

MATH VOCABULARY

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It is hard to imagine tools more useful than words. Without them, talkers, philosophers, actors, and writers, would simply be out of business.

~Karla Kuskin

BACKGROUND ON VOCABULARY

Vocabulary is a vital part of content areas. Richard Vacca states "Vocabulary is as unique to a content area as fingerprints are to human beings." Words make up how we describe the concepts we teach. Without a strong understanding of the vocabulary, students cannot apply those terms to the procedures and broader ideas they are learning. The question becomes: How do we best provide instruction of vocabulary in math so that are students have the understanding they need to be successful? As a math goal team over the last few months, we have been addressing this area. Our goal is:

To implement a systematic approach to math vocabulary instruction from preschool to eighth grade.

Throughout this packet, you will find research on best practices, graphic organizers, and our desired plan for implementation.



Why is math vocabulary so difficult?

Words differently arranged have a different meaning, and meanings differently arranged have different effects.

~Blaise Pascal

	CATEGORY OF DIFFICULTY	EXAMPLES
1	Some words are shared by mathematics and everyday English, but they have different meanings in the two contexts.	<ul style="list-style-type: none"> ★ foot, yard ★ right ★ range, median, mean ★ expression
2	Some mathematical words are shared with English and have comparable meanings, but the mathematical meaning is more precise.	<ul style="list-style-type: none"> ★ difference ★ fraction ★ patterns ★ multiply, divide
3	Some mathematical terms are found only in mathematical contexts.	<ul style="list-style-type: none"> ★ algebra ★ denominator, numerator ★ quotient
4	Some words have more than one mathematical meaning.	<ul style="list-style-type: none"> ★ square, cube ★ round ★ range
5	Some words shared with other disciplines have different technical meanings in the two disciplines.	<ul style="list-style-type: none"> ★ divide vs. Continental Divide ★ variable (letter vs. weather description) ★ coordinates (x,y vs. longitude, latitude)
6	Some mathematical terms are homonyms with everyday English words.	<ul style="list-style-type: none"> ★ sum, some ★ hole, whole ★ weight, wait
7	Some mathematical words are related, but students may confuse their distinct meanings.	<ul style="list-style-type: none"> ★ factor, multiple ★ hundred, hundredth ★ numerator, denominator
8	English spelling and usage have many irregularities.	<ul style="list-style-type: none"> ★ four, forty ★ fraction denominators
9	Some mathematical concepts are verbalized in more than one way.	<ul style="list-style-type: none"> ★ equal, congruent ★ one quarter, fourth ★ different terms for operations
10	Students may adopt an informal terms as if it is a mathematical term.	<ul style="list-style-type: none"> ★ diamond, rhombus ★ slide, translation ★ corner, point, vertex

**Table taken from "Understanding and Supporting Children's Mathematical Vocabulary Development" by Rubenstein & Thompson

Selecting Vocabulary...

