

The Academic Language of Mathematics

Nearly all states continue to struggle to meet the academic targets in math for English learners set by the No Child Left Behind Act. One contributing factor to the difficulty ELs experience is that mathematics is more than just numbers; math education involves terminology and its associated concepts, oral or written instructions on how to complete problems, and the basic language used in a teacher's explanation of a process or concept. For example, students face multiple representations of the same concept or operation (e.g., $20/5$ and $20\div 5$) as well as multiple terms for the same concept or operation



(e.g., 13 different terms are used to signify subtraction). Students must also learn similar terms with different meanings (e.g., *percent* vs. *percentage*) and they must comprehend multiple ways of expressing terms orally (e.g., $(2x + y)/x^2$ can be “two x plus y over x squared” and “the sum of two x and y divided by the square of x ”) (Hayden & Cuevas, 1990).

So, language plays a large and important role in learning math.

In this chapter, we will define academic language (also referred to as “academic English”), discuss why academic language is challenging for ELs, and offer suggestions for how to effectively teach general academic language as well as the academic language specific to math. Finally, we also include specific academic word lists for the study of mathematics.

What Is Academic Language?

Picture yourself preparing for your first meeting with a financial planner who is going to help you develop an investment portfolio. Memories of hearing or reading about the 1929 stock market crash and the serious economic down turn of 2008 crowd your mind as you gather together your tax returns, payroll stubs, list of assets, and other materials the financial planner has asked you to bring to the meeting. When you arrive at the office, you are introduced to the person who has vast financial knowledge as well as access to additional information about how to establish, maintain, and hopefully profit from a well-managed portfolio. As you seat yourself across the desk from the financial planner, he launches into a detailed explanation of what he thinks you should do. He uses terms and phrases such as:

- Ratio analysis
- Fixed interest securities
- Bulk
- Facultative reinsurance
- Deferred annuity
- Broker-deal
- Convertible

Finally, you recognize a word you know, *convertible*, but you quickly realize this man is not talking about an automobile without a top! You also recognize that the financial planner seems to be speaking a different language, although it certainly sounds like English. How are you going to be able to understand what he is asking you to do when you don’t know the language of finance and investment?

We have all had experiences where, as knowledgeable, well-read, educated people, we become lost when we listen to or read about a new and unfamiliar topic. We’re often tripped up by the terminology, phrases, and concepts that are unique to the subject matter. When this happens, we most likely become frustrated and disinterested, and we may tune out and give up. Every day, many English learners sit in classrooms where both the topic and the related words and concepts are totally unfamiliar to them. Other ELs may have familiarity with the topic, perhaps even some expertise, but because they don’t know the English words, terminology, and phrases—that is, the content-specific academic language—they are also unable to understand what is being taught.

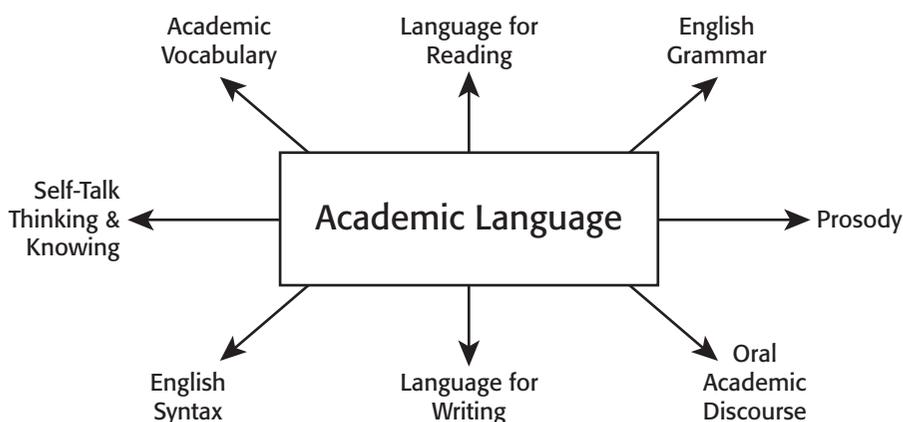
Although definitions in the research literature differ somewhat, there is general agreement that academic language is both generic and content specific. That is, many

academic words are used across all content areas (such as *demonstrate, estimate, analyze, summarize, categorize*), while others pertain to specific subject areas (*idioms, characterization, symbolism* for Language Arts; *angle, ratio, dispersion* for Math). It is important to remember that academic language is more than specific content vocabulary words related to particular topics. Rather, academic language represents the entire range of language used in academic settings, including elementary and secondary schools.

