Clueless

THE TROUBLE WITH CLUES AND KEY WORDS

By Cathy L. Seeley (to be published by Math Solutions in Smarter Than We Think, 2013, and included as a bonus message in the 2012 ebook publication of Faster Isn't Smarter by Math Solutions © 2009/2012)

In my high school French class, Madame Boissevain regularly told us (in French) that it was better to learn to think in French than to try to translate word for word what we were thinking in English. I don't know how she managed it, but somehow I more or less accomplished that goal. More than 30 years later, when I found myself in the Peace Corps, assigned to teach mathematics in French in Burkina Faso, much of my French from my years with Madame Boissevain came back to me.

More recently, I decided that I wanted to learn to speak Spanish. To jump-start my Spanish learning, I spent two weeks immersed in Spanish in Costa Rica, living with a family and taking Spanish classes four hours a day. I was fortunate to be matched with Teresa, a wonderful teacher who again encouraged me to think in Spanish rather than translate word for word. It's not easy to achieve this goal, but I'm moving in that direction, and I continue to marvel at how much I learn and progress when I turn off the translating switch.

Thinking about these experiences has made me wonder what the payoff might be with mathematics students if we could help them learn to think mathematically when they encounter a problem instead of trying to translate each word into the "correct" mathematical operation.

Teaching *Clue* or *Key* Words

A search on the Internet for *math key words* or *math clue words* leads to list after list of words to look for in word problems to know whether to add, subtract, multiply, or divide. On the surface, this may seem like a good idea and an appropriate strategy. After all, if a student understands addition, for example, then we might think the student should associate addition with words like *total, sum, altogether*, or *increase*. But this strategy comes with a high price.

The first problem with this approach is that it focuses on solving *word problems* instead of solving *problems*. It is true that many of the most interesting and relevant problems worth students' time and energy involve words. However, the key to these problems is not the words themselves, but the mathematics underlying the situation the words present. And the mathematics is not the same for all problems that include the word *decrease*, or for all problems in which the word *twice* appears, or for all problems using the words *shared among*. For any clue or key word on any list, most teachers can think of, or find, a problem that uses the word in a different way from the use commonly presented. This issue is demonstrated in a compelling way in a video interview conducted as

part of Marilyn Burns' project to develop formative assessment resources, the Mathematics Reasoning Inventory (MRI).

In the video, the teacher asks Marisa to solve the following problem and then to explain how she did it.

> *There are 295 students in the school. School buses hold 25 students. How many school buses are needed to fit all of the students?*

The student looks at the problem, pauses for a moment, then adds 295 and 25 to determine that 320 buses are needed. When the teacher asks how she figured it out, Marisa confidently explains that she listened for information to decide whether to add, subtract, multiply, or divide. She heard the word *all*, so she knew she should add.

Wasting Time and Worse

Clearly, time spent teaching Marisa a list of clue words did not pay off for her in terms of learning how to solve problems. One of the most serious problems with teaching students a list of magic words is the immense waste of instructional time and the waste of students' learning time. Time spent teaching Marisa these words meant that she did not have more time to develop her understanding of numbers and operations. She may not have had adequate opportunities to develop mental pictures for addition, subtraction, multiplication, and division that might have helped her solve the problem by thinking mathematically. She spent her energy memorizing words that turned out to not be useful, instead of working with these operations in meaningful ways in a variety of situations.

Even worse than wasting time, in the process of learning the list of words, students may develop mathematical misconceptions. What is intended as a strategy to help students deal with word problems may actually interfere with students' mathematical understanding. Because Marisa had learned that any problem involving the word *all* called for addition, she could not recognize a situation that might be associated with division or possibly multiplication. This kind of teaching may well reinforce the notion that mathematics is a bit like magic, but if you know the key word, you can get through it. Such a strategy fosters a very different, often negative, disposition toward mathematics than what might be developed in a classroom that embraces the development of mathematical habits of mind—a classroom where the teacher uses mathematically substantive tasks to engage students in wrestling with mathematical ideas, becoming increasingly strong problem solvers as they develop mathematical ways to think about problem situations.

Developing Mathematical Language

There's nothing wrong with having discussions with students about what words mean mathematically. This is an important part of learning how to communicate with and about mathematics. But mathematical communication needs to be connected to mathematical understanding. Students are far more likely to be able to take on interesting and challenging problems if they have strong mental pictures of what addition, subtraction, multiplication, and division are, what numbers look like in many different forms, and how numbers and operations can be modeled in different ways. In order to develop these mental pictures, students need lots of opportunities to model numbers and operations with objects and in situations, combined with lots of conversation about the mathematics they are using. It is only when words are used in reference to a particular situation or idea that they become a useful tool in mathematics.

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What Can We Do?

Let us not waste teachers' and students' precious time or brain cells teaching students lists of words they are supposed to memorize at the expense of teaching them the mathematical ideas, themes, properties, and structures that will prepare them to deal with problems mathematically. Rather, let us spend our instructional time andenergy helping students develop a deep understanding of mathematical concepts and the meanings of numbers and the operations they perform on numbers.

One of the interesting things I learned in my Spanish class is that there are different words for the different ways in which we use the English word key. The word llave is used for a physical key to a lock, and the word clave is used to describe the idea of a key, like the key to success. I would argue that there are different kinds of keys in mathematics as well. We can choose to clunk along, teaching kids how to use the hardware—the keys and clues in the words—or we can teach them the real key: the mathematical tools, ideas, and representations they can use when they encounter a problem.

The family I lived with during my Costa Rican Spanish experience often laughed that they were always misplacing the key (la llave) to the outside gate. Let us not spend our time trying to give students keys they will misplace or misuse as they try to remember words on a list. Instead, let us invest in giving them the key of mathematical thinking (la clave) that will help them develop mathematical habits of mind to become problem solvers willing to tackle and able to solve challenging problems.

Reflections and Discussions

FOR TEACHERS

- What issues or challenges does this message raise for you? In what ways do you agree with or disagree with the main points of the message?
- How can you help students make sense of the words used in a problem without relying on a memorized list?
- What strategies have you used, or can you use, to help students make sense of and represent the mathematical operations used in a problem?

FOR FAMILIES

- What questions or issues does this message raise for you to discuss with your son or daughter, the teacher, or school leaders?
- What kinds of questions might you ask to help your student make sense of word problems brought home for homework?

FOR LEADERS AND POLICY MAKERS

- How does this message reinforce or challenge policies and decisions you have made or are considering?
- How can you help teachers and those who support teachers, especially if they may not be experts in mathematics, understand the dangers with teaching students clue words? How can you help them promote more productive strategies?