6 Teaching Content-Specific Academic Vocabulary

CHAPTER

Remember the first time you saw a video of a dung beetle in action? Or a photograph showing the microscopic mites that thrive in our pillows and mattresses by the tens of millions? As your teacher intended, those images definitely got your attention and drew you into the subject at hand. That engagement also supported your learning of the appropriate vocabulary. What your teacher may not have shared with you, however, are the meanings and connotations couched within the structures of the words (see Figure 6.1). For example, the Latin term for one family of dung beetle is *trox horridus,* a name that immediately signifies something horrid. The literal meaning is even creepier; *trox* means "to gnaw," so this type of beetle is literally a "horrid gnawer." Another Latin term, *dermatophagoides,* for a family of mites, literally means "skin eating."

Both of these terms include word parts that most students may recognize in other more familiar words such as *horrid* and *dermatologist.* And *this* is where much of the value lies in sharing and examining the structures or spellings of the words themselves that represent concepts large and small. Connections are made within content area concepts—such as dung beetles, mites, and their functions—and concepts and general experience. A specific dung beetle (*horridus,* "scary") leads to associations with *horrid* and *horrible.* The *concept* that the word represents and the *spelling* of the word itself work together to deepen students' understanding.

Lemke observed that "the mastery of academic subjects is the mastery of their specialized patterns of language use" (1988, p. 81). As you help students construct knowledge of your discipline, you're also helping them learn the *language* of your discipline: the words that historians, mathematicians, or scientists use to talk about their worlds. Toward this end, this chapter uses the following organizational framework:

- *An overall instructional emphasis on generative and word-specific strategies and activities for each content area.* Examples are grouped together to encourage thinking across the subject matter areas and to underscore the similarities among ways of approaching different

FIGURE 6.1 ***Trox Horridus* and *Dermatophagoides***

trox horridus ***dermatophagoides***

strategies and activities across all disciplines. As you read and think about each of the content areas, please keep in mind how activities may also be used, with different content, at any level of instruction for that subject. In addition, it is important to keep in mind that most activities work *before, during,* and *after* reading or exploring a unit. The examples provided in this chapter should help to illustrate this. Because prior misconceptions held by students are often difficult to break even in the face of new facts (cited in Pearson, Hiebert, & Kamil, 2007), by returning to earlier activities in a unit such as concept sorts and graphic organizers, students are much better able to determine what has been learned and is now understood that might have been unknown or confused before.

- *Tables of generative Greek and Latin roots and affixes for each content area.* These tables include only those roots and affixes that occur most often in a particular discipline. Becoming familiar with these generative elements, therefore, should provide students with a leg up on learning much of the vocabulary in that content area. As an additional generative element, many of these roots and affixes occur in other areas.
- *Methods to become comfortable talking about how roots and affixes combine to create meaning.* Examples are provided throughout the chapter for each content area, illustrating the ways that teachers can discuss the meanings that result from combining generative elements. Some of these "word narratives" are straightforward and literal—an *equilateral triangle* has three (*tri,* "three") sides that are equal (*equ,* "equal" + *later,* "side"). Some are more general—*endogenous* is the quality of being produced from within (*gen,* "produce" + *endo,* "within"). Students will still need to learn many specific examples of this process. An understanding of the general meanings produced by combining the word parts, however, will be a strong memory hook on which students can hang the specifics.

For the vast majority of words and their parts, however, we leave the narratives to you. You understand the nuances of the language of your content area. What we hope to do is help you realize the potential for these narratives to enhance content area study. The more you think about specific words and the generative elements of the words in your discipline, the more confident and comfortable you become talking about the words and language of your discipline.

VOCABULARY AND THE CONTENT AREA TEXTBOOK

The core resource for most content area teachers is the textbook. Together with continually evolving Web support, textbooks reflect the content standards for the subject and grade level. These standards are established by each state, usually with close attention to the standards developed by the professional organization of each discipline, such as the National Council for the Social Studies (www.socialstudies.org), the National Council for Teachers of Mathematics (www.nctm.org), and the National Science Teachers Association (www.nsta.org). Though textbooks may be the core resource, however, they should not be the sole resource. Content teachers supplement, elaborate, and extend instruction in many ways, and these should include the approach to and types of vocabulary instruction presented in this chapter. The concepts and vocabulary that are presented in your district's adopted curriculum, represented by the core textbook, should be a very good guide to your vocabulary selection and focus.

Understanding the structure of the textbook is an important part of developing the necessary background for a content area, scaffolding knowledge for exploring the discipline and its language and vocabulary. The organization of the textbook usually reflects the structure of the discipline. In algebra, for example, simple operations and equations precede and are necessary for understanding polynomials and factoring. History usually follows a chronological structure, though this is not an imperative, and innovative history teachers often complement this structure with other perspectives.

There are strategies for using textbooks effectively that have stood the test of time and of research (e.g., Blachowicz & Ogle, 2008; Fisher & Frey, 2007; Vacca & Vacca, 2007). They all incorporate aspects of basic educational psychology—*preview, read,* and *reflect:*

- Prior to the preview, help students get a sense of what they may already know about the topic, becoming aware of their own level of background knowledge.
- Then, as they preview, help them think about how the organization and presentation of information can provide support in thinking about important ideas and supporting information. Note and discuss titles and headers, boldfaced words, charts, and diagrams. Let them in on an important psychological trick: If it isn't already framed as such, turn each heading into a question. This simple adjustment "primes" their brain to be more attentive when they return to read in more depth.
- As students read, suggest that they keep prior questions and information in mind, make notes as necessary, and on reaching the end of a section, take a minute or two to reflect and think back on the information presented and how it fit with their prior understandings.

However, there are so many new vocabulary terms—and so little time, it seems—that you may have to streamline your approach by adapting the steps first presented in Chapter 4 in your selection of vocabulary. In general, as a subject matter teacher—or a teacher of several subjects in the intermediate grades—you will want to apply the following criteria:

- What are the "big ideas" that you will want to emphasize and develop throughout the year? As you plan for each unit or chapter, think about how these overall ideas are reflected by the vocabulary and concepts in each chapter or unit.
- Reading through the chapter and thinking about your unit as a whole, what are the words that represent the "big ideas"—the major concepts for which students will need to develop a deep understanding? Introduce and develop these at the beginning of the unit of study and before the reading, as well as during and after. Examples from math are *proof* and *algebraic expression;* from science, *organ* and *cell;* from social studies, *civil rights.*
- Which words are necessary for the specific reading assignment but do not require deep understanding? You may mention these, providing definitions, without exploring further unless it becomes necessary for some students.
- As with core academic vocabulary, which words are important but may be figured out by the students through application of their structural analysis strategy together with help from the context?
- Which of these words or ideas may be developed by walking students through the constituent roots and affixes?

New and important vocabulary in textbooks is likely to be shown in bold letters, italics, or treated in some way so as to draw attention to it. In addition, these highlighted terms are usually defined either in context, in a sidebar note, or in some other way right on the page where they first appear, as well as in the glossary of the book. Students need to be explicitly taught to use these sources of information and to pay attention to new vocabulary. While it may be possible to skip over unfamiliar words and still easily comprehend a piece of fiction, this is often not true when reading expository text whose very purpose is to introduce new concepts and the labels for those concepts. Teachers should preview texts to look for vocabulary that is not bolded but may present a challenge to their students. While new vocabulary is often listed in the teacher's edition or guide, the list may not be comprehensive.

Rare words, like those encountered in the sciences, are likely to have single meanings (Nagy & Scott, 2000). There will be words with multiple meanings like *organ* and *tissue* that will be used in new ways in the study of body systems, but words like *pathogen, loess,* and *epidermis* will only mean one thing. Teachers may find that textbook glossaries

are more helpful than standard dictionaries both to supply the subject-specific meanings of words with multiple meanings like *front* and *resistance* and to offer well-developed definitions of new vocabulary. Some textbook glossaries have both English and Spanish. Glossaries will get heavy use when teaching vocabulary and they should be examined carefully as part of any textbook review process. Glossaries should include pronunciation guides but often do not.

GENERATIVE INSTRUCTION

It is especially important in the content areas for students to understand the ways in which meaningful word parts combine. This understanding will help them learn the key vocabulary of each content area, and understanding the roots and affixes that frequently occur in each discipline can generate an understanding of quite literally hundreds of additional words in each discipline.

To dramatize this effect, Sonia Gretzky, a secondary science teacher, talks about the root *struct* and discusses how its meaning, "to build," functions to contribute to the meaning of many words. She shares a complete list of *struct* words she obtained from www.onelook.com (similar to Figure 4.1 on p. 53) and comments, "Pretty impressive, isn't it? This one root occurs in well over 300 words in English! Now let's look at the root *hydr*—we don't see it too often, do we? Any ideas what it means?"

If there's no response, Sonia may ask "If you have to *hydrate* someone after a long soccer practice on a hot day, what does that mean?" She helps the students understand that *hydr* usually means "water" or "fluid." She then asks, "How many of you think this root will occur in more words than *struct?* Fewer words?" Sonia then shares the results of her Onelook search for **hydr**, and students are usually quite surprised to see that this root occurs in almost 900 words in English—more than three times as many words as *struct*.

Sonia continues: "Wow! We've got a lot of curious-looking words in these lists! Check them out: *dehydrochlorinase, hydrocephalous, sterhydraulic*—not exactly everyday words, are they? But somewhere inside of them, you know they've got something to do with 'water' or 'fluid.' And although you're not going to run into the word *dehydrochlorinase* very often, you *are* going to run into the root *hydr-* quite a bit in science. In fact, you're not going to run into this root in many places *other* than in the sciences, such as biology and chemistry. So, for us, it's an important root to learn—as are a few others we'll be exploring this year!"

Conducting word sorts and exploring roots and affixes are those aspects of *generative* instruction that best develop students' awareness and application of generative learning.

Word Sorts

The word sorts from different content areas illustrated in this section illustrate how comparing and contrasting words and their *structures* can unlock and reinforce word *meanings.* Word sorts also offer opportunities for teachers to bring in interesting, often historical background information relating to the origins of many of the words and word parts. Our hope is that, over time, students begin to internalize these dialogues and modes of thinking about words, becoming motivated to explore further. Additional sorting activities with base words, affixes, and roots are provided in the lessons found in Appendixes A and B.