When you reflect on the previous examples for Language Arts and Mathematics, you can see that academic language differs considerably from the social, conversational language that is used on the playground, at home, or at cocktail parties (see Figure 1). Social or conversational language is generally more concrete than abstract, and it is usually supported by contextual clues, such as gestures, facial expressions, and body language (Cummins, 1979; 2000; Echevarria & Graves, 2010). To clarify further what academic language is, the following definitions are offered by several educational researchers:

- Academic language is “the language that is used by teachers and students for the purpose of acquiring new knowledge and skills . . . imparting new information, describing abstract ideas, and developing students’ conceptual understandings” (Chamot & O’Malley, 1994, p. 40).
- Academic language refers to “word knowledge that makes it possible for students to engage with, produce, and talk about texts that are valued in school” (Flynt & Brozo, 2008, p. 500).
- “Academic English is the language of the classroom, of academic disciplines (science, history, literary analysis) of texts and literature, and of extended, reasoned discourse. It is more abstract and decontextualized than conversational English” (Gersten, Baker, Shanahan, Linan-Thompson, Collins, & Scarcella, 2007, p. 16).
- Academic English “refers to more abstract, complex, and challenging language that will eventually permit you to participate successfully in mainstream classroom instruction. Academic English involves such things as relating an event or a series of events to someone who was not present, being able to make comparisons between alternatives and justify a choice, knowing different forms, and inflections of words and their appropriate use, and possessing and using content-specific vocabulary and modes of expression in different academic disciplines such as mathematics and social studies” (Goldenberg, 2008, p. 9).

FIGURE 1 *The Spectrum of Academic Language*



- “Academic language is the set of words, grammar, and organizational strategies used to describe complex ideas, higher-order thinking processes, and abstract concepts” (Zwiers, 2008, p. 20).

It is important to note that some educators suggest that the distinction between conversational and academic language is somewhat arbitrary, and that it is the *situation*, *community*, or *context* that is either predominantly social or academic (Aukerman, 2007; Bailey, 2007). For purposes of this book, we maintain that academic language is essential for success in school and that it is more challenging to learn than conversational English, especially for students who are acquiring English as a second or additional language. Although knowing conversational language assists students in learning academic language, we must teach English learners (and other students, including native speakers) the “vocabulary, more complex sentence structures, and rhetorical forms not typically encountered in nonacademic settings” (Goldenberg, 2008, p. 13).

How Does Academic Language Fit into the SIOP[®] Model?

As you know, the SIOP[®] Model has a dual purpose: to systematically and consistently teach both content and language in every lesson. Content and language objectives not only help focus the teacher throughout a lesson but also (perhaps even more importantly) focus students on what they are to know and be able to do during and after each lesson as related to *both* content knowledge and language development.

A critical aspect of academic language is academic vocabulary. Within the SIOP[®] Model, we refer to academic vocabulary as having three elements (Echevarria, Vogt, & Short, 2008, p. 59). These include:

1. **Content Words.** These are key vocabulary words, terms, and concepts associated with a particular topic. Key vocabulary typically come from math texts (such as *prime factor*, *congruence*, *reliability*, *subset*, *centimeter*, *proof*, *symbolic representation*, *histogram*) as well as other components of the curriculum. Obviously, you will need to introduce and teach key content vocabulary when teaching numbers and operations, algebra, geometry, measurement, and data analysis and probability.
2. **Process/Function Words.** These are the words and phrases that have to do with functional language use, such as *how to restate a problem*, *justify opinions*, *state a conclusion*, *work backwards*, “*state in your own words*,” *summarize*, *question*, *interpret*, and so forth. Tasks that students are to accomplish during a lesson also fit into this category, and for English learners, their meanings may need to be taught explicitly. Examples include *list*, *explain*, *paraphrase*, *identify*, *create*, *monitor progress of a problem*, *define*, *share with a partner*, and so forth.
3. **Words and Word Parts That Teach English Structure.** These are words and word parts that enable students to learn new vocabulary, primarily based on English morphology. Although instruction in this category generally falls under the responsibility of English-language arts teachers, we also encourage teachers of other content areas to be aware of the academic language of their own disciplines. While an English teacher teaches past tense (such as adding an *-ed* to regular verbs) as part of the English-language arts curriculum, as a math teacher you might reinforce past tense by pointing

