As a student, I struggled with math. I didn't understand why it came so naturally to some students, but not to me. Looking back, however, I realize that I had an advantage that I wasn't even aware of — I understood the language in which the problems were written, even if I didn't understand how to solve them! Although it is easy to assume that many English language learners (ELLs) will excel in math because math is a "universal language" and students may have had prior educational experience that included mathematical instruction, that assumption can lead educators astray.

As I spoke with teachers and did research for this article, it became very clear that making sure that students understand math vocabulary and have ample opportunities to use it are very important. Solving word problems, following instructions, understanding and using mathematical vocabulary correctly — all of these skills require a language proficiency that sometimes exceeds our expectations. We tend to think of mathematics as a subject that does not require a strong command of language. In reality, however, mathematical reasoning and problem solving are closely linked to language and rely upon a firm understanding of basic math vocabulary (Dale & Cuevas, 1992; J arret, 1999).

For many educators, the challenge of bringing language and math instruction together is a relatively new one. ELL teachers who hadn't taught content areas previously are now being asked to lead or support instruction in the math classroom, and many math teachers who don't see themselves as language instructors are now responsible for providing effective math instruction to ELLs.

High school math teacher Hillary Hansen learned just how big a role language plays in math instruction when she taught her first Basic Math course for ELLs last year. She wanted so much to provide the students with the good foundation they needed, but she felt unable to reach the students or engage them in her lessons, and by the end of the year she was exhausted and frustrated.

That summer she had an opportunity to join a district Sheltered Instruction Observation Protocol (SIOP) cohort to receive professional development and support to meet the needs of ELLs in content classes. She learned about the importance of language acquisition, building background knowledge, increasing student language production, and explicitly teaching academic language. She began this school year with a new set of tools and a deeper understanding of the instructional scaffolding ELLs need in order to learn the content while also learning English. I am happy to report that while Hillary still feels challenged and is working very hard, this year has been much more successful for her and her students.

As a result of more effective instruction, her students:

- understand the content better and are working together to find creative ways to learn
- discuss math more and know how to use the instructional supports their teacher has in place
- are comfortable with math and asking questions to get the help they need.

Hillary feels that she is providing them with the foundation they need not only to understand the mathematical concepts, but also to successfully interact within a math classroom in order to continue learning more advanced concepts.
Following are some strategies that Hillary and some of the other teachers I spoke with found helpful this year, and that they recommend as best practices when teaching math to ELLs.

**The Importance of Teaching Academic Vocabulary**

Vocabulary instruction is essential to effective math instruction. Not only does it include teaching math-specific terms such as "percent" or "decimal," but it also includes understanding the difference between the mathematical definition of a word and other definitions of that word.

The following example, used in a presentation by Dr. Judit Moschkovich of the University of California at Santa Cruz, underscores why vocabulary must be introduced within the context of the content (Moschkovich, 2008):

In this problem, the student is instructed to "find x." The student obviously knew the meaning of the word "find" because he/she "found" it on the page and circled it. The student even put a note on the page to help the teacher in locating the lost "x". The student understood the meaning of "find" in one context, but not in the appropriate mathematical context.

I recently helped a math teacher create a Sheltered Lesson, and I was surprised to find that there were some vocabulary words that I didn't understand. My lack of familiarity with the words hindered my ability to do the math problem and gave me a deeper empathy for ELLs who struggle in the same way with vocabulary and comprehending math assignments. Following is a list of tips for explicitly teaching mathematical academic vocabulary:

- **Demonstrate that vocabulary can have multiple meanings.** Help students understand the different meanings of words such as "table" and "quarter," as well as how to use them correctly in a mathematical context.

- **Encourage students to offer bilingual support to each other.** Students will understand material better if they explain it to another student, and the new student will benefit from hearing the explanation in their first language. (Check the hotlinks for a list of bilingual translations of math vocabulary in multiple languages).