History/Social Studies. The following sort focuses on the roots *crat/cracy* (rule, government) and *arch/archy* (rule), both of which originated in Greek. Related words may be matched and discussed. Have students work in pairs to match up the base and

derived forms, then discuss their possible meanings. Most students will have at least heard most of these words, though they may be uncertain about the meanings, which can easily be checked in dictionaries.

cracy	*crat*	*archy*	*arch*
autocracy	autocrat	monarchy	monarch
democracy	democrat	oligarchy	oligarch
plutocracy	plutocrat	anarchy	anarchist
aristocracy	aristocrat	hierarchy	hierarchical
bureaucracy	bureaucrat	matriarchy	matriarch
technocracy	technocrat	patriarchy	patriarch

In follow-up discussion, the teacher explores with students their ideas about the meanings of *crat/cracy* and *arch/archy,* along with the dictionary information they found. For example, *plutocrat/plutocracy* refers to wealth and government or rule by the wealthy or rich. Although they realize it probably doesn't apply, on occasion students joke about Pluto, the beloved Disney dog, ruling. Actually, teachers may share with students that the Disney dog was indeed named after the planet Pluto (long before the planet was demoted to just a ball of ice). In Roman mythology, Pluto was the god of the underworld, and the underworld was not as scary as it later became in the Western mind. *Pluto* meant "wealth" in Roman mythology, because it was believed that the underworld was the source of wealth that comes from the ground—grain, gold, and so forth. The teacher shares a quote from Theodore Roosevelt: "Of all the forms of tyranny, the least attractive and most vulgar is the tyranny of mere wealth, the tyranny of plutocracy."

Following are additional morphological analyses that may be discussed:

- *aristocrat/aristocracy.* Literally, rule by "the best," though this has come to mean rule by the nobility and the rich.
- *bureaucrat/bureaucracy.* Literally, rule from "an office."
- *theocrat/theocracy*. Literally, rule by "God"—though in fact it is humans who are ruling, but claiming to do so in the name of a god, following his or her precepts.
- *oligarch/oligarchy*. Rule by "a few."
- *anarchy/anarchist*. In these words, *an-* is a prefix meaning "without" (as in *amoral*). Literally, *anarchy* is "without rule"—there is no government in control.

An excellent follow-up to this type of sort is the game "It's All Greek to Us" in Appendix E.

Science. The following sort explores the suffixes *-phobia/-phobic* (fear), *-ine* (like; chemical substance), *-itis* (disease of; inflammation of), and *-ide* (chemical substance). These suffixes apply to a very large number of words in the sciences and might best be approached through an explicit walk-through before students sort the words that contain them.

First discuss the meanings of each of the suffixes in the words. The suffixes *-phobia/-phobic* come from Phobos, the name of the Greek god of fear and also the name of one of the moons of Mars (see "Greek and Roman Myths and Legends" in Chapter 5). (*Note:* If students mention that *-ia* and *-ic* are also suffixes, good! These suffixes have the meaning "relating to," so literally *phobia* and *phobic* both mean "relating to fear.") The suffix *-ine* can also mean "of or relating to," as in *serpentine, crystalline,* and *medicine,* or indicate a chemical substance. Prior to taking a course in chemistry or biology, understanding that the suffix *-ide* refers to a chemical substance is sufficient.

Discuss which of the words in this sort fall into the category "I've heard of it but am not sure of the meaning." You may wish to discuss some of them. After discussing the meaning of *claustrophobia,* for example, tell the students that the root *claustr* comes from the Latin word for an enclosed space—the same word that also generated *cloister* and *closet.* Or you may simply direct the students to look them up and study the etymolo-

gies before discussing with the rest of the group how the words have come to have their current meanings. Students may know that *arachnophobia* means "a fear of spiders" but may not know the myth of Arachne. *Xeno* comes from Greek and means "stranger"; illustrate its meaning with the sentence "During the war the nation was gripped by a wave of xenophobia."

-phobia/-phobic	*-ine*	*-itis*	*-ide*
claustrophobia	adrenaline	tonsillitis	monoxide
arachnophobia	alkaline	laryngitis	peroxide
technophobic	medicine	arthritis	bromide
xenophobia	chlorine	sinusitis	hydroxide
	crystalline		fluoride
	figurine		chloride
	antihistamine		
	serpentine		

This sort may be extended by generating other words that share spelling–meaning relationships with the words in the sort: For example, *arthritis/arthritic; tonsillitis/tonsillectomy* (literally, *ec,* "out" + *tomy,* "cutting" of the tonsils). Note a link with Indo-European, by the way: *arth* comes from *ar*, the Indo-European root meaning "joint"; this Indo-European root is still evident in the word *arm.*

Math. This sort engages students in exploring the number prefixes *quadr-* (four), *tetra-* (four), *quint-* (five), *penta-* (five), and *deca-* (ten). An earlier sort would have addressed *uni-*, *mono-*, *bi-*, and *tri-* (for example, *mono*pod, *uni*lateral, *bi*ceps, *tri*athlon; see Greek Number Prefixes in Appendix B).

First, students will sort the words according to number prefix. Have them discuss any words they know or have at least seen or heard. Speculate as to their meaning: If *triad* refers to a group of three, for example, what does a *tetrad* refer to? If *tripod* refers to three feet, what does *tetrapod* refer to? Share the following sentence with students: "Scientists reported today that they discovered the leg bone of the oldest amphibian, a tetrapod that lived 360 million years ago." If *monarchy* refers to rule by a single person—a king or a queen—then what might a *tetrarchy* refer to? A *pentarchy?* While students may know *quintuplets* refers to five, share with them that the word *quintessence,* which refers to the purest or highest essence of something—"She was the quintessence of gymnastic ability"—historically and literally means from the fifth and highest "essence" after the essences of air, earth, fire, and water. The sentence "We now have the quintessential recipe for tacos" means that the recipe is the most representative one for tacos.

quadr-	*tetra-*	*quint-*	*pent-*	*dec-*
quadruple	tetrad	quintuple	pentagon	decimal
quadruplets	tetrarchy	quintuplets	pentangle	decathlon
quadrangle	tetralogy	quintessence	pentathlon	decathlete
quadruped	tetrapod	quintessential	pentathlete	decimate
quadrennial			pentarchy	

After several number prefixes have been explored, share with the students *why* there are different prefixes for one, two, four, five, and so forth: Greek had its own words for these elements; Latin had other words for them. Both sets of number elements survived and were passed down through other languages without significant change.

This sort may be extended by discussing why there seem to be so many Greek-derived words and elements that refer to *athletics.* This may evolve into an exploration of the value the Greeks placed on physical prowess and beauty.

Generative Roots and Affixes

As noted earlier, learning and understanding how the generative roots and affixes function within a content area will support learning of specific concepts as well as help students access new concepts. Note that terms appear as they represent concepts to be taught at different levels; this does not mean that they cannot be addressed earlier as they arise or as you feel appropriate.

We have shared many examples of how to talk about the generative aspects of words with students. As we've seen, much of this discussion occurs in the context of word sorts. But there are other, more focused walk-throughs of words, targeting structural relationships and discussing how meaning is created by combining morphemes—bases and affixes or roots in general. For each content area, examples of these walk-throughs are offered.

Mathematics. The vocabulary of *geometry* (*geo*, "earth" + *metr*, "measure") lends itself quite obviously and transparently to the combination of Greek and of some Latin elements—for example, *sphere, diameter, hypotenuse,* and *symmetry.* Geometry has a long history going back to the Egyptians and Babylonians, who knew the Pythagorean theorem 1,000 years before the Greek mathematician for whom it is named. However, the ancient Greek Euclid wrote the first definitive book on geometry so it should come as no surprise that the study of geometry is full of vocabulary terms whose origins are Greek.

Algebraic terms are often not so transparent. Nevertheless, there is a sequence for exploring Latin roots in mathematics, and it begins with some simpler terms and concepts. Often, even Algebra II students are surprised when they learn how Latin elements contribute to the meaning of the simpler terms and concepts that they learned years earlier in elementary school.

For older students, share with them how the structures of the words they learned in elementary school hold within them the key to their meaning, as in the following examples:

- *Fraction* comes from the Latin word part *fract,* meaning "to break." If you break a bone into two or more pieces, you have a *fracture. Fractions* are a way of talking about breaking things into smaller pieces (like bones).
- *Circumference* may be broken down as
  ence—the result
  fer—of carrying
  circum—around
  which is literally what *circumference* means!
- A *triangle* is a figure with three (*tri*) angles. A *rectangle* is a figure with all right (*rect*) angles (yes, *rect* is the root of the common word *correct,* meaning "right").
- A triangle that has equal sides is an *equilateral* triangle, from the Latin *equ,* meaning "equal," and *lat,* meaning "side." (What other words do the students know that have *lat* in them? When you *lateral* a football you throw it to the side; *latitude* is literally a measurement around the *side* of the earth.)

Students' understanding about word structure with these more simple, familiar concepts can be extended to newer words and concepts.

- The prefix *com-*, meaning "together, with," appears in a number of terms assimilated as *con-* and *cor-,* and suggests "with" or "togetherness":
  *con*verse—"turn (*vers*) with," suggesting "opposite"
  *cor*respond—"respond or answer together"
  *con*centric—"circle together" or common center

- *Trans,* meaning "across," shows up in many words:
  *trans*late—"to remove from one place to another"
  *trans*verse—"turn across" (*vers*)
  *trans*form—"form across" or change shape
- *Parallel* and *perpendicular* are often confused by students. The prefix *para-* means "beside," as suggested in *paraphrase*—a phrasing that is "beside" or close to the original phrasing. It is commonly used to label various assistants who would work "beside" experts as in *paraprofessional, paralegal,* and *paramedic. Parallel* is composed of *para* + *allel* (from a Greek word meaning "other"); literally, one line that is "beside the other" line. *Perpendicular* is built around the root *pend* (to hang) and refers to a plumb line that would hang vertically or perpendicularly to the ground. *Pendant, pendulum, appendage, appendix, dependent,* and *pending* are also derived from the same root and all suggest hanging of some kind.
- After the formal definition and examples of a *tangent* have been provided, the teacher tells the students, "When something is tangible we say we can touch it. What do you think: Do tangents in math have anything to do with touching something?"

