What Works In Classroom Instruction

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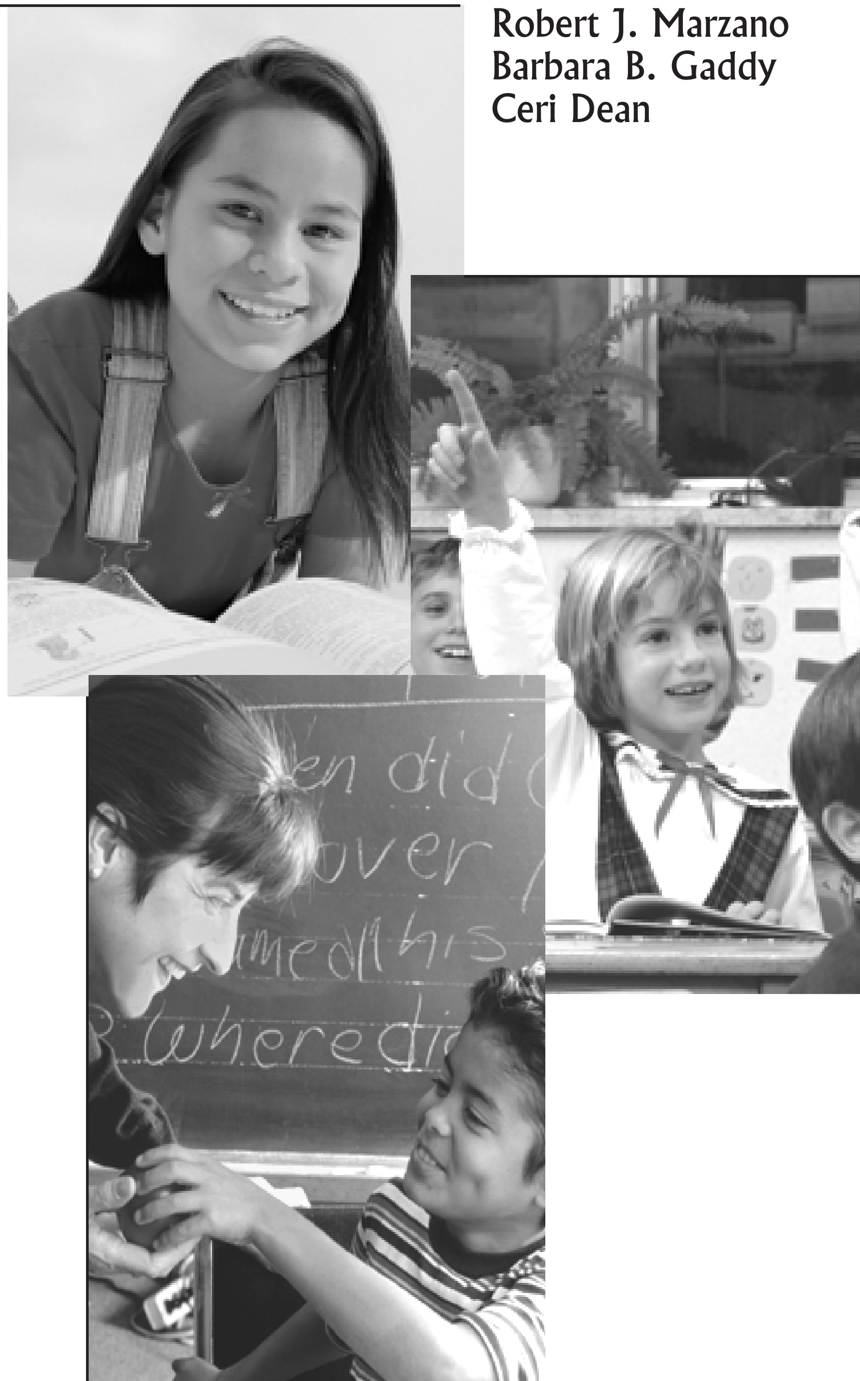

McREL
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Chapter 1

INTRODUCTION

In 1986, the U.S. Department of Education published a report unlike any report it had previously published. As described by then-Secretary of Education William J. Bennett, the report was "intended to provide accurate and reliable information about *what works* in the education of our children" (p. v). The report, entitled *What Works: Research About Teaching and Learning*, had been Secretary Bennett's dream since the beginning of his tenure:

> The preparation of this report has been in my mind since the day, a year ago, when I was sworn in as Secretary of Education. In my first statement upon assuming this office, I said, "We must remember that education is not a dismal science. In education research, of course, there is much to find out, but education, despite efforts to make it so, is not essentially mysterious." In an interview shortly thereafter, I added that "I hope we can make sense about education and talk sense about education in terms that the American public can understand. I would like to demystify a lot of things that don't need to be mystifying. I would like specifically to have the best information available to the Department and therefore to the American people." (p. v)

The report argued that the "first and fundamental" role of the federal government in education was to give American educators and noneducators the most accurate information available about the instructional strategies that are most effective. Indeed, the report was an attempt to provide just that to the American people.

However, the report was never purported to be comprehensive. In fact, it was designed as a prototype of what could be accomplished if a concerted attempt was made to synthesize the research in education. In a preface to the report (U.S. Department of Education, 1986), then-President Ronald Reagan wrote, "In assembling some of the best available research for use by the American public, *What Works* exemplifies the type of information the Federal government can and should provide" (p. iii).

This publication attempts to respond to President Reagan's challenge and build on the foundation established by Secretary Bennett's work. The purpose of this publication is to provide educators with instructional strategies that research shows have the greatest likelihood of positively affecting student learning. The guidance offered in this manual builds on years of practical experience and efforts to synthesize the research on teaching by the Mid-continent Research for Education and Learning (McREL), formerly known as the Mid-continent Regional Educational Laboratory. This publication is designed to be used by K–12 classroom teachers, building-level administrators, and central office administrators. It is offered as a tool to enhance students' achievement in any content area.

BACKGROUND

The synthesized research findings presented in this document are based in part on an earlier technical document published by McREL entitled *A Theory-Based Meta-Analysis of Research on Instruction* (Marzano, 1998), which summarizes findings from more than 100 studies involving 4,000+ comparisons of experimental and control groups. Since that document was published, McREL researchers have analyzed additional research findings from selected research on instructional strategies that could be used by teachers in K–12 classrooms. The combined results of these syntheses are presented in the following chapters.

The research technique we used is referred to as *meta-analysis*, a strategy that combines the results from a number of studies to determine the net effect of an intervention. Just as with a single study, this net effect can be translated into an expectation about achievement gain or loss, but in this case it has the added value of representing many studies.

The studies reviewed for this publication report the effects of an instructional strategy on an experimental group — a group of students who are exposed to a specific instructional technique — compared to a control group — students who are not exposed to the strategy. When conducting a meta-analysis, a researcher translates the results of a given study into a unit of measurement referred to as an *effect size*. An effect size expresses in standard deviations[1] the difference between the increased or decreased achievement of the experimental group with that of the control group.

This means that if the effect size computed for a specific study is 1.0, the average score for students in the experimental group is 1.0 standard deviation higher than the average score of students in the control group. Another way of saying this is that a student at the 50th percentile in the experimental group would be one standard deviation higher than a student at the 50th percentile in the control group.

Statisticians tell us that, in general, we can expect students' achievement scores to be distributed like the well-known "bell curve" or "normal distribution." Figure 1.1 shows that the normal distribution has a range of about three standard deviations above the mean and three standard deviations below the mean. About 34 percent of the scores in the normal distribution will be found in the interval between the mean and the first standard deviation above (or below) the mean, about 14 percent of the scores will be found in the interval between the first standard deviation and the second standard deviation, and so on.

One of the more useful aspects of an effect size is that it can be easily translated into percentile gains. Being able to translate effect sizes into percentile gains can lead to dramatic interpretations of the possible benefits of a given instructional strategy. Thus, throughout this manual, we present the research we reviewed both in terms of effect sizes and percentile gains.

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[1]Standard deviation is a measure of the variability of scores around the mean.

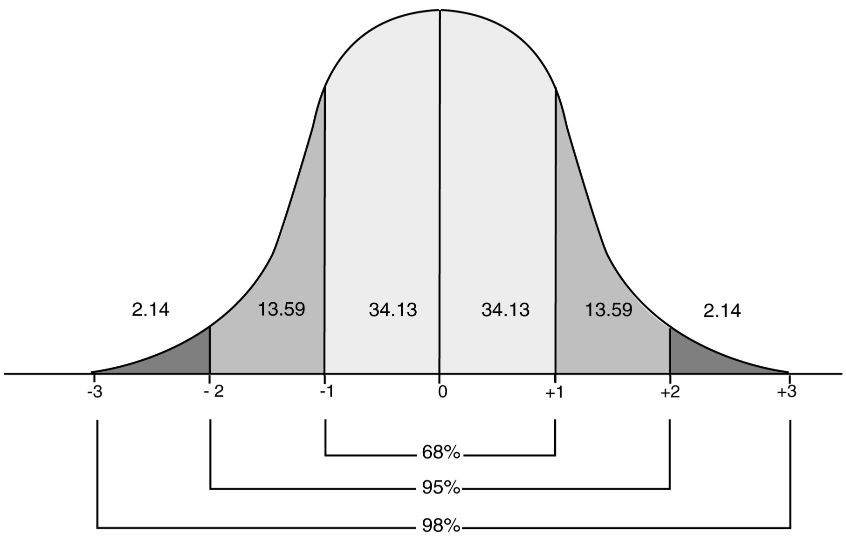


Figure 1.1: Normal Distribution

As a preview of the summaries you will encounter in the following chapters, consider a meta-analysis by Redfield and Rousseau (1981) of 14 studies on the use of higher-level questions (see Chapter 10). Redfield and Rousseau computed the average effect size for these 14 studies to be .73. This means that the average student who was exposed to questioning strategies scored 0.73 standard deviations above the score of the average student who was not exposed to the questioning strategies. (This difference is depicted by the shaded area in Figure 1.2.) By consulting a statistical conversion table for translating effect sizes to percentile gains, we find that an effect size of 0.73 represents a percentile gain of about 27 points.

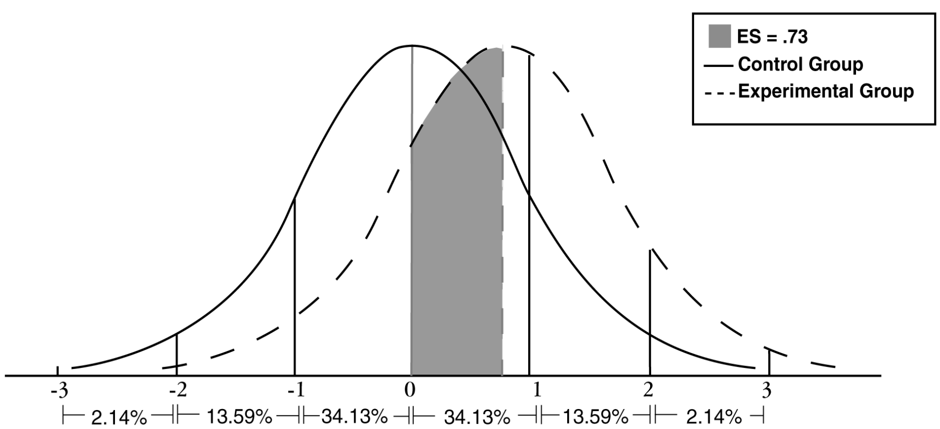


Figure 1.2. Effect Size of .73 Standard Deviations

Another way of interpreting an effect size is in terms of a year's growth. Meta-analysis experts Glass, McGaw, and Smith (1981) explain that an effect size of 1.0 can be interpreted as roughly one year's growth in achievement. Relative to the Redfield and Rousseau study, this means that students who received the higher-level questions exhibited achievement that was about three-quarters of a year higher than those who did not.

Overall Findings

One of the primary goals of the McREL study was to identify those instructional strategies that have the highest probability of enhancing student achievement for all students in all subject areas at all grade levels. However, there was a great deal of variance across the studies in instructional strategies --- both in terms of the extent to which they were defined and how their use in the classroom was described. Thus, to identify the most effective strategies, McREL researchers considered the results of its meta-analyses along with our experiences in the field with thousands of educators over the past 30 years. Table 1.1 lists the nine categories of strategies that research and experience show have a strong influence on student achievement. Since these averages do not include overlapping data, they provide a more accurate picture of the effect of a particular category of instructional strategy.

Table 1.1: Categories of Instructional Strategies that Strongly Affect Student Achievement

Category	Ave. Effect Size	Percentile Gain[a]	N	SD
Identifying similarities and differences	1.61	45	31	.31
Summarizing and note taking	1.00	34	179	.50
Reinforcing effort and providing recognition	.80	29	21	.35
Homework and practice	.77	28	134	.36
Nonlinguistic representations	.75	27	246	.40
Cooperative learning	.73	27	122	.40
Setting goals and providing feedback	.61	23	408	.28
Generating and testing hypotheses	.61	23	63	.79
Activating prior knowledge	.59	22	1251	.26

Note: N = Number of effect sizes. SD = standard deviation.
[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

In the following chapters, we discuss these nine categories in depth. However, it is useful to consider them briefly as a group. As indicated in Table 1.1, the average effect size of these strategies ranges from .59 to 1.61. One of the most important things to remember when interpreting Table 1.1 is that the effect sizes reported in the second column ("Ave. Effect Size") are averages for the studies we examined. Some of the studies within each category had effect sizes much higher than the average; some had effect sizes much lower than the average. In fact, the expected range of effect sizes for a given category of instructional techniques is a spread of six standard deviations — three standard deviations above the average effect size and three standard deviations below the average effect size.

To illustrate, consider the general category of instructional strategies referred to as reinforcing effort and providing recognition. As shown in Table 1.1, the average effect size for this category is .80 and the standard deviation (SD) is .35. We also see that 21 studies were used to compute the average effect size of .80. The standard deviation of .35 tells us how different the findings of those 21 studies were. Among the 21 studies that were reviewed to compute the average effect size (.80), some applications had an effect size as high as three standard deviations above the mean of .80. Conversely, some effect sizes in the set of 21 were three standard deviations below the mean of .80. Since the standard deviation is .35, some effect sizes in the set of 21 were as high as 1.85 [.80 + 3(.35)]; some were as low as -.25 [.80 - 3(.35)]. Stated differently, on average, reinforcing effort and providing recognition produced a gain of .80 years' growth in student achievement. However, some uses of these strategies produced a gain as high as 1.85 years growth, while others produced a loss in achievement of .25 years. Some of the studies within a given category, then, had negative effect sizes. A negative effect size means that the experimental group actually performed worse than the control group did.

The inference that can be drawn from this illustration is that no instructional strategy works equally well in all situations. The effectiveness of a strategy depends in part on the current achievement level of a student, in part on the skill and thoughtfulness with which a teacher applies the strategy, and in part on contextual factors such as grade level and class size. Instructional strategies are only tools. We strongly recommend that teachers keep this in mind as they review the strategies presented in this manual and use them with students. Although the strategies presented in this manual are certainly good tools, they should not be expected to work equally well in all situations, or with all students, even when expertly used.

The following chapters discuss the nine categories of instructional strategies in depth. Each chapter follows a similar format. Suggestions for using the strategies with students are first discussed, along with examples that illustrate how to use these practices to teach specific academic content. This section is followed by a discussion of the research and theory underlying each category of strategies. Whenever possible, the findings of specific studies are presented.

When reviewing these research findings, please note that it is not possible to derive the average effect sizes shown in Table 1.1 from the effect size information provided in the tables in each of the following chapters. The studies listed for a specific category of instructional strategy often involved a review of some of the same research and a comparison of some of the same experimental and control groups. Therefore, an "average of these averages" would lead to inaccurate conclusions. The average effect sizes reported in Table 1.1 are based on independent comparisons.

Finally, when considering the research summarized in each chapter, the reader should note that not all teachers in these studies followed exactly the same approach when using one of the instructional strategies. Thus, the practices that are suggested in the following chapters are not based solely on research, but reflect current best practice relative to using particular instructional strategies.

USING THE RESEARCH

Although a great deal of education research has been and is currently being conducted in universities and research centers across the country, some educators and noneducators hold a fairly low opinion of that research. In fact, it is probably accurate to say that there are some who believe that research in education is not as rigorous or conclusive as research in the "hard sciences," such as physics or chemistry.

The general lack of confidence in the findings of education research was addressed in depth in a 1987 article by researcher Larry Hedges entitled "How Hard Is Hard Science: How Soft Is Soft Science?" Hedges examined studies across 13 areas of research in psychology and education, which he referred to as the "social sciences," and compared them with studies in physics. He found that the studies from physics were almost identical to the studies from the social sciences in terms of their variability: "Almost 50% of the reviews showed statistically significant disagreements in both the social sciences and the physical sciences" (p. 450). This means that studies in physics exhibit the same discrepancies in results as studies in education — one study shows that a particular technique works; the next study shows that it does not. Hedges also found that researchers in the hard sciences much more frequently discarded studies that seemed to report "extreme findings." For example, in the area of particle physics, roughly 40 percent of the studies were omitted from a synthesis of studies because their findings were considered unexplainable. However, in education and psychology, Hedges found that it is rare for even 10 percent of studies with extreme findings to be discarded when research is synthesized.

Hedges' overall conclusion was that research in the soft sciences, such as education, is indeed comparable to research in the hard sciences in terms of its rigor. His overall recommendation was that educators, like researchers in the hard sciences, look for general trends in the findings from studies. In other words, findings from no single study or even a small set of studies should be taken as the final word on whether a strategy or approach works well or not. In fact, educators should analyze as many studies as possible about a given strategy. The composite results of those findings should be considered the best estimate of how well the strategy works.

OVERVIEW OF THIS GUIDE

The following chapters provide a more detailed discussion of instructional strategies that are likely to enhance student learning. *Chapters 2 through 10* present specific suggestions for using each of the instructional strategies in the classroom, along with a summary of relevant research findings. Each chapter follows the same basic format: classroom strategies are related examples are presented, followed by a discussion of the research and theory related to that category of strategies. *Chapter 11* presents a discussion of instructional strategies that are specific to five types of knowledge: (1) vocabulary terms and phrases, (2) details, (3) organizing ideas, (4) skills and tactics, and (5) processes. The instructional strategies presented in Chapters 2 through 10 apply to all types of knowledge, whereas those presented in Chapter 11 are designed to increase understanding and skill in specific knowledge domains. Finally, *Chapter 12* demonstrates how a teacher might use the instructional strategies in a unit of instruction.

The instructional strategies presented in this guidebook are designed to be used by educators whose work reflects a variety of theories and frameworks of human learning and human cognition. Thus, educators can use the various instructional strategies presented in this document regardless of the particular theoretical framework they generally follow. Readers should feel free to pick and choose from among the strategies presented and integrate them with current programs or practices in their districts, schools, or classrooms.

Chapter 2

IDENTIFYING SIMILARITIES & DIFFERENCES

As part of a world literature unit, students in Ms. Scott's advanced placement language arts class were studying the epic poem Beowulf *and the 20th century novel* Grendel*, by John Gardner. To extend and refine their understanding of the two pieces, Ms. Scott created a task in which she asked students to compare and contrast these two works. Students were to identify the characteristics on which to compare the works and then determine how the works are similar and different. Finally, students were to write a paper describing how the works are alike or different in terms of the characteristics they selected, using as many examples from the works as possible to make their points.*

After students turned in their papers, Ms. Scott led a class discussion on what students had learned. Ms. Scott was particularly interested in the characteristics students had used to compare the two works. Students discussed the fact that both works deal with the story of a monster named Grendel and its interactions with human beings, specifically with Beowulf, the human hero whose mission is to destroy Grendel at any cost. Most of the students agreed that the plot and characters are very similar but that the two works are quite different in terms of point of view. Beowulf *is told from the point of view of the human hero;* Grendel *is told from the point of view of the monster. The class concluded that this essential difference between the two works also influenced students' opinions of who was the hero of each work.*

Ms. Scott engaged her students in a mental activity that can have a profound effect on their learning — analyzing how things are similar and different.

****

The first general category of instructional strategies reviewed in this guide includes comparing, classifying, creating metaphors, and creating analogies. All of the processes discussed in this chapter are fairly complex mental operations that involve analyzing information at a fairly deep level (see Sternberg, 1978, 1979). All of these processes also require students to analyze two or more elements in terms of their similarities and differences on one or more characteristics, a mental operation that researchers have concluded is basic to human thought (see Markman & Gentner, 1993a, 1993b; Medin, Goldstone, & Markman, 1995; Gentner & Markman, 1994).

Obviously, identifying similarities and differences is explicit in the process of comparing. It is also critical to classifying. To illustrate, when classifying an individual first identifies similarities and differences between and among the elements in a given set and then organizes these elements into two or more categories, based on the identified similarities and differences. Similarly, creating a metaphor involves identifying abstract similarities and differences between two elements. Finally, creating analogies involves identifying how two pairs of elements are similar.

There are a number of ways to help students use these processes to identify similarities and differences between topics or items. The following sections include examples of strategies that teachers might use in the classroom to help students learn to use these reasoning processes to enhance their understanding of specific academic content. Three types of strategies are presented for each reasoning process: *teacher-directed tasks*, *student-directed tasks*, and *graphic organizers*.

The reasoning processes reviewed in this chapter can be very difficult for students. Even after students have been introduced to the process and have a general understanding of the process, they may struggle to apply the process to specific academic content. At this stage of the learning process — or when teachers have a very specific academic goal in mind — *teacher-directed tasks* can be very useful. These tasks give students more of the essential information they will need to complete the task. For example, a comparison task that is teacher directed is one for which the teacher has provided the items to compare and the characteristics on which they are to be compared. To complete the task, students must describe how the items are similar and different, using the characteristics the teacher has identified. When the comparison is completed, teachers typically ask students to summarize what they learned. Teacher-directed tasks focus — and perhaps constrain — the type of conclusions students will reach. Consequently, they should be used when a teacher's goal is that all students will obtain a general awareness of the same similarities and differences between items.

When students have become more skilled at using a particular process, teachers can give them *student-directed tasks* — tasks that are less structured and that give students less guidance. This kind of task requires much more of students, but also gives them more freedom to work and think independently. For example, a comparison task that is student directed is one for which the teacher has provided the items to be compared, but asks students to identify the characteristics to use to compare the items. Even though unstructured tasks give students more freedom, teachers should still monitor students' work to help ensure that they are engaged in tasks that will enhance their learning of important content knowledge.

Presenting students with graphic organizers is the third type of strategy for which examples are provided for each of the reasoning processes reviewed in this chapter. Graphic organizers or graphic representations are particularly useful for helping students understand, visualize, and use whatever thinking process they are learning.

COMPARING

Comparing is the process of identifying similarities and differences between or among things or ideas. Comparing activities have broad applications. They can be used with any subject area, at any grade level. The key to an effective comparison is the identification of important characteristics — those that will enhance students' understanding of the similarities and differences between the items being compared. For example, if students are comparing President Franklin D. Roosevelt and

President Harry S. Truman during a history class, comparing the two men in terms of “how happy their childhoods years were” might be interesting, but certainly not the most important characteristic to use. A more useful characteristic might be “role during World War II” or “domestic policies initiated.”

1. Use Teacher-Directed Comparison Tasks.
(See Illustration 1)

When students are first learning to use the process of comparing, a teacher might present students with highly structured tasks, such as the one shown in Illustration 1. In this example, the teacher has provided students with the elements to be compared as well as the characteristics on which they are to be compared. To determine how well students complete these tasks, the teacher would examine the extent to which students correctly described how the items are similar and different with respect to the characteristics identified by the teacher.

2. Use Student-Directed Comparison Tasks.
(See Illustration 2)

Student-directed tasks are useful when students have gained some level of skill using the process of comparing with teacher-directed comparison tasks. These tasks are slightly more difficult than teacher-directed tasks because they challenge students to draw on their content knowledge to some extent before they even begin the task. When teachers give students these kinds of tasks, they may ask students to identify the items to be compared *as well as* the characteristics on which to base their comparison. Typically, however, teachers give students the items to be compared, but ask them to identify the characteristics to use to compare the items, as exemplified in Illustration 2.

To determine how well students perform on student-directed comparison tasks, the teacher would not only look at the accuracy of the comparisons students made, but whether they selected comparison characteristics that were truly important to the task. For example, did students select characteristics of volcanoes and geysers that were likely to help deepen their understanding of the similarities and differences between these natural processes?

3. Use Graphic Organizers for Comparison.
(See Illustrations 3.1 and 3.2)

Two types of graphic organizers are commonly used for comparison: the Venn diagram and the comparison matrix. The Venn diagram gives students a way to visually see the similarities and differences between two items. The similarities are listed in the intersection between the two circles. The differences are listed in the parts of each circle that do not intersect. The Venn diagram is particularly useful for highlighting the fact that the two things being compared have some things in common, but not others, as shown in Illustration 3.1. For example, like modern homes, the homes of Pilgrims were wood framed and had fireplaces. But the shelter they used differs in a number of ways. For example, Pilgrims used outdoor ovens, whereas modern humans primarily use indoor ovens. The comparison matrix graphically depicts a more detailed approach to the comparison process than does the Venn diagram, as exemplified by Illustration 3.2.

ILLUSTRATION 1: TEACHER-DIRECTED COMPARISON TASK *tennis*

We have been studying and practicing the serve in tennis — one of the more difficult aspects of the game. We are now going to watch a video of two tennis players serving. The video shows each player serving in slow motion a number of times. You will be given statistics for each of the two players. Your job is to compare the players on the following characteristics:

- height of ball toss
- speed of serve
- trajectory of serve

After you have finished your comparison, write a summary of what you learned. For each characteristic, clearly describe the similarities and differences between the two players.

ILLUSTRATION 2: STUDENT-DIRECTED COMPARISON TASK *volcanoes*

All kinds of interesting natural processes happen on the earth every day. Many materials fall to the earth — rain, snow, sleet, hail, and debris from outer space. But some materials also are pushed out of the earth. The process of pushing things out of the earth is called "eruption." At least two things on earth from which material erupts are volcanoes and geysers.

One way to learn more about ideas or things is to compare them. Your task is to compare volcanoes and geysers. The first step is to write down the characteristics that you will use to compare them. Then compare volcanoes and geysers in terms of each of these characteristics. How are they the same? How are they different? Be sure to pick characteristics that will help you learn more about these natural earth phenomena. Apply what you have learned in class as well as information gathered from encyclopedias, books, magazines, the Internet, or other resources.

After you have finished your comparison, write a summary of what you learned. Clearly describe how volcanoes and geysers are similar and how they are different.

ILLUSTRATION 3.1: VENN DIAGRAM *Pilgrims & modern humans*

PILGRIMS AND MODERN HUMANS — SHELTER

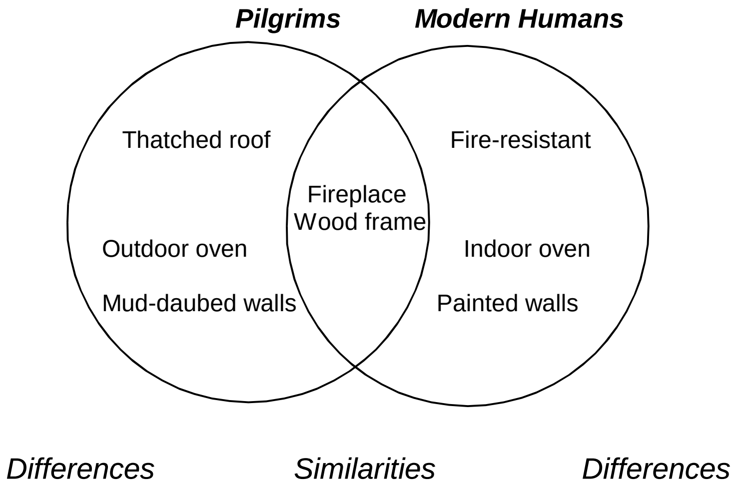


ILLUSTRATION 3.2: COMPARISON MATRIX *19th century U.S. expeditions*

A number of expeditions took place in the early 19th century that marked the early stages of the expansion into the western regions of the United States. Perhaps the best-known expedition was that undertaken by army officers Meriwether Lewis and William Clark. About the same time, another army officer, Zebulon Pike, explored the American southwest — one of Pike's expeditions in the southwest was known as the Arkansas River Expedition of 1806.