TIERED VOCABULARY APPROACH

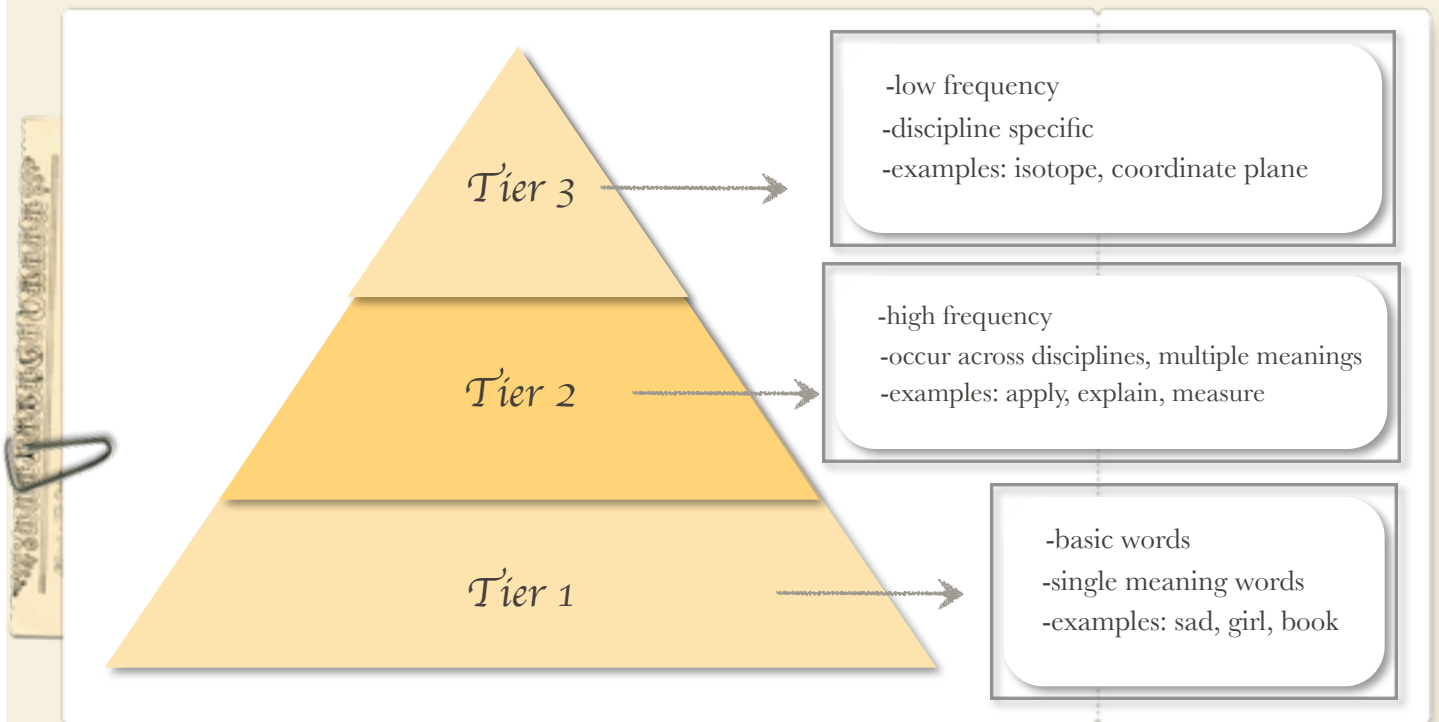
As teachers, it is our job to determine which words are the most vital for our students to master. We cannot always rely on our textbooks to be the best judge of that. Often times a text may have over a dozen words for a single chapter, which is too many words to master in a limited time frame. It is important that we expose our students to all the words deemed important by the CCS Standards and the textbooks publishers; however, we must also be realistic in how many words we desire our students to **master**. Students second grade and younger should only be learning two words per day. While older students, grades three and above,

should learn between six and eight words per day (Arguelles, 2008).

A research-based approach to word selection is the Tiered method. Using this approach to vocabulary selection forces us to carefully examine the terms we wish our students to know (see the diagram below).

In the math classroom, we must find a balance between providing instruction of Tier 2 and Tier 3 words. An approach to addressing this is recommended by Marzano and Pickering (2005). They suggest a systematic approach to content vocabulary is "one of the most crucial services that [we] can provide" our students (p. 3). When

looking at low-achieving students the case for implementing a systematic approach is even more compelling (Marzano, Pickering & Pollock, 2001, p. 124). By implementing a system for vocabulary acquisition, teachers across grade levels become responsible for the master of a smaller list of Tier 2 and Tier 3 words, which will help to ensure students will "own" the words rather than simply memorize them and quickly forget them. With grade levels working together, they can divide up the key terms (Tier 3) for their disciplines. Schools could even go as far as focusing on certain Tier 2 terms across content areas for each grade level.



Fractions				
Vocabulary Term	I've never heard of the term	I've seen or heard of the term before	I think I know the term	I know the term
common denominator	1	2	3	
denominator	1	2	3	
equivalent fractions	1	2	3	

Assessing Vocabulary Acquisition

A FORMATIVE APPROACH

In order to ensure that students are mastering their vocabulary, we must progress monitor their understanding. One approach is through using a self-assessment with our students, which doubles as a formative assessment for the teacher. An approach recommended for math is the "Vocabulary Knowledge Rating" tool. This approach is a "way to keep students closely connected to the terms and concepts in a unit, giving them the exposure they need to learn new words deeply" (Thomas & Brunsting, 2010, p. 20).

The above graphic provides you with a visual of this tool. This approach could be used to monitor vocabulary intake throughout a chapter, unit, or a quarter. Once you have selected your key terms, this is how you implement the tool with your students:

- 1. Pre-Assessment** - Before beginning the unit have students self-assess their knowledge of the key terms. At the bottom of the sheet, they would mark their knowledge rating and date.
- 2. Progress Monitor** - Depending on the length of your study, progress monitor at least once. Follow the same procedure as the pre-assessment. Discuss the data with the students and use the check as an opportunity for the students to share their understandings.
- 3. Post-Assessment** - At the end of the unit have students assess themselves one last time again marking their rating and date. This time use the information to lead into a review for the test.

Students must encounter a new word 12 times before they will own its meaning enough to improve their comprehension...