Table 6.1 presents generative roots and affixes for mathematics.

TABLE 6.1 Generative Roots and Affixes in Mathematics

	Intermediate/Middle Grades	Secondary
a- (L) not		*a*symptote ("not converging")
ab- (L) away		*ab*scissa ("cut away")
co-/cor- (L) with, together	*co*ordinate ("ordered together")	*cor*relation ("relate together")
circum- (L) round	*circum*ference	
syn-/sym- (L) together, with	*sym*bolic/*sym*metry/axis of *sym*metry/rotation *sym*metry/line of *sym*metry	*syn*thetic geometry/a*symp*tote
iso- (G) same, equal	*iso*sceles triangle ("equal legs")/*iso*metry	
equ- (L) equal	*equi*lateral triangle ("equal sides")/*equ*ation/*equi*distant	
ex- (L) out	*ex*ponent ("to put out")	*ex*ponential notation
trans- (L) across	*trans*formation	*trans*verse/*trans*pose/*trans*lation
poly (L) many	*poly*gon	
cycl/cyl (G) circle	*cyl*inder	
fract (L) break	*fract*ion	
log (L) reason		*log*arithm ("arithmetic reason")
med (L) middle	*medi*an	
hedron (G) face	tetra*hedron*	
nom (L) name	mo*nom*ial	poly*nom*ial
quadr/quar (L) four	*quadr*ant/*quadr*ilateral ("four sides")	q*uadr*atic/*quar*tile
cent (L) hundred	*cent*imeter/per*cent*	

continued

TABLE 6.1 Continued

	Intermediate/Middle Grades	Secondary
mill (L) thousand	*mill*ion	
kilo (G) thousand	*kilo*gram/*kilo*meter	
deci (L) ten *deca* (G) ten	*deci*mal/*deca*de/*deca*gon *deci*meter/(1/10th of a meter) *deca*meter/(ten meters) *deci*liter/(1/10th of a liter) *deca*liter/(10 liters)	*dec*ibel (after Alexander Graham Bell) non*deci*mal numeration
liter (G) unit of weight	*liter*/milli*liter*/deci*liter*/deca*liter*	
gon (G) angle	penta*gon*/octa*gon*/hexa*gon*/deca*gon*/poly*gon*/irregular poly*gon*/dia*gon*al	tri*gon*ometry tri*gon*ometric ratio tri*gon*ometric relation
lat (L) side	quadri*lat*eral	
angle (L) angle	right *angle*/equilateral tri*angle*/scalene tri*angle*/isosceles tri*angle* ("equal legs")/rect*angle* ("right [*rect*] *angle*s")/acute *angle*/obtuse *angle*/complementary *angle*/corresponding *angle*s	central *angle*/right tri*angle* geometry/interior *angle*/*angle* bisector/*angle* of depression/supplementary *angle*
metr/meter (L) measure	dia*meter* ("measure across")/peri*meter* ("measure around")/sym*metr*y ("measure together")/geo*metr*y ("measure the earth")	para*meter* ("measure/beside")
rad (L) root		*rad*ical/*rad*ical expressions
ratio (L) relation (reason)	*ratio*	*rati*onal number
sect (L) cut	bi*sect*/inter*sect*	
pl(ic)/*pl*(y) (L) fold	multi*ply*/multi*pli*cation	
sinus (L) bend curve		*sine*/arc*sine*/co*sine*
tang (L) touch		*tang*ent/line of *tang*ency

Science. Once students have been shown how to explore words for Greek and Latin roots and affixes, the type of lesson shown here is very effective (Invernizzi, 2007). The example is similar in some ways to a vocab-o-gram in that students are making predictions prior to reading a selection, but it is different in that their predictions are based on only *one* term—notice how the teacher gets them to think about that term and other structurally related words.

Before reading and discussing an article based on the potential dangers of living close to Mt. Rainier in Washington, students make predictions based on the term *hydrothermal alteration.* The teacher asks them, "What would a passage about hydrothermal alteration on Mt. Rainier contain? What makes you think that?"

The teacher then guides the students in an examination of the word. "Look at the word roots."

hydrothermal	*alteration*
hydro	alter
thermal	

"Now let's think of some related forms."

hydro	*thermal*	*alter*
hydrogen	thermal	alter
hydrant	thermos	alter ego
hydraulic	thermometer	alterable
hydrate	thermostat	alternate
		alternative

"Now, what do you think *hydrothermal alteration* might be in relation to an active volcano?" The teacher has helped students explore networks of words they already know that contain these roots, thereby activating and energizing their underlying understandings of meanings represented by *hydro, thermal,* and *alter.* She then helps them bring those understandings to bear on their thinking about the characteristics of an active volcano.

Biology. In the context of studying angiosperms and gymnosperms—plants whose seeds are enclosed within an ovary versus plants whose seeds are not so enclosed—the teacher walks students through an analysis of two words, *conifer* and *gymnospermous.* The science teacher presents the following display:

- *Conifer* is a combination of *fer* (bearing) and *con* (cones). The dictionary definition of *conifer* is given: "Any of various mostly needle-leaved or scale-leaved, chiefly evergreen, cone-bearing gymnospermous trees or shrubs such as pines, spruces, and firs" (*American Heritage Dictionary*).
- *Gymnospermous* is a new but critical term, so the science teacher reminds the students that they've already learned in English class the origin of *gymnasium* and *gymnast—gym* means "naked." They have learned in biology that *sperm* literally means "seed," so putting the parts together and reading right to left in *gymnospermous:* "containing" (*ous*) "seeds" (*sperm*) that are "naked" (*gymn*). (This usually brings hoots of laughter from adolescents—but they are certainly paying attention!) The teacher explains that the *o* is just a connecting vowel; it doesn't attach to either of the roots but makes the word easier to pronounce when the parts are blended together. When the students then examine pinecones that the teacher has distributed, they observe how the seeds are exposed. The concept that the word represents, and the spelling of the word itself, work together to deepen students' understanding.

Cellular Biology. New vocabulary terms presented in the reading material are usually key to understanding the concepts involved. Even rather intimidating words can be related to other words and word parts that students may already know to become easier to understand, read, and spell.

Before delving into the lesson "Homeostasis and Transport," the teacher guides the examination of the following important words:

hypertonic	endocytosis
hypotonic	exocytosis
isotonic	pinocytosis
	phagocytosis

The teacher guides the students into the terms by exploring roots in the more familiar terms *hyperactive, hyperventilate, hypertension, hypothermia,* and *hypodermic.*

She asks them to speculate as to the meaning of *hyper* and *hypo* in these words, and the students come to the conclusion that *hypo* has to do with "under" (as in *hypodermic* needle) and *hyper* with "over" (*hyper* or "over excited"). The students realize that *hyper* has in fact come to be used by itself to refer to someone's behavior or personality.

Returning to the new terms *hypertonic* and *hypotonic,* the teacher tells the students that *tonic* has to do with "stretching." So, the students conclude that the terms are dealing

with "under"-stretching and "over"-stretching with regard to cells. The teacher points out that *iso* means "equal," as in *isometric,* so the students conclude "equal" stretching must somehow mean that a cell is "just right."

Sketching the outlines of cells on the board, the teacher goes on to explain that cells transport fluids through the cell walls. Three conditions are possible, she tells the students. "So if a cell had just the right amount of fluid inside the cell as there was outside the cell, how would we describe it? What if it was almost ready to burst because it had a great deal of water? What if the cell lost fluid and became shrunken and limp or pressure from outside caused it to shrink?" She then writes the definitions next to each term:

hypertonic—excessive stretching due to too much fluid
hypotonic—lack of stretching or the opposite of stretching due to too little fluid
isotonic—equal stretching due to a balance of fluids inside and outside the cell

Next, the teacher discusses the root *cyt,* "cell or vessel," as in *cytoplasm,* and the suffix *-osis,* "process," as in *metamorphosis* and *osmosis.* She introduces *endo* and *exo,* and if the students do not know them she mentions that they are opposites like *hyper* and *hypo: endo* means "within," as in *endoplasm;* and *exo* means "out of, away from" as in *exoskeleton* and *exorcise,* which literally means "cut out."

Writing the following terms on the board, the teacher explains that they involve transporting substances in and out of cells; the students discuss them and decide which term applies to which process and arrive at a definition:

endocytosis—"inside–cell–process" (the process of transporting into a cell)
exocytosis—"out of–cell–process" (the process of transporting out of a cell)

The teacher and students talk about what kinds of things cells would need to transport in and out, such as water, oxygen, and nutrients.

The last two terms are presented:

pinocytosis—pino = "drink" (*pino* does not show up as a root in many other words)
phagocytosis—phago = "eat" (many words have the root *phag* including *esophagus* and *sarcophagus,* literally "eating flesh")

The teacher asks, "Which one of these involves the transportation of fluids? Of solids?"

Table 6.2 presents generative roots and affixes for science.