Using a comparison matrix, compare these two expeditions on the following characteristics: "who ordered the expedition," "purpose of the expedition," "areas explored," and "outcomes of the expedition."

Use what you have learned in class as well as other resources (e.g., books, CDs, encyclopedias, the Internet) to do this task. After you have completed the center sections of the matrix, use the column on the far right to make notes about the similarities and differences between the items in terms of the characteristics. What did the Lewis and Clark expedition and Pike's exploration of the southwest have in common? How were they different? Finally, write a one-page summary of what you learned about the westward expansion of the United States by doing this task.

(See completed matrix on next page.)

ILLUSTRATION 3.2 *(continued)* *Comparison matrix — Lewis & Clark and Pike expeditions*

CHARACTERISTICS	**ITEMS TO BE COMPARED**		**SIMILARITIES (SIM)/ DIFFERENCES (DIFF)**
	Lewis & Clark expedition	**Pike's 1806 Arkansas River Expedition**	
1. Who ordered the expedition?	Thomas Jefferson	General James Wilkinson	***Sim*** —As President, Jefferson was interested in the findings of both expeditions.
			Diff—Commissioned by different people.
2. Purpose of the expedition	To find a Northwest passage - water route linking the Columbia and Missouri rivers, leading to the Pacific Ocean. To make a detailed report on western geography, climate, plants, and animals; to study the customs and languages of the Indians; and to establish relations with Indians.	To explore the Arkansas and Red Rivers; to obtain information about Spanish territory; to improve relations with and among Indians, including the Osage, Kansas Indians, and Comanche.	***Sim***—Wanted to help establish claim to U.S. territories, study the geography of unfamiliar areas, and establish relations with Indians.
			Diff—Encountered different Indian tribes. Lewis & Clark's expedition had a larger scientific focus.
3. Areas explored	Started from the confluence of the Mississippi and Missouri rivers near St. Louis. Traveled up the Missouri to modern-day North Dakota, across modern-day Montana, Idaho, Washington, and Oregon to the Pacific. Then back to St. Louis.	Traveled the Missouri and Osage Rivers. Crossed Kansas, through Colorado, then south into what is now northern New Mexico. Held for some time by the Spanish authorities on the upper Rio Grande River for trespassing in Spanish Territory.	***Sim***—Explored new areas acquired as part of the Louisiana Purchase.
			Diff—Lewis & Clark traveled farther north and west and reached the Pacific Ocean. Pike went west and south down different rivers into territory that included parts of present-day Mexico and Texas.
4.Outcomes of the expedition	Learned about the land, natural resources, and native people. Helped map makers. American settlers & traders soon began to travel over the route they blazed. The expedition also provided support for the U.S. claim to the Oregon country. Learned that the Rocky Mountain range was too wide for an easy connection between the Missouri & Columbia rivers.	Brought back knowledge of the geography and native peoples. Generated interest from businessmen and politicians in expanding into Texas. Helped to establish the myth of the "Great American Desert," which slowed growth into the Great Plains.	***Sim***—Brought back knowledge of the geography and native peoples. Encouraged settlement and growth in new territories.
			Diff—Pike's expedition resulted in slowed expansion into the Great Plains area. Lewis & Clark's expedition received more attention.

CLASSIFYING

Classifying involves grouping things into definable categories based on like characteristics. This process also involves the critical step of determining the rules that govern category membership.

How things are classified influences our perceptions and behaviors. For example, think about how things are grouped in a grocery store and how shopping would be affected if items in the store were classified by letter of the alphabet. In the classroom, using classifying can influence what students see about what they are learning.

Classifying activities can be relatively easy or difficult, depending on how structured the tasks are and how familiar students are with the content. There are a number of ways to ensure that the process of classifying enhances learning. One way to do this is to help students learn to select categories that are related to one another. For example, if students are classifying animals and the first characteristic is "animals that are carnivores," the second characteristic should be something like "animals that are herbivores." Selecting a second characteristic such as "animals that are reptiles" will create confusion and not help students understand the similarities and differences between and among the animals they are studying.

Another way to make the most of the process of classifying is to ask students to classify items and then reclassify them. This helps students notice distinctions among the items that they might miss if they classify the items only once. For example, after students have classified the animals according to the food the animals typically eat, a teacher might ask them to classify them according to the areas of the world in which they are generally found.

1. Use Teacher-Directed Classification Tasks.
(See Illustration 1)

Teacher-directed classification tasks are those for which students are given the elements to classify and the categories into which the elements should be classified. In teacher-directed tasks, the focus is on placing items into their appropriate categories and understanding why they belong in those categories. Illustration 1 at the end of this section is an example of a teacher-directed classification task. To determine how well students perform on these tasks, a teacher would judge the degree to which students' accurately placed the items into the categories they were given.

2. Use Student-Directed Classification Tasks.
(See Illustration 2)

Student-directed classification tasks are those for which students are given the items to classify but must form the categories themselves. Sometimes students might also be asked to generate the items to classify as well. These tasks sometimes are called *unstructured tasks* in that students can form any categories or identify any items they wish, within the parameters of a given assignment. Illustration 2 is an example of a student-directed classification task. To assess students' performance on student-directed classification tasks, a teacher would focus on the logic of the categories students constructed. Specifically, students should be able to defend the logic of the categories they created by explaining the "rule" or "rules" for category membership.

3. Use Graphic Organizers for Classification.
(See Illustrations 3.1 and 3.2)

Graphic organizers provide students with a visual guide to the classifying process. Students can be encouraged to use these graphic organizers as they complete their classification tasks. Two of the more popular graphic organizers for classification are shown in Illustrations 3.1 and 3.2.

ILLUSTRATION 1: TEACHER-DIRECTED CLASSIFICATION TASK *musical instruments*

Below are listed 12 instruments. Classify them into three categories: strings, woodwinds, and percussion instruments.

piano	cello	cymbals	drum
viola	tuba	trombone	saxophone
flute	guitar	violin	xylophone

ILLUSTRATION 2: STUDENT-DIRECTED CLASSIFICATION TASK *literature*

An advanced placement literature class had just finished the last book they were to read for the year. As a culminating activity, Mrs. Blake asked students to do the following activity, both to use what they knew and to discover new connections they had missed throughout the year:

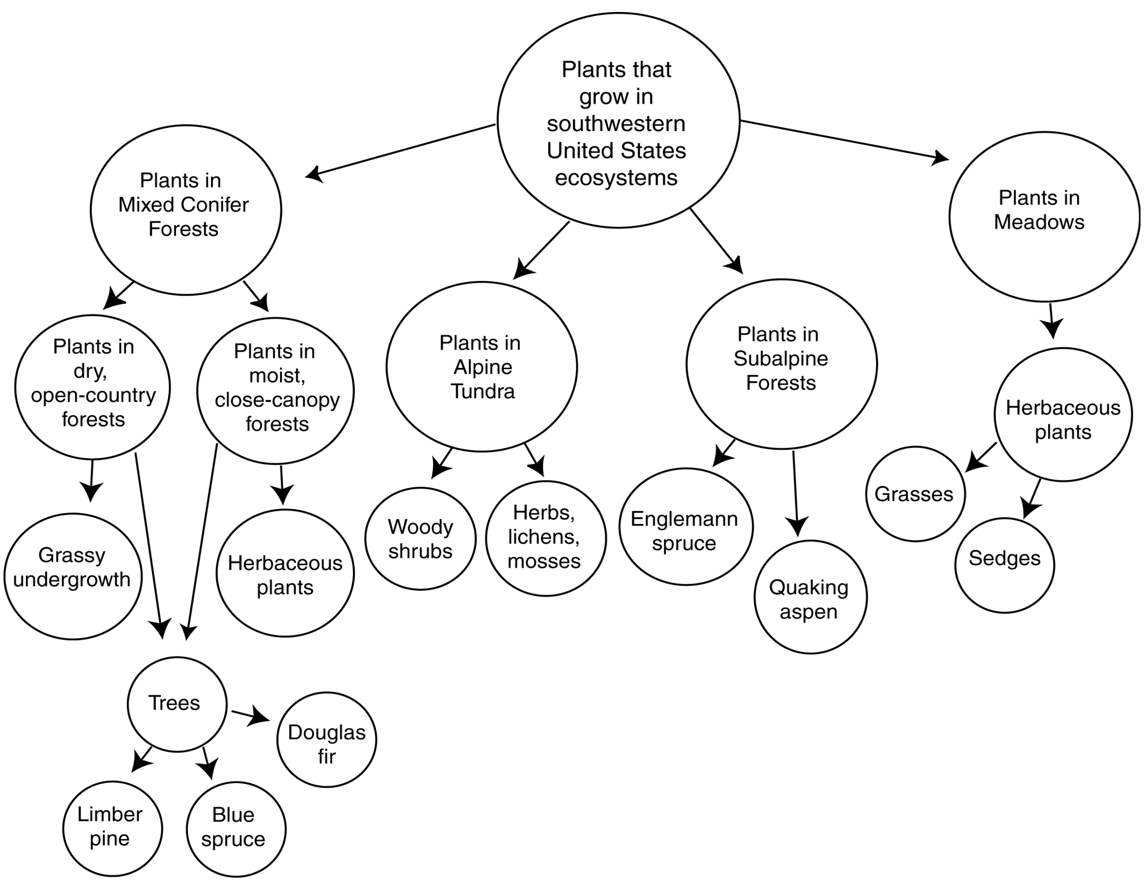
With a partner, make a list of as many characters as you can recall from the books we have read. Then classify them into categories of your choosing. Stay away from obvious categories, such as gender or nationality. Use categories that show your understanding of character development. When you are finished, reclassify the characters using new categories. Find another pair of students and discuss what you learned.

ILLUSTRATION 3.1: GRAPHIC ORGANIZER FOR CLASSIFICATION COLUMNS FORMAT *food*

Categories

Vegetables	**Fruit**	**Grains**	**Seafood**	**Meats**	**Dairy**
asparagus	apples	millet	flounder	turkey	yogurt
spinach	cherries	oats	halibut	chicken	butter
broccoli	avocados	rye	swordfish	lamb	cottage
carrots	limes	corn	tuna	beef	cheese
kelp	raspberries	barley	salmon	pork	milk
potatoes	olives	rice	sea bass		
	papayas	wheat			

ILLUSTRATION 3.2: GRAPHIC ORGANIZATION FOR CLASSIFICATION WEB FORMAT *Southwest U.S. ecosystems*



Creating Metaphors

Creating metaphors is the process of identifying a general or basic pattern in a specific topic and then finding another topic that appears to be quite different but that has the same general pattern. Metaphors frequently are used by authors to provide readers with strong images. For example, an author might say that the character is "walking on thin ice," meaning that he is in a situation where he doesn't have much support or the support he does have could break apart at any moment — just as someone walking on thin ice could fall into ice-cold, dangerous waters if the ice breaks. This figure of speech provides the reader with a mental picture of a dangerous or uncertain situation.

Although metaphors are typically used to express abstract relationships of singular ideas or items, metaphorical thinking can be applied to larger bodies of information or ideas — resulting in a kind of extended metaphor. For example, *West Side Story* and *Romeo and Juliet* are related at an abstract, nonliteral level. The stories are different, but the themes are the same.

Teaching students how to use and create extended metaphors encourages them to explore and understand ideas and information at deeper levels. This process also helps students connect unfamiliar information to what they already know. Many teachers, for example, introduce *West Side Story* to students by discussing *Romeo and Juliet*. Metaphors can also help students understand familiar information in new ways.

1. Use Teacher-Directed Metaphor Tasks.
(See Illustrations 1.1 and 1.2)

The process of creating metaphors is new to many students. Teachers can introduce students to the process by guiding them through metaphors to help them understand how two unlike items are alike at an abstract level. Once students have a general understanding of the concept of an abstract pattern or relationship, students should be given an opportunity to complete teacher-directed metaphor tasks that are less structured. These tasks are ones in which the teacher provides the first element of the metaphor and the abstract pattern. This structure provides a "scaffold" on which students can build the rest of the metaphor. Illustrations 1.1 and 1.2 at the end of this section exemplify how teacher-directed metaphor tasks can be used in both highly structured and less structured ways, depending on students' level of understanding and skill in creating metaphors.

2. Use Student-Directed Metaphor Tasks.
(See Illustration 2)

Once students become more skilled at identifying abstract patterns or relationships, teachers can assign tasks that require them to develop metaphors. Teachers might present students with one element of a metaphor and ask them to identify the second element and describe the abstract relationship. Such tasks are more student directed. Note that in Illustration 2 students are provided with only one element of the metaphor and asked to generate the second element *and* the abstract pattern. Obviously, tasks like this give students greater flexibility to make connections between what they are learning and what they already know.

3. *Use a Graphic Organizer for Metaphors.*
(See Illustration 3)

A graphic organizer is particularly useful as a visual aid to help students understand the nature of metaphors and how they are constructed. Illustration 3 shows how a graphic organizer can help students identify the literal information for an element, use this information to describe the literal information in general or abstract terms, and finally to identify a second item that is similar to the first at an abstract level.

The key benefit of a graphic organizer is that it visually depicts the fact that two elements might have somewhat different literal patterns, but share an abstract pattern. Using the graphic organizer, students can fill in the elements of a metaphor, the literal pattern for each element, and the abstract relationship that connects them.

ILLUSTRATION 1.1: TEACHER-DIRECTED METAPHOR TASK — HIGHLY STRUCTURED *"love is a rose"*

As a way of introducing the idea of metaphors to students, Mrs. Hoffman asked students to think about the saying "love is a rose." First, she asked students to describe love. Then she guided students through the process of turning this literal description of love into a general or more abstract description. Next, she asked students to describe a rose.

Literal: *Love:* When we are in love, we often feel happy. But being in love can be painful if the person you love hurts you, doesn't love you, or leaves.

Abstract: Something that makes us feel good can also cause us pain.

Literal: *Rose:* The blossoms are sweet to smell and pleasant to touch, but if you touch the thorns, they can stick you.

After students wrote their descriptions of a rose, Mrs. Hoffman asked them to talk with a partner about what they had learned about metaphors and about how an author's use of this figure of speech might affect the reader.

ILLUSTRATION 1.2: TEACHER-DIRECTED METAPHOR TASK — LESS STRUCTURED *disease*

Mr. Wong's health class had studied about disease, how diseases spread, and how they affect the human body. In order to extend their understanding, Mr. Wong ask students to think about a metaphor for disease:

Disease is ________________.

Mr. Wong led the students through the process of identifying the abstract pattern associated with disease. He wrote the following statements on the board:

1. A small number of cells invade a host.
2. These cells multiply.
3. The host organism tries to fight the diseases.

Then the class made more general statements about disease to identify an abstract pattern. Mr. Wong wrote the general statements on the board:

A small number of things invade or affect something.
The things grow in number and/or strength.
The affected thing tries to fight back.

Mr. Wong asked his students to work in pairs to complete the statement "Disease is a _________" and then write a paragraph that explained how the second element of the metaphor fit the general pattern they had identified.

ILLUSTRATION 2: STUDENT-DIRECTED METAPHOR TASK *the Internet*

Mrs. Sullivan's students were studying influences on contemporary American culture. As part of their discussion about the effect of the Internet, students brought up a common metaphor — the information "superhighway."

During the discussion, students began to identify specific areas where they thought the information superhighway metaphor broke down. Denzel pointed out that "superhighway" seemed like a misconception because some people have easy and speedy access like on

(Illustration continued on next page.)

ILLUSTRATION 2 *(continued)*

a large highway, but many people are still negotiating down a dirt road. Paige said she thought "information" was also too limiting to describe the way people currently use the Internet.

For homework, Mrs. Sullivan asked students to use the Internet as the first element of a metaphor, identify a second element other than "information superhighway," and then describe the abstract relationship.

The next day students worked as a class to describe the abstract pattern of the metaphor. Then individual students took turns explaining the elements they had chosen and how they related to the abstract pattern. Denzel explained his metaphor of the Internet as a giant flea market. "The Internet is a flea market," said Denzel. "There's a lot available. Some things are what they seem to be. Others aren't. Sometimes you can get something you need for very little money."

ILLUSTRATION 3: METAPHOR GRAPHIC ORGANIZER

"the brain is a conductor"

Element/ Item	Literal Pattern	Abstract Relationship	Literal Pattern	Element/ Item
Brain ➜	Control center for emotions and all body functions vital to survival. Helps the parts of the body work together. ➜	Controls many different parts of a system. Vital to health of the system.	← Sends signals to members of the orchestra that tell them when and how to play. Necessary to the orchestra playing well together.	← Conductor

CREATING ANALOGIES

Creating analogies is the process of identifying relationships between pairs of concepts — in other words, identifying relationships between relationships. Like metaphors, analogies help us to see how seemingly dissimilar things are similar, increasing our understanding of new information. An analogy typically follows the form A:B::C:D (read as "A is to B as C is to D") (Sternberg, 1977). For example:

> carpenter:hammer::painter:brush ("carpenter is to hammer as painter is to brush")
> *Hammer* and *brush* are tools used by a *carpenter* and a *painter*, respectively.

1. Use Teacher-Directed Analogies.
(See Illustrations 1.1 and 1.2)

A teacher might introduce analogies by giving students *complete* content-area examples, such as those in Illustration 1.1. The teacher might ask students to explain how the relationship between items A and B is similar to that between items C and D. For example, students might be asked to explain how the relationship between *venom* and *snake* is similar to the relationship between *quill* and *porcupine*.

As students build their understanding of analogies, teachers can give them opportunities to apply what they have learned by presenting them with *incomplete* analogies, such as those found in Illustration 1.2. Incomplete analogies are still teacher directed in that the relationship between the two pairs has already been determined. But these tasks require students to provide the missing element and to explain how the relationships between the two pairs are similar.

2. Use Student-Directed Analogies.
(See Illustration 2)

As students become more proficient at completing analogies, teachers can give them opportunities to create the second pair of elements in an analogy. These tasks are student directed in that students have the freedom to consider a wider range of ways in which the first two elements are related. In fact, the analogies in Illustration 2 can be used in a music course, but also in other content areas.

3. Use a Graphic Organizer for Analogies.
(See Illustration 3)

A graphic organizer is a useful visual aid for enhancing students' understanding of the nature of analogies. Teachers can use these to introduce students to analogies. Teachers might also give students blank or partially blank organizers to use to solve analogy problems, as shown in Illustration 3. Note that students use the center portion of the organizer — between the parallel lines — to write their ideas about how the relationships between the pairs of items are similar.

ILLUSTRATION 1.1: TEACHER-DIRECTED ANALOGIES — COMPLETE *science*

venom is to snake
as
quill is to porcupine

tadpole is to frog
as
caterpillar is to butterfly

thermometer is to temperature
as
odometer is to speed

core is to Earth
as
nucleus is to atom

ILLUSTRATION 1.2: TEACHER-DIRECTED ANALOGIES — INCOMPLETE *language arts*

words are to books
as
notes are to _________

periods are to sentences
as
red lights are to ________

speaking is to humans
as
barking is to _______

To Kill a Mockingbird is to Scout
as
Catcher in the Rye is to _________

ILLUSTRATION 2: STUDENT-DIRECTED ANALOGIES *music*

Scott Joplin is to ragtime
as
_____ is to __________

Woodstock is to rock music
as
_______is to ________

♬ is to ♪
as
______ is to ________

F# is to the chord C-E-G
as
______ is to _________.

ILLUSTRATION 3: GRAPHIC ORGANIZER FOR ANALOGIES *thermometer and odometer*

A: thermometer . . . . is to . . . . B: temperature

as

A thermometer measures temperature.
What does an odometer measure?

C: odometer . . . . is to . . . . D: *speed*

THEORY AND RESEARCH IN BRIEF • • •
Similarities and differences

The category of instructional strategies dealing with the identification of similarities and differences between items is discussed first in this manual because of its potential for producing dramatic effects on student achievement. Results from some of the major meta-analyses that have synthesized the research on this category of instructional strategies are reported in Table 2.1.

The overall power of the instructional techniques reviewed in this chapter is perhaps best illustrated by considering a study by Gick and Holyoak (1980). These researchers presented their subjects with the following problem (which was adapted from a study by Duncker, 1945):

Table 2.1: Processes Involving the Identification of Similarities and Differences

Synthesis Study	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Stone, 1983	22	.88	31
Stahl & Fairbanks, 1986[b]	9	1.39	42
	20	1.76	46
Ross, 1988	2	1.26	38
Lee, undated	2	1.28	39

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.
[b]Two categories of effect sizes are listed for the Stahl and Fairbanks study because of the manner n which the effect sizes were reported. Readers should consult that study for more details.

> Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays reach the tumor all at once at a sufficiently high intensity, the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays and, at the same time, avoid destroying the healthy tissue? (pp. 307–308)

Only 10 percent of the people presented with this problem could solve it. However, when Gick and Holyoak also presented their subjects with the following story, 90 percent were able to solve the problem:

> A small country was ruled from a strong fortress by a dictator. The fortress was situated in the middle of the country, surrounded by farms and villages. Many roads led to the fortress through the countryside. A rebel general vowed to capture the fortress. The general knew that an attack by his entire army would capture the fortress. He gathered his army at the head of one of the roads, ready to launch a full-scale direct attack. However, the general then learned

> that the dictator had planted mines on each of the roads. The mines were set so that small bodies of men could pass over them safely, since the dictator need to move his troops and workers to and from the fortress. However, any large force would detonate the mines. Not only would this blow up the road, but it would also destroy many neighboring villages. It therefore seemed impossible to capture the fortress. However, the general devised a simple plan. He divided his army into small groups and dispatched each group to the head of a different road. When all was ready he gave the signal and each group marched down a different road. Each group continued down its road to the fortress so that the entire army arrived together at the fortress at the same time. In this way, the general captured the fortress and overthrew the dictator. (p. 351)

Why is it that the people who participated in the study found the problem so easy to solve after hearing the story? Quite simply, presenting them with a story that was more familiar than the problem helped them see that the general pattern of the story and the problem were the same, making it easy for them to solve the problem.

Chapter 3

SUMMARIZING & NOTE TAKING

As Ms. LaFortune prepared for the upcoming unit on the U.S. Constitution, she thought about how students had responded to the unit in previous years. Students always seemed to understand the gist of the Bill of Rights, but seemed to have trouble connecting limitations on the government's powers to the protection of individual civil rights. Ms. LaFortune wondered if students were overwhelmed by the amount of material they worked with during the unit. She decided to help students with their summarizing and note taking skills when she taught the unit this time.

After an introduction to the essential elements of American constitutional government, students read several primary source documents, including excerpts from the Constitution and the Declaration of Independence. Ms. LaFortune thought summarizing passages would help students analyze the content of the documents. First, she modeled summarizing using the Preamble to the Constitution as an example. She used a "rule-based" summary strategy and showed students how to delete trivial and redundant material, substitute superordinate terms for lists, and select a topic sentence. After she finished the summary, students worked on the Bill of Rights for homework. Students said that the summary strategies made them really think about the information they were reading.

After their intensive work with the primary source documents, Ms. LaFortune passed out notes she had prepared on the essential ideas of American constitutional government. The notes were useful to students in two ways --- they gave students a clear picture of the ideas Ms. LaFortune considered important and served as a model for students to follow as she taught them about the elements of effective note taking. Twice during the next week, students turned in notes they had taken during a lecture or a film. Ms. LaFortune gave each student written feedback about her or his notes and later reviewed various strategies with the entire class.

At the end of the unit, students debated limitations on the power of government and protection of civil rights. Ms. LaFortune was pleased with students' understanding of the connection between the power of the government and civil rights and their ability to make well-supported arguments for their positions.

****

Summarizing and note taking are part of the same category of instructional strategies because both require students to distill information. Although these processes may seem relatively straightforward for students, in fact they require a great deal of them. In order to make decisions about points that are important to a summary and those that are not, students must analyze the information in depth. Similarly, in order to decide what information is important to make notes about and information that is not, students must be able to mentally sift through and synthesize information. The following sections include suggestions for ways in which teachers might use these strategies in the classroom to enhance students' understanding of specific academic content.

SUMMARIZING

1. Use the "Rule-Based" Summarizing Strategy.
(See Illustration 1)

One summarizing strategy developed by Brown, Campione, and Day (1981) is referred to as the *rule-based summarizing strategy*. As the name implies, the strategy is one of following a set of rules or steps that help students construct a summary:

1. Delete trivial material that is unnecessary to understanding.
2. Delete redundant material.
3. Substitute superordinate terms for more specific terms (e.g., "flowers" for "daisies, tulips, and roses").
4. Select a topic sentence, or invent one if it is missing.

To make these rules "come alive" for students, a teacher might initially demonstrate them in some detail. For example, the teacher might present students with a passage and then walk them through the rules by "thinking aloud" as she summarizes the passage, as shown in Illustration 1.

2. Use Summary Frames.
(See Illustrations 2.1–2.6)

A summary frame is a series of questions that a teacher gives to students. Because these questions are designed to highlight the critical elements of specific types of information, they can help students develop accurate, written summaries of information. Different summary frames are useful for different types of information because each frame captures the basic structure of a different pattern of text. The elements of six patterns that are commonly found in text are reviewed below:

- ***Narrative or Story Pattern*** — text commonly found in fiction. It has seven elements. Of the following elements, 3–7 are sometimes repeated to create an *episode*.

  Setting: The time, place, and context in which the story took place.
  Characters: The main characters in the story.
  Initiating event: The event that starts the action rolling in the story.
  Internal response: How the main characters react emotionally to the initiating event.
  Goal: What the main characters decide to do as a reaction to the initiating event — the goal they set.
  Consequence: How the main characters try to accomplish the goal.
  Resolution: How the story turns out.

- ***T-R-I Pattern*** — text commonly found in expository material. It has the following elements:

  Topic (T): a general statement about the information to be discussed
  Restriction (R): statement that limits the information in some way
  Illustration (I): statement that exemplifies the topic or restriction

  The T-R-I pattern can have a number of restrictions and accompanying illustrations.

- ***Definition Pattern*** — text that describes a particular concept and identifies subordinate concepts. This pattern contains the following elements:

  Term: The subject to be defined.
  Set: The general category to which the term belongs.
  Gross characteristics: Those characteristics that separate the term from other elements in the set.
  Minute differences: The different classes of objects that fall directly beneath the term.

- ***Argumentation Pattern*** — text that attempts to support a claim. This pattern contains the following elements:

  Evidence: Information that leads to a claim
  Claim: The assertion that something is true
  Support: Examples of or explanations for the claim
  Qualifier: A restriction on the claim or evidence counter to the claim

- ***Problem/Solution Pattern*** — text that introduces a problem and then identifies one or more solutions to the problem:

  Problem: A statement of something that has happened or might happen that is problematic.
  Solution: A statement of a possible solution to the problem.
  Solution: Another possible solution.
  Solution: Another possible solution.

