

# Math Language That Works **Background for Teachers**

## ***1) Why do math students need to learn vocabulary?***

Mathematics includes three distinct language elements: symbolic language, content vocabulary, and academic language. As teachers of mathematics know, the organizational structure of mathematics relies heavily on *symbolic language*: numbers, graphs, and tables. It is important to provide students with clear verbal explanations and examples to effectively interpret these symbols.

Vocabulary knowledge is directly related to content knowledge. Stahl and Fairbanks (1986) found that vocabulary instruction directly improves comprehension. Therefore, it is critical for students to possess a deep understanding of the *content vocabulary* in order to perform the mathematical operations required by the mathematics content standards. Content vocabulary is the technical language associated with a specific content area. Examples of content vocabulary in mathematics are: equation, fraction, exponent, and monomial. Often these words have multiple meanings leading to confusion (i.e. square, coordinate, degree).

As when encountering content vocabulary, many students also have trouble interpreting the *academic language* used in teaching academic content. Academic language in the California Mathematics Standards, such as, "evaluate," "determine," "analyze," "simplify," and "convert," may differ in intended meaning depending on the contexts in which they appear. Mathematics students must know and use this sub-technical vocabulary found across all subject areas. Many students will benefit from specific instruction on the meaning and use of academic language as it pertains to mathematics.

## ***2) What is word knowledge?***

The degree to which a student knows a word may vary, and that level of word knowledge has implications for vocabulary instruction. Dale and O'Rourke (1986) identified four levels of word knowledge:

1. I never saw it before
2. I've heard of it, but I don't know what it means
3. I recognize it in context - it has something to do with...
4. I know it

Definitions alone are not sufficient to know a word and it is not necessary to be able to define a word in order to know it. Definitions provide information about the word; however, students also need to know how the word functions in different contexts. For students to learn the word, they benefit from a meaningful explanation of the word, rather than simply a definition. Stahl & Fairbanks (1986) found that providing students with both definitional and contextual information significantly improves comprehension.

English learners and special needs students approach language with unique challenges. In order for these students to experience success with vocabulary instruction, special considerations are necessary. Explicitly teaching vocabulary helps students learn words that represent complex concepts which are not part of the students' everyday experiences. Direct instruction of specific words and word-learning strategies relevant to a given content leads to better comprehension.

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## ***3) What is effective vocabulary instruction?***

Direct instruction is an effective approach to promote vocabulary learning. Baker (1995) found that “explicit instruction either in specific word learning or [developing] strategies for word learning is generally more effective for [struggling students] than incidental word learning from context or wide reading.” Therefore, it is important to explicitly teach critical vocabulary necessary for understanding the specific content.

Although students must know and understand the vocabulary needed to master the California Mathematics Content Standards, it is impractical to try to explicitly teach each and every word. Therefore, it is necessary to prioritize the words to address. When making decisions about selecting words to teach, Isabel Beck (2002) recommends consideration of the following criteria: importance and utility, instructional potential (usefulness), and conceptual understanding (difficulty). Marzano (2004), states that effective direct vocabulary instruction is characterized by the following:

1. Does not rely on definitions
2. Linguistic and non-linguistic representations
3. Multiple exposures
4. Teaching word parts
5. Specific instruction for different types of words
6. Student discussion of words
7. Student play with words
8. Focus on terms with a high probability of enhancing academic success

Stahl (1999) states that English learners “rely more heavily on direct instruction than native speakers, because they typically need to make up more ground quickly to learn English.” Direct instruction of content vocabulary and academic language with scaffolding and practice to promote student independence is considered to be highly effective. An effective tool for scaffolding language acquisition for English learners is the use of cognates. Sanaoui (1995) suggests the following mnemonic devices that support English learners: writing, immediate and spaced repetition, use in a sentence, contextual and lexical associations, talking with others, and imagery. Students with special needs will also benefit from these strategies. In addition, it is important that students see, hear, and translate new information into their own words and rehearse the new learning verbally. Embedding these strategies in vocabulary instruction will promote success for all students.

In *Building Background Knowledge* (2004), Marzano identifies Six Steps to Effective Vocabulary Instruction:

1. Teacher or other students provide description, explanation, examples/non-examples
2. Students restate word and explanation in own words, verbally and in writing
3. Students create non-linguistic representations
4. Students do periodic activities to refine knowledge of vocabulary terms (compare, classify, analogize, revise, explain, study roots and suffixes)
5. Students describe/discuss terms with each other
6. Students play games to practice the use of words

In *Math Language That Works*, we have embedded many of the research-based practices cited above. In this instructional supplement you will find direct instruction lessons utilizing a variety of graphic organizers with tasks that have been restructured to accommodate special needs students and English language learners. Suggestions for student practice activities, assessment options, and vocabulary references are also included.