TABLE 6.2 Generative Roots and Affixes in Science

	Intermediate/Middle Grades	Secondary
amphi- (G) both	*amphi*bian	
cata- (G) down, reverse, thoroughly	*cata*clysm	*cata*lyst (loosen thoroughly)
endo- (G) within	*endo*thermic	*endo*genous
equ- (L) equal	*equ*ator	*equ*ilibrium of ecosystems
iso- (G) same, equal	*iso*metric	*iso*tope
syn-/sym- (L) together, with	photo*syn*thesis	molecular *syn*thesis/organic compound *syn*thesis/protein *syn*thesis

TABLE 6.2 Continued

	Intermediate/Middle Grades	Secondary
trans- (L) across	*trans*form/*trans*port/*trans*fer ("carry across")/*trans*parent	neuro*trans*mitter
proto- (G) first	*proto*type	*proto*lithic
quadr (L) four	*quadr*ant	
cent (L) hundred	*cent*imeter/per*cent*	
dec (L) ten	*dec*imal/*dec*imeter	
mill (L) thousand	*mill*ipede/*mill*imeter	
kilo (G) thousand	*kilo*gram/*kilo*meter	*kilo*watt/*kilo*hertz
anthr (L) man	*anthr*opologist	*anthr*opology/*anthr*opoid
cult (L) cultivate	*cult*ure	*cult*ure/*cult*ivate
cyto/cyte (G) cell		*cyto*plasm/lympho*cyte*
eco (G) house	*eco*system/*eco*logy	equilibrium of *eco*systems
hered/herit (L) heir	*hered*ity	*heri*tability
gen (L) producing	*gen*e/*gen*etics/*gen*eration	*gen*e encoding/*gen*etic diversity/ phylo*gen*etics/phylo*gen*y
ign (L) fire	*ign*ite/*ign*eous rock	
hydro (G) water, liquid	*hydr*ogen/*hydr*aulic	*hydr*ogen ion/*hydr*oponics
aqu (L) water	*aqu*arium/*aqu*ifer	
chrom/chrome (G) color	*chrom*osome/mono*chrome*	*chrom*atography
chlor (G) green	*chlor*ophyll	
leuko/leuco (G) white *alb* (L)	*leuk*emia *alb*umin	*leuk*ocyte
magn (L) great, large	*magn*ify/*magn*ification	
meta (G) beyond	*meta*morphic/*meta*morphosis	
morph (G) form, shape, structure	meta*morph*ic/meta*morph*osis	*morph*ology
plasm (G) to shape, mold	*plasm*a/cyto*plasm*/*plas*tic	
plast (G) small body, structure, particle	chloro*plast*	leuco*plast*
som (G) body	chromo*som*e	
ceph (G) head	*ceph*aplic	
card (G) heart	*card*iovascular	
derm (G) skin	*derm*atology	
neuro (L) nerve	*neuro*n/*neuro*transmitter	

continued

TABLE 6.2 Continued

	Intermediate/Middle Grades	Secondary
ichthy (G) fish	*ichthy*ology/*ichthy*osaur	
flu (L) *rrhea* (G) flow	*flu*id/*flu*vial/*flu*ctuate/in*flu*enza/ dia*rrhea*	
radi (L) ray	*radi*ate/*radi*ation/*radi*o (clipped form; originally *radiography*)	*radi*o wave/*radi*oactive
zym (G) fermentation *ferm* (L)		en*zym*e/lyso*zym*e *ferm*ent
phen (G) show, display	*phen*omenon	*phen*otype
phyll (G) leaf *foli* (L)	chloro*phyll* *foli*age	hetero*phyll*ous ex*foli*ate
dent (L) tooth *dont* (G)	*dent*al ortho*dont*ist/pteranod*on*	
pter (G) wing	*pter*odactyl	
phy (G) natural		*phy*sics/*phy*siology
phyl (G) class		*phyl*um/*phyl*ogenetic
tom (G) cut	a*tom*	ana*tom*ical
sect (L) cut	in*sect*/dis*sect*	
pathy/path (G) disease, one who suffers from a disease	osteo*pathy*/osteo*path*	*path*ogen
sol (L) sun	*sol*ar system/*sol*stice	
stel (L) star *aster/astr* (G)	*stel*lar/con*stel*lation/inter*stel*lar *aster*oid/*astr*onomy	*stel*liform
therm (G) heat *calor* (L)	*therm*ometer/geo*therm*al/endo*therm*ic *calor*ie	
pyr (G) fire, heat	*pyr*ite	
phag (G) eat *vor* (L)	carni*vor*e/herbi*vor*e/omni*vor*e	bacterio*phag*e
algia/alg (G) pain	neur*algia*/an*alg*esic	
emia (G) blood, condition of the blood		leuk*emia*
-ician (L) specialist in	phys*ician*/diet*ician*	
ate (L) having, characterized by	vertebr*ate*/invertebr*ate*/hydr*ate*	
-ide (L) related or similar chemical compounds or elements		monosaccharide/ sodium chlor*ide*
-ine (L) chemical substance		chlor*ine*

TABLE 6.2 Continued

	Intermediate/Middle Grades	Secondary
-ite (G) rock, mineral, fossil	hemat*ite*/trilob*ite*	
-itis (G) inflammation		appendic*itis*/bronch*itis*
-ic (G) the higher of two valences		stann*ic* chloride ($SnCl_4$)
-ous (L) the lower of two possible valences		stann*ous* chloride ($SnCl_2$)
-on (G) unit of	electr*on*/prot*on*/neutr*on*	phot*on*
-logy/-logist (G) science of, scientist	*geology* (science of the earth, studying the earth)/*geologist* (one who studies the earth)	
-phobia (G) abnormal fear	claustro*phobia*	

History/Social Studies. The following two examples illustrate walk-throughs of several important generative roots.

The teacher begins a discussion about prejudice by writing the word on the board and asking the students what it means. Most students usually offer examples of prejudice before thinking about a "dictionary"-type definition. If no one points it out, the teacher then asks them if they notice which word *prejudice* comes from. Most students have never made this link, and if no one responds, the teacher writes the word *prejudge* underneath *prejudice.* He comments that all of their examples of prejudice involve situations in which a person, group, or idea has been *prejudged* by another person or group.

The teacher then writes the following words in a column:

judge
prejudge
prejudice
prejudicial

The teacher asks the students to offer examples of how *prejudicial* may be used in a sentence. Then, working off of the base word *judge,* the teacher writes the following words on the board, underlining the root *jud* in each:

judge
judicial
judiciary
adjudicate

Students discuss how these words are related, but many may not be sure about *adjudicate.* Using a sentence such as "The sports commissioner will adjudicate the disagreement between the coach and players," the teacher asks the students to discuss possible meanings based on the context and the root *jud* of the word. The teacher may then follow up by having students check in a dictionary or briefly explaining that when a judge or person in authority adjudicates a case, she "hears and settles" the case; literally, the word *adjudicate* means "to judge to or toward" something (*ad-*, the prefix, means "to or toward").

In the next example, the teacher discusses the roots of *politics* and *civics.* She writes the following words on the board:

politics
political
politician

She explains that the words come from the Greek word *polis*, meaning "city." In classical Greece, the city was the primary organizing form of government, and inhabitants of Athens, for example, considered themselves citizens of the city, not of a nation or country (concepts that would evolve centuries later). She asks the students to turn to a partner and think of other words that have the root *poli* in them; after about a minute, they share *police, policy, metropolitan,* and *cosmopolitan.* The teacher writes these on the board, discussing with the students what each of these words has to do with a city and which terms can apply beyond the idea of a city (*policy, cosmopolitan*). She adds *Minneapolis, Annapolis,* and *acropolis,* commenting that the students can figure these out on their own. (She knows that *acropolis* is unfamiliar; later in the unit, she will follow up and discuss with them the etymology they found in the dictionary: *acropolis* literally means the "tip" or highest point of the *polis*. In ancient Athens, the Acropolis was built on the hill above the surrounding city.) There are, in fact, hundreds of towns in North America with *polis* in their names—many students have never analyzed the meaning or origin of their town's name, and this awareness can begin the investigation.

The natural progression of this walk-through involves exploration of the word *city.* The teacher continues the discussion by pointing out that, while the Greeks had the word *polis* to represent the concept of "city," the Romans had the word *civis,* meaning "citizen" and *civitas,* meaning "city." The word *civil* is derived from these words and has to do with citizens and citizenship, including the civil rights that all citizens are entitled to in a democracy.

As she shares this information, the teacher writes the words in a column, underscoring the common element in each:

city
citizen
civic
civil
civil rights

The teacher draws the discussion to a close by noting that, for the Classical Greeks, the concept of the *polis* or city was in many ways the equivalent of the later concept of a nation. And while the Romans eventually developed the most extensive empire up until that time in history, they began as a small agricultural community that evolved into a city, and as with the Greeks, this city was the core of their form of government.

Table 6.3 presents generative roots and affixes for history and social studies.

TABLE 6.3 Generative Roots and Affixes in History/Social Studies

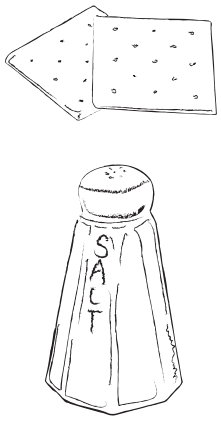
	Intermediate/Middle Grades	Secondary
trans- (L) across	*trans*portation	
neo- (G) new	*Neo*lithic	*neo*classical
arche (G) ancient	*arche*ology/*archa*ic	
anthr (L) man	*anthr*opology/*anthr*opologist/ phil*anthr*opist ("love for mankind")	

TABLE 6.3 Continued

	Intermediate/Middle Grades	Secondary
nat (L) to be born	*nat*ion/inter*nat*ional/*nat*ional	
bel (L) war	re*bel*/re*bel*lion	ante*bel*lum period
cap (L) head	*cap*ital/*cap*italism/per *cap*ita	
civ (L) citizen	*civ*ic/*civ*il rights/*civ*il war/*cit*y	*civ*ilization
crit (G) judge	*crit*ic/*crit*ique	
cult (L) cultivate	*cult*ure/multi*cult*ural/agri*cult*ure ("cultivate a field")	*cult*ure/*cult*ivate
demo (G) people	*demo*cracy	*demo*graphic
ethn (G) people	*ethn*ic/*ethn*ography	
popul/pub (L) people	*popul*ation/*popul*ace/*pub*lic/re*pub*lic	
dic (L) say, speak	*dic*tator	
dom (L) home	*dom*estic	
eco (G) house	*eco*nomy/*eco*nomics	
eval (L) age	medi*eval*	prime*val*
greg (L) gather	se*greg*ation/inte*gr*ate	
jud (L) judge	*jud*icial/pre*jud*ice/*jud*icial	
jur/jus (L) law, just	*jur*y/*jus*tice	
leg (L) law	*leg*al/*leg*islate	
liber (L) free	*liber*ty/*liber*ate/*liber*ation	
mono (G) one	*mon*archy/*mon*astery	
urb (L) city	*urb*an/sub*urb*/ex*urb*	
poli (G) city	metro*poli*s/cosmo*poli*tan/*poli*tics	
port (L) carry	trans*port*ation/im*port*/ex*port*	
*sen** (L) old	*sen*ate/*sen*ator	
soc (L) companion	*soc*ial/*soc*iety	*soc*iology
terra (L) earth *geo* (G)	*terr*itory *geo*graphy	
vol (L) roll, turn	American Re*vol*ution	French Re*vol*ution/ Russian Re*vol*ution
-crat/-cracy (G) rule	demo*cracy*	auto*crat*/auto*cracy*
-ism/-ist (L) belief in/ one who believes		commun*ism*/commun*ist*/ capital*ism*/capital*ist*

*In Roman times, the meaning of the root *sen* also connoted "elder," which the word *senator* more directly meant.