- **Provide visual cues, graphic representations, gestures, realia, and pictures.** Offer students the chance to work with objects and images in order to master vocabulary. If there aren't enough items for each student, use manipulatives on the overhead or posted throughout the classroom, and demonstrate the vocabulary in front of the students. For example, Hillary created a Math Word Wall that has three parts: key vocabulary, "in your own words" definitions, and a variety of ways to portray a function. For example, multiplication is portrayed by the following symbols: x, *, and ( ).

- **Identify key phrases or new vocabulary to pre-teach.** This strategy will help students decide which math function they should apply. Example: "more than" means "add." (See hotlinks for more references about math vocabulary.)
The Importance of Reading and Understanding Written Math Problems

Written word problems present a unique challenge to ELL students and teachers alike. In *Reading and Understanding Written Math Problems*, Brenda Krick-Morales writes, "Word problems in mathematics often pose a challenge because they require that students read and comprehend the text of the problem, identify the question that needs to be answered, and finally create and solve a numerical equation — ELLs who have had formal education in their home countries generally do not have mathematical difficulties; hence, their struggles begin when they encounter word problems in a second language that they have not yet mastered" (Bernardo, 2005).

Teacher Xiao-lin Yin-Croft has encountered this pattern in her classroom of bilingual Chinese students in San Francisco. She has developed a very creative way to use her students' background knowledge of math as a stepping stone for other language learning. She does this by accelerating math instruction at the beginning of the school year and then building on what students have learned in math in reading and other content areas. In *Building Bridges for the Future*, a Colorín Colorado "From the Heart" article, Xiao-lin explains her strategy:

First, we read math word problems; I demonstrate the logical thinking process while translating words into pictures and, finally, into number sentences. Soon, they start to explain their own thinking after reading complicated word problems that involve several steps. They correct each other, and argue about which number sentences they should use to arrive at the correct final results. As they sharpen their math skills, I capitalize on their enthusiasm to teach them how to extract the most important information from texts, and move them toward the oral and reading fluency they need to understand and discuss more challenging texts.

Even if you aren't accelerating math instruction, however, there are a number of ways to help students master word problems. Krick-Morales offers suggestions in the previously mentioned article, such as explicit instruction of key vocabulary, daily practice of problem solving, repeated readings of the word problem together as a class, and hands-on activities such as movement, experiments, or drawing to help students comprehend the problem. As students become more familiar with math vocabulary, they will be able to solve problems more easily.

If you'd like to look at some other tips for increasing comprehension of word problems, be sure to take a look at the *Word Problem Procedure* from Kathryn Heinze, Associate Professor at Hamline University, which she shared at the Teachers of English to Speakers of Other Languages (TESOL) conference in April 2005.

The Importance of Building Background Knowledge

As the opening quote from the Shel Silverstein poem reminds us, background knowledge plays a critical role in math class! My colleague Hillary found that sometimes her students would get "lost" in a problem simply because they didn't understand the context. Following are some tips to help in building background knowledge of students.

- **Modify the linguistic complexity of language and rephrase math problems.** Students will understand the problem better if it is stated in shorter sentences and in language they understand.

- **Guide students to cross out the unnecessary vocabulary in word problems.** Doing so allows students to focus on the math function required. For example, one problem Hillary's students came across referred to a "school assembly." Even though the meaning of that phrase wasn't important in the solving of the math problem, students didn't know it wasn't important, and the lack of understanding contributed to their confusion.

- **Build knowledge from real world examples.** Try to reinforce concepts with examples that students can picture and talk students through the situation. For example, if you need to paint a room, you need to know how much area will be covered so that you know how much paint to buy. Look for familiar ideas or props that can be used to engage students such as recipes, news stories about the economy, or discussion of personal spending habits.
• **Use manipulatives purposefully.** This is important at all grade levels. Hillary has found math cubes to be very useful in having students represent the numbers in the problems and then manipulate the cubes to get the answer. She used the cubes and the terms "hot" and "cold" numbers when teaching with the concept of negative numbers. Students would use the red cubes as "hot" or positive numbers and the blue cubes as "cold" or negative numbers. As students laid out the number of hot cubes and cold cubes represented, they could easily see if the answer would be a positive or negative number by which color had the most cubes. A problem such as \(-2 + 1 = -1\) would look like this:

![Image of cubes]

The student then removed pairs of cubes — one red, one blue — until they could longer remove any blocks. The remaining blocks represent the answer.