out that when we talk about math operations or concepts we learned previously, we use the past tense of English, much like a history teacher might draw attention to past tense forms when discussing and reading about historical events. Similarly, English teachers teach morphology (base words, roots, prefixes, suffixes), but you may teach many words with these word parts as key vocabulary (such as *application* or *bivariate*). If English learners (and other students) have an opportunity to read, write, and orally produce these words during math and other subjects such as English-language arts, history, or science, the words are repeatedly reinforced. And, if this reinforcement occurs every school day, one can assume that English learners' mastery of English will be accelerated, as happens with repeated practice in any new learning situation. For a usable and informative list of English word roots that provide the clue to more than 100,000 English words, refer to pages 60–61 of *Making Content Comprehensible for English Learners: The SIOP® Model* (Echevarria, Vogt, & Short, 2008). This is a must-have list for both elementary and secondary teachers in ALL curricular areas.

Picture a stool with three legs. If one of the legs is broken, the stool will not be able to fulfill its function, which is to hold a person who sits on it. From our experience, an English learner must have instruction in and practice with all three “legs” of academic vocabulary (key vocabulary, process/function words, and words/word parts that teach English structure) if they're going to develop the academic language they need to be successful students.

How Is Academic Language Manifested in Classroom Discourse?

Our teachers come to class,
And they talk and they talk,
Til their faces are like peaches,
We don't;
We just sit like cornstalks.

(Cazden, 1976, p. 74)

These poignant words come from a Navajo child who describes a classroom as she sees it. Teachers like to talk. Just observe any classroom and you'll find that the teacher does the vast majority of the talking. That might be expected because the teacher, after all, is the most expert math person in the classroom. However, for students to develop proficiency in language, interpret what they read, express themselves orally and in writing, participate during whole-class and small-group instruction, and explain and defend their answers, they need opportunities to learn and use academic language. To promote more student engagement in classroom discourse, the Interaction component is included in SIOP® Model. The features of the Interaction component, which should be familiar to you at this point, include:

- Frequent opportunities for interaction with and discussion between teachers and students and among students, which encourage elaborated responses about lesson concepts
- Grouping configurations support language and content objectives of the lesson
- Sufficient wait time for student responses consistently provided
- Ample opportunities for students to clarify key concepts in L1 (native language) as needed.

These features promote balanced turn-taking both between teachers and students and among students, providing multiple opportunities for students to use academic English. Notice how each feature of Interaction encourages student talk. This is in considerable contrast to the discourse patterns typically found in both elementary and secondary classrooms. Most instructional patterns involve the teacher asking a question, a student responding, the teacher evaluating the response (IRE: Initiation-Response-Evaluation), or providing feedback (IRF: Initiation-Response-Feedback), followed by another teacher-asked question (Cazden, 1986; 2001; Mehan, 1979; Watson & Young, 1986). A typical interaction between a teacher and her students during a math lesson is illustrated in the following example:

- T: Who can tell me what we call the longest side of a triangle?
 S: A hypotimus.
 T: Well, that's close. Who can help Rodolfo with, who can tell us?
 S: Hypotenuse.
 T: That's right. It's called the hypotenuse. Very good.

And so it goes, often for a good portion of the lesson. Notice that the teacher asked questions that had one correct answer with no reasoning or higher level thinking required, the teacher controlled the interchange, and the teacher evaluated student responses. Also note that the person who used the most academic language (*hypotenuse, triangle*) was the teacher. The students didn't need to use more than one or two words in response to the teacher's questions in order to participate appropriately. Only two students were involved, while the others sat quietly.

The IRE/IRF pattern is quite typical and it has been found to be one of the least effective interactional patterns for the classroom (Cazden, 1986; 2001; Mehan, 1979; Watson & Young, 1986). More similar to an interrogation than to a discussion, this type of teacher-student interaction stifles academic language development and does not encourage higher level thinking because most of the questions have a straightforward known answer. Further, we have observed from kindergarten through high school that most students become conditioned to wait for someone else to answer. Often it is the teacher who ultimately answers his or her own question, if no students volunteer.