FIGURE 6.2 **Explore-a-Root: *sal***



-sal-

Comes from Latin: salt

salinate: to make salty
saline: containing salt
desalinate: remove salt
salimeter: something that measures salt content

salami: salted pork
salary: Roman soldiers were paid in salt

Others: salad, saltines, sauce (French), salsa (Spanish)

Explore-a-Root: All Subjects. Another way to investigate root meanings while turning responsibility for researching them over to students is with the *explore-a-root* process. Assign one root to each student with the challenge to find out its meaning, origin, and as many words as possible that are derived from it. They can be asked to each create a small visual display that can become part of a bulletin board and take turns reporting their findings to a classmate. Students might also enjoy creating a PowerPoint slide for each root so that all the slides could be compiled into a class effort. This way everyone could have a copy. Figures 6.2 and 6.3 provide two student-created examples.

A good dictionary with word origins like the *American Heritage Dictionary* or *Merriam-Webster Intermediate* in either hard copy form or on the Web is a good starting point for students. Students can search electronically for words using asterisks before and after the root (**sal** and ***pter***) but need to understand that not all the words that turn up are related in meaning. Provide several books about the origins of words (see "Resources for Language History, Word Origins, and Greek and Latin Roots" on pp. 42–43 in Chapter 3).

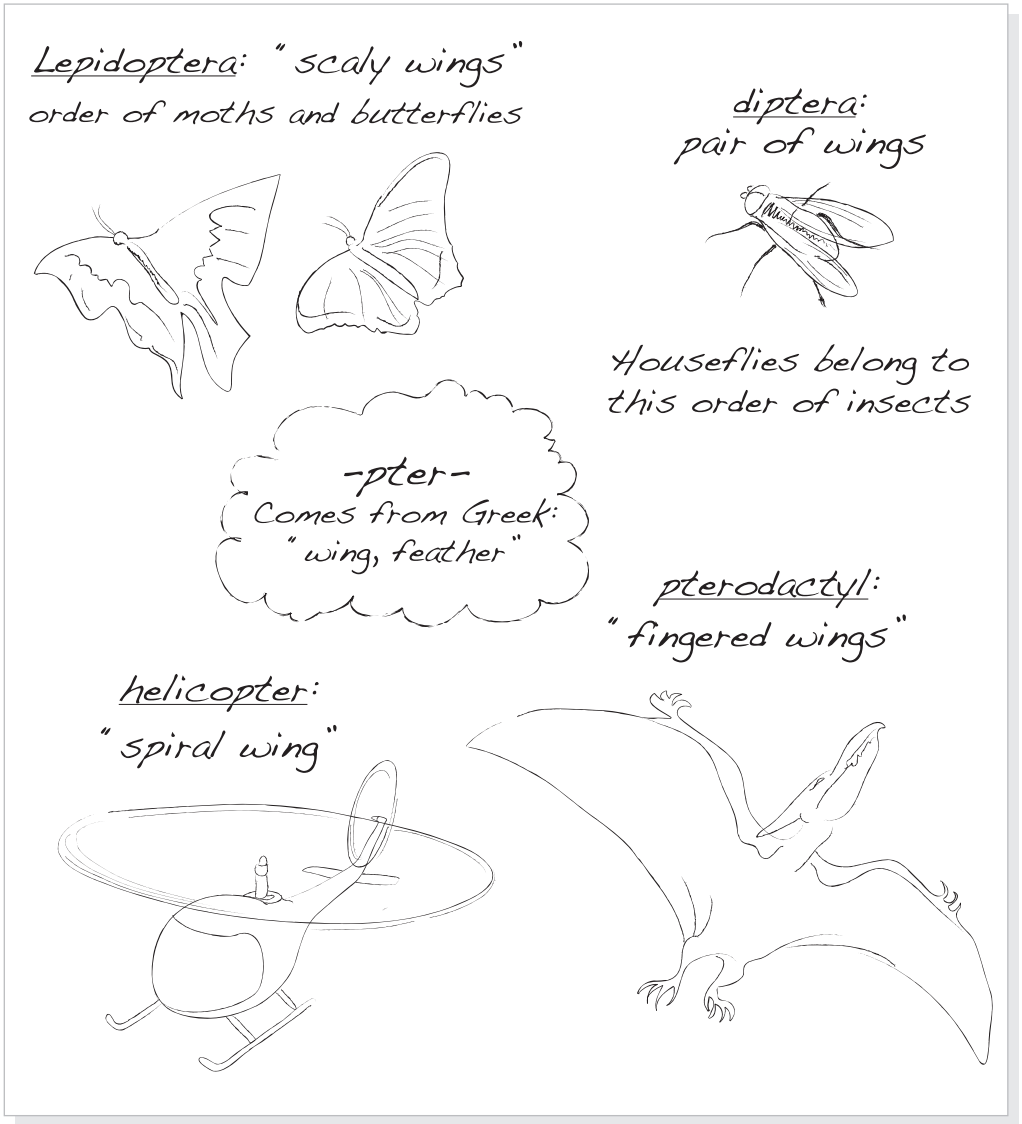
WORD-SPECIFIC INSTRUCTION

As you read and think about each of the activities focusing on teaching specific word concepts, recall the suggestion at the beginning of the chapter: Please keep in mind how activities within each example may be used, with different content, at any level, and before, during, or after reading or exploring a unit. These activities very often include an assessment aspect that will help to focus and ground the learning that will occur. In addition, content inventories should help you assess the overall levels of students' familiarity with the subject that you teach. These are discussed in Chapter 8.

Concept Sorts

A *concept sort* will activate students' prior knowledge and raise questions about the topic they will be studying. They also afford possibilities for reviewing vocabulary and can be revisited at the end of a unit of study as a summative assessment. See Chapter 8 for more information about using concept sorts diagnostically. Following the guidelines presented in Chapter 4 for preparing a concept sort, key words are selected as well as characteristics and examples of each.

FIGURE 6.3 Explore-a-Root: *pter*



Earth Science: The Four Earth Systems. For a unit on the four earth systems—atmosphere, biosphere, hydrosphere, and lithosphere—a concept sort could be created based on collecting terms from the chapter (for example, *mantle, organisms*) and also including a number of words that students already know (*gas, animals*).

Introduce the four category headers—atmosphere, biosphere, hydrosphere, and lithosphere—by writing them on the board. Students will probably know the word *atmosphere*—the air surrounding the earth. Have them speculate about *hydrosphere* (What do *hydro* and *sphere* mean?). This is an opportunity to apply students' work with word roots:

hydrosphere: hydro = "water," as in *hydroplane*
biosphere: bio = "life," as in *biology*

Lithosphere may elude them, but students may be able to figure it out a bit later from the characteristics and examples they discover.

Give each student a page with the words all scrambled up and have them cut it apart. Put up the four headers and ask them to sort the words under the appropriate header. They may work with a partner. The sort will look like the following list:

atmosphere	*biosphere*	*hydrosphere*	*lithosphere*
gases	organisms	water	crust
hydrogen	humans	glaciers	mantle
water vapor	animals	oceans	granite
oxygen	plants	groundwater	basalt
air	living things	icebergs	rocks

After the students have completed the sort, discuss it with them and try to reach agreement about where the terms are categorized. If there are words students do not know where to sort, set them aside in a "Don't Know" pile. For example, if they are uncertain about *lithosphere,* ask them to speculate about what it might mean—most or all of the words that could not be sorted under the other three headers have to do with the lithosphere, and that may give students a clue. The teacher may ask, "If granite and rocks are not living things, are not in the air, and are not floating in water, where might they be found? How would you describe the *sphere* where granite and rocks might be found?" The teacher or students would then follow up by checking the Online Etymology Dictionary or an unabridged dictionary, discovering that *litho* means "rock." Art students might have heard of *lithographs,* which are prints made with stones. The teacher may ask for definitions of other words such as *basalt* or *mantle.*

Wrap up the activity by explaining that the students will encounter these words in their reading in the chapter and throughout the unit, and they should pay careful attention to them. Students may save the words for additional activities in an envelope stapled inside their Vocabulary Notebooks (see the discussion of Vocabulary Notebooks later in this chapter).

Chemistry: Elements, Compounds, and Mixtures or Solutions. As with the previous example, this concept sort is created using terms from the chapter (*covalent bonds, ionic bonds, isotopes*) as well as a number of words that students already know (*air, soil, water*).

Elements	*Compounds*	*Mixtures/Solutions*
gold	different atoms	seawater
pure	molecule H_2O	soil
one kind of atom	water	air
isotope	covalent bond	parts retain identities
molecule H_2	ionic bond	can be separated
hydrogen	metallic bond	made of elements and compounds
oxygen	salt	

Earth Science: Geological Forces That Shape the Earth. Ideas and word lists for content-specific concept sorts are available in Appendix F. The words have been selected to represent significant concepts specified in the national standards for the different content areas.

Mass Movements	*Wind*	*Water*	*Ice*
creep	abrasion	runoff	glacier
mudflow	sand dune	delta	cirque
landslide	deflation	load	moraine
avalanche	ventifact	meander	drumlin
slump	loess	oxbow	eskers
earthquake	drought	flood	U-shaped valley
		alluvial plain	
		V-shaped valley	

Geometry: Planes and Solids. Often, this sort is best begun with pictures or actual figures, which are particularly helpful with English learners. In addition to classifying according to planes and solids, the terms can be classified in other ways. For example, triangles could be classified according to lengths of sides or sizes of angles. The following sort classifies figures as planes or solids.