### The Importance of Increasing Student Language Production in the Content Area

As I’ve worked with content area teachers in my district to develop Sheltered Instruction lessons and activities to enhance ELL learning, I’ve told them, "If a student doesn't say it in your class, they're never going to say it." This is a bit dramatic, but it's true to some extent. When students learn new vocabulary, the opportunity to use it must be presented in class, because students are unlikely to try it out on their own — especially academic words like "parallelogram" or "function"!

Here are some tips to increase student-to-student interaction with academic language in the math classroom:

• **Have students translate symbols into words, and write the sentence out.** Hillary used this strategy to check students' comprehension of problems before they solved them. For example, \(3x + 4 = 16\) would be written out, "Three times \(X\) plus four equals sixteen." This helps students process the operations involved in the question and gives them an opportunity to think through how to solve it. It also gives students a chance to familiarize themselves with important vocabulary words.

• **Create a "sentence frame" and post it on the board.** Write the format of the sentence you would like students to use in discussion and then hold them accountable for using it. For example, "The answer is _______ degrees because it is a _________ triangle.

• **Have students share problem-solving strategies.** This involves asking a simple question such as, "Did anyone else get the answer in a different way?" Then allow enough wait time so students can think through how their problem-solving process was similar or different to the one offered.

• **Allow students to discuss how they are thinking about math.** This is a way of redirecting the lesson from teacher-to-student to student-to-student. For example a student might ask a question, "How do you know what kind of triangle it is?" Instead of the teacher answering and going to the board and pointing out the names and different triangles, the teacher can simply ask, "Does someone have an answer? Or "Would someone like to offer help to Mario?" Allow students to share how they think about the math concept and any tips they have for remembering the information.
• **Incorporate writing activities like math journals.** This is an excellent way for students to process what they've learned and what questions they still have. The journal could start with simple prompts such as, "One thing I learned today..." "One thing I still don't understand..." "One way I can get the help I need..." "The answer to this problem is..." Writing out the answer to a problem is a very important skill to develop because many state math tests require a constructed response to questions.

• **Challenge students to create their own math problems.** This can be a fun activity if students create a problem similar to the ones you have used in class and they exchange problems with a partner. By creating the problem and checking the answer they are reinforcing their own learning.

**Using Technology**

Technology can also be a powerful tool in math instruction for ELLs. Here are some ideas ways you can play with technology in a math lesson:

• **Teach students how to use a calculator.** Based on background and prior educational experience, students might not be familiar with how to use a calculator nor some of the more sophisticated models, such as the graphing calculator. Give students a chance to practice solving problems with their calculators once you have reviewed different functions. Texas Instruments offers numerous activities and product tutorials in their educational materials.

• **Look for educational resources that accompany your school's technology tools and programs.** For teachers who have an electronic whiteboard in the classroom, there are many resources available on links that can be easily accessed and brought into the classroom. One in particular comes from SMARTTech, and features SMART Notebook lesson activities.

• **Look for interactive games that offer students a chance to practice their mathematical skills.** Nintendo DS has an educational game called Brain Age, which is not language specific. The game provides excellent mathematical training for numbers and tracks results, showing student improvement over time.

• **Find out what's available online.** Vital NY (Video Teaching and Learning for NYS Educators) on Teachers' Domain offers an online library of free media resources from the best in public television. Teachers' Domain resources include video and audio segments, Flash interactives, images, documents, lesson plans for teachers, and student-oriented activities. (Free registration required.)

Even if it doesn't come easily at first, there are ways to get ELLs excited about math. By keeping their language skills and needs in mind when planning mathematical instruction (and by helping your colleagues do the same), you will be taking important steps in helping students master mathematical concepts and skills — and who knows? Your students may be the next generation of economists, rocket scientists, and math teachers just waiting for the tools they need!