- ***Conversation Pattern*** — a verbal interchange between two or more people. Commonly, a conversation has the following components:

  Greeting: Some acknowledgment that the parties have not seen each other for a while.
  Inquiry: A question about some general or specific topic.
  Discussion: An elaboration or analysis of the topic. Commonly included in the discussion are one or more of the following elements:

Assertions: Statements of facts by the speaker.
Requests: Statements that solicit actions from the listener.
Promises: Statements that assert that the speaker will perform certain actions.
Demands: Statements that identify specific actions to be taken by the listener.
Threats: Statements that specify consequences to the listener if demands are not met.
Congratulations: Statements that indicate the speaker values something done by the listener.

Conclusion: End of the conversation.

To create a summary frame from these patterns, a teacher first identifies the pattern of text students are reading, then uses the pattern elements to develop a set of guiding questions, which students then use to summarize a text, as exemplified by Illustrations 2.1–2.6. For example, a teacher who wants students to analyze a conversation between two characters in a story would turn each of the elements of a conversation pattern into a question (e.g., How did the participants in the conversation greet one another? What question or topic was brought up or referred to?). Students would use their answers to summarize the conversation.

3. Use the Reciprocal Teaching Process.
(See Illustration 3)

Reciprocal teaching, developed by Palincsar and Brown (1984, 1985), is an instructional technique that incorporates the process of summarizing but also engages students in cognitive processes that go well beyond summarizing, as Illustration 3 exemplifies. The strategy has been the subject of a number of empirical studies, many of which have been summarized by Rosenshine and Meister (1994).

The summary statement that begins the reciprocal teaching strategy might be considered a "first draft" of a summary. The other phases of reciprocal teaching — questioning, clarifying, and predicting — help students analyze the information they are attempting to summarize. Strategies that emphasize the analytic aspect of summarizing produce powerful effects in terms of student's ability to summarize (see Rosenshine & Meister, 1994; Rosenshine, Meister, & Chapman, 1986). The following is an adaptation of the strategy:

Summarizing — After students have silently or orally read a short section of a passage, a single student acting as teacher (i.e., the student leader) summarizes what has been read. Other students, with guidance from the teacher, may add to the summary. If students have difficulty summarizing, the teacher might point out clues (e.g., important items or obvious topic sentences) that help them build good summaries.

Questioning — The student leader asks some questions to which the class responds. The questions are designed to help students identify important information in the passage. For example, the student leader might look back over the selection and ask questions about specific pieces of information. The other students then try to answer these questions based on their recollection of the information.

***Clarifying* —** The student leader then tries to clarify confusing points in the passage. He might point these out or ask other students to point them out. For example, the student leader might say, "I'm confused about why the butler said the owner of the house wasn't home. Can anyone explain this?" Or, the student leader might ask students to ask clarification questions. The group then attempts to clear up the confusing parts. This might involve rereading parts of the passage.

***Predicting* —** The student leader asks for predictions about what will happen in the next segment of the text. He or she writes these on the board or asks students to write them in their notebooks.

ILLUSTRATION 1: USING THE RULE-BASED STRATEGY *solar wind*

Passage: Studying Solar Wind

Most scientists believe the solar system was formed 4.6 billion years ago by the gravitational collapse of the solar nebula, a cloud of interstellar gas, dust, and ice created from previous generations of stars. As time went on, the grains of gas and dust were pulled together by gravity to form the sun, while other gains of ice and dust stuck to one another, eventually forming the planets, moons, comets, and asteroids as we know them today.

How this transition from the solar nebula to planets took place has fascinated and mystified scientists. Why did some planets, like Venus, develop thick, poisonous atmospheres, while others, like Earth, become hospitable to life? Partial answers are available from the study of the elemental and isotopic composition of the solar system bodies, which suggests that moons, planets, and even asteroids, are significantly different in composition. Although this information helps scientists model various evolutionary processes, they are still hampered by one major question: What was the original solar nebula made of?

Our sun may help us find the answer. It contains well over 99 percent of all the material in the solar system and, although its interior has been modified by nuclear reactions, its outer layers are composed of very nearly the same material as the original solar nebula. By collecting and studying solar wind, the material flung from the sun, scientists may find more answers to this mysterious puzzle. (Adapted from http://www.genesismission.org)

Think Aloud

"I'll think aloud as I use the rules of the strategy. See if my thinking makes sense to you.

"The rules say to 'delete trivial material, delete redundant material, and substitute superordinate terms for more specific terms.' The first paragraph is almost all background,

(Illustration continued on next page.)

ILLUSTRATION 1 *(continued)*

but it doesn't seem trivial. There are also a couple of lists. Let's see. '*Cloud of interstellar gas, dust, and ice*' I'll substitute '*interstellar material*.' For '*planets, moons, comets, and asteroids*,' I'll substitute '*heavenly bodies*.' But now I see something redundant. '*Solar nebula*' and the '*cloud of interstellar material created from previous generations of stars*' are the same thing, so I'll delete one of them. And come to think of it, the expression '*stuck to one another*' seems redundant. I think I can take it out, too. Here's my first paragraph now:

Most scientists believe the solar system was formed 4.6 billion years ago by the gravitational collapse of the solar nebula. As time went on, grains from the solar nebula were pulled together, eventually forming the heavenly bodies we know today.

"Now I'll apply the rules to the second paragraph. Let's see. '*Fascinated and mystified*' is a little redundant. I'll just say '*intrigued,*' which sort of combines them. Also, the examples about Venus and the Earth are interesting, but I don't need them to understand the paragraph. I think I'll take them out.

"The rest of the paragraph explains what scientists already know and what they need to know. It's not really trivial, but for a summary I''ll try to say it more simply. I'll take the part that begins with '*partial answers are available'* and ends with *'What was the original solar nebula made of?'* and just say *'They have some of the answers, but they really need to know what the original solar system was made of*.' How's this?

How this transition from the solar nebula to planets took place has intrigued scientists. They have some of the answers, but they really need to know what the original solar nebula was made of.

"The third paragraph is full of interesting information. How can I apply the rules here? Is anything redundant, trivial, or unnecessary to my understanding?

"The first sentence says '*our sun may help us find the answer*.' That seems important, so I'll keep it. The second sentence explains why the sun may contain the answer. Only part of that sentence — '*its outer layers are composed . . . the original solar nebula*' — is necessary to my understanding so I'll delete the rest. In the last sentence, '*solar wind*' and '*the material flung from the sun*' are the same, so I'll keep only one. Now I've got:

Our sun may help us find the answer. Its outer layers are composed of nearly the same material as the original solar nebula. By collecting and studying the material flung from the sun, scientists may find more answers to this mysterious puzzle.

"Finally I can put it all together. What do you think of my final summary?"

(Illustration continued on next page.)

ILLUSTRATION 1 *(continued)*

Most scientists believe the solar system was formed 4.6 billion years ago by the gravitational collapse of the solar nebula. As time went on, grains from the solar nebula were pulled together, eventually forming the heavenly bodies we know today.

How this transition from the solar nebula to planets took place has intrigued scientists. They have some of the answers, but they really need to know what the original solar nebula was made of.

Our sun may help us find the answer. Its outer layers are composed of nearly the same material as the original solar nebula. By collecting and studying the material flung from the sun, scientists may find more answers to this mysterious puzzle.

ILLUSTRATION 2.1: THE NARRATIVE FRAME *Little Red Riding Hood*

Passage: [the story *Little Red Riding Hood*]

Frame Questions:

1. When and where did the story take place? What was the place like? *Near a wood long ago. The cottage where Red Riding Hood lives is at the edge of the woods. To get to her grandmother's house, Red Riding Hood must go through the woods.*
2. Who are the main characters in the story? *Little Red Riding Hood, her grandmother (Granny), the wolf, and the woodsman.*
3. What happens at the start of the story? *Little Red Riding Hood's mother wants her to take some food to Granny, who is ill.*
4. How do the main characters react to what happens at the start of the story? *Little Red Riding Hood is excited to go visit Granny.*
5. What goals do the characters set? *Little Red Riding Hood decides to go see Granny.*
6. What are the characters' actions and how do they interact? *Red Riding Hood sets off through the woods to take the food to Granny. She runs into a wolf along the way. She has never seen a wolf and he seems kind, so she tells him where she is going.*
7. How does the story turn out? *The wolf runs ahead and gets into Granny's bed, pretending to be Granny. The wolf almost eats Little Red Riding Hood, but a passing woodsman hears her scream and saves her.*

Summary: Little Red Riding Hood *takes place near a wood long ago. The little girl's mother wants her to take some food to Granny, who is ill. Little Red Riding Hood sets off through the woods to take the food to Granny. She runs into a wolf and tells him where she is going. The wolf runs ahead and gets into Granny's bed, pretending to be Granny. The wolf almost eats Little Red Riding Hood, but a passing woodsman hears her scream and saves her.*

ILLUSTRATION 2.2: THE T-R-I FRAME *mammoths*

Passage: Mammoths

Millions of years ago, giant animals that are now extinct lived on Earth. One of these giant animals was the mammoth, which could be up to 14 feet tall. The mammoth is a lot like the elephant. Both have a long trunk and tusks. No one knows for sure why all the mammoths died, but scientists think there were a number of reasons. One reason was the weather, which became much warmer. Another reason was that mammoths were hunted by people, who ate their meat and used their fur and bones for warmth and protection.

Frame Questions:

Topic (T): What is the story about in general? *Giant animals that lived long ago, but are now extinct.*

Restriction (R): What information author give that narrows or restricts the general topic? *One giant animal was a mammoth.*

Illustration (I): What examples does the author present to illustrate the restriction? *The mammoth could be as tall as 14 feet. The mammoth is like the elephant —- both have long trunk and tusks. Mammoths may have died because weather got warmer and because people hunted them too much.*

Summary: A mammoth is a giant animal that lived long ago, but is now extinct. It's related to the elephant, but could be as tall as 14 feet. Warmer weather and hunting may have caused the extinction of mammoths.

ILLUSTRATION 2.3: THE DEFINITION FRAME *parallelogram*

Passage: Parallelogram

There are many types of four-sided figures — or quadrilaterals — that we learn about when we study geometry . Some of them have unusual names that tell us something about the shape or figure. For example, one type of quadrilateral is the "parallelogram." Its name tells us something important about how this shape looks. A parallelogram is a four-sided shape whose opposite sides are parallel and the same length.

But this general description fits a number of different shapes. One type of parallelogram that often comes to mind when people first learn about them is a square, which is a shape with four equal sides that meet at right angles. But a square is only one example of a parallelogram. Two others are the rectangle — opposite sides are parallel and meet at right angles — and the rhombus — whose opposite sides are parallel but don't necessarily meet at right angles.

(Illustration continued on next page.)

Illustration 2.3 (*continued)*

Frame Questions:

1. What is being defined? *A parallelogram*
2. To what general category of things does the item belong? *Quadrilaterals, four-sided shapes*
3. What characteristics separate the item from other things in the general category? *Opposite sides are parallel and the same length*
4. What are some types or classes of the thing being defined? *Square, rectangle, rhombus*

Summary: A parallelogram is a four-sided shape whose opposite sides are parallel and the same length. Examples of parallelograms are the square, the rectangle, and the rhombus.

Illustration 2.4: The Argumentation Frame *crowded highways*

Passage: Highway Driving

Driving a car in this state has become a huge problem. The highways are so crowded that it takes twice as long to get where you want to go. It's a real mess. As far as I'm concerned, the source of the problem is the unrestrained growth policies of the last two administrations.

The governor and his supporters led the parade of developers and short-sighted business owners who sold citizens on the idea that economic growth and new jobs would benefit the state and that a state either "grows or dies." Whenever environmental protection bills were introduced in the legislature that seemed to put restraints on businesses, the governor argued against them and, when necessary, vetoed them.

Over the last five years, so many businesses and people have moved into the state that the population has doubled. There's not much room for growth in the downtown areas of the state's major cities, so developers have bought up thousands of acres of what used to be beautiful farm land. Now people have to commute long distances to their jobs, making the highways jam-packed with vehicles almost all day long.

I suppose one reason so many people and businesses have moved here is that our state is beautiful. Plus, states farther west were — and still are — so crowded and polluted that this state's relatively open spaces and clean air looked like heaven to many people.

(Illustration continued on next page.)

ILLUSTRATION 2.4 (*continued)*

Frame Questions:

1. What information is presented that leads to a claim? *Highways are crowded.*
2. What claim does the author make about a problem or situation? What does he or she assert is so? *Growth policies of former administration caused the problem.*
3. What examples or explanations does the author present to support this claim? *Governor vetoed environmental protection laws that would have restrained growth a little. He sold us on the idea that growth was good.*
4. What restrictions or explanations does the author present to support his or her claim? *But we have a beautiful, less polluted state — so that's appealing to people.*

Summary: The population has doubled, and people commute long distances, making the highways very crowded. The former governor caused the problem. He vetoed laws that would have restricted growth a little and sold us on the idea that growth would be a good thing. But our state is beautiful and less polluted than others, so that might be one reason so many people have moved here.

ILLUSTRATION 2.5: THE PROBLEM/SOLUTION FRAME *drug abuse*

Passage: The Problem of Drug Abuse

Drug abuse is a problem in most countries, including the United States. Many people think that the best way to decrease the number of people who abuse drugs is to wage a "war" on drugs. Thus, laws have been passed aimed at selling and using drugs, and much money is spent each year for drug enforcement agents to patrol the border, particularly the border between the United States and Mexico, to arrest drug smugglers.

Many people disagree with this approach to the drug problem. Some agree that selling and using drugs should be illegal, but they also believe that more time and effort should be spent educating people about the dangers of drug use and abuse. Others believe that marijuana should be legalized so that resources can be directed to combating more dangerous drugs. Still others argue that the best way to solve the problem is to legalize drugs to make them less enticing, an idea that most of those who support the "war on drugs" vehemently oppose.

In addition to these approaches to the issue, there are a variety of solutions to the problem along the continuum between a total war on drugs and complete legalization — some of which are being used in conjunction with other approaches. For example, in the 1980s, President and Mrs. Reagan led an educational campaign aimed at teaching young children to "just say no" to drugs, while the legal war on drugs was also being waged.

(Illustration continued on next page.)

ILLUSTRATION 2.5 *(continued)*

Frame Questions:

1. What is the problem? *Drug abuse*
2. What is a possible solution? *Wage a "war" on drugs.*
3. What is another possible solution? *Keep drugs illegal, but spent money on education.*
4. What is another possible solution? *Legalize marijuana, so more effort can be spent on other, more dangerous drugs.*
5. What is another possible solution? *Legalize all drugs, making them less enticing.*
6. What is another possible solution? *Educate children to "just say no."*

Summary: Drug abuse is a problem. One solution is to pass tougher laws and patrol our borders — wage a "war." Another is to make drugs less enticing by legalizing some or all of them. Another solution is education.

ILLUSTRATION 2.6: THE CONVERSATION FRAME *Winnie-the-Pooh*

Passage: Excerpted from* Winnie-the-Pooh

Outside his house [Pooh] found Piglet, jumping up and down trying to reach the knocker.

"Hallo, Piglet," he said.

"Hallo, Pooh," said Piglet.

. . . The first thing Pooh did [when they went in the house] was to go to the cupboard to see if he had quite a small jar of honey left; and he had, so he took it down.

"I'm giving this to Eeyore," he explained, "as a present. What are you going to give?"

"Couldn't I give it too?" said Piglet. "From both of us?"

"No," said Pooh. "That would not be a good plan."

"All right, then, I'll give him a balloon. I've got one left from my party. I'll go and get it now, shall I?"

"That, Piglet, is a very good idea. It is just what Eeyore wants to cheer him up. Nobody can be uncheered with a balloon."

So off Piglet trotted; and in the other direction went Pooh, with his jar of honey.

**Note*: Passage excerpted from *Winnie-the-Pooh* (pp. 78–79), by A.A. Milne, 1954, New York: Dell. Copyright 1954 by A.A. Milne.

(Illustration continued on next page.)

ILLUSTRATION 2.6 *(continued)*

Frame Questions:

1. How did the participants in the conversation greet one another? *Hello.*
2. What question or topic was brought up or referred to? *Gifts for Eeyore's birthday.*
3. How did the discussion progress?
   - Did anyone state facts? *Pooh said he was giving a jar of honey to Eeyore.*
   - Did anyone make a request? *Piglet asked if they could both give the honey.*
   - Did anyone demand a specific action? *No.*
   - Did anyone threaten specific consequences if a demand was not met? *No.*
   - How did the other characters say in respond to the request, demand, or threat? *Pooh said that he thought they should not give the gift together.*
   - Did anyone say something that indicated that he or she valued something that someone else had done? *Pooh said that Piglet's idea to give Eeyore a balloon was a good one.*

Summary: Pooh and Piglet meet at Pooh's house. Pooh says he will give Eeyore a jar of honey for Eeyore's birthday. Piglet asks if they can share the gift, but Pooh says he thinks that's not a good idea. Piglet decides to give Eeyore a balloon, which Pooh thinks is a great idea.

ILLUSTRATION 3: RECIPROCAL TEACHING *poetry*

Students in Mrs. Webster's class were studying poetry. Mrs. Webster asked several students to serve as student leaders for an upcoming task. As part of the unit, students read several passages about poetry that Mrs. Webster printed from an encyclopedia CD in the classroom. Megan, one of the student leaders, ***summarized*** the first passage:

> "Poetry is a lot like music. Like music, there is great variety in what is considered poetry. Like music, rhythm or meter is a central device in the art of poetry for expressing ideas and feelings. However, there is not a black-and-white difference between poetry and regular prose. It's more like a continuum with distinct rhythm and meter at one end and no discernable rhythm or meter at the other. Even free verse poetry has a rhythm, although in general, authors who write in free verse, use the rhythm of natural speech."

Mike, another student, added, "Much of the poetry written in English is iambic — that means the lines use a certain combination of stressed and unstressed syllables. Many poems also

(Illustration continued on next page.)

ILLUSTRATION 3 *(continued)*

have a rhythm or structure to the lines. One example is the four-line stanza where the second line rhymes with the fourth. There are a number of different types of poetry. Among these are lyric poetry, narrative poetry, and dramatic poetry."

Megan then initiated the ***questioning*** phase of the process by asking a number of questions about specific information from the passage students had read:

> "What are the two types of lyric poetry that the Japanese are particularly known for? What other techniques do poets use besides rhyme?"

After students answered the questions, Megan asked the class if anyone had questions they wanted to ask to ***clarify*** confusing points in the passage. Ben said he was a little confused about what the author of the passage said about poetry as art and "didactic" poetry. Brian, another student, answered, "There's a difference between poetry that is artistic and writing that is only considered *technically* to be poetry because it rhymes — for example, sayings that help people remember facts, like 'thirty days hath September, April, June, and November. . . .' They're technically poetry, but not very poetic."

Finally, Megan asked students to ***predict*** what they thought the next passage, entitled "How Poetry Has Changed Over the Centuries," might say. Nicole said that she predicted that the passage would say that poetry has changed over time as people have changed the way they express their feelings and ideas just like music has changed over time. She predicted that the passage would say that free verse poetry has become much more commonplace, a reflection of the more casual and open attitude people have about self-expression in general.

NOTE TAKING

3. Give Students Teacher-Prepared Notes.
(See Illustration 1)

A good way to introduce note taking is to provide students with notes. Doing this gives students a clear picture of what the teacher considers important, as exemplified by Illustration 1. It also gives students a model of how notes might be taken.

4. Teach Students to Use Different Formats for Taking Notes.
(See Illustrations 2.1 and 2.2)

There is no one correct way to take notes. In fact, different students might prefer different note-taking formats. Thus, it is advisable to present students with a variety of formats for taking notes. Two common formats are the *informal outline* and the *web*. The informal outline uses indentation to indicate major ideas and their related details, as shown in Illustration 2.1. Students simply indent ideas that are more subordinate. Webbing is a note-taking strategy that uses the relative size of circles to indicate the importance of ideas and lines to indicate relationships. More important ideas are in larger circles than less important ideas. Lines from one circle to another indicate that the concepts in the connected circles are related in some way. One advantage of the webbing strategy is that it provides students with a visual representation of the relationship between ideas or elements, as Illustration 2.2 exemplifies. One disadvantage of the strategy is that it somewhat limits the amount of information a student can record simply because the circles themselves can hold only so many words.

5. Help Students Learn to Take Combination Notes.
(See Illustration 3)

A very flexible note-taking strategy that uses both the informal outline and pictures or graphic representations is referred to as a *combination technique,* exemplified in Illustration 3. Each page of notes is divided into two parts by a line running down the middle of the page. The left-hand side of the page is reserved for notes taken using some variation of informal outlining. The right-hand side of the page is reserved for graphic representations. Finally, a strip across the bottom of the page is reserved for summary statements.

To use this note-taking strategy, students must stop periodically and make a graphic representation of their notes or portray the information in some visual way. At the end of their note taking, or periodically throughout the process, students record summary statements of what they have learned in the section at the bottom of the page. This note-taking method takes extra time, but is very useful because students review the information a number of times — first, as they record their notes; second, as they create drawings or other graphics for their notes; and third, as they record summary statements of what they have learned.

ILLUSTRATION 1: TEACHER-PREPARED NOTES *ants*

I The Basics

A. Ants are part of a family of insects that have a very organized social life.
B. Nearly 9,000 species exist.
C. Ants are found around the world, except in the polar regions and at the highest altitudes.

II Characteristics

A. Ants are related to wasps — have an abdomen that is joined to the thorax by a "pedicel."
B. Have antennae that have "elbows" or joints in the middle.
C. Some ants have a sting that the workers use to defend the colony or themselves.
D. Many species secrete a type of acid that is a strong repellent.
E. The way particular ants look and act often relates to the type of work they do in the colony.

III Environmental Helpers

A. Ants play several critical roles in the environment:
   1. Population control of pests
   2. Recycling of plant material
   3. Turning over the soil
   4. Dispersing seeds

IV Life Span

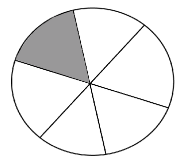
A. Queens and workers of some species can live more than 15 years.
B. Most ants live only a few months.
C. Male ants die soon after they mate with the queen.

V Social Organization

A. Ants are masters of social organization.
B. Ants live together in extended families of just a few to 500,000 or more.
D. Colonies have two classes of ants: reproductive and nonreproductive.
   1. The queen and the male ants are reproductive.
E. Most ants in a colony are workers.
   1. Workers are generally female, wingless, and don't reproduce.
   2. Workers gather food, care for the young, and defend the colony.
   3. Largest workers are soldiers.
   4. Medium-sized workers gather food.
   5. Smallest workers act as nurses, taking care of the young.
   6. Some workers have very specialized jobs, such as cracking open seeds for other ants to eat.

ILLUSTRATION 2.1: NOTE TAKING — INFORMAL OUTLINE *fractions*

Fractions are part of a number – like 3/4, 1/6, 5/8
like a piece of pie ➔ ➔ ➔ ➔ ➔ ➔ ➔



- Numerator is the top number ➜ 3
- Denominator – bottom number ➜ 4

it tells how many pieces the number has been divided up into

Adding and subtracting fractions:

- bottom number has to be the same ➜ $\frac{1}{5}$ ➜ $\frac{3}{5}$
- then just add or subtract top numbers

Examples: 1/4 + 2/4 = 3/4
3/5 - 2/5 = 1/5

When bottom number is different —

find Least Common Denominator (LCD)
Step 1: Find multiples of each denominator
Step 2: Identify the Least Common Multiple – the first number that is the same – also the LCD

Then multiply each denominator and numerator by the appropriate number
Then reduce number to lowest terms.
Examples:
++Adding –
1/3 + 1/4 = ?
Multiples of 3 = 3, 6, 9, (12), 15 . . . Multiples of 4 = 4, 8, (12), 16 . . .
LCM is 12. ➜ ➚ ➜ ➜ ➜ ➜ ➜ ➜ ➚
1/3 x 4/4 = 4/12 1/4x 3/3 = 3/12
4/12 + 3/12 = 7/12

– Subtraction:
5/6 - 1/4 =?
Multiples of 6 = 6, 12, 18 (24) 36 . . . Multiples of 4 = 4, 8, 12, 16, 20 (24) 28 . . .
LCM is 24. ➜ ➚ ➜ ➜ ➜ ➜ ➜ ➜ ➚
5/6 x 4/4 = 20/24. 1/4 x 6/6 = 6/24.
20/24 - 6/24 = 14/24

ILLUSTRATION 2.2: NOTE TAKING — WEBBING *the Olympic Games*

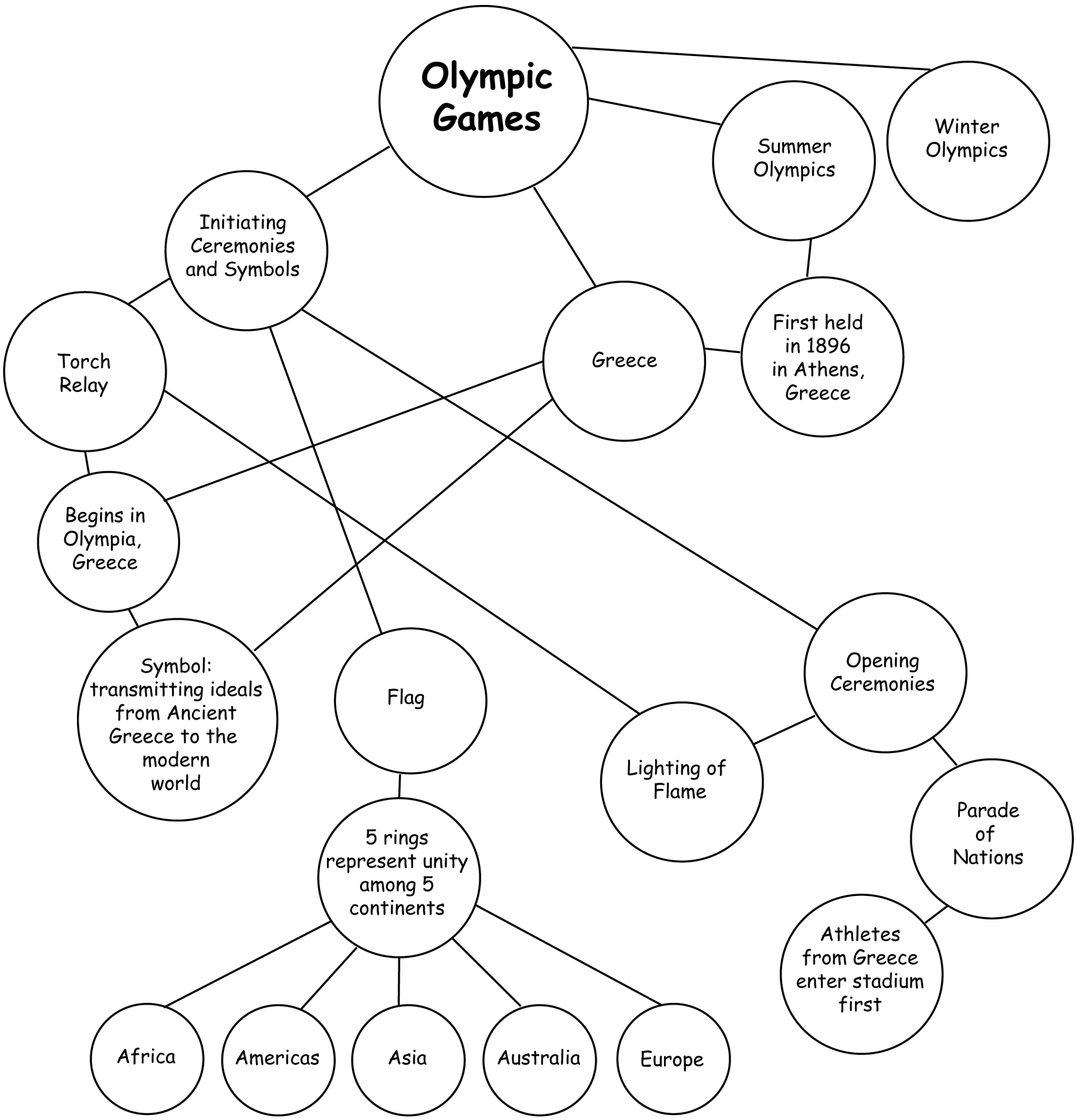


ILLUSTRATION 3: COMBINATION NOTES *inflation*

Inflation —

Increases . . .
When the money supply is greater than value of nation's output of good and services

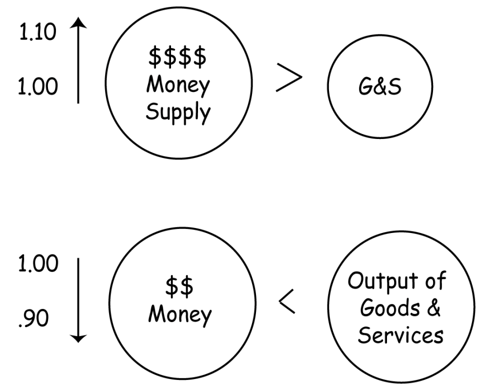
OR

when expenditures for food, goods, investment, government spending, and net exports are ***greater than*** *the value of nation's output of G&S*

Decreases *. . .*
When the money supply is smaller than the value of nation's output of G&S

OR

when expenditures are ***less than*** *value of nation's output*



Summary*: Inflation results from the relationship between the money supply and the value of a nation's output of goods and services.*

THEORY AND RESEARCH IN BRIEF • • •
Summarizing and note taking

SUMMARIZING — The process of summarizing is a well-studied phenomenon. Table 3.1 reports findings from some of the meta-analyses that synthesize the research on the effectiveness of summarizing.