Plane	*Solid*
_____	_____
_____	_____
_____	_____

cube triangular prism rectangle rectangular prism cylinder triangle

Geometry: Points, Lines, and Planes. Terms to be sorted are words that represent the characteristics and examples of points, lines, and planes. The completed concept sort would appear as follows:

Points	*Lines*	*Planes*
pen point	edge of a ruler	piece of paper
collinear	parallel	desktop
A	A–B	floor
intersection of two lines	intersection of two planes	coplanar
	skew	3 points
	segment	
	ray	

History/Social Studies. As students move through a unit titled "Reformation and Counterreformation," they might conduct concept sorts with the words and concepts associated with either or both movements. One possible "target" sort is represented in the following list:

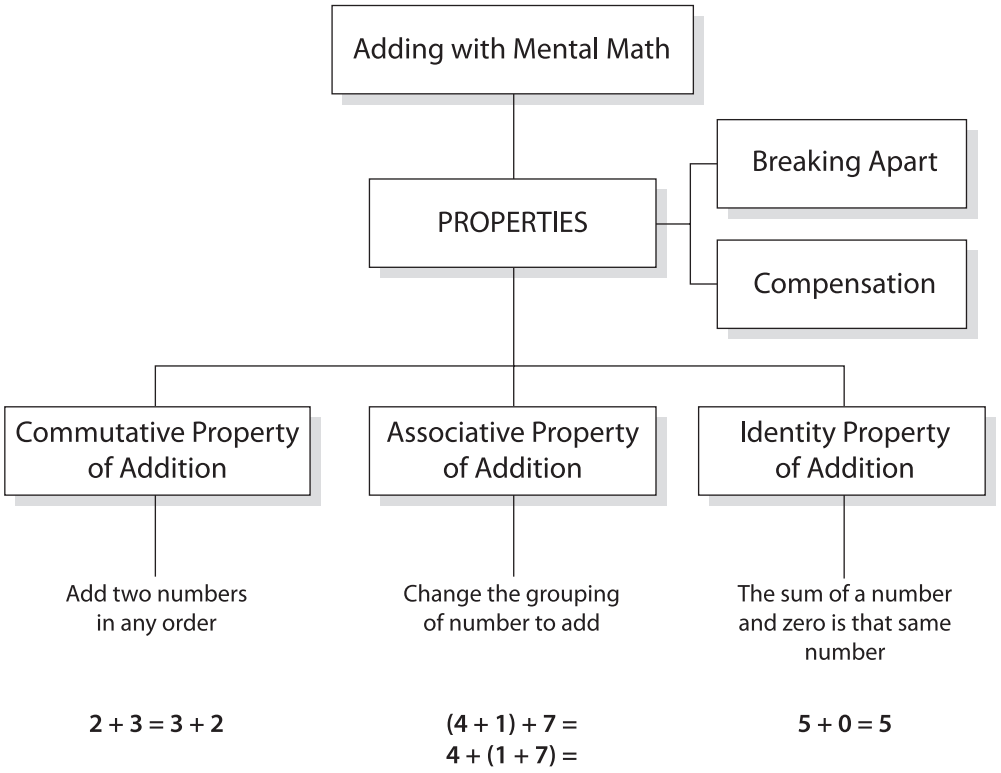
Reformation	*Counterreformation*	*Both*
self-government	Jesuits	New World colonization
indulgences	Council of Trent	Erasmus
Martin Luther	St. Ignatius of Loyola	
John Calvin	Catholic Church	
95 theses		

Graphic Organizers

Graphic organizers can be used before, during, or after a unit of study to capture related ideas. Teachers can use them to find out how much background knowledge students have about a topic and students can use them as a study tool. See Chapter 8 for ideas about using graphic organizers for assessment purposes.

Concept Map: Mathematics. The example in Figure 6.4 would be appropriate for illustrating the characteristics of a concept map for older students, as well as for providing a review of some simple concepts often forgotten. "Adding with Mental Math" is the topic of one section in a unit. Different *properties,* the focus term or concept, illustrate how to add with mental math, and different property types are arrayed below the major focus, together with their definitions and examples. The related concepts of "breaking apart" and "compensation" are arrayed to the side. Alternatively, these two concepts could be addressed lower on the page, where examples could be shown.

FIGURE 6.4 Concept Map for Addition Properties

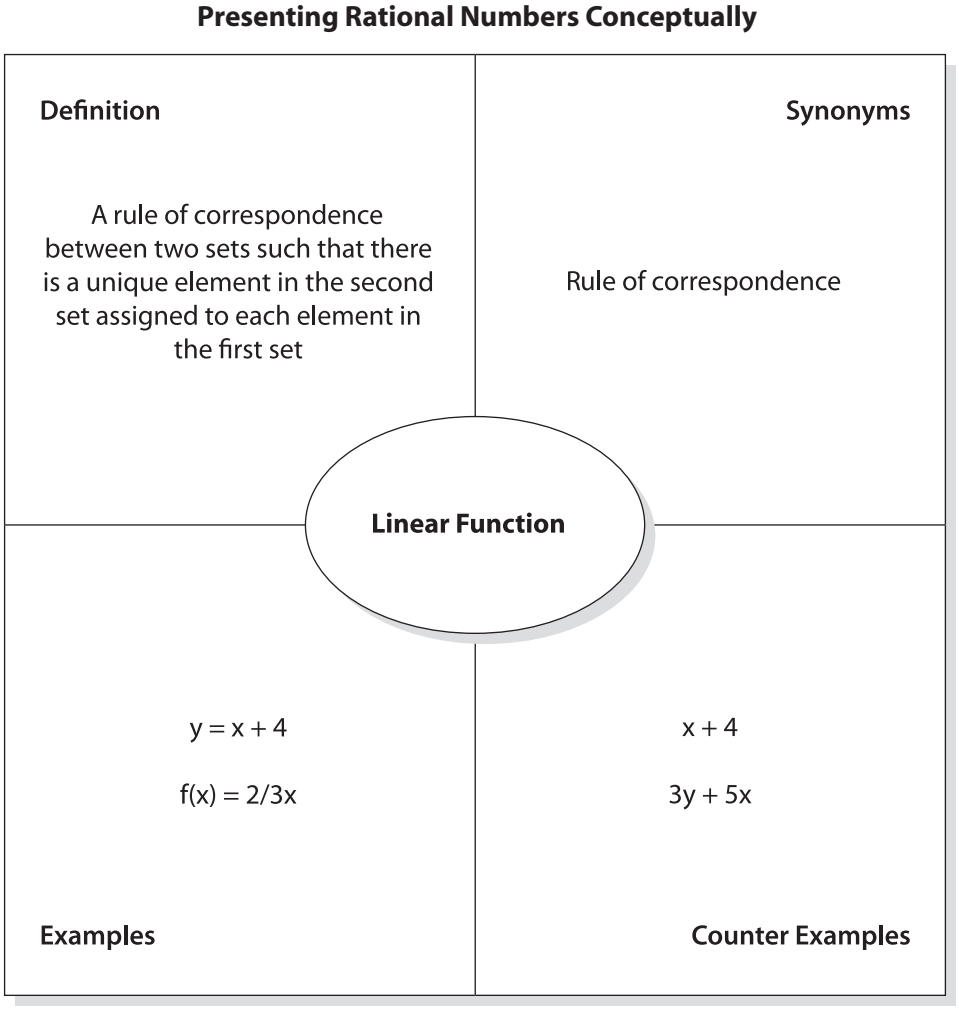


4-Square Concept Map: Algebra. The textbook definition of the target concept *linear function* is provided in the upper left quadrant of Figure 6.5. Students may also, in their own words, write a definition underneath the textbook definition if they wish. Examples and counterexamples will be discussed and entered. Constructing this 4-square should be a whole-class or small-group activity, so that the concept of rational numbers can be explored, discussed, and applied.

Semantic Feature Analysis: Earth Science. A semantic feature analysis as shown in Figure 6.6 offers another way to think about terms that might have been introduced in discussions or concept sorts such as the one described earlier for geology. Talk about the words across the top and the fact that many of them end in *-ologist*. Determine what that means (one who studies something) and then ask students which of the four earth systems each of the scientists would need to study. Use two plus signs for things they would need to study well and only one for related areas. A variation is to have students write a written reflection of why they marked the grid as they did.

Semantic Map: Science. In a unit on environmental issues the teacher writes the term *Population Density* and then brainstorms with students which factors might influence population density. They might explore both human populations and animal populations. Terms that students might suggest are *food supply, water, births, deaths, predators,* and *pollution.* The teacher then introduces some key vocabulary words—*dispersion, immigration,* and *emigration*—and guides students in categorizing the terms. As students read and discuss the content of the unit over several days, the categories may change with additional words added to the map.

FIGURE 6.5 4-Square Concept Map



Source: © David Chard 2006. Used by permission.

FIGURE 6.6 Semantic Feature Analysis—Earth Science

	geologist	biologist	ecologist	meteorologist	paleontologist	oceanographer
lithosphere	++		+		++	
atmosphere			++	++		
hydrosphere	+	+	++	+	+	++
biosphere		++	++		+	+

