} \), 8 \( \frac{3}{5} \)). When asked for the number between 7 and 9,
we assume that the only correct answer is the whole
number 8.

6) Teach mathematics symbols only after stu-
dents have the necessary experiential background
and language development to understand them. For
example, when learning the concepts *is less than* and
*is greater than*, students need to work with concrete
objects and pictures, accompanied by class discus-
sion, before the highly abstract symbols < and > are
introduced.

7) Introduce and develop pertinent vocabulary in
each mathematics lesson, and then review the terms
frequently. A rule of thumb recommended by Capps
(1989) is to provide six exposures to a new word during
the initial lesson and at least 30 additional exposures
during the ensuing month. Remember, new vocabu-
larly should be repeated often in meaningful settings
before students will retain and actually use it to con-
struct mathematical concepts.

8) Model the use of appropriate mathematics voca-
dulary when interacting with students. When dis-
cussing examples using addition, for example, ask
"How did you find the sum?" rather than "How did you
find the answer?"

9) Give students many opportunities to talk about
new mathematical concepts. Discussion will be greatly
facilitated through cooperative learning groups and peer
tutoring.

10) Use writing assignments to develop mathemat-
ics vocabulary. Students will enjoy drawing pictures
and writing definitions to create their own math diction-
aries. They could also keep journals of mathematical
concepts, thus using writing to clarify their thinking.
Rewriting a textbook sentence or definition in one's
own words can often help clarify a concept and aid
retention.

11) Share selections from children's literature. Some
books are specifically designed to teach mathematics
concepts; however, choices should not be limited to
these. Much of children's literature can be used to
develop and extend mathematical concepts. For help in
getting started, consult sources such as Gailey (1993),
Lewis, Long and Mackay (1993), Richardson and Mon-

12) Teach students to read their math textbooks
slowly and carefully, stressing that every word and
symbol is important to their understanding. Also teach
them to use text guides such as boldface print and
definitions. Rather than avoiding text because it is
difficult to read, students need to learn to use it effec-
tively and to learn concepts independently.

13) As students develop dictionary skills, encourage
them to learn new mathematics vocabulary on their
own by consulting the glossaries in their mathematics
textbooks and, when available, mathematics diction-
aries. "Regular" dictionaries can also be helpful, particu-
larly if students are taught the process of "fine tuning,"
as described by Thomas (1980). When teaching this
process, use the numerals on a radio dial as an analogy.
Tell students to keep "fine tuning" until they find the
definition that best fits the context, just as they fine tune
their radios to find their favorite music. Avoid routine
assignments, such as looking up words in a glossary or
dictionary and writing definitions or sentences. These
types of assignments do little to encourage enthusiasm
for vocabulary development.

**In Summary**

Just as vocabulary building enhances literacy develop-
ment, it is especially important in developing mathematical
competency. "...[T]he content of mathematics is not
taught without language” (Capps & Pickreign, 1993, p. 12). Yet, learning the necessary vocabulary may be difficult because of complex terminology, abstraction and the infrequent use of specialized mathematics vocabulary in nonmathematical contexts. The classroom teacher needs to remember that several kinds of vocabulary must be actively taught during each mathematics lesson. The teaching methods to be used should not be unique to mathematics. Rather, teachers can draw upon their existing repertoire of strategies to help students construct vocabulary meanings in a variety of subject areas. The “baker’s dozen” of suggestions included here are offered simply as ways to help teachers begin.

References

For some kids school segregation

DIDN’T END IN THE SIXTIES.

Students with disabilities should be evaluated individually to decide their best situations for learning. Because when kids are kept apart just for being different, it teaches all the wrong things.

GIVE ABILITY A CHANCE