

Teaching Math to English Language Learners 1

If you are a classroom teacher, it is likely that you have students in your class for whom English is a second language. It is also likely that, while language arts is their biggest challenge of the school day, these students are struggling in mathematics. Achievement data show that English language learners (ELLs) are not performing at the same levels as their native English-speaking counterparts (NAEP 2007). This inequity can be addressed if teachers provide well-designed extra support for their students.

Why should teachers have to address English language development (ELD) during the precious academic time allotted to the instruction of mathematics? After all, in many schools across the United States, ELD has its own mandated daily instructional minutes. And teachers have learned strategies for helping English language learners understand their lessons. Isn't the incorporation of visuals, the use of manipulatives, and a conscious effort to read word problems aloud enough to address the needs of these students?

English language learners need to learn the content of their mathematics courses. But learning is mediated through language—in our case, the English language. Every part of learning is language dependent, from the arousal of a curiosity, to the teacher's explanation of a concept, to the formation of an understanding of that concept, to the verbalization or written expression of that understanding. Along the path from curiosity to demonstrated understanding, a learner—any learner—needs to clarify his developing understanding, test hypotheses, and solicit confirmation of his thinking. All of these activities are conducted through the medium of language. When a learner is carrying out all of this cognitive work in a second language, limitations in language can lead to limitations in learning. Compounding this situation is

the time crunch that faces students of mathematics: each year math becomes more challenging and more abstract. Therefore, in classrooms where instruction is provided only in English, the more support provided to English language learners, the sooner they can enter and appreciate the world of mathematics.

This book is intended to assist teachers in helping their students accomplish two goals: develop their proficiency in English and develop their mathematical understanding. To that end, the lessons in the book seek to amplify rather than simplify the role of language in math class. The lessons show different ways that teachers can explicitly structure experiences so that all students, especially ELLs, can engage in conversations about math in English that promote better understanding of the content being taught.

To accomplish these goals, it is important for teachers to be aware of the factors that contribute to English language learners' success in mathematics. These include the backgrounds and experiences that these students bring to the classroom; how students acquire a second language; the challenges ELLs face when learning mathematics; determining the linguistic demands of a math lesson; and specific strategies and activities that simultaneously support learning English and learning mathematics with understanding.

The Backgrounds of English Language Learners

There are approximately five million ELLs enrolled in public schools in the United States (National Clearinghouse for English Language Acquisition 2007). That's more than 10 percent of the school population. And every year, the percentage of ELLs increases. In some states, ELLs represent a far larger portion of the school population. In California, for example, more than 25 percent of students are English language learners (California Department of Education 2006–2007). Texas, New York, Florida, Illinois, and Arizona also have substantial numbers of students who are learning English as a second language.

In some states, the school population of English language learners is relatively not as large, but the percent increase in recent years is significant. In the southeastern United States, for example, the ELL population in schools has increased more than 200 percent in the last ten years (National Clearinghouse for English Language Acquisition 2007).

The profiles of English language learners vary in the length of time they've been in the United States and in the amount of schooling they received in their home country. The educational backgrounds of ELLs

range from recent arrivals with little or no schooling, or interrupted schooling in their country of origin, to those who have a high degree of literacy in their native language. And there are those students whose families have been in the United States for one or two generations and have maintained their native language at home but have not yet acquired enough English to be proficient in academic settings.

ELLs are enrolled in different types of programs in school, depending on the resources and philosophies of the state or district they are educated in. Many states offer bilingual education in a student's primary language as well as English. This allows students to continue their conceptual growth and literacy skills in the primary language while adding English. When children are provided an education in their first language, they get two things: academic knowledge and literacy skills. Both the knowledge and the literacy skills students develop in their first language help English language development enormously. The knowledge students acquire using their first language makes the input they hear and read in English much more comprehensible. This results in more language acquisition and more learning in general (Krashen and Terrell 1983). TESOL (Teachers of English to Speakers of Other Languages) sees the maintenance and promotion of students' native languages as an important part of effective education for students learning English (TESOL 2006).

In locations where bilingual education is unavailable because of different factors (no teachers speak the students' language, district or state policies, parent input), ELLs are placed in English-only classrooms, and in some schools and districts they receive English language development as part of the day. Some districts offer newcomer programs for recent immigrants to help them learn some basic survival English and become acquainted with American culture.

The length of time English language learners have been in the United States, the amount of schooling they have had in their home country, and the kinds of support they have received here in our schools all affect their progress in acquiring English. As well, any instruction, including math, that is delivered in English affects students' English language development.