FIGURE 6.7 Student-Constructed Semantic Maps—Before and After

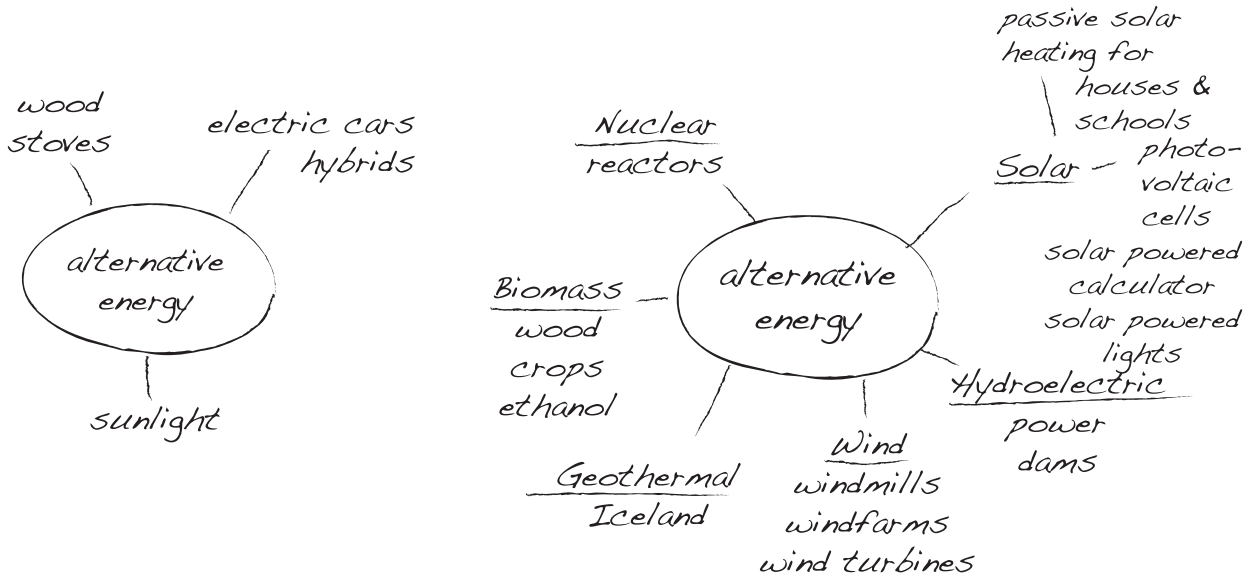
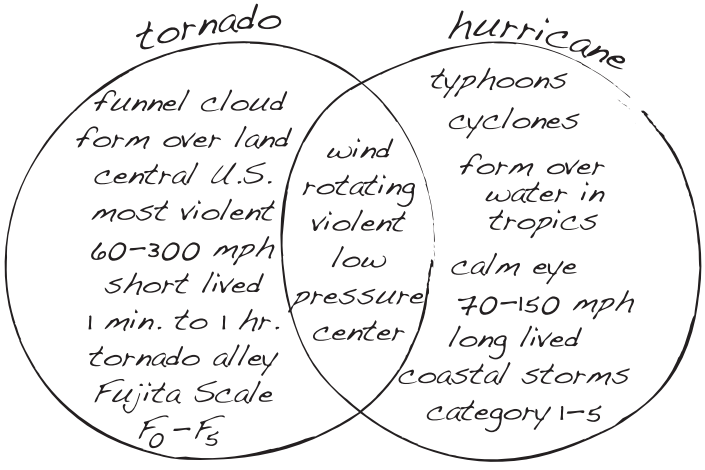


Figure 6.7 illustrates how a semantic map grows in complexity as students learn more about a topic of study, in this case "alternative energy." One is completed as a way to activate and assess prior knowledge before the unit, and the second one is completed as a way to demonstrate new concepts and vocabulary acquired during the unit. By comparing these versions, students clearly can appreciate their growth in knowledge and understanding.

Venn Diagram: Earth Science. Figure 6.8 shows one student's Venn diagram constructed after completing a unit of study about violent weather systems. Venn diagrams can also be used as assessments of students' knowledge.

FIGURE 6.8 Student-Constructed Venn Diagram Comparing Tornadoes and Hurricanes



Venn Diagram: Mathematics. Given the following characteristics and examples, students can work in groups to construct a Venn diagram with one circle labeled *Triangle,* the other circle labeled *Quadrilateral,* and the overlap labeled *Both:*

Triangle	*Both*	*Quadrilateral*
3 sides and angles	equilateral	4 sides and angles
scalene	equiangular	parallelogram
isosceles	acute angles	rectangle
right	right angles	rhombus
sum of angles = 180°	obtuse angles	square
		trapezoid
		sum of angles = 360°

Vocab-o-Gram: Biology. A vocab-o-gram can be used to introduce a unit of study. For the following terms, students should make some guesses about what the words suggest and how they are related to the topic of blood. They may note, for example, that two words start with *anti,* which suggests "against." Three words end with *cytes* and students will already have learned that these have to do with cells. They have probably heard of white blood cells and red blood cells to link to these words. *Plasma* and *platelets* might also be familiar.

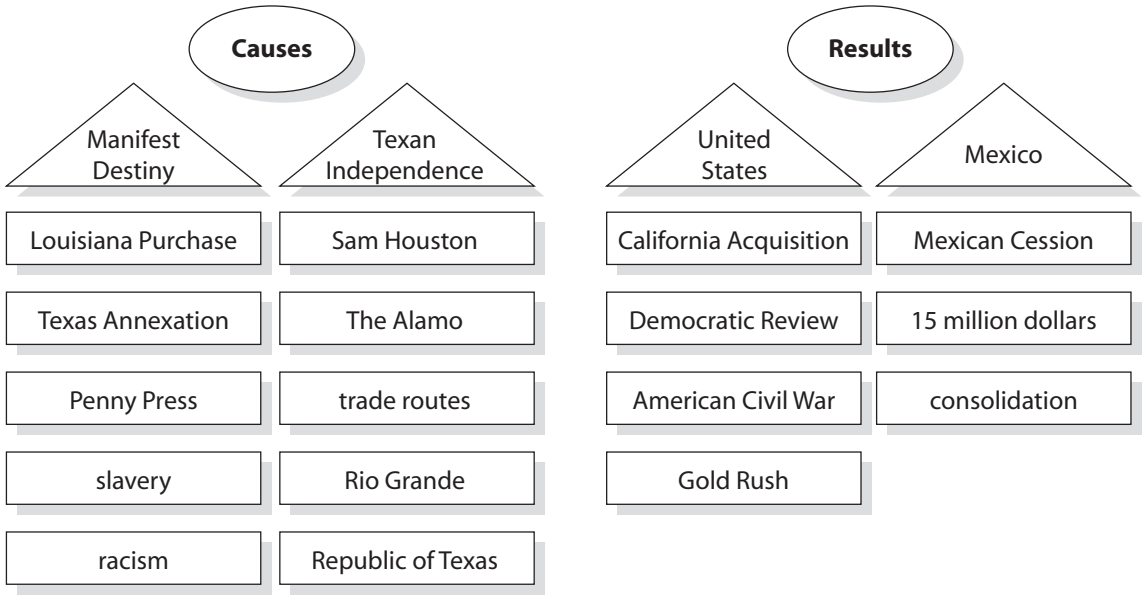
plasma erythrocytes hemoglobin leukocytes phagocytes

antibodies platelets fibrin antigen Rh factor agglutinate

Vocabulary Notebooks: All Subject Areas. Chapter 4 described how Vocabulary Notebooks may generally be used; they are certainly a mainstay in English/language arts instruction. They should, however, also be a mainstay in other content areas—in whichever form works better for students, as either a single spiral-bound notebook tabbed for each different subject or as a tabbed section within the notebook for each separate subject. In addition to the guidelines provided in Chapter 4, here are some additional ways in which they may be used across subject areas:

1. As a follow-up to a concept sort, students write a sentence for each category:
   - "The biosphere includes all the living things on earth such as humans, animals, plants and other organisms."
   - "The lithosphere is the surface of the earth and includes the crust, which is made up of granite and basalt as well as the mantle that lies below the crust."
2. Students write using the target words in context:
   - Students write definitions in their own words.
   - Students write a summary of what they learned using posted vocabulary words (this may also be part of a learning log).
   - Students write questions for each other using the new vocabulary. The questions have to be in a form that indicates an understanding of the term. One way to do this is to challenge them to use two new words in one question. "Why would a geologist need to study the *hydrosphere?*" In "what part of the *lithosphere* is *granite* likely to be found?" Students can work in groups to answer each other's questions.
3. Vocabulary Notebooks may be the "home" for graphic organizers containing new vocabulary that students create on their own.
4. Ongoing word sorts are recorded in Vocabulary Notebooks. As existing words are used and additional ones are introduced throughout the unit, word sorts develop, maintain, and extend word and conceptual knowledge.
5. Students illustrate terms. For example, if you are studying coastal landforms students may create their own drawings to show *estuary, barrier island,* and *lagoon.*

FIGURE 6.9 Power Map: Mexican-American War



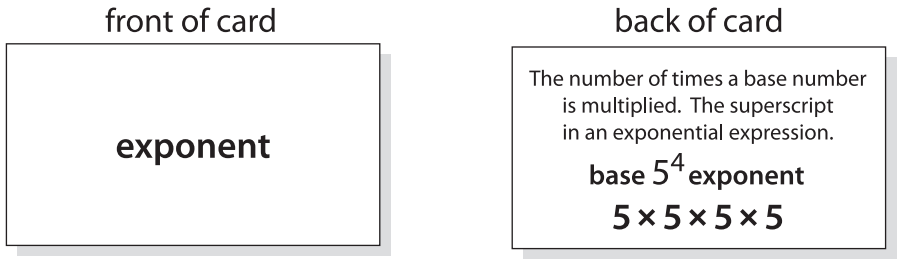
Power Map: History/Social Studies. Power maps help students consider the relative importance of ideas. Echoing a theme of professional historians, Kevin Flanigan approaches his unit on the Mexican-American War with the objective of supporting his students' awareness and understanding that "many truths constitute the past" (Weber, 2006). Both the U.S. and the Mexican perspectives leading up to the war and after the war are examined. Figure 6.9 shows the completed power map based on main ideas (Power 1), subtopics (Power 2), and supporting details (Power 3) in the textbook section addressing the war. Kevin determined that his students had enough background to do the power map prior to moving into the unit; for another class, he may have determined that the map would be constructed after the unit had been underway for a couple of days.

Vocabulary Cards: Mathematics. Vocabulary cards are especially good for related, straightforward definitions—more complex concepts lend themselves to other types of graphic organizers. Teachers should walk students through the process of using these cards:

- The term is written on one side and the definition, examples, or formulas on the back.
- Students can work with a partner; one student reads or shows a word for the other student to define.
- Show students how to sort words into two piles, *Known* and *Unknown.* Unknown words get reviewed until they are moved to the known pile.

Figure 6.10 provides an example for the term *exponent* in an algebra class.

FIGURE 6.10 **Vocabulary Card: Exponent**



ETYMOLOGICAL NARRATIVES: STORIES ABOUT WORD HISTORIES

Many new words in the humanities and the sciences and mathematics are "big words," but breaking them into meaningful parts is in many ways like finding the episodes in a narrative. Let's return to Sonia Gretzky, our secondary science teacher.

