English Language Learners and the Academic Language of Math: Making it Work in the Classroom

"Mathematics and language are inexorably linked."

—T.C. Dale and G.J. Cuevas, 1992

"Mathematics performance and learning of groups that have traditionally been underrepresented in mathematics fields can be improved by interventions that address social, affective, and motivational factors. Recent research documents that social and intellectual support from peers and teachers is associated with higher mathematics performance for all students, and that such support is especially important for many African-American and Hispanic students."

—National Mathematics Advisory Panel, 2008

"Talking math not only makes use of specialized vocabulary…but it also uses a variety of words and phrases that mean one thing in mathematics and another in everyday contexts."

—David Slavit and Gisela Ernst-Slavit, 2007

According to the U.S. Department of Education's Institute of Education Sciences[1], there are five key recommendations for instruction of English Language Learners (ELLs). These recommendations—focused on literacy acquisition—provide a basic framework for ELL instruction throughout the United States, particularly in the elementary grades:

- Screen for problems and monitor progress
- Provide intensive, small-group interventions
- Provide extensive and varied vocabulary instruction
- Develop academic English
- Schedule regular, peer-assisted learning opportunities

Today, these findings serve as a foundation for ELL instruction in all academic subjects, including mathematics. Following decades of research, educators recognize that without sufficient knowledge of the academic language of mathematics, ELLs will continue to encounter significant challenges with grade-level math curriculum and math tests. As a result, effective mathematics instruction—particularly math programs geared toward the ELL population—should focus on four key principles:

- Teach the essential academic language of grades 3, 4, and 5 mathematics curriculum
- Offer modularized and non-sequential instruction
- Provide educators with the ability to work with varying levels of ELLs
- Establish and measure standards-based objectives of student performance

[1]Gersten, R. et al. (2007) *Effective Literacy and English Language Instruction for English Language Learners in the Elementary Grades.* Washington, DC: Institute of Education Sciences.

Perfection Learning's *Academic Language Notebook:* The Language of Math is based on these proven principles and decades of scientific research to specifically address the math instruction needs of ELL students. Released in 2007, the program builds on the rich history of mathematics and ELL findings to provide a research-based approach to classroom instruction.

Too often, math instruction for ELL students is ignored, as some claim that students are not ready or that classroom time should be focused exclusively on literacy skill development. According to a recent study from the U.S. Department of Education's National Mathematics Advisory Panel, educators know that math should be a primary focus for all students, regardless of socio-economic background or first language:

> "Teachers and developers of instructional materials sometimes assume that students need to be a certain age to learn certain mathematical ideas. However, a major research finding is that what is developmentally appropriate is largely contingent on prior opportunities to learn. Claims based on theories that children of particular ages cannot learn certain content because they are "too young," "not in the appropriate stage," or "not ready" have consistently been shown to be wrong. Nor are claims justified that children cannot learn particular ideas because their brains are insufficiently developed, even if they possess the prerequisite knowledge for learning the ideas.[2]"

As the nation has seen in recent National Assessment of Educational Progress (NAEP) and Programme for International Student Assessment (PISA) results showing U.S. student math proficiency relatively stagnant in the United States and slipping compared to other industrialized nations, the math skills of *all* U.S. students has never been more important than it is today. As such, it is essential to get proven-effective, research-based instructional programs that work for *all* students into U.S. classrooms.

Focus on The Language of Math—Research-Based Instruction

Research in the fields of ELL instruction and mathematics highlight the foundational building blocks necessary to effectively teach math to ELLs. Whether it be computational word problems, fractions, or even algebra, students' understanding and application of the math skill is based on:

- A clear understanding of the topic or main idea
- Acquisition of the vocabulary used in instruction
- Use of more language in the learning process
- Successful completion of math assignments

Researchers have documented that the acquisition of academic language typically takes ELLs five to seven years.[3] For math instruction, even native English speakers learn a new vocabulary and understanding that is only applicable in the math world. Because of our nation's growing emphasis on math skills—both for education and career—it is essential that ELLs acquire math skills as they are gaining English language ability. Programs such as *Academic Language Notebook:* The Language of Math ensure that students gain the necessary math skills, through instruction and materials that build on English language acquisition in English language development (ELD) classes. *Academic Language Notebook:* The Language of Math thus serves as an instructional tool to boost both language and math ability.

[2]National Mathematics Advisory Panel. (2008) *Foundations for Success: The Final Report of the National Mathematics Advisory Panel.* Washington, DC: U.S. Department of Education.

[3]Thomas, W.P. & Collier, V. (2002) *A National Study of School Effectiveness for Language Minority Students' Long-Term Academic Achievement.* Santa Cruz, California: Center for Research on Education, Diversity & Excellence, University of California.

Understand the Main Idea

"Children cannot learn the language they need for academic development on their own. All students need instructional support but especially English Learners."

—Lily Wong Fillmore, 2004

Review and Practice

Write *exact, exactly, approximate,* and *approximately* on the board.