In classrooms where the IRF pattern dominates (Initiation-Response-Feedback), the teacher's feedback may inhibit learning when she changes students' responses by adding to or deleting from their statements or by completely changing a student's intent and meaning. Because the teacher is searching for a preconceived answer and often "fishes" until it is found, the cognitive work of the lesson is often carried out by the teacher rather than the students. In these classrooms, students are seldom given the opportunity to elaborate on their answers; rather, the teacher does the analyzing, synthesizing, generalizing, and elaborating.

Changing ineffective classroom discourse patterns by creating authentic opportunities for students to develop academic language is critically important because as one acquires language, new concepts are also developed. Think about the previous example of visiting a financial planner. Each new vocabulary word you learned and understood (e.g., deferred annuity, fixed interest securities) is attached to a concept that in turn expands your ability to think about how to protect your hard-earned money. As your own system of word-meaning grows in complexity, you are more capable of understanding the associated concepts and generating the self-directed speech of verbal

thinking: “When that Certificate of Deposit matures, I think I’ll put it in a mutual fund.” Without an understanding of the words and the concepts they represent, you would be incapable of thinking about (self-directed speech) or discussing (talking with another) financial planning.

Why Do English Learners Have Difficulty with Academic Language?

Developing academic language has proven to be quite challenging for English learners. In fact, in a study that followed EL students’ academic progress in U.S. schools, researchers found that the ELs actually regressed over time (Suarez-Oroczo, Suarez-Oroczo & Todorova, 2008). There are myriad influences that affect overall student learning, and academic language learning in particular. Some factors, such as poverty and transiency, are outside of the school’s sphere of influence, but let’s focus on some of the influences that are in our control, namely what happens instructionally for these students that facilitates or impedes their learning.

Many classrooms are devoid of the kinds of supports that assist students in their quest to learn new material in a new language. Since proficiency in English is the best predictor of academic success, it seems reasonable that teachers of English learners should spend a significant amount of time teaching the vocabulary required to understand the lesson’s topic. However, in a study that observed 23 ethnically diverse classrooms, researchers found that in the core academic subject areas only 1.4% of instructional time was spent developing vocabulary knowledge (Scott, Jamison-Noel, and Asselin, 2003).

The lack of opportunity to develop oral language skills hinders students’ progress in all subject areas. Passive learning—sitting quietly while listening to a teacher talk—does not encourage engagement. In order to acquire academic language, students need lessons that are meaningful and engaging and that provide ample opportunity to practice using language orally. Successful group work requires intentional planning and giving students instructions about how to work with others effectively; teacher expectations need to be made clear. Grouping students in teams for discussion, using partners for specific tasks, and other planned configurations increase student engagement and oral language development.

Another related influence on language development is access to the language and the subject matter. Think about a situation in which you hear another language spoken. It could be the salon where you get a manicure or your favorite fast food place. Just because you regularly hear another language, are you learning it? Typically, not. Likewise, many English learners sit in class and hear what amounts to “English noise.” It doesn’t make sense to them and thus, they are not learning either academic language or the content being taught. Without the kinds of practices that are promoted by the SIOP® Model, much of what happens during the school day is lost on English learners.

Finally, some teachers have low expectations for EL students (Lee, 2005; NCTM, 2008). They are not motivated to get to know the students, their cultures, or their families. Poor performance is not only accepted, but expected. Rather than adjusting instruction so that it is meaningful to these students, teachers attribute lack of achievement to students’ cultural background, limited English proficiency and, sadly, ability.

How Can We Effectively Teach Academic Language in Mathematics?

In a recent synthesis of existing research on teaching English language and literacy to ELs in the elementary grades, the authors make five recommendations, one of which is to “Ensure that the development of formal or academic English is a key instructional goal for English learners, beginning in the primary grades” (Gersten et al., 2007, pp. 26–27). Although few empirical studies have been conducted on the effects of academic language instruction, the central theme of the panel of researchers conducting the synthesis was the importance of intensive, interactive language practice that focuses on developing academic language. This recommendation was made based upon considerable expert opinion, with the caveat that additional research is still needed.

Because you are already familiar with the SIOP[®] Model, you know that effective instruction for English learners includes focused attention on and systematic implementation of the SIOP[®] Model’s eight components and 30 features. Therefore, use the SIOP[®] protocol to guide lesson design when selecting activities and approaches for teaching academic language in mathematics.