Table 3.1: Research Results for Summarizing Strategies

Synthesis Study	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Pflaum, Walberg, Karegianes, & Rasher, 1980[b]	2	.62	23
	2	.73	27
Crismore, 1985	100	1.04	35
Rosenshine & Meister, 1994	10	.88	31
Hattie, Biggs, & Purdie, 1996	15	.88	31
Rosenshine, Meister, & Chapman, 1996	16	.87	31
Raphael & Kirschner, 1983	3	1.80	47

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.
[b]Two categories of effect sizes are listed for the Pflaum et al. study because of the manner in which the effect sizes were reported. Readers should consult that study for more details.

Cognitive psychologists (see Kintsch, 1979; van Dijk, 1980) have found that summarizing involves at least two highly related elements: (1) filling in missing parts, and (2) translating information into a synthesized form. The first aspect of summarizing — filling in the missing information — can be illustrated using the following short scenario:

> Two card players stared at each other from across the table. Both appeared tense, although the man smoking the cigar seemed to have a slight smile on his face. He laid down his cards in a fanning motion that displayed one card at a time. With each new card that was shown, his opponent in the silk shirt seemed to sink lower and lower into his chair. When all of the cards had finally been shown by the cigar-smoking antagonist, the silk-shirted man got up and left the table without showing his cards and without saying a word.

As you read these sentences, your mind quite naturally fills in many unstated elements. For example, you probably inferred that both men had bet substantial amounts of money on the hand; the cigar-smoking man knew he had a winning hand as soon as it was dealt to him; the silk-shirted man lost the hand, and so on. Inferences like these are sometimes referred to as *default inferences* (Holland, Holyoak, Nisbett, & Thagard, 1986). Unless explicitly stated otherwise, we expect certain things to occur in certain situations.

The second aspect inherent in summarizing most likely would be evident a few hours from now if you were asked to retell what you had read in the passage. In your retelling, you probably would not give a verbatim account of the passage. Rather, you might provide a brief, synthesized version like the following:

> Two men had a large bet on a single hand of poker. As soon as the cards were all out, one of the men knew he had won the hand. After he showed his hand, his opponent silently got up and left, knowing he had lost.

The synthesized version of information we read or hear is sometimes referred to as a *macrostructure* (see Kintsch, 1974; van Dijk; 1980). Apparently, human beings quite naturally generate macrostructures for information they read, hear, or even see. This explains why we tend to remember the "gist" of movies we see rather than a scene-by-scene account.

NOTE TAKING — A number of studies have been conducted on the effects of note taking on student achievement. A useful source for a review of many of these studies is the monograph entitled *Note-Taking: What Do We Know About the Benefits* (Beecher, 1988). The results of some of these studies are reported in Table 3.2.

Table 3.2: Research Results for Note Taking

Synthesis Study	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Henk & Stahl, 1985[b]	25	.34	13
	11	1.56	44
Marzano, Gnadt, & Jesse, 1990	3	1.26	40
Hattie, Biggs, & Purdie, 1996	3	1.05	35
Ganske, 1981	24	.52	20

[a] These are the maximum percentile gains possible for students currently at the 50th percentile.
[b] Two categories of effect sizes are listed for the Henk and Stahl study because of the manner in which the effect sizes were reported. Readers should consult that study for more details.

There are a number of generalizations that can be induced from the research on note taking. First, although note taking generally improves student achievement, verbatim note taking is probably the least effective technique (see Bretzing & Kulhary, 1979). In fact, it is safe to say that it should be strongly discouraged.

Second, notes should be considered a work in progress. That is, once students initially take notes they should be encouraged to continually add to them and revise them as their understanding of content deepens and sharpens (for discussions, see Einstein, Morris, & Smith, 1985; Anderson & Armbruster, 1986; Denner, 1986).

Third, one of the most powerful uses students can make of their notes is to review them before tests. If notes have been well designed and students have systematically elaborated on them, they are perfect tools for test preparation (for discussions, see Carrier & Titus, 1981; Van Matre & Carter, 1975).

Finally, one of the common misconceptions about note taking is that "less is more." Sometimes students are advised to keep their notes very short. Researchers Nye, Crooks, Powlie, and Tripp (1984) explain that their examination of guides prepared by universities to teach students how to take notes found that "five out of ten guides examined emphasized the importance of keeping notes 'brief' and not putting too much material in notes" (p. 95). Yet, in their study of the effects of note taking, Nye et al. found a very strong relationship between the amount of information taken in notes and students' achievement on examinations.

Chapter 4

REINFORCING EFFORT & PROVIDING RECOGNITION

Mr. Colasanti's debate team was known as one of the best in the city. One of the reasons that his teams were consistently good was that Mr. Colasanti worked very closely with students, helping them to refine their debating skills. However, he also attended to their beliefs about what makes a good debater. He noticed that many of his students believed that good debaters were "born, not made." He worked to dispel this myth. He paid particular attention to instilling in students the belief that effort was the key ingredient in developing debating skills. "Speaking in front of groups is a skill each one of you can develop," he always told the students. "Perhaps the most important keys to success are practice and commitment. If you're willing to put in the time, I promise to help you succeed."

Mr. Colasanti also made sure that he praised students when they accomplished something. He did so informally, by commenting on their accomplishments, and formally, by writing brief letters to their parents each time they accomplished something that was noteworthy.

****

Unlike the other categories of instructional strategies reviewed in this manual, this category does not deal directly with enhancing or engaging students' cognitive skills. However, reinforcing effort and providing recognition are strategies that deal with students' attitudes and beliefs and, thus, are likely to affect students' level of engagement in cognitive processes.

REINFORCING EFFORT

1. *Teach Students about the Role that Effort Can Play in Enhancing Achievement.*
(See Illustration 1)

Students may not realize the influence that effort can have on achievement. One way to help them understand this is to explicitly teach it and share examples. For example, teachers might share personal examples of times that they succeeded by continuing to try even when a task was hard or when a solution was not immediately apparent, as exemplified by Illustration 1. Teachers might also seek out and share examples of well-known athletes, educators, or political leaders who succeeded in large part simply because they didn't give up (e.g., Daniel "Rudy" Ruettiger, the Notre Dame student whose unwavering commitment to play on the university's football team was the subject of the inspiring movie *Rudy*). Examples might also be shared from stories that are familiar to students.

Still another way to help students understand the value of effort is to ask them to recall personal examples of times that they succeeded primarily because they didn't give up. Reflecting on their personal experiences in this way helps make the rewards that can come from effort more real and attainable to students.

2. Have Students Assess Their Effort and Achievement.
(See Illustration 2)

A powerful way to reinforce the influence of effort on achievement is to have students occasionally assess their effort and achievement on a task and note the relationship between the two. This can be accomplished by first presenting students with rubrics for effort and achievement. As exemplified by Illustration 2, students might use these rubrics for particular assignments and then complete a chart so that they can readily see the relationship between their effort and achievement.

In addition to charting the relationship between the two variables, students might be asked to identify what they learned from the experience. For example, teachers might periodically ask students to describe what they noticed about the relationship between the effort they put into a project or task and their achievement. Reflecting on their experiences in this way heightens students' awareness of the power of effort.

ILLUSTRATION 1: TEACH STUDENTS ABOUT THE ROLE OF EFFORT *"The Little Engine That Could"*

When Ms. Norford read "The Little Engine That Could" with her first graders, she always tried to tell them a personal story that made a connection about the value of effort. One day she told them a story about how she learned to snowboard:

> "The first time I went snowboarding, my brothers took me to the top of the mountain, told me not to 'catch my front edge,' and took off. Well, I spent about two hours falling down the mountain. Once when I fell, I cut my chin. I had to get seven stitches, and I was so sore I could barely sit down for about three weeks.
>
> "But I didn't give up. Two months later I went again. Only this time I took a lesson. We practiced on a small slope where I learned how to stand up on the board and how to stop myself. I still fell, but no stitches this time.
>
> "I fell a lot my first year of snowboarding, but I kept practicing. I've been snowboarding now for three years. Sometimes you have to keep telling yourself, 'I can do it,' just like the Little Engine in the story. You'll find that effort like this also pays off in your schoolwork. When we begin subtraction next week, whenever you are frustrated, remember to keep trying and see what happens."

ILLUSTRATION 2: ASSESSING EFFORT AND ACHIEVEMENT *language arts*

Mr. Semenov taught his language arts students to assess their effort and how well they were learning the skills and information designated for the grading period. Students quickly became accustomed to filling in "effort and learning scores" for each assignment based on rubrics they had helped Mr. Semenov create at the beginning of the year.

At the end of each week, Mr. Semenov gave students a few minutes to reflect on their effort and learning on assignments. If students seemed to be having trouble focusing, he asked the entire class, or individual students as appropriate, to look at their effort and learning scores to see if they noticed any patterns. Often during a particularly distracting time, such as before spring break, he would ask students to chart their effort and learning so they had a visual representation of the connection between the two.

Effort Rubric

4 I worked on the task until it was completed. I pushed myself to continue working on the task even when difficulties arose or a solution was not immediately evident. I viewed difficulties that arose as opportunities to strengthen my understanding.

3 I worked on the task until it was completed. I pushed myself to continue working on the task even when difficulties arose or a solution was not immediately evident.

2 I put some effort into the task, but I stopped working when difficulties arose.

1 I put very little effort into the task.

Achievement Rubric

4 I exceeded the objectives of the task or lesson.

3 I met the objectives of the task or lesson.

2 I met a few of the objectives of the task or lesson, but did not meet others.

1 I did not meet the objectives of the task or lesson.

Effort and Achievement Chart			
Student: Tani Suyieshi	**Assignment**	**Effort**	**Achievement**
Date: Fri., Oct 22	Homework: essay, *Animal Farm*	4	4
Wed., Oct 27	In-class essay re: allegory	4	3
Thurs., Oct. 28	Pop quiz	3	3

Providing Recognition

1. Personalize Recognition.
(See Illustration 1)

Providing recognition for achievement works best when students are working toward an identified level of performance, beyond simply completing a task. It is important to make the recognition as personal to students as possible, as exemplified by Illustration 1.

2. Use the Pause, Prompt, and Praise Strategy.
(See Illustration 2)

Teachers and/or tutors can adapt and use the "pause, prompt, and praise" technique (see Merrett & Thorpe, 1996) to give students immediate, specific, and contingent praise. This strategy works particularly well with students who are struggling with a challenging task, as exemplified by Illustration 2.

The "pause" phase of the strategy is typically initiated by the teacher, who asks the student to stop working on the task momentarily when the student makes an error. Many times when a student encounters difficulty, he looks immediately to the teacher for help. During the "pause" phase of the strategy, the student hesitates while performing a task or the teacher asks the student to pause. This gives the student an opportunity to identify and correct his mistake. It is also a time during which the teacher and the student can talk briefly about why the student is having difficulty.

The next phase of this strategy is the "prompt" phase, during which the teacher gives a specific suggestion for improvement based on the type of error the student made. The "praise" element provides a further opportunity for feedback based on the student's success. But the praise step is not just an opportunity to say "good job" or "well done." Praise offered at this time should only be given if the student's performance improves as a result of implementing the specific suggestion the teacher gave during the prompt phase. In other words, the praise is contingent on the student correcting his error or improving his achievement as a result of using the teacher's specific feedback.

3. Use Concrete Symbols of Recognition.
(See Illustration 3)

Symbolic tokens, such as stickers, certificates, or treats, can be effective tools for recognizing the successful completion of specific learning goals, as exemplified by Illustration 3. However, to keep students from losing their intrinsic motivation, teachers should avoid rewarding students for simply completing an activity. Connecting a token to reaching an identified performance standard makes the recognition concrete *and* contingent on achievement of a goal.

ILLUSTRATION 1: PERSONALIZED RECOGNITION *multiplication*

Ms. Perron met individually with her fifth grade students after the first few weeks of class so they could review the student's progress on 2-digit multiplication problems. Ms. Perron helped each student set a goal related to accuracy and speed.

Throughout the semester, students charted their progress. At the end of the semester, she sent a letter of recognition to the parents of students who met their identified goal.

ILLUSTRATION 2: PAUSE, PROMPT, AND PRAISE STRATEGY *reading*

Teachers at South Middle School noticed that sixth grade students who began the year with reading difficulties quickly fell behind in all of their subjects, not just language arts. The school began a peer-tutoring program to help these students develop their reading skills. Older students were trained as tutors to use the "pause, prompt, and praise" technique.

Using this method, Gayle tutored Miller twice a week for the entire semester. Gayle listened as Miller read. When Miller encountered a problem, Gayle did not respond immediately (she "paused"). If Miller could not self-correct during the pause, Gayle provided a prompt that specifically addressed his error. For example, when he completely skipped over a word, she prompted him to reread the entire sentence for context. Gayle gave more feedback in the form of praise for Miller's successes — for example, if he corrected his own mistake, responded correctly to a prompt, or read an entire paragraph without making any mistakes. From her training, Gayle knew to make specific comments, such as, "Good job, Miller. You realized that you didn't have exactly the right word, but you reread to correct yourself."

ILLUSTRATION 3: CONCRETE SYMBOLS OF RECOGNITION *electronic bulletin board*

Students in Mr. Bjorn's senior physics class used an electronic bulletin board to generate threaded discussions about current events related to physics. Mr. Bjorn devised a system to recognize participation as students developed the online community. After posting ten messages to the discussion board, a student earned one blue atom. Whenever that student entered the discussion again, the blue atom appeared beside her screen name, acknowledging her ten posted messages. As the students became more active on the discussion board, Mr. Bjorn added a yellow atom for 25 posted messages, a green atom for 50 posted messages, and a larger, red atom for 100 posted messages. This system rewarded students in an informal way for participating in the discussions.

THEORY AND RESEARCH IN BRIEF • • •
Reinforcing effort and providing recognition

REINFORCING EFFORT — A number of researchers have synthesized studies on the effects on student achievement of reinforcing effort. The results from some of those syntheses are reported in Table 4.1.

Psychologist Bernard Weiner (1972, 1983) popularized the notion that a belief in effort ultimately pays off in terms of enhanced achievement. However, research studies by Covington (1983) and Harter (1980) also have revealed the effect of believing in the importance of effort. This body of research has shown that people generally attribute success at any given task to one of four causes — ability, effort, other people, or luck. Three of these four beliefs ultimately inhibit achievement.

Table 4.1: Research Results for Reinforcing Effort

Synthesis Study	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Schunk & Cox, 1986	3	.93	32
Stipek & Weisz, 1981[c]	98	.25	10
Hattie, Biggs & Purdie, 1996[b]	8	1.42	42
	2	.57	22
	2	2.14	48
Kumar, 1991	5	1.76	46

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.
[b]Multiple categories of effect sizes are listed for the Hattie, Biggs, and Purdie study because of the manner in which effect size was reported. Readers should consult that study for more details.
[c]These studies also dealt with students' sense of control.

On the surface, a belief in ability seems relatively useful — if you believe you have ability, you can tackle anything. However, regardless of how much ability you think you have, there inevitably will be tasks that you do not believe you have the ability to complete. In fact, Covington's research (1983, 1985) indicates that students who believe they do not possess the necessary ability to succeed at a task will not even try to succeed. Belief that other people are the primary cause of success also has drawbacks, particularly when an individual finds himself or herself alone. Belief in luck has obvious disadvantages — what if your luck runs out? Belief in effort is clearly the most useful attribution. Believing that effort will affect level of achievement can serve as a powerful motivational tool that students can apply to any situation.

A very interesting set of studies has shown that simply teaching students that added effort will pay off in terms of enhanced achievement actually increases student achievement (see Wilson & Linville, 1982; Craske, 1985). In fact, one study (Van Overwalle & DeMetsenaere, 1990) found that students who were taught about the relationship between effort and achievement increased their achievement more than students who were taught techniques for time management and comprehension of new material. These findings indicate that some students might not be aware of the fact that increased effort commonly translates into increased achievement.

PROVIDING RECOGNITION — Providing recognition is one of the most controversial and perhaps one of the most misunderstood of all the instructional strategies discussed in this manual. Results from studies that have synthesizes research on providing recognition are reported in Table 4.2.

The studies summarized in Table 4.2 primarily addressed the use of praise as recognition. These results show an overall positive effect size; however, some research indicates that praise can have negative effects on student achievement in some situations (for reviews, see Brophy, 1981; Morine-Dershimer, 1982; Lepper, 1983).

Table 4.2: Research Results for Providing Recognition

Synthesis Study	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Bloom, 1976	18	.78	28
Walberg, 1999	14	.16	6
Wilkinson, 1981	791	.16	7

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

Varying reports on the effects of praise and reward have led many educators to believe that *any* form of recognition has negative effects on student learning. However, a careful analysis of the research reveals that recognition does not necessarily decrease intrinsic student motivation; in fact, abstract rewards can be a strong motivator. Specifically, praise that is specific and contingent upon successful completion of an identified level of performance can have a powerful effect on student achievement. Giving praise involves complimenting students for legitimate achievements. It is important to note that giving praise is not a simple matter of saying, “job well done.” Researcher Jere Brophy (1981) summarized the guidelines for effective praise (see Table 4.3).

Because of the lack of understanding about the effects of rewards and the negative opinions associated with them, we believe the best way to think about abstract, contingency-based rewards is as “recognition” for specific accomplishments.

Table 4.3: Guidelines for Effective Praise

Effective Praise	**Ineffective Praise**
1. Is delivered contingently	1. Is delivered randomly or unsystematically
2. Specifies the particulars of the accomplishment	2. Is restricted to global positive reactions
3. Shows spontaneity, variety, and other signs of credibility; suggests clear attention to the student's accomplishment	3. Shows a bland uniformity, which suggests a conditioned response made with minimal attention
4. Rewards attainment of specified performance criteria (which can include effort criteria, however)	4. Rewards mere participation, without consideration of performance processes or outcomes
5. Provides information to students about their competence or the value of their accomplishments	5. Provides no information at all or gives students information about their status
6. Orients students toward better appreciation of their own task-related behavior and thinking about problem solving	6. Orients students toward comparing themselves with others and thinking about competing
7. Uses students' own prior accomplishments as the context for describing present accomplishments	7. Uses the accomplishments of peers as the context for describing students' present accomplishments
8. Is given in recognition of noteworthy effort or success at difficult (for *this* student) tasks	8. Is given without regard to the effort expended or the meaning of the accomplishment (for *this* student)
9. Attributes success to effort and ability, implying that similar successes can be expected in the future	9. Attributes success to ability alone or to external factors such as luck or easy task
10. Fosters endogenous attributions (students believe that they expend effort on the task because they enjoy the task and/or want to develop task-relevant skills)	10. Fosters exogenous attributions (students believe that they expend effort on the task for external reasons — to please the teacher, win a competition or reward, etc.)
11. Focuses students' attention on their own task-relevant behavior	11. Focuses students' attention on the teacher as an external authority who is manipulating them
12. Fosters appreciation of and desirable attributions about task-relevant behavior after the process is completed	12. Intrudes into the ongoing process, distracting attention from task-relevant behavior

Note: From "Teacher Praise: A Functional Analysis," by J. Brophy, 1981, *Review of Educational Research, 51*(1), p. 26. Copyright 1981 by the American Educational Research Association. Reproduced with permission of the publisher.

Chapter 5

HOMEWORK AND PRACTICE

Mrs. O'Ryan could see firsthand the effects of giving her third graders specific feedback on completed homework assignments. When she simply assigned a letter grade, she found that students' work didn't improve as quickly as when she wrote comments on their homework. For example, as part of a unit on pond life, Mrs. O'Ryan gave students a homework assignment of writing about an animal that commonly lives in or around a pond. She told students that she would grade their work in terms of the details included and how well they organized their papers, as well as their spelling and punctuation.

Mrs. O'Ryan created a grading sheet that she gave to students before they started their work. It described the criteria she would use to grade each assignment. As she reviewed each student's paper, she assigned separate grades and wrote short remarks, such as the following:

Content: A "I can tell that you know a lot about ducks. You have included some very nice details. Good work."

Spelling and Punctuation: B "You have made a lot of progress on spelling and punctuation since your last paper. Remember to use a dictionary if you are not sure how to spell a word. And remember to capitalize the first letter of the names of books and videos that you refer to in your writing."

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Homework and practice are instructional strategies that are well known to teachers. Both provide students with opportunities to deepen their understanding and proficiency in any content area.

Homework gives students an opportunity to learn new information and skills *and* to practice skills they have recently learned. But practice is an effective instructional strategy even when it is not part of a homework assignment. Thus, this chapter includes a separate discussion of specific ways in which practice can be used to enhance students' mastery of skills they are learning.

HOMEWORK

1. Establish and Communicate a Homework Policy.
(See Illustration 1)

Students and their parents need to understand expectations related to homework. What is the purpose of homework? How much homework will be assigned? What are the consequences for missing or late homework assignments? How should parents be involved in their child's homework? A district, a school, or a teacher can establish and communicate a homework policy to answer questions such as these and to set feasible and defensible expectations of students and their parents. A clearly articulated homework policy can decrease tensions about homework that might arise among parents, teachers, and students. Further, following explicit homework policies can enhance student achievement. A sample homework policy for a district is shown in Illustration 1.

2. Clarify the Purpose of Homework Assignments.
(See Illustration 2)

Many times, students do not understand the purpose of homework assignments. Consequently, they simply might want to "get through it" and complete the work. Homework provides opportunities for students to practice skills, prepare to learn new information, or elaborate on introduced material. Articulating the purpose of homework relative to these goals can help teachers and students focus on learning. For example, practicing a skill requires a different kind of assignment and a different focus on the student's part than learning new information. To increase speed and accuracy on a particular skill, a student might break an assignment into chunks and time herself as she completes each section.

Students can use an assignment notebook to keep track of their daily assignments. The school or teacher might provide students with assignment sheets that are similar to the pages found in a business day planner or a teacher's daily planner. Illustration 2 shows an example of a homework assignment sheet.

At the beginning of the year, the teacher might explain the purpose of assignment sheets and show students how to complete them. Filling out an assignment sheet clarifies for students what they are supposed to do and *why* they are supposed to do it. Further, the process helps students link their tasks with the information and skills they are learning.

3. Use Different Strategies for Giving Students Feedback on Homework.
(See Illustration 3)

Timely and specific feedback on homework can improve student achievement. However, teachers do not have enough time to provide extensive feedback on every homework assignment. To avoid overburdening themselves, teachers can explore different strategies to ensure that students receive feedback on homework, as exemplified in Illustration 3. For example, teachers might set up opportunities for students to share their work with one another and offer feedback, have students keep a journal in which they record self-assessments of their understanding and progress, or keep their work in a portfolio, which the teacher might examine later.

ILLUSTRATION 1: SAMPLE HOMEWORK POLICY

This letter explains the district's homework policy. Please read the policy with your child (or children) so that you understand the expectations of students and parents with regard to homework. We believe following these guidelines will help decrease tension associated with homework and increase your child's learning.

For your child to be successful with homework, she or he needs

- **A place to do homework.** If possible, your child should do her homework in the same place — an uncluttered, quiet space to study.

- **A schedule for completing homework.** Set a homework schedule that fits in with each week's particular activities.

- **Encouragement, motivation, and prompting.** It is not a good idea to sit with your child and do homework with him. He needs to practice independently and to apply what he has learned in class. If your child consistently cannot complete homework assignments alone, please contact the teacher.

- **Understanding of the knowledge.** When your child is practicing a skill, ask her which steps she finds difficult and easy; ask how she plans to improve her speed and accuracy with the skill. If your child is working on a project, ask her what knowledge she is using to complete the work. If your child consistently cannot answer these questions, please contact the teacher.

- **Reasonable time expectations.** Although there might be exceptions, as a general rule, your child should do homework for approximately ten times her grade level in minutes (for example, a second grader would spend 20 minutes, a fifth grader 50 minutes).

- **A bedtime.** When it is time to go to bed, please stop your child, even if he has not finished the homework.

Please return the policy with the appropriate signatures, acknowledging that you have read and discussed the policy with your child.

____________________________ ____________________________

Parent's Signature Student's Signature

ILLUSTRATION 2: HOMEWORK ASSIGNMENT SHEET

Subject: ______________________________ Date due: ______________________________

What I have to do tonight: ____

____

____

____

____

____

Purpose of the assignment: ____

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____

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Information I need to know or skills I need so I can complete the assignment:

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ILLUSTRATION 3: VARY FEEDBACK ON HOMEWORK *mathematics*

Ms. Kendall asked her third grade students to keep track of their own performance when they practiced a skill as homework. Three times a week, she assigned three sets of five computation problems. The students knew to time themselves as they completed each set of problems. Each student completed a chart that showed the total time for each practice set and the number of problems they completed correctly. In this way, students charted their own progress and could identify areas they needed to focus on. Ms. Kendall also encouraged students to request a conference with her if they had questions about their progress or wanted specific feedback from her.

PRACTICE

1. Ask Students to Chart Their Accuracy and Speed.
(See Illustration 1)

Practice is essential to students learning to perform new skills and processes quickly and accurately. Keeping track of their speed and accuracy helps students learn by making them more aware of their progress. One useful way to track speed and accuracy is to chart them, as exemplified by Illustration 1.

2. Design Practice Assignments That Focus on Specific Elements of a Complex Skill or Process.
(See Illustration 2)

When students are practicing a complex, multi-step skill or procedure, such as the writing process or the scientific method, they might benefit from "focused practice" that targets one specific aspect of the process. Focused practice can be particularly effective when students are having difficulty with a specific step or aspect of a complex procedure, as exemplified by Illustration 2.