English Language Development

Considering the importance that acquiring English has on learning in the content areas, English language development instruction should be based on sound theoretical principles of how children acquire a second

language. Dutro and Moran (2003) discuss the differences between the theories of the natural acquisition of English (Krashen and Terrell 1983), which is the idea that language can be acquired in a natural way through meaningful interactions, similar to how we acquire our first language, and the direct instruction of English (McLaughlin 1985). Dutro and Moran argue that there needs to be a balance between the two theories, stating that “a comprehensive theory of classroom instruction should incorporate both informal and formal-language learning opportunities” (228).

Fillmore and Snow (2000) echo this idea by explaining that certain conditions must be present for children to be successful in learning English. They state that ELLs must interact directly and frequently with people who are expert speakers of English, which mirrors the natural process of language acquisition; however, if that condition is not met for any reason, then direct instruction in English is essential for language learning. Regardless of ELLs’ primary language or school experience, we can maximize their academic opportunities by providing direct instruction for learning English that is embedded in a natural, meaningful context with many opportunities for practice. The lessons in this book were developed to include both informal and formal language learning opportunities in math class.

Another aspect of instruction for ELLs is that teachers need to use strategies that give students access to the content in mathematics and other curriculum areas, and help them learn the sophisticated vocabulary and language structures required in those academic settings. This focus on English as a language, not just as a means of instruction, should cut across all content areas and should be at the forefront of teachers’ thinking when planning a lesson. In other words, when we teach math to English language learners, we are also teaching English, not just teaching *in* English. Dutro and Moran (2003) have called this teaching of language prior to content instruction *frontloading*. Dutro, in conjunction with the California Reading and Literature Project, has developed frontloading approaches for language arts curricula in California. We offer here an approach to frontloading English academic language in math.

The Challenges of Teaching Math to English Language Learners

Many educators share the misconception that because it uses symbols, mathematics is not associated with any language or culture and is ideal for facilitating the transition of recent immigrant students into

English instruction (Garrison 1997). To the contrary, language plays an important role in learning mathematics. Teachers use language to explain mathematical concepts and carry out math procedures. While solving problems in mathematics, we often use specialized technical vocabulary (*addition, subtraction, addend, sum*). And researchers of mathematical learning have found that students can deepen their understanding of mathematics by using language to communicate and reflect on their ideas and cement their understandings. Classroom talk can cause misconceptions to surface, helping teachers recognize what students do and do not understand. When students talk about their mathematical thinking, it can help them improve their ability to reason logically (Chapin and Johnson 2006, Cobb et al. 1997, Hiebert and Wearne 1993, Khisty 1995, Lampert 1990, Wood 1999).

The challenge of teaching math to English language learners lies not only in making math lessons comprehensible to students but also in ensuring that students have the language needed to understand instruction and express their grasp of math concepts both orally and with written language. ELLs have the dual task of learning a second language and content simultaneously. For this reason, “it is critical to set both content and language objectives for ELLs. Just as language cannot occur if we only focus on subject matter, content knowledge cannot grow if we only focus on learning the English language” (Hill and Flynn 2006, 22).

English language learners are faced with some common obstacles when learning math. One challenge they face is unknown or misunderstood vocabulary. For example, they can become confused during a discussion if the mathematics vocabulary has different meanings in everyday usage, as with *even, odd, and function*. They also may be confused if the same mathematical operation can be signaled with a variety of mathematics terms, such as *add, and, plus, sum, and combine*. A word such as *left*—as in “How many are *left*?”—can be confusing when the directional meaning of the word is most commonly used in everyday English. The words *sum* and *whole* also can cause confusion because they have nonmathematical homonyms (*some* and *hole*).

A second obstacle is with an incomplete understanding of syntax and grammar. For example, math questions are often embedded in language that makes the problems unclear or difficult to comprehend. Consider the following problem:

*Samuel bought three bags of oranges with seven oranges in each bag.
How many oranges did he buy?*

This word problem uses both the past and present tense of the irregular verb *to buy* in one question, which may cause difficulty for an English language learner, depending on the student's English language proficiency.

Consider another problem:

Lisa gave a total of 12 treats to her cats.

She gave her large cat 2 more treats than she gave her small cat.

How many treats did she give to each cat?

Here, students need to understand or figure out the meanings of words such as *total* and *treats*. They also need to understand words that convey a mathematical relationship such as *more . . . than*. In addition, students need to infer that Lisa has only two cats.

English language learners typically experience difficulty understanding and therefore solving word problems, and this difficulty increases in the later grades of elementary school as the word problems become more linguistically and conceptually complex. Difficulty with grammar, syntax, and vocabulary lies in both understanding math instruction and having the ability to engage in discussions about math.