Jeff Zwiers (2008, p. 41) notes that “academic language doesn’t grow on trees.” Rather, explicit instruction through a variety of approaches and activities provides English learners with multiple chances to learn, practice, and apply academic language (Stahl & Nagy, 2006). Teachers must provide comprehensible input (Krashen, 1985) as well as structured opportunities for students to produce academic language in their content classes. This will enable English learners to negotiate meaning through confirming and disconfirming their understanding while they work and interact with others.

In addition to explicit vocabulary instruction, we need to provide a variety of scaffolds, including context. Writing a list of math terms on the board or pointing out sentences that are bolded in the textbook only helps if students know what they mean. To create a context for learning academic English, teachers must preteach terms and sentence patterns (e.g., interrogative and declarative), and explain them in ways that students can understand and relate to, followed by showing how the terms and sentence patterns are used in the textbook. Scaffolding involves providing enough support to students so that they are gradually able to be successful independently. Another way of scaffolding academic English is to have word walls or posters displayed that show commonly used terms, operations, and math processes. Certainly, older learners can work in groups to create these posters with mnemonics, including cartoons or other illustrations. These aids reduce the cognitive load for English learners so that they can focus on math operations or processes without having to remember their associated linguistic terms. As students refer to and use these posted academic language words and phrases, they will internalize the terms and begin to use them independently.

In the lesson plans and units that appear in Chapters 3–8, you will see a variety of instructional techniques and activities for teaching, practicing, and using academic language in the mathematics classroom. As you read the lesson plans, reflect on why particular activities were selected for the respective content and language objectives. Additional resources for selecting effective activities that develop academic language and content knowledge include: Buehl’s *Classroom Strategies for Interactive Learning* (2009); Vogt & Echevarria’s *99 Ideas and Activities for Teaching English Learners with the SIOP[®] Model* (2008); and Reiss’s *102 Content Strategies for English Language Learners* (2008).

Secondary teachers will also find the following books to be helpful: Jeff Zwiers's *Building Academic Language: Essential Practices for Content Classrooms (Grades 5–12)* (2008), and his book, *Developing Academic Thinking Skills in Grades 6–12: A Handbook of Multiple Intelligence Activities* (2004).

The Role of Discussion and Conversation in Developing Academic Language

Researchers who have investigated the relationship between language and learning suggest that there should be more balance in student talk and teacher talk in order to promote meaningful language learning opportunities for English learners (Cazden, 2001; Echevarria, 1995; Saunders & Goldenberg, 1992; Tharp & Gallimore, 1988; Walqui, 2006). In order to achieve a better balance, teachers need to carefully analyze their own classroom interaction patterns, the way they formulate questions, how they provide students with feedback, and the opportunities they provide for students to engage in meaningful talk.

Not surprisingly, teacher questioning usually drives the type and quality of classroom discussions. The IRE or IRF pattern discussed previously is characterized by questions to which the teacher already knows the answer and results in the teacher unintentionally expecting students to “guess what I’m thinking” (Echevarria & Silver, 1995). In fact, researchers have found that explicit, “right there” questions are used about 50% of the time in classrooms (Zwiers, 2008), and math lends itself to brief, factual exchanges.

In contrast, open-ended questions that do not have quick “right” or “wrong” answers promote greater levels of thinking and expression and are supported by the National Council of Teachers of Mathematics (NCTM). The teaching of mathematics has changed:

(I)n many mathematics classrooms today, the emphasis has shifted from students acquiring vocabulary and solving standard word problems to learners explaining solution processes, describing ideas, presenting arguments, and proving conclusions. The teacher–student interactions imply a complex association between language and mathematics in general, and more specifically, the intricate nature of the relationship between learning mathematics and acquiring the language . . . in which mathematics is learned (Cuevas, 2005, p. 71).

During math lessons, there should be more of an emphasis on promoting classroom discourse by students questioning one another, reasoning rather than merely memorizing

FIGURE 1.1 *National Council of Teachers of Mathematics Communication Standards*

Instructional programs from prekindergarten through grade 12 should enable all students to:

- organize and consolidate their mathematical thinking through communication.
- communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
- analyze and evaluate the mathematical thinking and strategies of others.
- use the language of mathematics to express mathematical ideas precisely.

procedures, making connections, solving problems and communicating solutions. In this way the NCTM communication standards, shown in Figure 1.1, can be met. For example, questions such as, “Would you add all these numbers or use multiplication? Why?” and requests such as, “Explain why we use arrows at the ends of a line. . . . Okay, what do they represent?” not only get students thinking about math processes, but also provide an opportunity for students to grapple with ideas and express themselves using academic English.