3. Help Students Increase Their Conceptual Understanding of Skills or Processes.
(See Illustration 3)

Many teachers identify the skills students must learn and then plan time for instruction and homework. Typically, a teacher might build in time for modeling the process, time for guided practice, and time for independent practice sessions.

However, it is also important for students to understand how a skill or process works. For example, a student may be able to compute percentages when given a page of math problems but not able to solve a word problem that requires the use of percentages. If the student doesn't know what a percentage means, or which number to divide by which, he will not be able to apply his computation skills in a problem-solving situation. During curriculum planning, a teacher must make a commitment to increasing students' understanding of skills and processes and then plan activities to achieve this goal, as exemplified by Illustration 3.

ILLUSTRATION 1: CHART SPEED AND ACCURACY *reading bar graphs*

Mr. Gallegos wanted to help his students improve their ability to reading bar graphs because he knew it was an important skill to success in daily life. In addition, the state test required students to read bar graphs in the social studies and the math sections. Mr. Gallegos had taught the steps for reading a bar graph and had set aside time for his students to practice in class. Now he wanted students to work on improving their speed and accuracy.

Twice a week, Mr. Gallegos gave students a bar graph with a set of questions to answer. He asked students to time themselves as they answered each question, keep track of the number of questions they answered correctly, and then chart their progress. Students could decide how to chart their progress. Some used line graphs; some kept track using a matrix for speed and accuracy; and some used bar graphs.

Based on the information students recorded, Mr. Gallegos focused his instruction on aspects of interpreting bar graphs that seemed to be giving students trouble. As students' understanding improved, so did their accuracy. The charts helped students see their progress as they worked toward mastering their ability to read bar graphs.

ILLUSTRATION 2: FOCUSED PRACTICE *writing*

Carly had been writing essays and stories all year, but she still had trouble with transitions between ideas and paragraphs. She knew that most of her transitions sounded forced and awkward — if there was any transition at all — but she didn't seem to be making any progress.

Mrs. Shaw, Carly's teacher, noticed that other students were having similar difficulties with transitions, so she decided to focus her instruction and give students opportunities to focus their practice. For the next two weeks, Mrs. Shaw gave students models of good transitions, assigned practice for them to rewrite awkward transitions, and gave them paragraphs that needed transitions.

When it was time to write the next essay, Mrs. Shaw reminded students to incorporate what they had learned about constructing transitions. Carly noticed that as a result of the intensive practice, her transitions were smoother and her writing was better overall.

ILLUSTRATION 3: INCREASE CONCEPTUAL UNDERSTANDING *golf*

When it was time for the golf unit, Mr. Montgomerie's physical education students couldn't wait to get outside and hit some balls. Mr. Montgomerie, however, had other plans. Before the students ever hit a golf ball, they were going to learn why golf is often called a "mental game." He wanted students to focus on their conceptual understanding of the skills and processes important in golf.

For one class period, students watched videos of drives and putts and discussed what Mr. Montgomerie called the "physics of the slice." The next day in small groups, the students began practicing their own drives and putts. Mr. Montgomerie went from group to group and videotaped individual students practicing. He reminded them to pause occasionally to think about what they were doing.

The next day the groups watched their practice drives on tape. Mr. Montgomerie and the students discussed the advantages and disadvantages of variations in the process. Some of them noticed that students who kept their lead arm straight when driving created a huge arc and drove the ball farther. They also observed that students with straight lead arms turned their shoulders when swinging the club rather than bending their elbows. Other students pointed out the importance of maintaining eye contact with the ball. The students took notes about what they were going to practice when they went back outside.

For homework, students described what they had learned about their drives and why they thought certain things they changed worked or didn't work.

THEORY AND RESEARCH IN BRIEF • • •
Homework and practice

HOMEWORK – It is no exaggeration to say that homework is a staple of American education. By the time students reach the middle grades, homework has become a part of their lives. The reason commonly cited for homework makes good sense: It extends learning opportunities beyond the confines of the school day. This appears to be a good idea given that schooling occupies only about 13 percent of the waking hours of the first 18 years of life, which is less than the amount of time students spend watching television (Fraser, Walberg, Welch, & Hattie, 1987).

Extending the influence of schooling makes sense from the perspective of the amount of time it would take to adequately address the content in the various subject-matter standards documents. For example, when the National Education Commission on Time and Learning (1994) held a hearing to discuss the needed changes in instructional time, the following comments were recorded by representatives from various subject-matter organizations:

> *Arts*. "I am here to pound the table for 15 percent of school time devoted to arts instruction," declared Paul Lehman of the Consortium of National Arts Education Association.
>
> *English*. "These standards will require a huge amount of time, for both students and teachers," Miles Myers of the National Council of Teachers of English told the Commission.
>
> *Science*. "There is a consensus view that new standards will require more time," said David Florio of the National Academy of Sciences. (p. 21)

Homework is a complex topic. Research shows that a number of factors are critical, including the grade level of the students and the type of feedback given. (Feedback is discussed in more depth in Chapter 8, Setting Goals and Providing Feedback.) Some of the general findings on the research about homework are reported in Table 5.1. Specific findings are reported in Table 5.2

As Table 5.1 shows, the overall effect of homework on students' achievement is noteworthy. Yet, as Table 5.2 indicates, the influence of homework varies depending on a number of factors. For example, after studying the relationship between time spent on homework and achievement, Keith's data (1982) indicate that on average, for every 30 minutes of homework per night, overall GPA increased by approximately ½ point.

Table 5.1: General Research Findings for Homework

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Paschel, Weinstein, & Walberg, 1984	General effects of homework	81	.36	14
Graue, Weinstein, & Walberg, 1983	General effects of homework	29	.49	19
Hattie, 1992	General effects of homework	110	.43	17
Ross, 1988	General effects of homework	53	.65	24

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

Table 5.2: Specific Research Findings for Homework

Study	Focus		No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Walberg, 1999	Homework with teachers' comments as feedback *(may or may not be graded)*		2	.83	30
	Homework that is graded		3	.78	28
	Assigned homework but not graded or commented on		47	.28	11
Keith, 1982	Time spent on homework		1	.68	25
Cooper, 1989	Grade level of students	4-6	13	.15	6
		7-9	5	.31	12
		10-12	2	.64	24

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

Another set of studies (see Walberg, 1999) found that the effects of homework vary depending on whether homework is graded or teachers have provided students with feedback. Walberg reports that homework assigned but not graded or commented on generates an effect size of only .28, representing a percentile gain of 11 points. However, when homework is graded, the effect size increases to .78, and homework that teachers provide written comments for has an effect size of .83, representing a percentile gain of 30 points. Finally, it is important to note the differential effect of homework on students at different grade levels. In general, the older the student, the more influence homework has on his or her learning.

PRACTICE — It is intuitively obvious that practice is necessary for learning knowledge of any type. It's not surprising, then, that research indicates that practices significantly enhances learning. Some of the results of studies that have synthesized the research on practice are reported in Table 5.3.

Table 5.3: Research Results for Practice

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[b]
Ross, 1988	General effects of practice	9	1.29	40
Bloom, 1976[a]	General effects of practice	7	.54	21
		3	.93	32
		10	1.43	42
Kumar, 1991	General effects of practice	5	1.58	44

[a]Multiple effect sizes are listed for the Bloom study because of the manner in which effect sizes were reported. Readers should consult that study for more details.
[b]These are the maximum percentile gains possible for students currently at the 50th percentile.

The effect of practice on learning can be substantial, as the effect sizes and percentile gains shown in Table 5.3 indicate. But other research tells us how learning occurs over time. Studies by Anderson (1995) and Newell and Rosenbloom (1981) clearly indicate that many practice sessions typically are required for students to reach a high level of competence, the most significant gains are made in the initial practice sessions, and future practice sessions add incrementally smaller gains. These important points are clearly demonstrated by the computations shown in Table 5.4.

First, notice how much practice it takes for students to reach a high level of competence in a skill or process. Students do not reach a high level of competence until they have engaged in many practice sessions. For example, they do not reach 80 percent competency until they have practiced 24 times.

Second, notice how gains in learning become smaller as the number of practice sessions increases. For example, it takes five practice sessions for students to reach a little more than 50% competency, but after ten sessions students' competency is only 65%, after fifteen, 73%, and after 20, 77%.

On one hand, these statistics paint a somewhat discouraging view of continued practice. But other research points to critical benefits gained from practice.

One finding from the research on practice that has strong classroom implications is that students must adapt or "shape" skills as they are learning them. During this shaping phase, learners modify the way they use the skill, become aware of potential problem areas as well as variations in how the skill can be used, and learn to use the skill in different situations.

The importance of the shaping phase cannot be overstated, yet this crucial stage of learning is often not given the necessary time and attention. Skipping or shortchanging this stage of learning can result in students' internalizing errors that are difficult to correct. It can also mean that students will not gain the conceptual understanding that is essential to truly mastering a skill or process.

Table 5.4: Increase in Learning Between Practice Sessions

Practice Session #	Increase in Learning	Cumulative
1	22.918%	22.918
2	11.741%	34.659
3	7.659%	42.318
4	5.593%	47.911
5	4.349%	52.260
6	3.534%	55.798
7	2.960%	58.754
8	2.535%	61.289
9	2.205%	63.494
10	1.945%	65.439
11	1.740%	67.179
12	1.562%	68.741
13	1.426%	70.167
14	1.305%	71.472
15	1.198%	72.670
16	1.108%	73.778
17	1.034%	74.812
18	.963%	75.775
19	.897%	76.672
20	.849%	77.521
21	.802%	78.323
22	.761%	79.084
23	.721%	79.805
24	.618%	80.423

In fact, when students lack conceptual understanding of skills and processes, they are likely to use procedures in shallow and ineffective ways. The Mathematical Science Education Board (1990) warns that skill learning in itself does not ensure conceptual understanding. Researchers Clement, Lockhead, and Mink (1979) have shown that even a solid knowledge of the steps involved in algebraic procedures does not imply in most cases (over 80 percent) an ability to correctly interpret the concepts underlying the procedures. Further, several studies have shown that students are able to use mathematics procedures most effectively when they have first learned them at a conceptual level (Davis, 1984; Romberg & Carpenter, 1986).

To help foster the shaping process, research suggests that it is not appropriate to engage students in rushed practice of multiple examples, but, rather, to give them an opportunity to practice a few examples in depth at a slower pace. Unfortunately, Healy (1990) reports, American educators tend to prematurely engage students in a heavy practice schedule and rush them through multiple examples. In contrast, as Healy reports, Japanese educators attend to the needs of this important phase of learning by slowly walking students through only a few examples:

> Whereas American second graders may spend thirty minutes on two or three pages of addition and subtraction equations, the Japanese are reported to be more likely at this level to use the same amount of time in examining two or three problems in depth, focusing on the reasoning process necessary to solve them. (p. 281)

Practice is a critical part of learning that must be well structured and well thought out to enhance learning. Although further practice does not result in significant gains in skill development, this additional time may be essential for students to gain the conceptual understanding that is critical to true learning.

Chapter 6

NONLINGUISTIC REPRESENTATIONS

Mr. McBride decided to introduce his primary students to the concept of supply and demand. First he explained that sometimes more people want a product when they think that it's hard to get or when there aren't many of the product around. Next, he gave examples of this idea.

But some students seemed confused. So Mr. McBride then explained that one way to remember an idea is to picture something in your mind that reminds you of it. He suggested that students try this to help them understand how limited supply can sometimes increase demand. He asked them to think of a time when they wanted something but it was hard to get. Students quickly thought of many examples.

One student, Matthew, recalled a soccer game when one of the moms brought some popsicles for the players to have after the game. But it was a very hot day, and many of the popsicles melted before the game was over. When the game was over, the players realized that many of the popsicles had melted, so they rushed over to try to be the first in line to get one.

Matthew especially remembered the incident because he really wanted a cherry popsicle, but as he stood in line he could see other players taking all of the cherry ones. By the time he got to the front of the line, there were no cherry popsicles left. Matthew thought he would remember the idea of supply and demand by picturing a cherry popsicle. He would picture the popsicle melting and imagine how much he wanted it but couldn't have it because it had melted.

Mr. McBride asked students to share their mental pictures with a partner in as much detail as possible. He also suggested that students draw or paint their pictures and then explain how the image would help them recall the idea that a limited supply of something can sometimes lead to more demand for it.

Mr. McBride has emphasized a very powerful aspect of learning — that generating mental pictures of information enhances recall and understanding.

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In this chapter, we consider five methods for generating nonlinguistic representations: graphic organizers, pictures and pictographs, mental pictures, concrete representations, and kinesthetic activity. Teaching students to use graphic organizers is perhaps the most common way to help students generate nonlinguistic representations, but other visual, mental, and physical strategies can be also be useful, as explained in the following sections.

Graphic Organizers

Graphic organizers combine the linguistic mode and the nonlinguistic mode of communication by using words and phrases to highlight key points and symbols and arrows to represent relationships. Six graphic organizers are commonly used in the classroom. These correspond to six common patterns into which most information can be organized: descriptive patterns, time/sequence patterns, process/cause-effect patterns, episode patterns, generalization/principle patterns, and concept patterns. Each graphic organizer arranges information differently and thus is more appropriate for some types of information than others.

1. Use Descriptive Pattern Organizers.
(See Illustration 1)

Descriptive organizers can be used for information related to vocabulary terms or for facts about specific persons, places, things, and events. The information in a descriptive organizer does not need to be in any particular order. For example, facts that characterize an equilateral triangle can be organized as a descriptive pattern and represented graphically as shown in Illustration 1.

2. Use Time/Sequence Pattern Organizers.
(See Illustration 2)

A time/sequence pattern organizes events in a specific chronological order. For example, information about the development of the "race" to the South Pole can be organized as a time/sequence pattern and represented graphically as shown in Illustration 2.

3. Use Process/Cause-Effect Pattern Organizers.
(See Illustration 3)

Process/cause-effect patterns organize information into a casual network leading to a specific outcome or into a sequence of steps leading to a specific product. For example, information about the factors that typically lead to the development of a healthy person might be organized as a process/cause-effect pattern and represented graphically as shown in Illustration 3.

4. Use Episode Pattern Organizers.
(See Illustration 4)

Episode patterns organize a large quantity of information about specific events, including (1) a setting (time and place), (2) specific people, (3) a specific duration, (4) a specific sequence of events, and (5) a particular cause and effect. For example, information about the 1987 stock market crash might be organized into an episode pattern using a graphic as shown in Illustration 4.

5. Use Generalization/Principle Pattern Organizers.
(See Illustration 5)

Generalization/principle patterns organize information into general statements with supporting examples. For instance, for the statement, "A mathematics function is a relationship in which the value of one variable depends on the value of another variable," examples can be provided and represented in a graphic as shown in Illustration 5.

6. Use Concept Pattern Organizers.
(See Illustration 6)

Concept patterns, the most general of all patterns, organize information around a word or phrase that represents entire classes or categories of persons, places, things, and events. The characteristics or attributes of the concept, along with examples of each, should be included in this pattern. The concept of *fables*, for example, can be organized into a graphic as shown in Illustration 6.

7. Use Multiple Organizers for the Same General Topic.
(See Illustration 7)

Although different types of organizers are more appropriate for some types of information, multiple graphic organizers might be used for the same general topic. For example, in a science class the steps for a lab experiment could be represented in a time/sequence organizer, while the results of the lab could be organized in a process/cause-effect graphic.

In addition, when using graphic organizers as an instructional strategy, different methods can be used in the classroom. For example, a teacher might give students completed graphic organizers as notes in order to highlight key issues and organize information students will be learning. The teacher might also ask students to complete graphic organizers to help them sort through and arrange information they are learning. To understand how different graphic organizers might be used around the topic of the Vietnam War, consider Illustration 7.

ILLUSTRATION 1: DESCRIPTIVE PATTERN ORGANIZER *equilateral triangle*

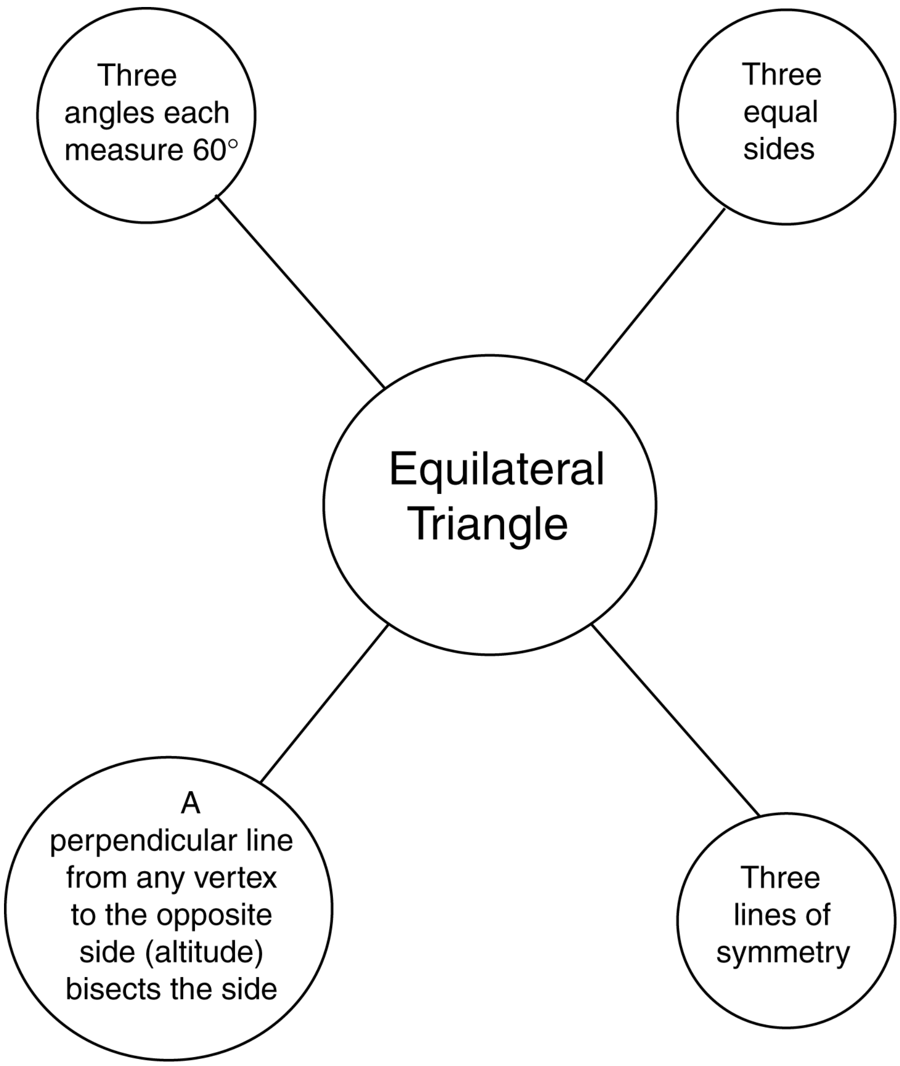


ILLUSTRATION 2: TIME/SEQUENCE PATTERN ORGANIZER *the race for the South Pole*

November 1902 British expedition led by explorer Robert Falcon Scott sets out. Scott expedition reaches farthest-south point ever recorded.
December 1902 Scott expedition turns back.
October 1908 British expedition led by Irish explorer Ernest H. Shackleton sets out. Team takes route from McMurdo Sound across the Ross Ice Shelf and through the Transantarctic Mountains.
January 1909 Within some 100 miles of pole, Shackleton expedition turns back. Had reached the newest farthest-south point recorded.
1910 Scott returns to McMurdo Sound to prepare for second trek.
October 1911 Norwegian explorer Roald Amundsen's team sets out, four days before Scott's team.
October 1911 Second Scott trek sets out from base on Ross Island following Shackleton's route. Used sleds to haul their supplies.
December 1911 Expedition led by Amundsen reaches pole after using teams of dogs on shorter, but steeper, route.
January 1912 Scott and his team reach pole.
January-March 1912 Scott and his team die on the return trip.

ILLUSTRATION 3: PROCESS/CAUSE-EFFECT PATTERN ORGANIZER *healthy person*

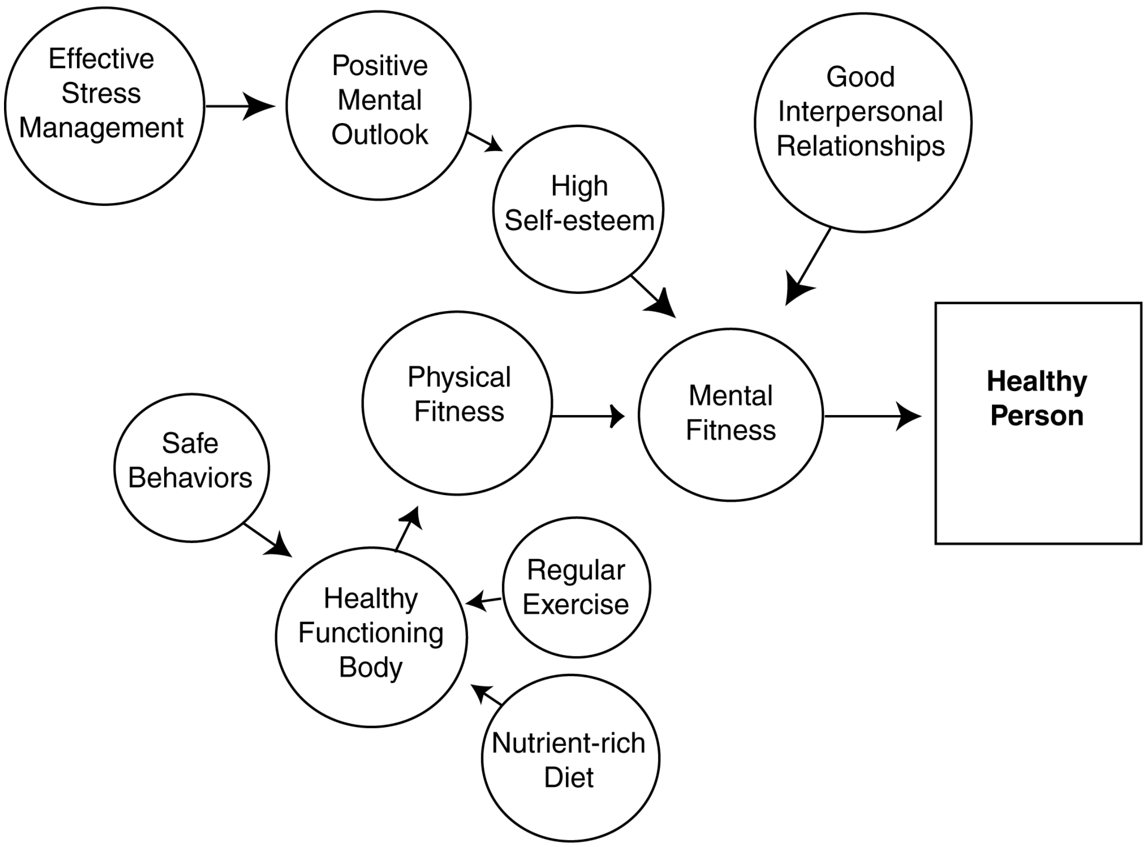


ILLUSTRATION 4: EPISODE PATTERN ORGANIZER *stock market crash 1987*

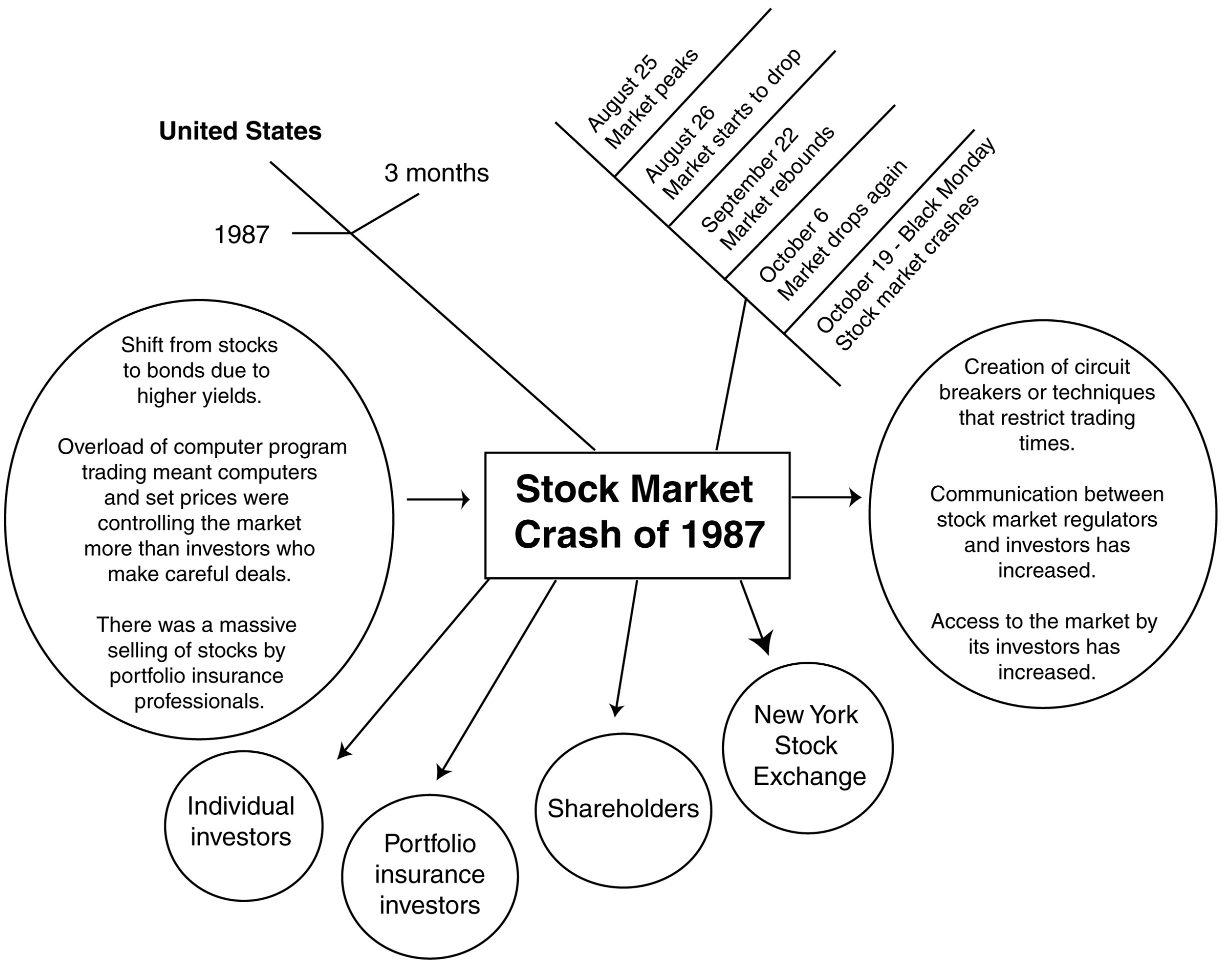


ILLUSTRATION 5: GENERALIZATION/PRINCIPLE PATTERN ORGANIZER *mathematics function*