Have students fold and tear a sheet of scrap paper into four pieces. Ask them to write one of the four words on each piece of paper.

Pick up a handful of paper clips. Say: *I have approximately, or about, 10 paper clips. 10 is the approximate number of paper clips.* Then count the paper clips. Say: *I have exactly (X) paper clips. (X) is the exact number of paper clips.* Model holding up the paper with the correct word on it as you say each of the four words.

Repeat this type of modeling with another handful of countable objects. Write: *I have ____. ____ is an ____.* Using the sentence frames, make four sentences with each word on the board. Have students hold up a piece of paper with the appropriate word on it as you model the sentence frames. Repeat several times, with students picking up the handful of objects themselves and finishing the sentence frames.

Tell students that when you add *-ly* to the end of the words, it changes the meaning. *Exact* and *approximate* tell about numbers. *Exactly* and *approximately* tell about what you have or do. Ask students for other examples of sentences using each of these words.

Elicit from Spanish-speaking students what these words are in their language. Point out that the English ending *-ly* is the same as the Spanish ending *-mente.*

Read the directions for the Practice Applying the Main Idea activity in the student worktext, and go over the example. After students complete problem 1, ask individuals to explain how they decided to match each clue word.

When students are working on problem 2, check students' work as they locate the clue word in the comic strip and write a sentence.

The first step to ensuring that all students understand the main idea of any lesson is to present the lesson in an experiential way that connects to what students know and might have experienced in their own lives. By using a minimum of technical math vocabulary and identifying the prerequisite knowledge that is needed for understanding the key concepts—both key components to *Academic Language Notebook:* The Language of Math—educators can build student comfort and understanding with the topic.

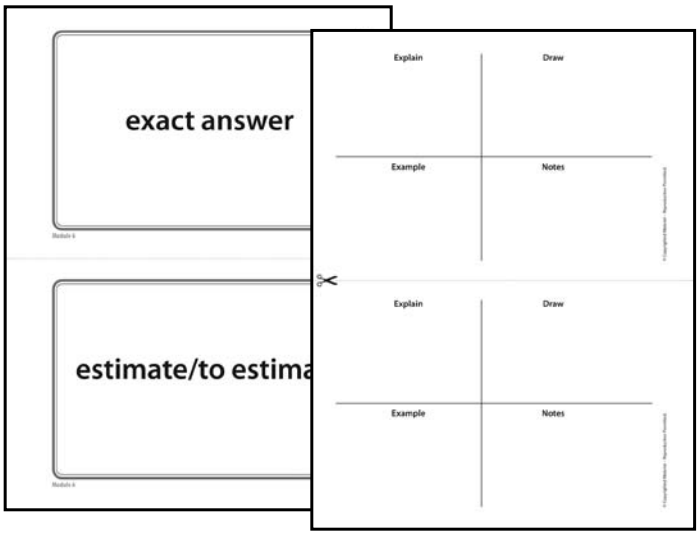
This proven approach allows effective educators to use the main idea to explain the key concept in understandable language that communicates the big ideas about math concepts.

Research shows that communicating a concept in the native language of the student can improve comprehension of the subject matter. This is not only true in English Language Arts, but is fully applicable in mathematics instruction. Teachers with an ability to translate key terms and use relevant vocabulary in the student's native language possess the teaching tools necessary to help all students learn the main idea.

Learn the Vocabulary

"Understanding multiple meanings in words require that 'ELLs discern the specialized meaning of common terms in a mathematical context.'"

—Garrison and Mora, 1999



As evidenced by research studies of literacy instruction and ELLs, vocabulary acquisition is essential to student achievement. In the field of math, achieving success in the grade-level math curriculum requires an understanding of math vocabulary, both specialized math terms and everyday words with additional math meanings (such as *table, point, or set).* That understanding is carefully modeled in *Academic Language Notebook:* The Language of Math.

Most studies of vocabulary conclude that the teaching of vocabulary lists is not viable and that seeing words out of context is not the most effective way to provide real and lasting meaning.

Isabel Beck, a researcher specializing in vocabulary acquisition, identifies three tiers of vocabulary.

- **Tier 1** words are basic words that are learned without direct instruction, everyday language like *hello, baby, walk, yes.*
- **Tier 2** words are those that are frequently and commonly used across different contexts or domains. In math, these are words like *relation, represent, analysis,* and *process.*
- **Tier 3** words are those used in specific contexts or domains, those that we call content-area words like *quadratic equation, trapezoids, exponent,* and *least common multiple.*

Successful math instruction of ELLs demands that Tier 2 words receive the greatest focus during instruction. These words require a more deep knowledge of how language works and how context affects meaning.

Robert Marzano, author of *Building Background Knowledge for Academic Achievement* (ASCD, 2004), has found that ELLs demonstrate significant gains through direct and explicit vocabulary instruction. This, along with similar data, all point to the need for specific vocabulary acquisition as part of math instruction for ELLs.