Something as simple as having students turn to a partner and answer a question first, before reporting out to the whole class, is an effective conversational technique, especially when the teacher circulates to monitor student responses. Speaking to a peer may be less threatening, and this method also gets every student actively involved. Also, rather than responding to student answers with “Very good!” teachers who value conversation and discussion encourage elaborated responses with comments like, “Can you tell us more about that?” or “What made you think of that?” or “Did anyone else have that idea?” or “Please explain how you figured that out.”

Jeff Zwiers (2008, pp. 62–63) has classified the types of comments teachers can make to enrich classroom talk. By using comments like those that follow, you will be able to achieve a greater balance between student talk and teacher talk. Further, classroom interactions will be less likely to result in an IRE or IRF pattern. Try using some of these comments and see what happens to the interaction pattern in your own classroom!

To Prompt More Thinking

- You are on to something important. Keep going.
- You are on the right track. Tell us more.
- There is no right answer, so what would be your best answer?
- What did you notice about . . .

To Fortify or Justify a Response

- That’s a good probable answer . . . How did you get to that answer?
- Why is what you said so important?
- What is your opinion (impression) of . . . Why?

To See Other Points of View

- That’s a great start. Keep thinking and I’ll get back to you.
- If you were in that person’s shoes, what would you have done?
- Would you have done (or said) it like that? Why or why not?

To Consider Consequences

- Should she have . . . ?
- What if he had not done that?
- Some people think that . . . is [wrong, right, and so on]. What do you think? Why?
- How can we apply this to real life?

A conversational approach is particularly well suited to English learners who, after only a few years in school, frequently find themselves significantly behind their peers in most academic areas, usually because of low reading levels in English and underdeveloped language skills. Students benefit from a conversational approach in many ways because conversation provides:

- A context for learning in which language is expressed naturally through meaningful discussion
- Practice using oral language, which is a foundation for literacy skill development
- A means for students to express their thinking, and to clarify and fine-tune their ideas
- Time to process information and hear what others are thinking about
- An opportunity for teachers to model academic language, use content vocabulary appropriately, and, through think-alouds, model thinking processes
- Opportunities for students to participate as equal contributors to the discussion, which provides them with repetition of both linguistic terms and thinking processes and results in their eventual acquisition and internalization for future use

A rich discussion, or conversational approach, has advantages for teachers as well, including the following:

- Through discussion, a teacher can more naturally activate students' background knowledge and assess their prior learning.
- When working in small groups with each student participating in a discussion, teachers are better able to gauge student understanding of the lesson's concepts, tasks, and terminology, as well as discern areas of weakness.
- When teachers and students interact together, a supportive environment is fostered, which builds teacher-student rapport.

When contemplating the advantages of a more conversational approach to teaching, think about your own learning. In nearly all cases, it probably takes multiple exposures to new terms, concepts, and information before they become yours to use independently. If you talk with others about the concepts and information you are learning, you're more likely to remember them.

English learners require even more repetition and redundancy. As they have repeated opportunities to improve their oral language proficiency, ELs are more likely to use English, and more frequent use results in increased proficiency (Saunders & Goldenberg, 2009). With improved proficiency, ELs are more adept at participating in class discussions. Discussion and interaction push learners to think quickly, respond, construct sentences, put their thoughts into words, and ask for clarification through classroom dialogue. Discussion also allows students to see how other people think and use language to describe their thinking (Zwiers, 2008).

Productive discussion can take place in whole class settings, but it is more likely that small groups will facilitate the kind of high-quality interaction that benefits English learners. Working to express ideas and answers to questions in a new

language can be intimidating for students of all ages. Small group work allows them to try out their ideas in a low-stress setting and to gauge how similar their ideas are to those of their peers. Working with partners, triads, or in a small group also provides a chance to process and articulate new information with less pressure than a whole class setting may create.

Sharing conversational control with students involves some risk-taking on the part of the teacher as well as practice on the part of students who may prefer to answer questions with monosyllabic words. Simply telling students to “discuss” will likely have poor results. We need to teach students how to engage in meaningful conversation and discussion and provide the structure and support they need to be successful. Rather than sitting as “quiet cornstalks,” students, including English learners, can learn to express themselves, support their answers, advocate their positions, and defend their beliefs. When this occurs, we establish a classroom environment in which conversational control is shared among teachers and students alike.