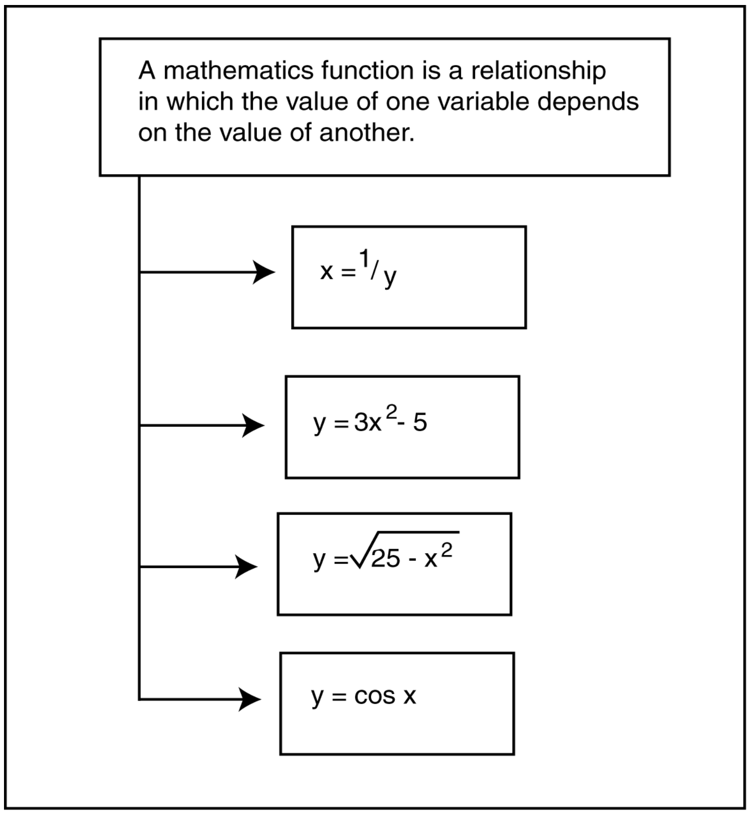


ILLUSTRATION 6: CONCEPT PATTERN ORGANIZER *fables*

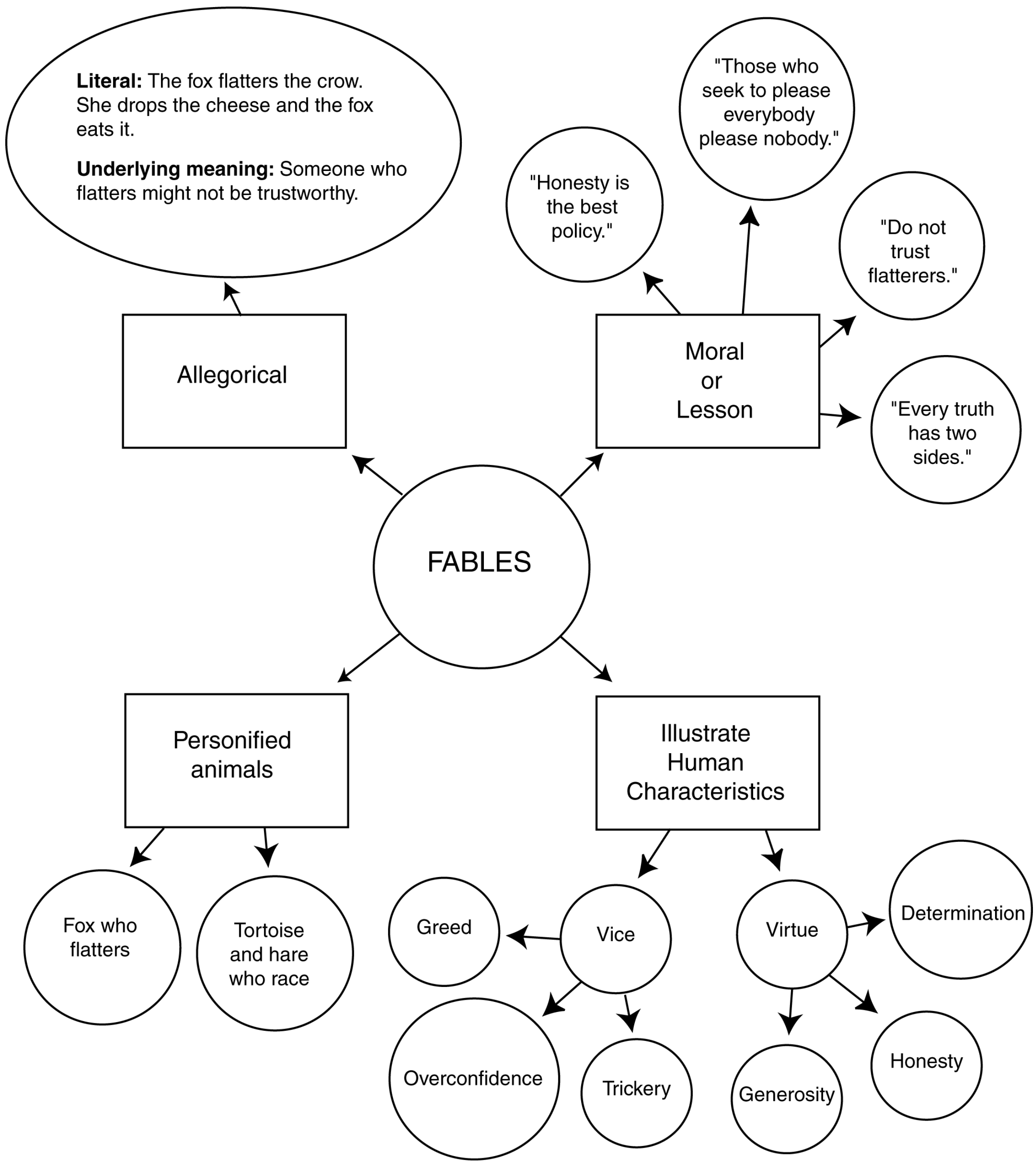


ILLUSTRATION 7: USING MULTIPLE ORGANIZERS FOR THE SAME TOPIC *the Vietnam War*

Mr. Hayslead was presenting a unit on the Vietnam War to his high school students. During the unit, he used graphic organizers in two ways:

a. He gave students blank organizers to help them organize information about different aspects of the war.
b. In addition, he presented students with two graphic organizers that he filled out prior to the beginning of the unit.

The completed organizers helped Mr. Hayslead organize into patterns the information he wanted students to learn. They also helped highlight different relationships among various pieces of information and ideas and clarify the connections he wanted students to make.

Mr. Hayslead gave students a completed time/sequence pattern to show key events of the war in chronological order and a completed concept pattern that clustered information around the phrase "anti-war demonstrations."

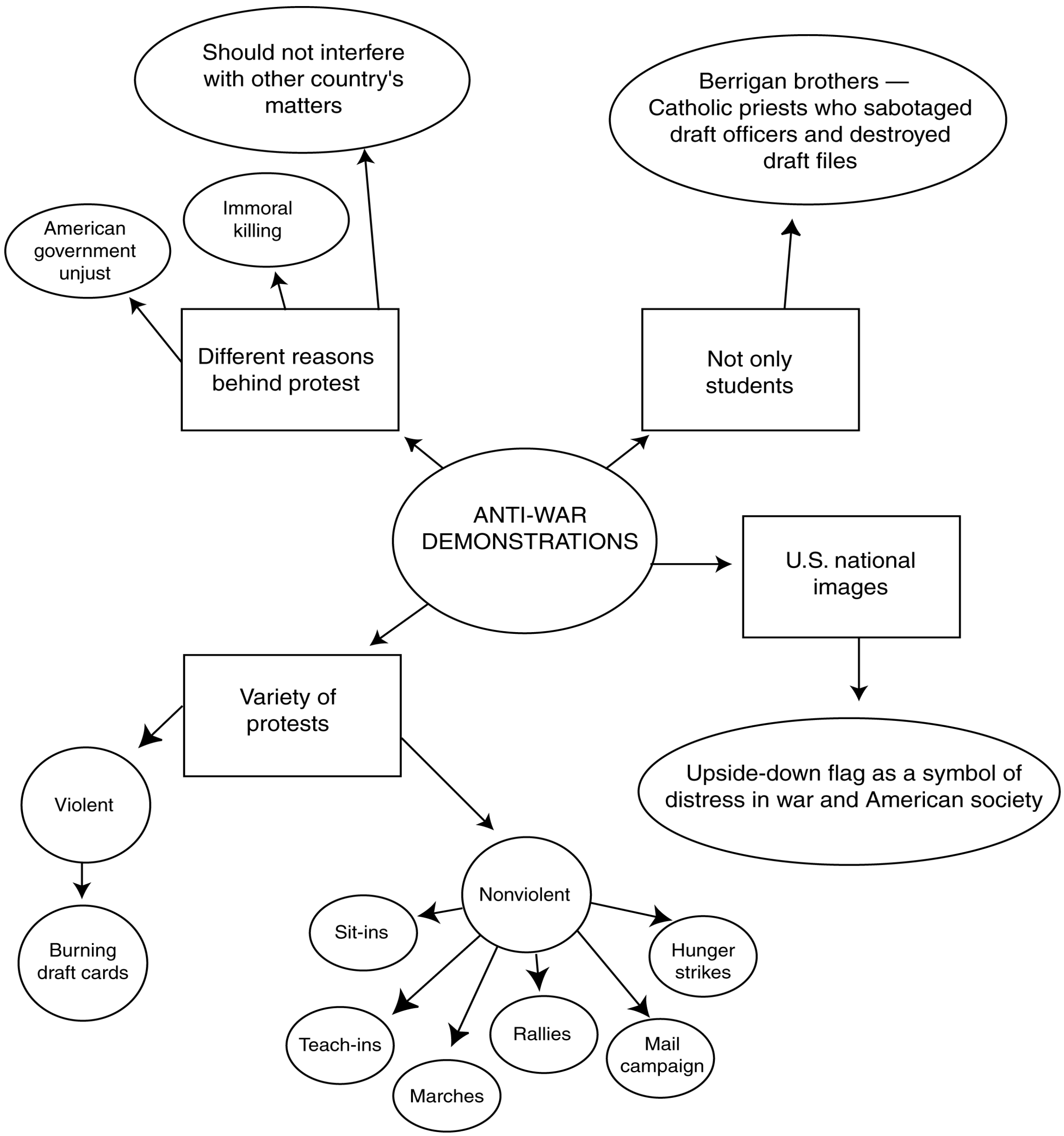
After they discussed the world events that led to the Vietnam War, he asked students to complete a process/cause-effect pattern to organize these world events. Finally, students talked in small groups about what they had learned as a result of doing the task.

(See completed organizers on following pages.)

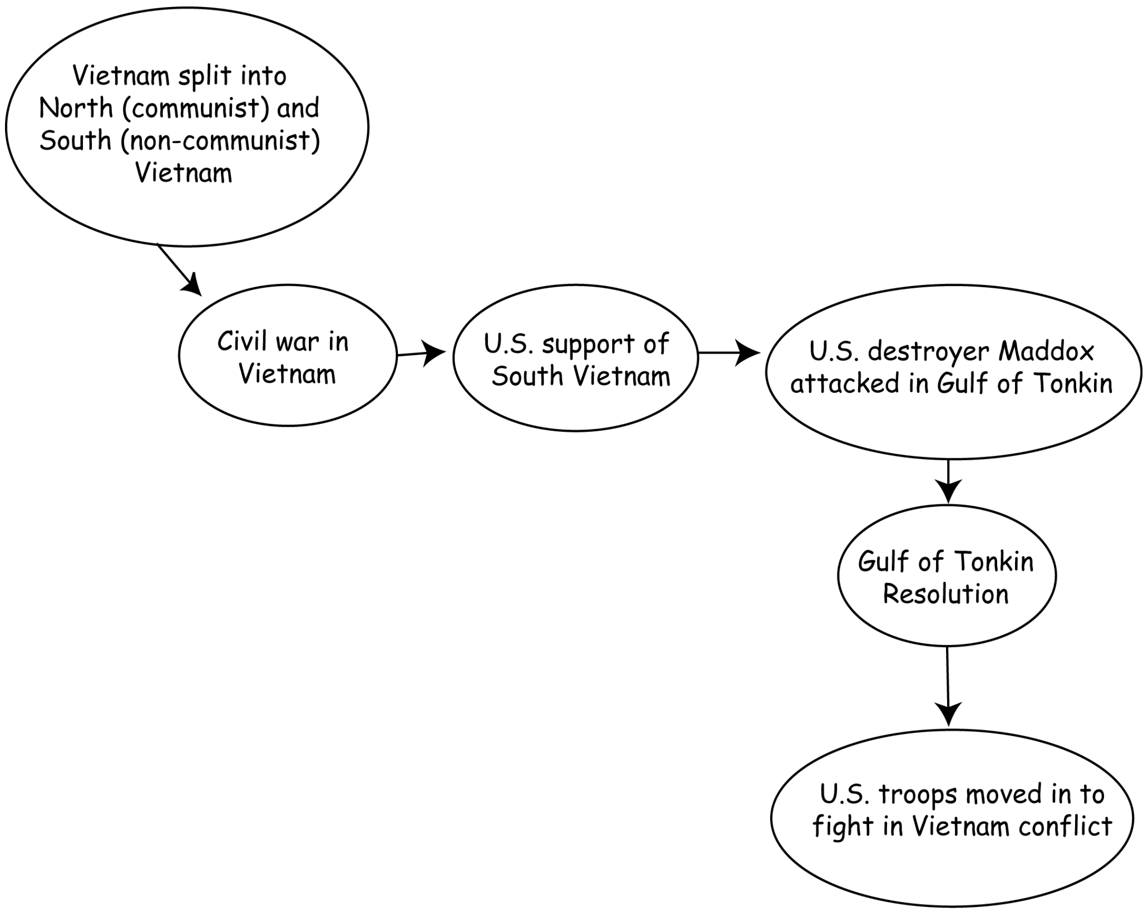
TIME/SEQUENCE PATTERN ORGANIZER *key events of the Vietnam War*

1960 December Ho Chi Minh, leader of the Democratic Republic of Vietnam, organizes the National Liberation Front (NLF) of South Vietnam, the Viet Cong. Ho commits the NLF to the overthrow of the non-Communist government in South Vietnam, the ousting of U.S. advisors, and a united Vietnam.
August 1964 U.S. destroyers Maddox and Turner Joy attacked in the Gulf of Tonkin, allegedly by North Vietnam. Congress approves Gulf of Tonkin Resolution granting President Lyndon Johnson the power to take "all necessary measures to repel any armed attack against the forces of the United States and to prevent further aggression."
March 1965 First American combat troops land in Danang, Vietnam.
January 1968 TET Offensive attacks on South Vietnam by North Vietnam and NLF troops.
March 1968 My Lai massacre.
December 1968 535,000 U.S. forces now in Vietnam.
May 4, 1970 Four Kent State college students shot to death by Ohio National Guardsmen during an anti-war protest on campus.
January 1973 Treaty signed by North Vietnam, South Vietnam, Viet Cong, and U.S.
March 23, 1973 U.S. combat forces withdrawn.
April 30, 1973 Government of Republic of Vietnam surrenders to North Vietnamese soldiers; U.S. personnel evacuated.

CONCEPT PATTERN ORGANIZER *anti-war demonstrations*



PROCESS/CAUSE-EFFECT PATTERN ORGANIZER *world events leading to the Vietnam War*



PICTURES AND PICTOGRAPHS

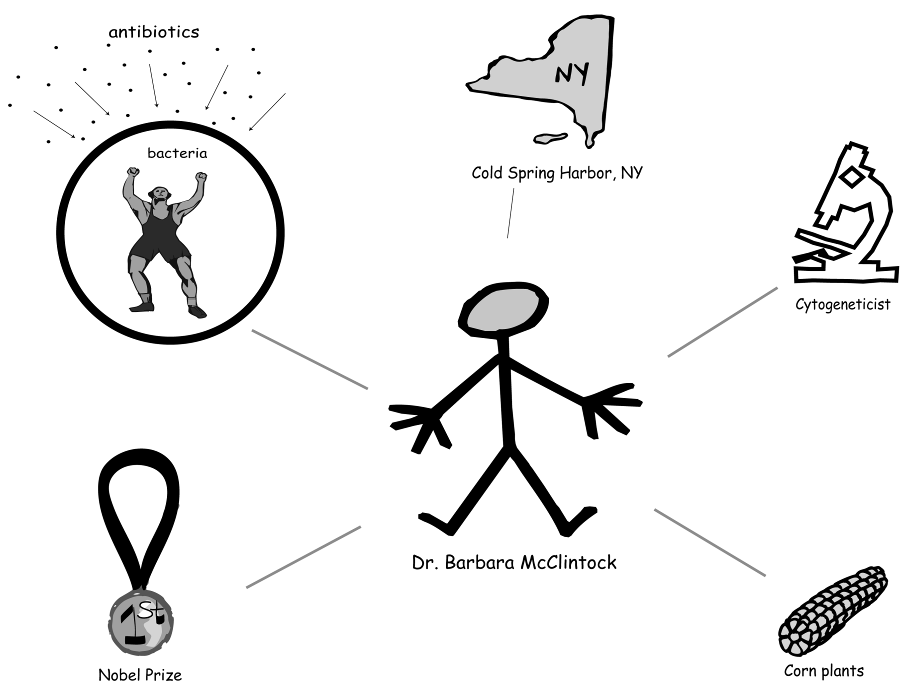
(See Illustration 1)

Drawing pictures to represent ideas, events, places, or objects is a powerful way to generate nonlinguistic representations in the mind. For example, most students have either drawn or colored a representation of the human skeletal system or have seen a picture of one in the classroom. A variation of a picture is the pictograph, which is a drawing that uses symbols or symbolic pictures to represent information, as shown in Illustration 1.

ILLUSTRATION 1: PICTURES AND PICTOGRAPHS *Barbara McClintock*

Students in Mr. Gregorio's class were learning about genetic research. As part of the unit, Mr. Gregorio discussed the history of genetic research, the key researchers, and the contributions that their discoveries made to the field.

One of the geneticists students learned about was Dr. Barbara McClintock (1902–1992). Mr. Gregorio explained that Dr. McClintock was one of America's most distinguished cytogeneticists. She studied genetic mutations in corn plants for many years at Carnegie Institute's Department of Genetics at Cold Spring Harbor, New York. In 1951 she first reported that genetic information could transpose from one chromosome to another. She received the Nobel Prize in 1983. Her work has helped scientists understand human diseases, including how some bacteria develop a resistance to antibiotics. One student drew a pictograph to help him remember some of the key information about Dr. McClintock:



MENTAL PICTURES

(See Illustration 1)

One of the most direct ways to generate nonlinguistic representations is to ask students to create mental pictures, as exemplified by Illustration 1. For abstract content, these mental pictures might be highly symbolic. To illustrate, psychologist John Hayes (1981) provides an example of how a student might generate a mental picture for the following equation from physics:

$$F = \frac{(M_1 M_2)G}{r^2}$$

This equation states that force (F) is equal to the product of the masses of two objects ($M_1$and M_2) times a constant (G) divided by the square of the distance between them (r^2). There are a number of ways this information might be represented symbolically. Hayes (1981) suggests an image of two large globes in space with the learner in the middle trying to hold them apart:

> If either of the globes were very heavy, we would expect that it would be harder to hold them apart than if both were light. Since force increases as either of the masses (M_1 and M_2) increases, the masses must be in the numerator. As we push the globes further apart, the force of attraction between them will decrease as the force of attraction between two magnets decreases as we pull them apart. Since force decreases as distance increases, *r* must be in the denominator. (p. 126)

ILLUSTRATION 1: CREATING MENTAL PICTURES *the American southwest*

Mr. Ranahan's class was beginning a unit on the history of Native American cultures in the American southwest. Early in the unit, Mr. Ranahan introduced his students to the strategy of creating mental pictures of information and ideas. He asked students to imagine that they were early European explorers who had stumbled onto the abandoned cliff palace of Mesa Verde. He asked them to close their eyes and imagine they were traveling by horseback through the canyon lands. He had them "feel" the hot desert sunlight, "see" the scrubby vegetation, and "smell" the junipers and pinon pines.

"Imagine," Mr. Ranahan said, "that you suddenly see something in the distance that looks like an apartment building carved into a cliff. Would you be puzzled? Curious? Frightened? Imagine you gallop your horse to the edge of the cliff and peer across at the black and tan sandstone and notice that yes, it is something like an apartment building. There are ladders up, black holes that are windows, and circular pits, but no people. It's absolutely quiet. There's no sign of life. Would you wonder what happened to the people who lived there? What would you think about the builders of this mysterious structure? Would you be brave enough to go inside? What do you think you would find?"

CONCRETE REPRESENTATIONS

(See Illustration 1)

As the name implies, concrete representations are physical models or representations of the knowledge that is being learned. Mathematics and science teachers commonly refer to the use of concrete representations as “manipulatives.” The very act of generating a concrete representation establishes an “image” of the knowledge in students’ minds, as exemplified by Illustration 1.

ILLUSTRATION 1: CONCRETE REPRESENTATIONS *mathematics*

When Ms. Coen wanted to extend her students’ understanding of the concepts of proportion and the relationships between two- and three-dimensional shapes, she asked students to build a 3-dimensional model to scale. Students chose any common object, identified a scale to use, drew a 2-dimensional sketch, built the model, and wrote two paragraphs explaining the proportional model and the process they used.

Kara decided to build a model of her cylindrical lip balm container and chose a scale of 4:1 for the model to the original. Some steps in the process were easy for Kara. She could easily determine the correct height for her model by measuring the lip balm container and multiplying by four. However, figuring out the circumference of the cylinder was a little harder.

Working with a piece of construction paper, Kara was able to make the connection between the length of the rectangle she was rolling to create a cylinder and the circumference of the cylinder. This concrete representation solidified in Kara’s mind the connection between 2-dimensional representations of 3-dimensional objects.

Kinesthetic Activity

(See Illustration 1)

Kinesthetic activities involve physical movement. By definition, physical movement associated with specific knowledge generates a nonlinguistic representation of the knowledge in the mind of the learner, as Illustration 1 exemplifies.

Illustration 1: Kinesthetic Activity *electric circuits*

To help her students create mental pictures, Ms. Zhou occasionally asked them to model a concept or scientific idea. During the unit on electricity, she noticed that some students had misconceptions about electric current in simple series and electrical circuits.

As a clarifying activity, Ms. Zhou told the students to pretend they were electrons in a circuit with one light bulb, a switch, and an ammeter. She organized the students into three groups and asked them to role play what would happen in the circuit as the voltage increased.

Students developed an understanding of what happens in electric circuits as they brainstormed ideas and refined the parts of their role play. Each group produced a model and shared it with the rest of the class. After their presentations, Ms. Zhou focused class discussion on the features of each role play that best represented what was happening in the circuit. Students were able to connect the scientific terms they were learning with the models they had created.

THEORY AND RESEARCH IN BRIEF • • •
Nonlinguistic representations

Many psychologists adhere to what has been called the *dual-coding theory* (see Paivio, 1969, 1971, 1990). This theory postulates that knowledge is stored in two forms — a linguistic form and an imagery form, also called a nonlinguistic form. The linguistic mode is semantic in nature. As a metaphor, one might think of the linguistic mode as containing actual statements in long-term memory. The imagery mode, in contrast, is expressed as mental pictures or even physical sensations, such as smell, taste, touch, kinesthetic association, and sound (Richardson, 1983).

The more we use both systems of representation, the better we are able to think about and recall our knowledge. This is particularly relevant to the classroom, because studies have consistently shown that the primary way teachers present new knowledge to students is linguistic. They typically either talk to students about the new content or have them read about the new content (see Flanders, 1970). This means that students are commonly left to their own devices to generate nonlinguistic representations for new knowledge. However, when teachers help students in this endeavor, the effects on achievement are strong. It has even been shown that explicitly engaging students in the creation of nonlinguistic representation stimulates and increases activity in the brain (see Gerlic & Jausovec, 1999).

Research indicates that creating nonlinguistic representations in the minds of students, and thus enhancing their understanding of the content, can be accomplished in a variety of ways: (1) creating graphic representations (Horton, Lovitt, & Bergerud, 1990; Darch, Carnine, & Kameenui, 1986; Alvermann & Boothby, 1986; Robinson & Kiewra, 1996; Griffin, Simmons, & Kameenui, 1992; McLaughlin, 1991; Armbruster, Anderson, & Meyer, 1992); (2) making physical models (Welch, 1997); (3) generating mental pictures (Willoughby et al., 1997; Muehlherr & Siermann, 1996); (4) drawing pictures and pictographs (Macklin, 1997; Newton, 1995; Pruitt, 1993); and (5) engaging in kinesthetic activity (Druyan, 1997; Aubussen, 1997).

Table 6.1 summarizes findings from a variety of studies that have synthesized research on nonlinguistic representation. These studies address a variety of techniques for generating nonlinguistic representations ranging from creating "pictures in the mind" to creating physical models. Although the specific instructional strategies addressed in the various studies might appear somewhat different on the surface, they all have a common goal — the creation of nonlinguistic representations for knowledge in the minds of learners.

Table 6.1: Research Results for Nonlinguistic Representation

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Mayer, 1989[b]	General nonlinguistic techniques	10	1.02	34
		16	1.31	40
Athappilly, Smidchens, & Kofel, 1983	General nonlinguistic techniques	39	.510	19
Powell, 1980[b]	General nonlinguistic techniques	13	1.01	34
		6	1.16	38
		4	.56	21
Hattie, Biggs, & Purdie, 1996	General nonlinguistic techniques	9	.91	32
Walberg, 1999[b]	General nonlinguistic techniques	24	.56	21
		64	1.04	35
Guzzetti, Snyder, & Glass, 1993	General nonlinguistic techniques	3	.51	20
Fletcher, 1990	General nonlinguistic techniques	47	.50	20

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.
[b]Multiple effect sizes are listed because of the manner in which the effect sizes were reported. Readers should consult these sources for more details.

Chapter 7

COOPERATIVE LEARNING

Students in Ms. Cimino's middle school class were beginning a unit on the regions of the United States. Ms. Cimino wanted students to understand how diverse the regions are. She explained that students would be working in small groups to create a class presentation about a specific region. Each presentation was to cover the geography, weather patterns, and economic/cultural activities of the region. Ms. Cimino told students that they could use the resources in the classroom, the library, or any of three Internet sites she had identified.

To facilitate the group work, Ms. Cimino began by dividing the class into groups of three and assigning a region to each group. Within each group, students agreed who would be the overall leader or organizer, the recorder of the group's discussions, and so on. Each group also decided how they would break up the work; because there were three students in each group, most groups divided the research into the three areas of focus Ms. Cimino had specified for the presentations. Ms. Cimino encouraged each group to take time every couple of days to evaluate each individual's progress as well as the group's overall progress, to solve any conflicts they were encountering, and to fine-tune their work as needed. Ms. Cimino met with each group periodically to monitor their progress, support their efforts to learn, and help them work together more effectively.

Ms. Cimino has used one of the most popular instructional strategies in American education — cooperative learning.

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Over the past decade, cooperative learning has become one of the most popular, but often misunderstood, instructional strategies. According to Roger Johnson and David Johnson, recognized leaders in the field of cooperative learning, there are five defining elements of cooperative learning:

- *positive interdependence* (a sense of sink or swim together)
- *face-to-face promotive interaction* (helping one another learn, applauding effort and success)
- *individual and group accountability* (each of us has to contribute to the group achieving its goals)
- *interpersonal and small group skills* (communication, trust, leadership, decision making, and conflict resolution)
- *group processing* (reflecting on how well the team is functioning and how it can function even better) (Johnson, Johnson, & Holubec, 1993)

1. Use a Variety of Criteria to Group Students.
(See Illustration 1)

Teachers can use a variety of criteria to group students: interests, birthday month, first letter of their first names, or color of their shirts. Students might also be grouped randomly by drawing names from a hat. Research indicates that grouping students according to ability levels should be used sparingly, as the strategy might have very different effects on different students. To maximize students' experiences, teachers might use different criteria for grouping throughout the year, as exemplified in Illustration 1, and have students use the characteristics of cooperative learning in their groups.