~Biemiller, Nagy & Anderson

This process also helps give our students a deeper encounter with these terms. Students must have authentic, real opportunities to apply their terminology to be able own the words.

Vocabulary Instruction

DIRECT & EXPLICIT

Our goal is for mathematical language to become fluid [and] natural...

~Rubenstein & Thompson

Whenever you are teaching Tier 2 and Tier 3 words the instruction must be **direct** and **explicit**.

One process suggested by research is as follows:

1. Introduce

- write and say the word
- have students repeat it

2. Explain

- use student friendly explanation
- show picture and/or demonstrate
- provide examples and non-examples

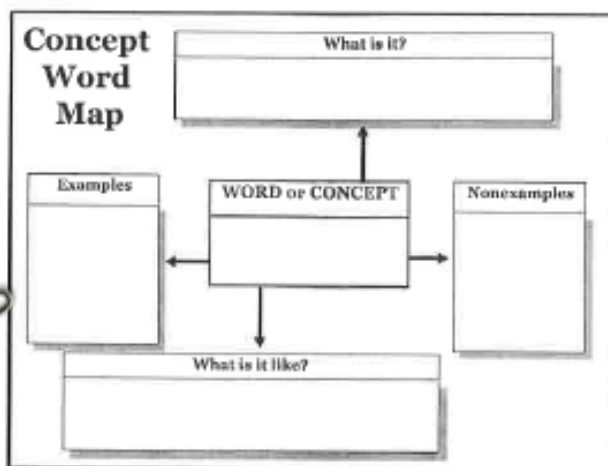
3. Practice

- word study activities (syllables, roots, affixes....)
- students generate their own description and picture of term
- engage students in activities
- connect to self
- monitor students' understanding
- revisit words over time

Two key components of this process is using nonlinguistic representations and the instructional strategy similarities and differences.

According to Marzano, Pickering and Pollock (2001), these two instructional strategies have a high probability of being effective for supporting the acquisition of knowledge and skills. This procedure for vocabulary instruction is also powerful, because it provides a “sequence that allows for multiple exposures [of the word] to students in multiple ways” (p. 128).

Below are two examples of graphic organizers that support this instructional process.



Constructing Meaning

My Content Dictionary

New Word	My Definition	Example	Non-Example	Sentence
Polygon	A polygon is a closed figure whose sides are all line segments			A rectangle is a polygon with opposite sides parallel and four right angles A quadrilateral is a polygon with four sides

Making Connections: Academic Language and Mathematics for English Learners, Sonoma County Office of Education

How Do I Implement This?

Goal: To implement a systematic approach to math vocabulary instruction from preschool to eighth grade.

Teacher Implementation Checklist:

- ___ 1. Before the school year starts, determine how you will assess whether students have mastered the key vocabulary.
 - ★ Self-Assessment (Vocabulary Knowledge Rating...)
 - ★ Check List (teacher developed...)
- ___ 2. At the student of the school year, review with students the key vocabulary terms that should have been mastered the previous year.
 - ★ Remember 2013-2014 will be the first year we implement this approach to vocabulary instruction...
 - ★ Since this is the case, you may also have to explicitly teach some of the previous year's words.
- ___ 3. Remember when providing instruction is must be **direct** and **explicit**.
- ___ 4. Have a variety of practice activities on hand!

Available Resources

- ★ Graphic Organizers
 - ★ 4 templates
 - ★ also located on server in folder "Vocabulary"
- ★ Vocabulary Knowledge Rating
 - ★ 2 templates
 - ★ also located on server in folder "Vocabulary"
- ★ Vocabulary Lists*



*Resources to come... Watch your mailboxes!

Resources

One forgets words as one forgets names. One's vocabulary needs constant fertilizing or it will die.
~Evelyn Waugh

Arguelles, M.E. (Oct. 2008). *Vocabulary instruction and language development for ALL*.

Hutton, T.L. (2008). Three tiers of vocabulary and education. *Super duper handy handouts!*

Marzano, R.J. & Pickering D.J. (2005). *Building academic vocabulary teacher's manual*. Association for Supervision and Curriculum Development: Alexandria, Virginia.

Marzano, R.J., Pickering D.J. & Pollock, J.E. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement*. Association for Supervision and Curriculum Development: Alexandria, Virginia.

Robb, L. (2003). *Teaching reading in social studies, science, and math*. Scholastic Professional Books: New York.

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Thomas, E.J. & Brunsting, J.R. (2010). *Styles and strategies for teaching middle school mathematics: 21 techniques for differentiating instruction and assessment*. Thoughtful Education Press.