What Is the Academic Language of Mathematics?

There are myriad terms that are used in academic settings. As mentioned previously, some of these are used commonly across content areas and others are content specific. The metaphor of bricks and mortar is helpful here as we think of some words representing bricks, such as math content-specific words (*algebraic symbol, formula, and geometric shape*). The mortar refers to general academic words such as *describe, represent, and approximate* (Dutro & Moran, 2003). Understanding both types of terms is often the key to accessing content for English learners. For example, although most students need to have terms related to math explicitly taught, English learners also require that general academic words be included in vocabulary instruction.

As you plan for lessons that teach and provide practice in both math-specific academic language and more general academic language, use your teacher’s guides from the math text to note the highlighted vocabulary, as well as other terms and phrases that may need to be taught. Also, you may use English language arts content standards and your state English language development standards for ELs to assist you in selecting the general academic language you need to teach and reinforce. Other resources include the “1,000 Most Frequent Words in Middle-Grades and High School Texts” and “Word Zones™ for 5586 Most Frequent Words,” which were collected by Hiebert (2005) and may be found online at www.textproject.org. For those of you who are high school teachers, you might also want to take a look at the Coxhead Academic Word List (Coxhead, 2000).

In the study of mathematics, students are exposed to many new terms that they most likely won’t encounter anywhere other than in math class. These terms are found in the textbook and ancillary materials, presented during lessons, and found in math standards. Let’s take a look at the various terms that are present in a few selected NCTM math standards. The words that are math-specific are **bolded** and general academic words are underlined:

In Pre-Kindergarten through Grade 2, All Students Should:

- understand situations that entail **multiplication** and **division**, such as **equal groupings of objects** and **sharing equally**.
- model situations that involve the **addition** and **subtraction of whole numbers**, using **objects, pictures, and symbols**.

In Grades 3–5, All Students Should:

- identify such **properties** as **commutativity**, **associativity**, and **distributivity** and use them to **compute with whole numbers**.
- propose and justify conclusions and predictions that are based on **data** and design studies to further investigate the conclusions or predictions.

In Grades 6–8, All Students Should Be Able to:

- compare and order fractions, decimals, and percents efficiently and find their approximate locations on a **number line**.
- understand both **metric** and **customary systems of measurement**.

In Grades 9–12, All Students Should:

- use **number-theory arguments** to justify relationships involving **whole numbers**.
- understand the meaning of **equivalent forms of expressions, equations, inequalities, and relations**.

As you can see, many of the underlined words may be used in other content areas as well, but students need to be explicitly taught their meaning. Some of these words are common, but have a specialized meaning in math. For students who speak a Latin-based language such as Spanish, cognates may help in teaching some words. For example, *predict* in English is *predecir* in Spanish; *justify* in English is *justificar* in Spanish; *multiply* in English is *multiplicar* in Spanish. Math-specific words should be explicitly taught as part of each math lesson.

In Appendix B you will find a comprehensive list of academic math vocabulary words and phrases found in the NCTM content and process standards organized by the grade-level clusters used throughout this book (K–2, 3–5, 6–8, 9–12). Your state’s standards and domains may differ a bit, but we hope this extensive list will assist you in your lesson and unit planning, and in the writing of your content and language objectives.

Concluding Thoughts

Proficiency in English is the best predictor of academic success, and academic language proficiency is an important part of overall English proficiency. In this chapter we have discussed what academic language is, why it is important, and how it can be developed in math classes and across the curriculum. In all content areas, teachers need to plan to explicitly teach both content area terms and general academic terms as well as provide opportunities for students to develop other aspects of academic language. In the mathematics classroom, we do so in order that English learners can fully participate in lessons, acquire concepts and processes of math, and increase their academic language proficiency.

An important way to provide opportunities for students to learn and practice academic language is through classroom conversations and structured discussions. When you teach students how to participate in classroom conversations, you not only improve their English skills but also prepare them to understand the type of language used by historians, scientists, mathematicians, authors, literary critics, and other scholars. You will give them the tools they need to have practice with language skills that enable them to back up claims with evidence, be more detailed in their observations, use persuasive language compellingly in arguments, and compare points of view, with the result being academic achievement and school success.