2. Use Informal, Formal, and Base Groups.
(See Illustrations 2.1, 2.2, and 2.3)

Using informal, formal, and base groups (Johnson & Johnson, 1999) is one way to vary grouping patterns and activities, as shown in Illustrations 2.1, 2.2, and 2.3. *Informal groups* (e.g., pair-share, turn-to-your-neighbor) are formed for specific or immediate needs and can last for a few minutes or an entire class period. For example, informal groups can be used to clarify expectations about an assignment, to focus students' attention, to give students time to process information, or to provide closure on an activity.

Formal groups are designed to give students time to thoroughly complete an academic assignment. These groups may last for several days or even weeks. For formal groups, the teacher designs tasks that encompass all of the defining elements of cooperative learning — positive interdependence, group processing, appropriate use of social skills, face-to-face promotive interaction, and individual and group accountability (Johnson & Johnson, 1999). *Base groups* are long-term groups designed to provide students with support throughout a semester or an academic year.

3. Manage Group Size.
(See Illustration 3)

Research indicates that cooperative groups should be kept small. Many teachers follow the rule of thumb "the smaller the better." Even though a particular task may seem to have enough work to occupy a large group, students may not have the skills necessary to work effectively in larger groups. Therefore, if resources allow, smaller groups are recommended, as exemplified in Illustration 3.

4. Combine Cooperative Learning with Other Classroom Structures.
(See Illustration 4)

Any classroom instructional strategy can be overused. Cooperative learning is no exception. Students need time to work independently to practice the skills and processes they need to master. If used too frequently, any strategy can lose its effectiveness; therefore it is best for teachers to vary the types of activities they use in the classroom, as exemplified by Illustration 4.

ILLUSTRATION 1: USE A VARIETY OF GROUPING CRITERIA *science and math*

Dmitri was not happy when his new fourth grade teacher, Mrs. Gant, explained that they would be working in cooperative learning groups throughout the year. In third grade during science, he had been in the same group all year. He and the other members of the group had grown tired of working in the same group all year. He thought Mrs. Gant's class would be the same way, but he soon discovered that she ran cooperative learning groups a little differently.

During the life cycle unit in science, Mrs. Gant organized groups based on the types of pets students had or wished they had. Dmitri, who had an iguana, got to work with Jerome, whose sister had a python; Jane, whose family owned a couple of leopard geckos; and Danette, who wanted an iguana. Because the students all knew something about reptiles, they had some common prior knowledge to build on and could share stories that related to their learning about life cycles.

In math when they worked on factors and multiples, Mrs. Gant organized students according to their favorite numbers. Because Ms. Gant made an effort to organize students using different criteria for grouping, Dmitri was more motivated during the cooperative learning sessions.

ILLUSTRATION 2.1: INFORMAL GROUPS *homework assignments*

Ms. Banner's third graders used homework sheets to record their assignments for each day, but sometimes the sheet just wasn't enough. Some students would forget to record an assignment; a few students would record the assignment incorrectly; often students weren't sure exactly what they were supposed to do, even after they had written it down.

At the end of each day, Ms. Banner made it a habit to ask her third graders to go over their homework sheets with a partner or in some kind of group (e.g., groups of three, groups of four). Students talked about homework expectations with one another and asked Ms. Banner for clarification when necessary. This process helped all of the students make sure they had the correct assignments for the day.

ILLUSTRATION 2.2: FORMAL GROUPS *pilgrims*

Mr. Hall's class was studying about the arrival of the Pilgrims to Plymouth Colony, the first permanent settlement in New England. As part of the unit, Mr. Hall designed a cooperative learning activity that involved students in considering the term *pilgrim* in a broader sense. To introduce the activity, Mr. Hall explained that although many people have come to associate the word *pilgrim* primarily with the first English settlers who arrived in what is now Plymouth, Massachusetts, the term has a much broader meaning.

He first assigned students to groups of four to work on the projects, which were to be presented in two weeks. He passed out guidelines and other materials while he explained that each group was to research, design, and make an in-class presentation to help the class gain a broader understanding of the concept of a pilgrim. Specifically, he wanted each group to research the term and put together a classroom presentation or dramatization that demonstrated what they had learned.

Mr. Hall explained that each team member was to participate both in preparing for the presentation and then making the presentation. Grades would be given to each group and to each team member. Mr. Hall set aside class time for the groups to meet, assign roles for each team member, and begin to map out their work together. As students met in their small groups, they quickly realized that they would only succeed as a group if all of the members of the group succeeded — each team member's responsibilities were essential to the overall success of the project. Over the next two weeks, the team members worked on their assignments — both individually and in their groups — and periodically met to assess their work.

At the end of the two weeks, the groups made their presentations. One group presented a dramatization about the Muslim tradition of making a pilgrimage to Mecca (in present-day Saudi Arabia). Another made a presentation about the pilgrimages of the early Christians to the scenes of the Passion of Christ in Jerusalem. Still another made a presentation about the woman known as Peace Pilgrim who traveled across the United States on foot for world peace. And another gave a presentation about the Pilgrims who established Plymouth Colony.

As a completion activity, Mr. Hall asked students to use their journals to reflect on what they had learned about pilgrims. Students also reflected on their work together as a group, noting, in particular, things that "worked" and "didn't work" about the group effort. As a result of the cooperative learning activity, students gained a broader understanding of what it means to be a pilgrim, as well as greater skill in working effectively with others.

ILLUSTRATION 2.3: BASE GROUPS *language arts*

Mrs. Garcia organized her seventh grade language arts students into base groups of three members each during the second week of classes. The base groups shared a number of responsibilities, including making sure an absent member received information and materials about any work he or she had missed, reviewing assignments and providing feedback for each other on “peer review” days, and working together to develop their skills in the research process.

Although Mrs. Garcia required students to individually complete most of the longer research projects, base group members were allowed to support one another. For example, Mrs. Garcia explained, a group member could read part of another student’s research paper and provide feedback; ask the rest of the group for suggestions about where to look for more resources, or practice an oral presentation with the base group.

Over the course of the year, students stayed in the same base groups. As a result, they were able to help each other identify strengths and work on specific weaknesses throughout the year. Members of the group came to trust each other’s opinions and feedback and developed a sense of camaraderie that helped them succeed with their learning.

ILLUSTRATION 3: MANAGE GROUP SIZE

Mr. Tempest organized his fifth graders into groups of six to work on their “Cities, Transportation, and Communication” project. As he watched the groups organize and begin their work, he realized the groups were too large. Students had plenty of work to do, but the dynamics of interacting and organizing with six people seemed overwhelming for them.

Mr. Tempest talked with his students about his observations. Students agreed that the groups were too large. Together, they reorganized the class into groups of three and adjusted the project time lines. As a result, students had an easier time coordinating the project with three people and spent more time focusing on their learning.

ILLUSTRATION 4: USE COOPERATIVE LEARNING IN MODERATION

Ms. Browder thought it was important for her students to learn from one another and strengthen their interpersonal skills. So when she first started teaching, she used cooperative learning groups three or four times a week — almost every class period. She thought most of her students enjoyed the group work.

Then Ms. Browder met Jennifer, who really liked to work alone. Jennifer participated in the cooperative learning groups but sometimes seemed frustrated and didn't always do her best work in the groups. One day Ms. Browder asked Jennifer about her experiences working in cooperative learning groups.

Jennifer explained that interacting with others in a group required a lot of energy and although she didn't mind cooperative learning sometimes, being part of a learning group nearly every day was too much. Jennifer said she felt distracted from her learning because she had to concentrate so much on working in the group. "Sometimes I just need time to think and practice quietly," she said.

After hearing Jennifer's comments, Ms. Browder decided to talk to the rest of the class. Other students felt the same way: They liked to work with each other, but not every day. A number of students said they thought it was better to work on some assignments alone.

After listening to her students, Ms. Browder changed the way she ran her classroom. She continued to use cooperative learning strategies, but used them less frequently. When she did use a group learning strategy, she varied the size of the groups and the activities as much as possible. In the following weeks, she frequently checked with students about how the activities were working for them. She soon realizing she was more effectively meeting her students' needs and more appropriately using cooperative learning strategies.

THEORY AND RESEARCH IN BRIEF • • •
Cooperative learning

Cooperative learning has a rich research history. Results from some of the studies that have synthesized research on cooperative learning are summarized in Table 7.1. Of the studies listed, the one most commonly cited is the 1981 study by Johnson et al. Perhaps most noteworthy about this research synthesis is that it contrasted cooperative learning with a number of related techniques, three of which are reported in Table 7.1: intergroup competition, individual competition, and use of individual student tasks.

Table 7.1: Research Results for Cooperative Learning

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Walberg, 1999	Cooperative learning (general)	182	.78	28
Lipsey & Wilson, 1993	Cooperative learning (general)	414	.63	23
Scheerens & Bosker, 1997	Cooperative learning (general)	—	.56	21
Hall, 1989	Cooperative learning (general)	37	.30	12
Johnson et al., 1981	Cooperative learning (general)	122	.73	27
	Cooperative learning (noncompetitive groups) vs. intergroup competition	9	.00	0
	Cooperative learning (competitive or noncompetitive groups) vs. individual competition	70	.78	28
	Cooperative learning (competitive or noncompetitive groups) vs. individual tasks	104	.78	28

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

The Johnson et al. synthesis found that cooperative learning groups and groups that engage in intergroup competition have the same effect on student learning — they are equally effective . (This effect is indicated by the .00 effect size when the two strategies are compared.) However, cooperative learning has an effect size of .78 when compared with strategies in which individual students compete with one another (individual competition). Finally, cooperative learning has an effect size of .78 when compared with instructional strategies in which students work on tasks individually without competing with one another (individual student tasks). In general, then, organizing students into cooperative learning groups has a powerful effect on learning regardless of whether or not the groups compete with one another.

The strong effects of cooperative learning have encouraged some teachers to use the strategy for virtually every new learning situation. However, some psychologists warn against the “overuse” of cooperative learning. Specifically, Anderson, Reder, and Simon (1997) warn that cooperative learning can be misused and is frequently overused in education. These researchers argue that it is *misused* when the tasks given to cooperative groups are not well structured and *overused* when it is used to such an extent that students have an insufficient amount of time to independently practice the skills and processes they must master.

Chapter 8

SETTING GOALS & PROVIDING FEEDBACK

Each year, the Midland County School District held an art fair, which Ms. Garcia always encouraged her students to enter. This year, one of her students, Allison, decided to do a watercolor painting for the show, even though she had very little experience using the paints. Nevertheless, she was bound and determined to create a painting for the show, which was six weeks away.

Ms. Garcia helped Allison create a time line of the things Allison would need to accomplish before the deadline for submitting her painting, which was one week before the show. Besides choosing a theme, Allison realized she needed to build in time to try different techniques, sketch out the theme, and find out how the painting should be mounted. Ms. Garcia agreed to help Allison with her watercolor techniques and to help her monitor progress toward her goal. Here's what Allison's plan looked like:

Goal: Enter a watercolor painting in the art fair

Week 1: Get schedule of deadlines from principal's office.
Find out if there are any guidelines I must follow (e.g., mounting).
Practice using the paints with different brushes. Try different techniques.
Find an "easy" picture to paint. Practice painting that.

Week 2: Ask Ms. Garcia for her feedback about the painting I did.
Practice again with different brushes and with differing amounts of water.
Decide what to paint. A scene? An object? A person? Then sketch out what I plan to paint.

Week 3: Do the painting. Ask Ms. Garcia for her feedback. Then refine my painting techniques depending on what Ms. Garcia says.

Week 4: If needed, do the painting again. Mount the painting.

Week 5: Submit my painting.

As Allison worked on her painting, Ms. Garcia provided her with very specific feedback on the painting, and on the way Allison was working on the project.

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Goal setting and providing feedback are activities that engage what many researchers and theorists refer to as the *metacognitive* system of thinking. Both strategies have been found to greatly enhance students' progress. Broadly defined, goal setting is the process of establishing direction and purpose. It is a skill that successful people have mastered to help them realize both short-term and long-term goals. Feedback about students' progress is one of the most generalizable strategies a teacher can use. In fact, feedback seems to work well in so many situations that after analyzing 8,000 studies, researcher John Hattie (1992) commented that "the most powerful single modification that enhances achievement is feedback. The simplest prescription for improving education must be 'dollops of feedback'" (p. 9).

SETTING GOALS

1. Set Goals That Are Specific Enough to Give Direction, but General Enough to Allow Flexibility.
(See Illustration 1)

It is important for teachers to set goals for student learning. However, it is also important to give students some flexibility, as exemplified by Illustration 1. If a teacher presents students with general learning targets, then students can personalize them. For example, a health teacher might set "understanding how each of the major organs works individually and how they work together as a system" as a learning goal for students. Individual students can then set more specific targets for learning, such as "I want to know what happens when someone has a heart attack" or "I want to know more about what the spleen does and why some people can live without one."

Students might need assistance setting specific personal learning goals. It is difficult to determine whether a goal has been achieved if it is too abstract. For example, how will a student know that she has reached a goal of "becoming a better reader"? Effective goals are stated specifically and concretely enough to give direction, yet general enough to provide flexibility. For example, "By the end of the quarter, I will know more vocabulary words so that I can read a passage without stumbling over more than two or three words." Goals should support performance, not constrain the goal setter.

2. Contract with Students for Specific Goals They Will Accomplish.
(See Illustration 2)

Setting specific goals in any situation makes it more likely that we will complete the tasks necessary to meet the goal and succeed in meeting the goal itself. Goal setting in the classroom increases the chances that students will accomplish their academic goals. Contracting with students regarding their specific goals for a unit of instruction is a way to formalize the goal-setting process, as exemplified by Illustration 2.

3. Give Students a General Process for Accomplishing Goals.
(See Illustration 3)

Research shows a consistent, positive relationship between setting goals and successfully performing tasks. In fact, successful people attribute much of their achievement to their ability to set, monitor, and achieve goals. Providing students with a goal-setting process or sharing goal-setting guidelines with them can help them more efficiently set and monitor their progress toward their goals, as exemplified by Illustration 3.

Goal-Setting Guidelines

- Start with short-term goals. If you have a long-term goal, break it down into a series of short-term goals.

- State your goal in written form.

- Make your goals as concrete as possible. The most useful goals are those that are more concrete and specific. For example:

Abstract Goals	*Concrete Goals*
Having more fun at home.	Laughing with my family at least once a night about something that happens at home.
Feeling better about myself.	Each day, writing down at least three things I accomplished.

- Identify a time frame in which you plan to accomplish your goal.

- Every day, imagine yourself accomplishing your goal.

- Periodically identify the next steps to take to accomplish your goal.

- Occasionally review your goal to see if you should change it.

- Allow yourself to fail at or drop some goals. Sometimes we set a goal and don't accomplish it. Other times we set a goal, but change it. Both of these are appropriate actions for goal setting. Goals should be tools to help you in life, not rules that constrain you. If a goal is not of interest anymore, change it or drop it.

- When you have reached your goal or have stopped working on it, identify the steps you took that worked and those that did not.

ILLUSTRATION 1: SET SPECIFIC YET FLEXIBLE GOALS *geography and science*

Mrs. Gleichman gave her fourth grade students broad learning goals, but allowed them to set personal learning targets for each unit. She explained that the upcoming ecosystems unit would focus on the ways in which humans change ecosystems and how changes in the environment affect different organisms. Mrs. Gleichman gave students sentence stems to help them create their personal learning goals.

Mica wrote the following personal learning goals for the ecosystems unit:

I want to know more about *how plants in a forest grow back after a fire*.

I know *there is a hole in the ozone layer*, but I want to know *what that really means*.

I want to know if *putting wolves back into Yellowstone National Park really worked*.

ILLUSTRATION 2: CONTRACT FOR GOALS *reading*

Students in Ms. Carraveo's language arts class had different levels of reading skills and vocabulary knowledge. To respond to these differences and keep students progressing toward their learning goals, Ms. Carraveo set up contracts with students.

There were two sections to each contract. One section addressed vocabulary. The other addressed reading skills.

Students agreed to identify 10 words per week from their reading and define them in their vocabulary journals. Students also agreed to spend 20 minutes each day reading. Students individualized their contracts with the names of books that were appropriately challenging given their reading ability. Students checked in bi-weekly with Ms. Carraveo to discuss their progress and update their reading lists as their reading skills improved.

ILLUSTRATION 3: SET AND MONITOR PROGRESS TOWARD GOALS *multiplication tables*

Mrs. Nakashima wanted her students to begin to understand the value of setting goals and keeping track of their progress. She created a simple form for students that asked them to identify a goal, list things they would do to accomplish the goal, and keep track of their progress. The form helped students monitor the steps they took and the improvement they made toward reaching their goals.

When Shana started working on her multiplication tables for 6 through 12, she filled out a goal form and used it each day to record the work she did and the progress she made.

Goal: *Learn the multiplication tables 6 through the number 12.* **By:** *4 weeks from now*

Things I will do to accomplish this goal:

Practice a lot.
Keep track of my progress.
Ask my parents to help me with flash cards.
Do the practice sheets that Mrs. Nakashima gives us each week.
Ask Mrs. Nakashima for help if I'm having trouble.

My Progress:

Week #1:

Mon. *Today I practiced the 6x tables 3 times by myself in class.*

Tues. *I practiced the 6x tables 3 times with a partner during study time.*
Mrs. Nakashima gave the class a quiz. I missed only two.

Wed. *I practiced 6x and 7x 3 times each.*

Thurs.

Fri.

PROVIDING FEEDBACK

1. Use Criterion-Referenced Feedback.
(See Illustrations 1.1 and 1.2)

Criterion-referenced feedback — feedback that tells students where they stand relative to a target level of knowledge or skill — gives students more information about their learning than norm-referenced feedback, which tells them how their performance ranks relative to the performance of other students. Rubrics are effective tools for providing students with criteria that describe specific levels of performance for content that is informational in nature as well as content that is process oriented. Teachers can adapt general rubrics to specific content, as shown in Illustrations 1.1 and 1.2. The following rubrics are general rubrics for information, and for processes and skills, respectively:

General Rubric for Information

4	The student completely understands the information important to the topic, is able to give detailed examples, and can explain complex relationships and distinctions between concepts.
3	The student completely understands the information important to the topic and is able to give detailed examples.
2	The student understands some of the important information related to the topic, but cannot give detailed examples.
1	The student understands very little about the important information related to the topic.
0	No judgment can be made about the student's understanding of the information important to the topic.

Generic Rubric for Processes and Skills

4	The student can perform the skill or process important to the topic fluently and without making significant errors. In addition, the student understands the key aspects of the process.
3	The student can perform the skill or process important to the topic without making significant errors.
2	The student makes some significant errors when performing the skill or process important to the topic but still performs the skill or process.
1	The student makes so many errors when performing the skill or process important to the topic that he or she cannot actually perform the skill or process.
0	No judgment can be made about the student's ability to perform the skill or process.

2. Provide Feedback for Specific Types of Knowledge and Skill.
(See Illustration 2)

In general, the more specific feedback is, the better. When possible, teachers should try to focus their feedback on specific types of knowledge and skill, as exemplified by Illustration 2.

3. Involve Students in the Feedback Process.
(See Illustration 3)

There is no reason that students should not be part of the feedback process. In fact, student-led feedback has many desirable effects (see Wiggins, 1993; Countryman & Schroeder, 1996). There are ways to involve students in the feedback process: through peer feedback and through self-assessment, as exemplified by Illustrations 3.1 and 3.2, respectively.

ILLUSTRATION 1.1: RUBRIC FOR INFORMATION *United States citizenship*

4 The student completely understands the information important to U.S. citizenship, including

- the requirements for US citizenship, such as five years of residence in the U.S.; ability to read, write, and speak English; proof of good moral character; knowledge of the history of the U.S.; knowledge of and support for American constitutional democracy;
- what constitutes citizenship by birth in the United States;
- privileges, such as the right to vote and hold public office; and
- responsibilities, such as respecting the law, voting, paying taxes, serving on juries.

In addition, the student is able to give detailed examples and can explain complex relationships and distinctions between concepts.

3 The student completely understands the information important to U.S. citizenship and is able to give detailed examples.

2 The student understands some of the important information related to U.S. citizenship, but cannot give detailed examples.

1 The student understands very little about the important information related to U.S. citizenship.

0 No judgment can be made about the student’s understanding of the information important to U.S. citizenship.

ILLUSTRATION 1.2: RUBRIC FOR SKILLS OR PROCESSES *solving a linear equation*

4 The student can perform the skills and processes important to solving a linear equation with no significant errors and with fluency. In addition, the student understands the key aspects of solving a linear equation, such as isolating the variable, combining terms, and using the distributive property.

3 The student can perform the process of solving a linear equation without making significant errors.

2 The student makes some significant errors when performing the process of solving a linear equation but still performs the process.

1 The student makes so many errors when performing the process of solving a linear equation that he or she cannot actually solve a linear equation.

0 No judgement can be made about the student's ability to perform the process of solving a linear equation.

ILLUSTRATION 2: PROVIDE SPECIFIC FEEDBACK *tennis*

Students in Ms. Greenfield's class were focusing on improving their tennis skills for an upcoming tournament with another school. Some of the students needed to hone their serving skills; others were more focused on improving their volleying skills.

Ms. Greenfield set up class time as well as after-school clinics during which students could practice their skills. As students practiced, she gave frequent, specific, individual feedback on how they could improve their skills or correct any specific problems she noticed.

As students continued to practice, she continued to give them feedback — if a student's skill improved, she said so and pointed out the specific way in which it had improved. For example, one student's volleying skills improved because he seemed to focus his attention more fully on the ball and followed through after he hit it. If a student's skill did not improve, she continued to give the student specific feedback and help him or her make corrections.

ILLUSTRATION 3.1: INVOLVE STUDENTS IN THE FEEDBACK PROCESS *technology*

PEER FEEDBACK

Mr. Baird's "Build Your Own Web Site" unit gave him the perfect opportunity to involve students in the feedback process. After the lesson on Web site usability, he introduced students to the next lesson.

> "We've learned about the importance of making your site easy for people to use and making it pleasing to the eye. As part of the design process, I want you to conduct tests with five users from the class. The feedback you gain from these tests will give you ideas for improving your design."

When Alma's site was almost ready to test, she scheduled five tests with different students at different times. She planned to get feedback from three students on her original design, make adjustments to the site based on their comments, and then test the new design on two more students.

Her plan worked well. Joe, her first test user, happened to have a red-green color deficiency, so he had problems using the navigation bar with purple lettering on top of a green background. Devon made some suggestions about how to make the text on the site more concise. Her third test user, T. J., asked some questions about the purpose of an e-mail form and how it worked.

Using the feedback she received from the first round of usability tests, Alma revised the site before testing it again. To follow up on Joe's problem with her color scheme, she asked him to take another look at her revised site.

New feedback from Joe and the two new testers informed Alma that her color scheme worked and the form was much easier to use, but she still needed to improve the text on the site. Involving students in the feedback process provided Alma with immediate responses to her work and helped her monitor her own progress as she continued working on the Web site.

ILLUSTRATION 3.2: INVOLVE STUDENTS IN THE FEEDBACK PROCESS *speech communications*
SELF-ASSESSMENT

Mr. Reagan thought it was important for students in his speech communications class to assess their effectiveness in making speeches. Each time students gave a class presentation or participated in a schoolwide debate, they rated themselves on a number of factors, including the accuracy and thoroughness of the information they presented or used in their arguments, the degree to which they considered the characteristics of their audience and the purpose of the presentation, and how organized their presentation was.

Mr. Reagan passed out a self-assessment sheet for each student to use and demonstrated how to use it. The sheet had blank spaces where students could periodically rate themselves using 4-point scales to assess their understanding and skill. The sheet also had spaces where students could write specific comments about their progress. Mr. Reagan told students that they should write freely about how well they thought they did after each speech.

Once every two weeks, Mr. Reagan collected students' self-assessments and then met with students to give them his feedback about their progress. During each conference, the student and Mr. Reagan identified those areas the student seemed to be doing well in, those that could be improved, as well as strategies for improvement.

Student: *Al Cheney*	**Speech/Presentation**	**Skill**	**Understanding of the Content**
Date: *Mon., Nov. 1*	*The Role of the U.S. Vice President in Foreign Affairs*	*2*	*3*
Comments/Analysis: *I included a few important details about the topic. All of my facts were accurate. My talk could have been organized more clearly, and I didn't keep my audience's background knowledge in mind.*			
Fri., Nov. 19	*Genetically Modified Foods: Safe for Human Consumption?*	*3*	*3*
Comments/Analysis: *I had enough details and facts so that people knew what I was talking about. I took my audience into consideration and provided enough background when I started so they could follow me. And my organization made it easy for people to follow my presentation. I still need to work on adding more details to show that I have a complete understanding. I also need to learn to use my voice better to make my points more strongly.*			

THEORY AND RESEARCH IN BRIEF • • •
Setting goals and providing feedback

Goal Setting — Findings from some of the studies that have synthesized research on goal setting are reported in Table 8.1.

Table 8.1: Research Results for Goal Setting

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Wise & Okey, 1983[b]	General effects of setting goals or objectives	3	1.37	41
		25	.48	18
Walberg, 1999	General effects of setting goals or objectives	21	.46	18
	Effects on unintended outcome	20	–.20	–8
Fraser et al., 1987	Behavioral objectives	111	.12	5

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.
[b]Two effect sizes are listed because of the manner in which effect sizes were reported. Readers should consult that study for more details.

Note the relatively low effect of behavioral objectives on achievement reported in Table 8.1 as compared to the general effects of setting goals. One can only speculate why this discrepancy exists. A plausible explanation is that behavioral objectives are simply too specific. Behavioral objectives gained prominence in 1962 when evaluation expert Robert Mager published the book *Preparing Instructional Objectives*. Mager explained that effective instructional objectives have three defining characteristics:

1. *Performance*. An objective always says what a learner is expected to be able to do; the objective sometimes describes the product or result of the doing.
2. *Conditions*. An objective always describes the important conditions (if any) under which the performance is to occur.
3. *Criterion*. Whenever possible, an objective describes the criterion of acceptable performance by describing how well the learner must perform in order to be considered acceptable. (p. 21)

Instructional objectives generated using Mager's criteria obviously were highly specific in nature. Perhaps they were simply too specific to accommodate the individual and constructivist nature of the learning process.

Another interesting finding reported in Table 8.1 is the negative effect that setting goals has on outcomes other than those specified in the objectives. This means that if a teacher establishes a goal, for example that students understand how a cell functions, students' understanding of information incidental to this concept but still addressed in class might actually be less than if a specific goal were not set. This phenomenon might occur because setting a goal focuses students' attention to such a degree that they ignore information not specifically related to the goal.

FEEDBACK — Findings from some of the studies that have synthesized research about the general effects of feedback are reported in Table 8.2. Note that some of the effect sizes reported in Table 8.2 are .90 and even higher. Generally, feedback that produces these large effect sizes is "corrective" in nature — that is, the teacher identifies what is correct and incorrect about students' knowledge or skill.

Some of the more interesting findings regarding feedback were reported by Bangert-Downs, Kulik, Kulik, and Morgan (1991). The overall effect size they reported was only .26. However, it is important to note that their study focused on feedback that takes the form of a test or, as they refer to it, "test-like events." Their findings are reported in Table 8.3.