Many teachers use strategies to help students understand the content in their math lessons. Scaffolds for learning may include manipulatives, visuals, and graphics. These supports are all essential for building a cursory understanding of math concepts, but they may not provide students enough linguistic support for them to discuss their thinking, which would lead to a deeper understanding of content. For example, let's say that a student's understanding of polygons is based on a two-column chart with drawings that distinguish polygons from shapes that are not polygons. Once the chart is put away, the student may not have internalized enough of the linguistic elements of the lesson to be able to continue her learning in subsequent lessons on polygons. Having the language to talk about math concepts is crucial to developing an understanding of those concepts.

Classroom discussions about math have been shown to deepen students' conceptual understanding. These discussions are a critical aspect of the development of language and content, providing a setting for English language learners to negotiate meaning in daily instructional interactions (García 2003). However, if the language needed to engage in these discussions is not made explicit, ELLs are less likely to benefit from mathematical discussions and can fall further behind their peers.

The challenge for teachers is to focus on math concepts *and* the academic language that is specific to mathematics. Teachers must be

cognizant of the linguistic demands of their lessons and how they will address those demands explicitly during instruction so that ELLs can fully participate.

Determining the Linguistic Demands of a Math Lesson

Before providing specific support for ELLs in mathematics, we first need to consider the linguistic demands of a math lesson. This involves determining what academic language students will need to understand and use and knowing how much of the English language students are capable of understanding and producing.

Social or conversational language is the language that students use in familiar, face-to-face situations. This is different than academic language, which includes knowledge of technical and less frequently used vocabulary and ways of speaking English that are not usually heard or used in everyday conversation. The academic language of mathematics includes specialized vocabulary (*polygon, sides, vertices, corners, open, closed, straight, curved*) and the language structures and grammar needed to use the vocabulary (“*The shape is not a polygon because it has curved sides and it is open.*”).

The publishers of math textbooks often make note of the academic vocabulary being introduced in a particular lesson. Frequently, however, there is no direction provided, either to the teacher or to the students, on how to correctly use the new terms. Just because an English learner is told the meaning of a new word does not mean he can construct a coherent sentence (thought) using that term. Simply knowing the term does not allow the learner to use it to express or develop understanding or learning related to the concept. For example, an English learner might be taught the term *polygon*, but that does not mean that same student can draw conclusions, either orally or in writing, about a particular shape and determine whether or not it is a polygon. And if the English learner cannot construct the sentences necessary to talk about particular figures, how does the teacher know what the student has learned?

Once teachers have identified what academic language students will need to know and understand in a particular math lesson, they can then plan strategies for supporting students’ ability to use the language in order to carry on mathematical discussions in English. To provide the appropriate support, teachers must be aware that there are varying levels of proficiency with language acquisition.

Given that many teachers have a wide range of levels in their class, from beginning ELLs to fully proficient native English speakers, it can be

overwhelming to figure out how to meet all of their needs in one math lesson. It is important, however, for classroom teachers to know each student's level of English proficiency. The descriptions of the levels of English language proficiency differ from state to state. In California, for example, the California English Language Development Test (CELDT) identifies the levels as beginning, early intermediate, intermediate, early advanced, and advanced. In the state of Washington, the levels of English language proficiency are beginning, advanced beginning, intermediate, advanced, and transitional. In Illinois, the levels are described as follows: beginning, developing, expanding, and bridging.

In this book, we identify the English language proficiency levels as beginning, intermediate, and advanced. What's important is that teachers recognize that there *are* different levels of English language proficiency, and that the kind of support they give to students often depends upon how much of the second language students are capable of understanding and producing.

Specific Strategies and Activities That Simultaneously Support Learning English and Learning Math

There are a variety of effective strategies and activities that teachers can use in a lesson that will help all students, particularly English language learners, understand math content and develop English language skills. The use of gestures, manipulatives, charts, and graphs, for example, helps students understand the math content when it is being taught in English. Other strategies and activities, such as the use of sentence frames (e.g., *This is a _____.* *It is/has _____.*) and allowing time for class discussions, provide students with the support and the opportunity to talk about their mathematical ideas in English and actively use the language of mathematics.

While the use of the following strategies and activities in a math lesson can benefit all students, it is essential for ELLs.

Activate prior knowledge.

Prior knowledge provides the foundation for interpreting new information, and it enables all students, especially English language learners, to make inferences about the meaning of words and expressions that they may not have come across before. The more connections we can make to students' experiences and interests, the more relevance math is likely to assume in students' minds and lives.