Note: I’d like to thank my Minnesota colleagues, Hillary Hansen at Burnsville Senior High School and Kim Olson at Hidden Valley Elementary, as well as Xiao-Lin Yin-Croft from San Francisco for providing many of the helpful math teaching tips in this article. It is inspiring to know that there are talented, creative teachers who are always finding better ways to teach and are willing to share the knowledge.
**Hot links**: Go directly to website [http://www.colorincolorado.org/article/30570](http://www.colorincolorado.org/article/30570) to access these and other links to an entire library of resources with information in English and in Spanish for teachers and parents of English Language Learners

- **Colorín Colorado: Reading and Understanding Written Math Problems**
  
  This article offers a concise overview of strategies for helping ELLs master written word problems. The author is a middle school math teacher in a building with a high ELL population.

- **Dr. Judit Moschkovich: Language(s) and Learning Mathematics**
  
  This PowerPoint presentation, presented by Dr. Judit Moschkovich at the Silicon Valley Mathematics Initiative in 2008, describes the background information on why it is challenging to teach math to ELLs and makes the connection between vocabulary development and content knowledge. The presentation is hosted on the NOYCE Foundation website.

- **Catherine Snow: Word Generation**
  
  Catherine Snow's new website provides information and resources for educators who would like to learn more about Word Generation and how it is implemented. Includes links to comprehensive academic word list that students need to master to comprehend academic content.

- **Catherine Snow: Intervening to Increase General Academic Vocabulary**
  
  Catherine Snow's powerpoint, "Intervening to Increase General Academic Vocabulary." This PowerPoint was featured at the CREATE Conference in 2008. It includes information on the Word Generation program that was created in response to her research on explicit vocabulary teaching and academic content learning. Includes study information and description of how the Word Generation program works.

- **Kathryn Heinze: The Language of Math**
  
  Kathryn Heinze's handout from her TESOL 2005 presentation that provides a detailed description of the Word Problem Procedure (WPP). She also includes a very extensive bibliography with many helpful resources.

- **Virginia Department of Education: Strategies for Mathematics Instruction in the LEP Classroom**
  
  A resource guide that includes information on language acquisition, challenges to ELLs and teachers, instructional strategies, assessment and a list of resources published in 2004. Due to the age of this document some of the links are dead, but overall the information is very solid.

- **"The Inclusive Classroom: Teaching Mathematics and Science to English Language Learners."**
  
  Jarrett, Denise. Although this booklet from the Northwest Regional Education Laboratory was written in 1999, it has a thorough overview of the issues facing ELLs learning math, and has chapters with focus on strategies such as vocabulary development and cooperative learning.

- **NCELA: Reforming Mathematics Instruction For ESL Literacy Students**
  
  This article written by Keith Buchanan and Mary Helman provides an overview of how to approach math instruction for ELLs. Includes tips for instruction, ideas for lessons, and examples of assessments. (NCBE Program Information Guide Series, Number 15, Fall 1993)
• **Translating Word Problems: Key Words**

This article from Purple Math discusses the challenges ELLs face when trying to decipher the meaning of word problems and includes a very useful chart of math vocabulary and its "word problem" equivalent.

• **Bilingual Glossaries: Academic Vocabulary**

The glossaries listed include math as well as science and social studies and come in a variety of languages.

• **Dave's Math Tables: English/Spanish Dictionary**

List of English math vocabulary words with the Spanish equivalent.

• **PBS Teachers: Math Lessons**

PBS Teachers offers a database of multimedia math lessons and activities that can be searched by grade or topic.

• **SMART Notebook Lesson Activities**

Browse lesson activities and materials for classrooms using SMART notebook software. Choose the country or region, and search by curriculum standards, subject and grade level.

• **"Smart" by Shel Silverstein: Complete poem and activity**

This worksheet offers the complete poem cited in the article, as well as some fun related activities and questions.

• **Colorín Colorado Webcast: English Language Learners in Middle and High School**

This webcast features Dr. Deborah Short and discusses effective instructional strategies for teaching English language learner students in middle and high school, such as the SIOP model.

### References

Click the "References" link above to hide these references.


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