Successful ELL math programs often use graphic organizers, such as the Frayer Model, to provide a concept map for learning about a word or phrase and offer more interaction with the vocabulary than just a base definition. This approach, which has been adopted by *Academic Language Notebook:* The Language of Math, ensures that the pre-teaching of vocabulary is done early in the learning process, to prevent the interruption of thinking that often makes concepts more difficult to understand.

Use More Language

Following the acquisition of key vocabulary and an understanding of the main idea, students must focus on using more language. Doing so addresses language structures and functions and how such concepts will be used to talk about the math topic. In essence, students must apply their newly gained math vocabularies as part of the learning process.

During this stage, students learn to use specific language structures and phrases to carry out functions that are commonly needed in math classes. This stage includes language patterns such as logical connection *(if…then, since, although)* that indicates relationships between parts of sentences; the relationship of words and math symbols *(4 less than x does not mean 4-x);* and semantic difficulties such as *divided by* and *divided into.* Students are asked to use the language they are learning to explain the math problems they are solving.

Solve Math Problems

"A key question that must be asked is whether or not an assessment measures students' mathematical skills or their proficiency in English…ELLs must process and interpret information in a language in which they are not fully proficient to be able to perform the mathematical tasks."

—Gottlieb, 2007

Equipped with an understanding of a math concept and the vocabulary and fluency to discuss the concept with teachers and classmates, ELLs are now better able to solve math problems. For most, this is the ultimate goal. Establishing core learning building blocks is important, but demonstrating student success—both in the classroom and on local and state assessments—ensures that ELLs remain part of the learning process, regardless of their English language ability at that moment. This is particularly true with regard to those tests used to assess student ability that ask students to "explain your answer."

Because of this, effective ELL math programs—such as *Academic Language Notebook:* The Language of Math—provide educators the tools and opportunities to assess student skill acquisition. Based on these assessments, teachers possess the knowledge and ability to intervene, when necessary, to aid the learning process and help those students needing specific assistance.

In this regard, data has been particularly useful in identifying the importance of differentiation. Differentiation occurs through a scaffolded set of language expectations for intermediate and advanced level ELLs. Adjusting assessment to mirror where students are positioned on the second language acquisition continuum, as reflected in their level of English language proficiency, enables teachers to better gauge student performance and progress over time. Teachers can utilize a data management system, either electronically or in print, by mapping student performance as part of the lesson. By plotting student responses to the main idea of each module in relation to vocabulary, language use, and problem solving on a regular basis, teachers can develop a profile of student performance by lesson type. Using this formative assessment, teachers can have a direct impact on instruction when they use the data to inform instruction.

Best Practices for Teaching ELLs

"With practice, teachers of ELLs can learn to recognize aspects of vocabulary, semantics, discourse patterns, and background knowledge that may prevent ELLs from fully understanding or producing the language they need in math classes and textbooks, and on math tests. One way to identify language problems is to observe students…but it is not very practical for larger groups of students. So a more effective way to identify language problems is to examine textbooks or tests, looking for language that is potentially difficult."

—Suzanne Irujo, ELL Outlook, Nov./Dec. 2007

As illustrated by the literacy instruction research of the National Academy of Sciences, the National Reading Panel, the U.S. Department of Education, and from math-focused organizations such as the National Council of Teachers of Mathematics and the National Science Foundation, effective professional development and teacher support is just as important as an effective instructional model. Success comes at the classroom level, from teachers who are knowledgeable and skilled to understand the instructional approaches, effectively apply them in the classroom, and provide the necessary interventions to ensure all students are gaining the math abilities expected for their grade level.

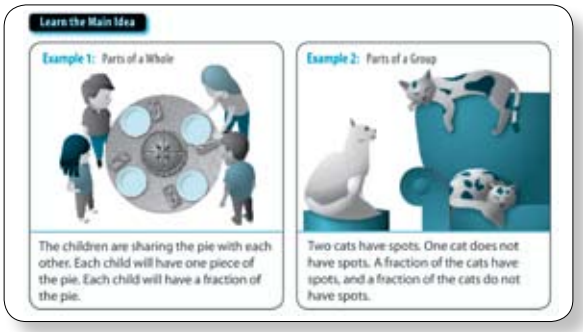
To ensure that all teachers are provided the guidance and support needed to succeed in the classroom, effective programs such as *Academic Language Notebook:* The Language of Math provide comprehensive teacher supports focused on a range of best practices, including:

- Comprehensible Language
- Assessing, Activating, and Building Background Knowledge
- Performance Assessment
- Interaction
- Higher-Order Thinking, and Hands-On Activities

Such Best Practices are most effective when integrated throughout each teaching module, providing educators the opportunity to incorporate Best Practices as part of their everyday classroom practice. This is especially useful in cases where teachers have limited experience with ELLs, where they can see how a specific best practice is exemplified in a classroom activity.

Best Practice 1: Comprehensible Language

Language is made more comprehensible by using clear language; by supporting meaning through the use of visuals and real objects; and by avoiding complex sentences, figurative or idiomatic phrases, and abstract vocabulary.



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