Selecting a word that she knows many of her students are already familiar with, Sonia breaks *hydraulic* into its "episodes" for her students: *hydr,* which means "water, fluid" plus a Greek word, *aulos,* which means "pipe, flute." Literally, the early meaning of our present-day word *hydraulic* was "relating to a water organ"—an organ powered by controlling the water running through its pipes. She then asks for a volunteer to explain how hydraulic brakes work. They're not running on water flowing through pipes, but is the basic principle the same?

Exploring an academic domain or content area is really a narrative of inquiry. Words have stories about where they come from and why they have come to have the meanings they now represent. *Etymology,* as noted in Chapter 3, comes from Greek and means "the true sense of a word." Stories usually have both word-specific and generative characteristics. Teachers may plan to tell more in-depth narratives about some of the interesting vocabulary in their content areas, as well as providing shorter "mentionings," where appropriate, along the way.

At the beginning of the year, you might wish to share with students narratives about the origins of the important terms for your subject area. You will be able to build on this narrative as the months go by, but it's an engaging hook up front. The origins of the labels for the following academic domains are quite literal indeed:

- *Geometry* literally means "measuring" (*metry*) the earth (*geo).* A long time ago, farmers in the Mideast needed a way to reliably determine how much land that their plots covered so they wouldn't be continually bickering over what belonged to whom.
- *Mathematics* comes from the Greek meaning "to learn." A *polymath* is a person who has learned or become knowledgeable about many different academic domains.
- *Arithmetic* was first used by Archimedes, the mathematician who is credited with so many insights, including the potential of the lever—he uttered the phrase "Give me a place to stand and I will move the earth." *Arithmetic* describes operations with numbers and comes from the same root as *arm* and *arthritis,* meaning "to fit" or "join"—*arithmetic* literally means to fit and join numbers together.
- *History* comes from a root meaning "to inquire," from an earlier meaning of "wise, learned."
- *Science* comes from the root "to know"—students are often intrigued to learn how *science* works in the word *conscience:* Literally, *conscience* means "knowing with" oneself—it's not a far leap to realize how our present understanding of conscience has to do with knowing oneself.

- *Art* is a distant relative of *arithmetic,* in that art involves "fitting together" colors, shapes, and materials.
- *Music* comes from the *Muses,* mythological Greek goddesses who presided over the arts and sciences.

Following are some examples of how content teachers can use the structure of words in their respective content areas to share intriguing etymological narratives with their students.

History/Social Studies

How does the word *Mesopotamia* figure into a middle grade social studies teacher's lesson? Because the social studies/world history content standards for his state specify that students be introduced to the Babylonian Empire in the middle grades and study it in more depth in high school, Derek Tarleton helps to frame his students' understanding by beginning with a discussion of the Iraq War. He then tells them that part of modern-day Iraq includes what is known as "the cradle of civilization"; thousands of years ago, between the Tigris and Euphrates rivers in Iraq, a number of civilizations and empires developed, the most famous being the Babylonian Empire. Because this area was between two rivers, it became known as Mesopotamia, from the Greek words for "river" (underlining *pot*) and "middle" or "in-between" (underlining *meso*). Before he finishes his lesson with the students, Derek writes the word *hippopotamus* on the board, underneath *Mesopotamia,* and asks them to turn to their neighbor and discuss whether they notice any similarities between the two words. After a minute, the students share out; many will notice the similar letters *potam.* Reminding the students that *pot* means "river," he asks them, "Do hippopotami have anything to do with rivers?" The students agree that they do, and then Derek underlines *hippo* and tells them it comes from a Greek word meaning *horse;* "the Greeks referred to hippopotami as 'river horses'!"

Pointing to a map, he indicates the location of Baghdad, the capital of Iraq. He then points to two rivers, the Tigris and the Euphrates, and notes that Baghdad lies along the Tigris River: "Thousands of years ago, this area in between these two rivers, which includes Baghdad, was called Mesopotamia. It is often referred to as the 'cradle of civilization' because of the advanced civilizations that began and developed there. The most well known is the Babylonian Empire, whose capital was Babylon, down here about 50 miles south of Baghdad, on the Euphrates River. These civilizations all lay between these two rivers, the Tigris and Euphrates. And this is where the word *Mesopotamia* comes in, from the Greek words for "river" and "middle." (Later in the year, when students are learning about Meso-American and Andean cultures, they can make a connection by realizing how the name of the *Meso-American* culture describes its location.)

Here are two additional examples from history:

- In discussing the Pax Romana with her world history class, a teacher shares that *pax* is the Latin word for "peace." *Pax* can take the form *pace,* from which come our words *pacify, pacifist, pacification,* and *Pacific.*
- This teacher also shares with her students the origin of a famous phrase, *Veni, vidi, vici,* which they might encounter at some time. Supposedly posted in a letter sent home by Julius Caesar after defeating the Parthians in 47 B.C.E. (Parthia is modern Iran), it means "I came, I saw, I conquered." For a teacher, much of the power of this utterance lies in the related words that spring from the roots of *veni, vidi, vici.*

  veni = con*ven*e, con*ven*tion (come together)
  vidi = *vid*eo
  vic = *vic*tor, *vic*tory

Science

Chemistry teachers may share a brief narrative about the atom. While the existence of atoms was not confirmed until the late nineteenth century, their existence was first hypothesized approximately 2,500 years ago by the Greek philosopher Democritus. He was thinking about what happens when you keep cutting something up and reach a point where you cannot cut it up any smaller. He believed that whatever you have at that point must be the smallest unit of matter, and he referred to that unit as an atom, from the Greek word *atomos*—"that which cannot be cut." The word *atom* is made up of the root *tom,* meaning "cut," and the prefix *a-,* meaning "not." Of course, we have known for some time now that it *is* possible to "cut up" an atom into smaller particles, but when we do that we no longer have the element of matter we began with—if we began with copper or bismuth, we no longer have copper or bismuth. At that level, we have a lot of *sub*atomic particles, many of which may in turn be broken down even further. While *electrons* can't be broken down further, *protons* and *neutrons* can, and the resulting "sub-" subatomic particles reveal the universe of *hadrons,* showing even more interesting words worthy of exploration.

The origin of *chemistry* is intriguing. The word comes from Middle English *alkamie,* which came originally from Medieval Latin *alchymia,* which in turn came from an Arabic word *al-kimiy. Al* means "the" in Arabic, and *kimiy* refers to *chemistry.* Going way back, this term probably came from *Khemia,* the Greek name for Egypt. In a way, modern-day chemists are descendants of medieval alchemists, who believed a process could be found that changed ordinary metals into gold. Newton practiced alchemy throughout most of his life, and most alchemists also practiced what we would consider "legitimate" chemistry. Their desire to learn how to turn metals into gold was hardly a belief in magic; based on their understanding of chemistry at that time, this seemed a possibility.

Mathematics

Origin of the Calendar. Discussing how the calendar evolved is of interest to students from the intermediate grades on, in part because it explains why the ninth month in the year, September, has the root *sept* (seven), the tenth month the root *oct* (eight), and so on. The early Roman calendar was supposed to have been introduced by Romulus, who according to legend was the founder of Rome. This calendar, which in reality was borrowed from the Greeks, who in turn borrowed it from the Babylonians, was based on the phases of the moon. It had ten months that covered 304 days. From a solar year perspective, that left 61 days kind of floating out there in the middle of winter. The first month of the year was March, the fifth month was named *Quintilis,* the sixth *Sextilis,* so *Sept*ember was indeed the seventh month, *Oct*ober the eighth month, *Nov*ember the ninth month, and *Dec*ember the tenth month. A calendar that did not match up to the solar year, however, became quite awkward, so Numa Pompilius, another legendary figure and supposed successor to Romulus, added the months of January and February, which brought the calendar to 355 days, closer to the solar year. *January* came from *Janus,* the god of doors who had two faces, one looking forward and one looking backward (new year/old year). This addition threw off the months that were named for numbers. As time went on, Roman politicians began playing around with the months, extending the days for some, subtracting days for others, all on a whim. Julius Caesar decided to change all that, and introduced the Julian calendar, substituting his own name (*July*) for *Quintilis.* His great nephew's name, Caesar *August*us (considered the greatest of the Roman emperors), was later substituted for the month of *Sextilis.*

Caesar's calendar worked rather well for many centuries, but by the late sixteenth century it was about 10 days off, so for this reason—as well as political reasons—Pope

Gregory modified the Julian calendar, and his version is the one used to this day among Western cultures.

Origin of *Multiply*. The root *ply/pli* means "fold," as in *ply*wood and *pli*able. In mathematics, the word *multiply* literally means "to fold many times." The sense of "folding" may be illustrated by walking students through the process of folding a piece of paper two, three, four, and five times. What happens each time you fold the paper into another square? (Each time you fold into an additional square you are doubling by 2 the number of squares.)

1 fold = 2
2 folds = 4 (then take 4 and fold it into another square, you get 8—$2 \times 2 \times 2 = 8$)
3 folds = 8 (then take 8 and fold or "square" it, you get 16—$2 \times 2 \times 2 \times 2 = 16$)
4 folds = 16
5 folds = 32

You always have two halves to the paper, as it were, but when the paper is unfolded, you see twice as many squares as before.

Trigonometry. Share with students that a "trigon" was originally a musical instrument in Greece. How many sides did it have? We still have the word *trigon* in *trigonometry.* So, we're literally measuring—*metr*—in terms of three. Trigonometry is, at its heart, the exploration of the angles and sides of triangles. The *o* between *trigon* and *metry* is a connecting vowel—it's there because it makes trigonometry easier to say.

Further Exploration

In this section, we have shared just a few examples to illustrate the possibilities of exploring etymological narratives. As we shared at the beginning of this chapter, we leave the rest of the narratives to you. The "Resources for Language History, Word Origins, and Greek and Latin Roots" on pp. 42–43 in Chapter 3 provides information for sources that provide some of the best etymological information available.

LOOKING AHEAD

For both generative and word-specific vocabulary instruction, teachers will be able to apply the strategies and activities presented thus far to students who are learning English as a new language. This is the terrain to be explored in Chapter 7, and that examination will complete our investigation of teaching vocabulary *their* way. Chapter 8 will round out that picture by examining assessment of our students' vocabulary knowledge, seeking to discern their underlying knowledge *their* way. Assessment to determine our students' word and concept knowledge and their generative or morphological understanding can provide the foundation for organizing supportive vocabulary instruction.