The findings shown in Table 8.3 have some rather strong implications for education. Notice that simply telling students that their answer is right or wrong has a negative effect on achievement. Providing students with the correct answer has a moderate effect size (.22). The best feedback appears to involve an explanation as to what is accurate and what is inaccurate in terms of student response. In addition, asking students to keep working on a task until they succeed appears to enhance achievement.

Timing of feedback is also important. Feedback given immediately after a test (or test-like situation) is best. In general, the more delay that occurs in giving feedback, the less improvement there is in achievement. Finally, consider the different effects that the timing of a test has on achievement. Giving tests immediately after a learning situation has a negligible effect on achievement. Giving a test one day after a learning situation seems to be optimal.

Table 8.2: Research Results for Providing Feedback

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Lysakowski & Walberg, 1982[b]	General effects of feedback	22	.92	32
		7	.69	2
		3	.83	3
		9	.71	26
Lysakowski & Walberg, 1981[b]	General effects of feedback	39	1.15	37
		9	.49	19
		49	.55	21
		11	.19	7
Walberg, 1999	General effects of feedback	20	.94	33
Tennebaum & Goldring, 1989[b]	General effects of feedback	15	.66	25
		7	.80	29
		3	.52	20
		3	.51	19
		2	.67	25
Bloom, 1976	General effects of feedback	7	.54	21
Haller, Child, & Walberg, 1988	General effects of feedback	20	.71	26
Bangert-Downs, Kulik, Kulik, & Morgan, 1991	General effects of feedback	58	.26	10

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.
[b]Multiple effect sizes are listed because of the manner in which effect sizes were reported. Readers should consult these studies for more details.

Table 8.3: Research Results for Corrective Feedback

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Type of Feedback	Teacher says whether the answer is right or wrong	6	-.08	-3
	Teacher provides correct answer	39	.22	9
	Student continues to answer until gives correct response	4	.53	20
	Teacher explains what is correct & what is not	9	.53	20
Timing of Feedback	Immediately after each test item	49	.19	7
	Immediately after test	2	.72	26
	Delayed after test	8	.56	21
Timing of Test	Immediately after instruction	37	.17	6
	One day after instruction	2	.74	27
	One week after instruction	12	.53	20
	Longer than one week	4	.26	10

Note: From "The Instructional Effects of Feedback in Test-like Events," by R. L. Bangert-Downs, C. C. Kulik, J. A. Kulik, & M. Morgan, 1991, *Review of Educational Research*, *61*(2), 213–238.
[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

Chapter 9

GENERATING & TESTING HYPOTHESES

Mrs. Justice designed a multidisciplinary unit around Goldilocks and the Three Bears *that would help her primary students learn concepts in many different academic areas. One lesson involved helping students learn the skills of scientific observation.*

She began the lesson by reading Goldilocks and the Three Bears. *She then read this poem:*

"Peas porridge hot
Peas porridge cold
Peas porridge in the pot
Nine days old."

With students' help, Mrs. Justice made a bowl of oatmeal. After it cooled, she covered it with plastic. She then asked students to predict what the oatmeal would look like after sitting on the classroom counter for nine days, like the porridge in the poem. She wrote each student's prediction on a chart on the board. Some students thought the oatmeal would dry up; others thought it would evaporate; others thought it would get moldy and smell bad.

Each day students observed what the oatmeal looked and smelled like. They then colored pictures in a journal and made notes about what they observed. For example, students wrote whether there was water on the plastic wrap, used crayons to indicate the color of the oatmeal, and wrote whether the oatmeal looked the same as it had the day before. On the ninth day, students compared their original predictions to what the oatmeal really looked like.

The lesson Mrs. Justice designed gave her students an opportunity to experience what it might be like to be a scientist and involved them in a highly complex form of thinking — generating hypotheses and then testing these hypotheses.

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Generating and testing hypotheses involves applying knowledge. For example, consider a student who watches a demonstration of how air flows over the wing of an airplane. After watching the demonstration, he applies what he has learned to hypothesize that changing the shape of the wing in a specific way will have a specific effect on the flow of air, designs a wing with the desired shape, and then tests his conjecture.

1. *Use a Variety of Structured Tasks to Guide Students Through the Process of Generating and Testing Hypotheses.*
(See Illustrations 1.1–1.6)

Many people associate generating and testing hypotheses with the scientific method. However, this strategy can be used across all disciplines. In this section we describe six types of tasks that require students to generate and test hypotheses: systems analysis tasks, problem-solving tasks, historical investigation tasks, invention tasks, experimental inquiry tasks, and decision-making tasks.

Systems Analysis

Across the disciplines, students have opportunities to study systems: computer network systems, the highway system, ecosystems, government systems, weather systems. To analyze these systems, teachers can ask students to generate and test hypotheses about what might happen if a part of the system changed. Teachers might guide students' work using the following general framework:

1. Explain the purpose of the system, the parts of the system, and the function of each part.
2. Describe how the parts affect one another.
3. Identify a part of the system, describe a change in that part, and then hypothesize what might happen as a result of this change.
4. When possible, test your hypothesis by actually changing the part. Or "test" the hypothesis by considering the effects of the change on the system.

Problem Solving

Solving a problem requires students to understand obstacles and constraints. They also must generate and test hypotheses about possible solutions. Teachers might guide students' work using the following general framework:

1. Identify the goal you are trying to accomplish.
2. Describe the barriers or constraints that are preventing you from achieving your goal — what is creating the problem?
3. Identify different solutions for overcoming the barriers or constraints and hypothesize which solution is likely to work.
4. Try your solution — either in reality or through a simulation.
5. Explain whether your hypothesis was correct. Determine if you want to test another hypothesis using a different solution.

Historical Investigation

Historical investigation involves examining defensible scenarios for a past event about which there is no general agreement. To engage in historical investigation, students must use their understanding of the past situation and key players in the event to generate a hypothesis. Testing the hypothesis requires collecting and analyzing information to determine if the evidence supports it. Teachers can adjust the complexity level of an investigation for younger students, as exemplified by Illustration 1.4. Teachers might guide students' work using the following general framework:

1. Clearly describe the historical event to be examined.
2. Identify what people know or agree about and what people do not know or disagree about.
3. Based on what you understand about the situation, develop a possible explanation or a resolution of the disagreement.
4. Seek out and analyze evidence to determine if your explanation or resolution is plausible.

Invention

People invent products or processes to fulfill specific needs. The invention process involves hypothesizing what might work, developing the idea, and testing the invention. This process might require developing several hypotheses and conducting multiple tests before achieving an effective result. Teachers might guide students' work using the following general framework:

1. Describe a situation you want to improve or a need you want to respond to.
2. Identify specific standards for the invention that would improve the situation or meet the need.
3. Brainstorm ideas, and hypothesize the likelihood that each will work.
4. If your hypothesis suggests that a specific idea might work, begin to draft, sketch, and actually create the invention.
5. Develop your invention to the point that you can test your hypothesis.
6. If necessary, revise your invention until it reaches the standards you have set.

Experimental Inquiry

Although many educators commonly associate the process of experimental inquiry with generating and testing hypotheses in science, this strategy can be used across the disciplines to help students use knowledge meaningfully. The same process that drives inquiry in science classes can be used to explain observations, generate explanations, and make and test predictions. Teachers might guide students' work using the following general framework:

1. Observe something of interest to you and describe what you have observed.
2. Apply specific theories or rules to explain what you have observed.
3. Based on your explanation, generate a hypothesis to predict what might happen if you apply the theories or rules to what you observed or to a situation related to what you observed.
4. Set up an experiment or engage in an activity to test your hypothesis.
5. Explain the results of your experiment or activity. Decide if your hypothesis was correct. Also decide whether you need to conduct additional experiments or activities or generate and test an alternative hypothesis.

Decision Making

Generating and testing hypotheses may not seem related to making a decision, but students can examine hypothetical situations using a structured decision-making process. For example, when choosing the best or worst representative of a specific category, such as the worst movie of the 1990s, students will likely make a prediction. A structured decision-making framework requires them to use a broad range of knowledge to develop criteria and test their predictions against these criteria. Teachers might guide students' work using the following general framework:

1. Describe the decision you are making and the alternatives you are considering.
2. Identify the criteria that will influence the selection and indicate the relative importance of the criteria by assigning an importance score, such as 1, 2, 3, or 4.
3. Using a designated scale, such as 1–4, rate each alternative to indicate the extent to which each alternative meets each criterion.
4. For each alternative, multiply the importance score and the rating and then add the products to assign a score for the alternative.
5. Examine the scores to determine the alternative with the highest score.
6. Based on your reaction to the selected alternative, determine if you need to change any importance scores or add or drop criteria.

2. Ask Students to Explain Their Hypotheses and Conclusions.
(See Illustration 2)

The process of explaining their thinking helps students enhance their understanding of the concepts they are using. To facilitate this process, teachers can design assignments that require students to explain how they generated their hypotheses and describe what they learned as they tested them, as Illustration 2 exemplifies. Teachers might use a variety of strategies, such as the following:

- Provide students with a "results template" that highlights areas where students will be required to explain their work and describe what they learned.

- Give students (especially younger students) sentence stems to prompt their thinking about the process, for example, "I think if I change _________, then _________ will happen"; "While doing this task, I learned _______."

- Ask students to submit an audio tape that describes the steps they used to generate and test a hypothesis and what they learned in the process.

- Work with students to develop a rubric that establishes criteria for evaluating the clarity and thoroughness of explanations as well as the degree to which the explanations are supported by evidence.

- At school events, such as parent-teacher conference days, provide opportunities for parents and others to ask students to explain their thinking.

ILLUSTRATION 1.1: STRUCTURED TASK *systems analysis*

Mrs. Ollinger had been teaching her third graders about simple food chains and food webs, but she wasn't sure they were seeing how all the pieces connected. She decided to talk to her class about food chains and webs as systems.

After she explained the purpose of a food web, she called on students to identify the parts of a specific food web and describe the function of each part. Students described a food web in a forest that included squirrels, birds, rabbits, snakes, deer mice, owls, white-tailed deer, black bears, spruce, fir, aspen trees, berries, and various grasses. Students drew diagrams and pictures to show how different parts affected one another.

For homework, Mrs. Ollinger asked students to choose a part of the food web, describe a change in that part, and make a prediction about what might happen to the rest of the web. Although students could not actually change a part of the system, the next day they "tested" their hypotheses by explaining them and the conclusions they had drawn.

Dan wondered what would happen if the owls became extinct. He hypothesized that if the owls disappeared, the population of deer mice and rabbits would grow a lot because there would not be as many predators. Another student pointed out that the number of snakes might also increase, which might in turn help reduce the number of rabbits and deer mice. In this way, students described their hypotheses, explained their conclusions, and extended their understanding of food chains as systems.

ILLUSTRATION 1.2: STRUCTURED TASK *problem solving*

Mr. Deshler's sixth graders were studying how political, religious, and social institutions affected family and community life in colonial America. He wanted them to gain an in-depth understanding of what people faced when they came to the English colonies. To focus the rest of the unit, he presented them with the following scenario:

> You are a 25-year old woman on a ship headed to the British colonies. Your husband died 6 days into the journey, leaving you on your own. You are devastated by your loss but decide you want to live in the new colonies as an independent woman. How will you achieve this goal?

Mr. Deshler and his students completed a character sketch of the woman on the ship by giving her a name and filling in details: how much money she had, what her skills were, etc. They decided where the ship would land and spent the next week identifying the barriers and constraints she would face, describing different solutions, and testing these hypotheses based on what they were learning about colonial America.

ILLUSTRATION 1.3: STRUCTURED TASK COMPLEX *historical investigation*

While teaching her world history students about the Great Depression, Mrs. Belvin seized the opportunity to engage her students in an investigation: What caused the Great Depression?

The class discussed events leading up to the Depression. In addition, Mrs. Belvin presented some of the commonly held views about the cause of the Depression, including the decline in investment spending, the high tariff passed during the Hoover administration, and poor monetary policy. Although she did not expect her students to resolve a disagreement that economic historians have debated for years, Mrs. Belvin thought the investigation would help her students gain an in-depth understanding of the historical issues and economic concepts related to the Great Depression.

Students created possible explanations based on their understanding of the economic elements and key players of the time. Students then collected and analyzed information to determine if the evidence supported their hypothesis. When they shared their findings, students realized that the evidence could support more than one hypothesis. This discovery taught them an important lesson about how people interpret history — sometimes more than one plausible explanation or interpretation exists.

ILLUSTRATION 1.4: STRUCTURED TASK LESS COMPLEX *(typically for younger students)* *historical investigation*

Ms. Schoch's fourth graders were learning research skills. Ms. Schoch wanted her students to think about what people commonly know about historical figures. She asked them to pick one of their favorite people from history and research a famous story about that person.

One student wanted to find out if George Washington really chopped down the cherry tree. Another student wanted to know why Amelia Earhart just disappeared. As they were doing their research, students learned that some widely shared stories are not true at all and that sometimes history books do not have all the answers. These discoveries gave Ms. Schoch and her students a chance to discuss history in a new light. Her students learned that often there is more to a story than what one first hears.

ILLUSTRATION 1.5: STRUCTURED TASK *invention*

Several students in Mr. Eversole's small engines class were serious snowmobile riders. Concerned about the recent ban of snowmobiles from various parks and national forest lands, they decided to build a cleaner, quieter snowmobile for their final team project.

Students consulted regulations on several government Web sites to help them set standards for acceptable emissions and noise levels. Next, using what they had learned throughout the year, students generated hypotheses about engine redesign, alternative fuels, and materials for noise reduction. Keith suggested they design a four-stroke engine, but other team members thought it would be too heavy and have a sluggish throttle response.

Finally, students decided to refine a two-stroke engine and reduce carbon monoxide emissions. As they drafted the model for the new engine, the team members checked in periodically with Mr. Eversole to ask questions and receive feedback. They constructed their invention in stages, testing and revising the engine until they were happy with the results before moving on to other design features of the snowmobile. When they were finished, the students explained how their snowmobile was quieter than existing models and how it met emission and noise level standards.

ILLUSTRATION 1.6: STRUCTURED TASK *experimental inquiry*

Chantelle had been a "Navy brat" her whole life. By the time she was in eighth grade, she had grown accustomed to her father's schedule — 12 months at home, six months away.

One day in her health and life skills class, the teacher talked about test-taking skills and how "outside" factors could influence a student's performance. For example, if a student had a cold, she might not perform as well on a test as she would if she didn't have a cold. This idea made Chantelle think about how her father's long absence might affect her school work. She knew that sometimes when her father was gone, she didn't know where he was and worried about his safety. Was this distraction one of those "outside factors"?

Chantelle hypothesized that the long absence of a child's father or mother would have a negative effect on the child's performance in school. In order to test her hypothesis, she worked with her teacher to create a questionnaire and collect some data. Chantelle interviewed students and their parents who served in the military. She also talked to teachers who had taught children from military families to see if they had any insights. Her teacher helped her gather some student achievement data from published studies so Chantelle could look for related patterns. Chantelle was surprised to find that she could not come to a definite conclusion about the effects of a parent's long absence on student performance. In some cases, her hypothesis was correct, but in others it was not. She concluded that more study was needed in this area.

ILLUSTRATION 1.7: STRUCTURED TASK *decision making*

Mrs. Switzer's primary students had been studying different characteristics of music and how music affects people's moods. To help her students put it all together, Mrs. Switzer asked them to help her friend, Dr. Watson, figure out what type of music to play in her waiting room.

Mrs. Switzer explained that Dr. Watson was a family doctor who saw all kinds of patients, including very young children, pregnant women, and older patients. Mrs. Switzer drew a decision-making matrix on the board and filled in the alternatives the class wanted to consider: jazz, classical, contemporary pop, and "oldies."

As a large group, the class identified the characteristics of music that would influence their decision. They chose "smooth rhythm," "soothing melody," and "steady tempo." Mrs. Switzer explained that they would rate each type of music to show how it matched each characteristic. She described the rating scale in terms students could understand: 4 meant "a whole lot," 3 meant "some," 2 meant "a little bit," and 1 meant "barely at all." Mrs. Switzer walked them through the first couple of characteristics for jazz and then asked students to work individually.

After the students finished filling in the matrix, she showed them how to add up the numbers to find out which alternative had the highest score. (Because of their age, she automatically assigned each criterion an importance score of 1, so that multiplication was not required.) Students checked each other's math, and then the class discussed the choices they made.

Decision-Making Matrix

	Alternatives			
Criteria	Jazz	Classical	Contemporary Pop	"Oldies"
smooth rhythm	1			
soothing melody	2			
steady tempo				
Totals				

ILLUSTRATION 2: EXPLAIN HYPOTHESES & CONCLUSIONS *"small engines" class*

Mr. Eversole, the small engines teacher, was very pleased with the progress his snowmobile team was making on their project. However, he really wished students would concentrate more on explaining their thinking. To encourage this behavior, he provided the team with a "thinking sheet" to complete at regular intervals during the invention process.

Our hypothesis: ____

____

____

We think this idea will work because

____

____

____

____

____

After we tried this idea, we found

____

____

____

____

____

____

____

We made modifications ____Yes ____No

After we made modifications, we found

____

____

____

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____

THEORY AND RESEARCH IN BRIEF • • •
Generating and testing hypotheses

Findings from some of the studies that have synthesized research on generating and testing hypotheses are reported in Table 9.1. Notice that some of the studies listed in Table 9.1 distinguish between strategies that are more *deductive* in nature and those that are more *inductive*. Using the figures in Table 9.1, we can compute an average (weighted) effect size for techniques that are more deductive in nature of .60 and an average (weighted) effect size for techniques that are more inductive in nature of .39. Given this difference, it is useful to consider the nature of deductive versus inductive techniques.

Table 9.1: Research Results for Generating and Testing Hypotheses

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Hattie, Biggs, & Purdie, 1996	General effects of generating & testing hypotheses	2	.79	28
Tamir, 1985	Deductive techniques	13	.27	11
Lott, 1983	Deductive techniques	18	.02	1
	Inductive techniques	4	.10	4
Ross, 1988	Deductive techniques	65	.83	30
	Inductive techniques	39	.48	19
El-Nemr, 1980	Inductive techniques	250	.38	15
Sweitzer & Anderson, 1983	Inductive techniques	19	.43	17
Walberg, 1999	Inductive techniques	38	.41	16

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

Deductive thinking is commonly thought of as the process of using a general rule to make a prediction about a future action or event (see Johnson-Laird, 1983). For example, while beginning to read a story about a particular wolf, you will naturally access some of the generalizations you have about wolves from your permanent memory. If one of those generalizations is “wolves run in packs and are highly social,” then you will predict that the story will contain episodes about the interaction of the individual wolf with other wolves that are members of a pack.

It is worth noting that thinking in real life is probably never purely inductive or deductive. Rather, scholars assert that reasoning is often more "messy" and nonlinear than it is commonly believed to be (Eco, 1976, 1979, 1984; Medawar, 1967; Percy, 1975; Deely, 1982). Many philosophers have advanced the concept of *retroduction* as a more fruitful approach to understanding the nature of inferential thinking. Retroduction is the act of generating and shaping an idea based on one or more cases. Sometimes inferences made during this process are more inductive in nature; sometimes they are more deductive in nature.

Inductive thinking is thought of as the process of drawing new conclusions based on information we know or are presented with (see Holland, Holyoak, Nisbett, & Thagard, 1986). For example, if you are reading an account of how a particular bear behaved when observed by a scientist, you would induce that the behaviors observed multiple times by the scientist are behaviors the bear habitually engages in or even behaviors that *all* bears habitually engage in.

Inductive techniques are those that require students to first discover the principles from which hypotheses are generated. To illustrate using the example of air flow, a teacher would be using an *inductive* approach if she had students first discover principles about air flow and then generate hypotheses based on these discovered principles. However, a teacher would be using a *deductive* approach if she first presented students with a principle of air flow such as the Bernoulli theorem. With this knowledge as a basis, she would then ask students to generate and test hypotheses based on the principles they have been taught.

The process of generating and testing hypotheses is not limited to physical phenomena, although we generally think of generating and testing hypotheses about the physical world. For example, people discover or are taught principles that relate to phenomena like air flow and then use those principles to make and test predictions. However, the same process can be applied to psychological phenomena. For example, based on observations about how people relate to specific types of visual stimuli, someone might generate and test a hypothesis about the effects of a specific type of advertisement.

Chapter 10

ACTIVATING PRIOR KNOWLEDGE

At the beginning of an introductory psychology course, Mrs. Penley wrote the word psychology *on the board. Then she asked students to tell her everything they knew about the term.*

As students answered, she wrote key words on the board. Students analyzed the word itself (e.g., its root, its meaning, its basic definition). They also discussed their associations with the word. Students identified the following associations: Sigmund Freud, dream interpretation, therapy, and hypnosis.

By the end of the discussion, Mrs. Penley had a list of the basic knowledge students had about psychology. Throughout the course, Mrs. Penley used the information students already had learned about psychology as a springboard for helping them learn new information.

****

The strategies in the final category of instructional approaches all help students retrieve what they already know about a topic. In nontechnical terms, this is sometimes referred to as "activating prior knowledge." Mrs. Penley was activating the prior knowledge of her students in an informal but effective way when she asked students to think about what they already knew about the word *psychology*. Cues and questions, as well as advance organizers, are techniques that teachers can use to activate students' prior knowledge.

Cues and questions are very similar. Cues are "hints" about what students are about to experience. For example, a teacher is giving students a cue when she explains that the film they are about to watch on the functioning of the cell will provide some information they already know about the cell, but it will also provide some new information. The teacher has told students what the topic of the film is, which helps them to activate their prior knowledge. Also, the teacher has told them to expect some new information, which establishes expectations for students. Questions perform about the same function. For example, prior to watching the film on the functioning of the cell, the teacher might ask students questions that elicit what they already know about the topic.

Another way that teachers can help students use their background knowledge to learn new information is to present them with advance organizers. Advance organizers are organizational frameworks that a teacher presents in advance of learning. Advance organizers emphasize the essential ideas that the teacher plans to cover in a lesson or unit.

CUES AND QUESTIONS

1. Present Students with Explicit Cues.
(See Illustration 1)

Cues are very straightforward ways of activating prior knowledge. Teachers can give students explicit previews about what they are about to experience, as exemplified by Illustration 1.

2. Ask Questions that Require Students to Make Inferences About Content.
(See Illustration 2)

Even the best-designed lesson requires students to "fill in" a great deal of missing information. Questions can greatly aid students in this process, as exemplified by Illustration 2. To use questions, a teacher would identify things, people, actions, events, and states or conditions referred to in information students are learning and then ask questions such as those listed below.

Questions About Things or People

- How is this thing usually used? (*How is a hammer usually used?*)
- What is this thing (or person) part of? (*What is a piston part of?*)
- What is the process for making this thing? (*What is the process for making cotton?*)
- What action does this thing (or person) usually perform? (*What action does the U.S. Speaker of the House usually perform?*)
- What action is usually performed on this thing? (*What action is usually performed on a piano?*)
- Does this thing have a particular taste, feel, smell, sound? What is it? (*Do roses have a particular feel?)*
- What particular color, number (or quantity), location, or dimensionality does this thing have? (*What particular number of electrons, protons, and neutrons does hydrogen have?*)
- How is this thing usually sold? (*How are eggs usually sold?*)
- Does this person have a particular emotional state? What is it? (*What is the emotional state of Hamlet after his father's death?*)
- Does this thing have a particular value? (*What is the value of a 5-carat diamond?*)
- When this thing is used, does it present a particular danger to other things or to people? What is it? (*What danger might a knife present to things or people?*)

Questions About Actions

- What thing or person usually performs this action? (*Who usually flies an F-18 fighter plane?*)
- What effect does this action have on the taste, feel, sound, or look of this thing? (*What effect does boiling have on the look of water?*)
- How does this action typically change the emotional state of a thing or person? (*How does a stressful situation at work typically change the emotional state of a person?*)
- How is the value of a thing changed by this action? (*How is the value of a river changed by building a dam?*)
- How does this action change the size or shape of a thing? (*How does freezing and thawing change the size or shape of a concrete sidewalk?*)
- How does this action change the state of a thing? (*How does raising interest rates change the state of the economy?*)

Questions About Events

- What people are usually involved in this event? (*What people are usually involved in a legal trial in the United States?*)
- During what season or time of year does this event usually take place? (*During what season or time of the year is the shortest day of the year?*)
- On what day of the week does this event usually take place? (*On what day of the week does the stock market usually open?*)
- At what time of day does this event usually take place? (*At what time of day do fish usually eat?*)
- Where does this event usually take place? (*Where do sessions of the U.S. Congress usually take place?*)
- At what point in history did this event take place? (*At what point in history did the death of Socrates take place?*)
- What equipment is typically used in this event? (*What equipment is typically used in a debate?*)
- How long does this event usually take? (*How long does a volcanic eruption usually take?*)

Questions About States

- What is the basic process involved in reaching this state? (*What is the basic process involved in hypothermia?*)
- What are the changes that occur when something reaches this state? (*What are the changes that occur when someone becomes hypothermic?*)

3. Present Students with Questions that Require Them to Analyze What They Are Studying in Complex Ways. ***(See Illustration 3)***

Some questions require students to analyze information that is presented to them, as exemplified by Illustration 3. To facilitate this type of questioning, it is useful for students to be able to use analytical skills such as the following, each of which can be cued by one or more specific questions:

Analyzing Errors: Identifying and articulating errors in the logic of information.
What are the errors in reasoning in this information?
How is this information misleading?
How could it be corrected or improved?

Constructing Support: Constructing a system of support or proof for an assertion.
What is an argument that would support the following claim?
What are some of the limitations of this argument or the assumptions underlying it?

Analyzing Perspectives: Identifying and articulating personal perspectives about issues.
Why would someone consider this to be good (or bad or neutral)?
What is the reasoning behind his or her perspective?
What is an alternative perspective, and what is the reasoning behind it?

ILLUSTRATION 1: GIVE EXPLICIT CUES *Romeo and Juliet*

Ms. Baker's English class was about to begin a Shakespeare unit. One of the plays students were going to read was *Romeo and Juliet*. To introduce the play, Ms. Baker presented the following cues:

- The play takes place in a town in Europe.
- The country is shaped like a boot.
- The main characters are "star-crossed lovers."
- The male lead gives a romantic monologue under his lover's balcony.
- The play has a tragic end.

Ms. Baker then asked students to talk in pairs about the cues and what they already knew about *Romeo and Juliet.*

ILLUSTRATION 2: ASK QUESTIONS THAT ELICIT INFERENCES *the Federal Reserve System*

Ms. Bodrova assigned a reading about U.S. monetary policy for homework. To focus students as they read, she asked them to be ready the next day to discuss three questions:

1. What actions does the Federal Reserve System usually perform?
2. How is monetary policy usually used?
3. How does monetary policy affect inflation in the United States?

Juan took notes on each of the questions so he would be ready for the next day's discussion:

What actions does the Federal Reserve System usually perform?

We usually just think that the Federal Reserve System raises or lowers interest rates — which they do, but not directly. The "Fed" uses "tools" to affect interest rates:

open market purchases or selling government securities
increasing the discount rate charged on loans it makes to commercial banks
raising or lowering reserve requirements for commercial banks

How is monetary policy usually used?

The Federal Reserve System uses monetary policy to control the amount of money in circulation and the availability of credit in the financial system. Basically this means they do things to raise or lower interest rates and that affects demand for good and services (for individual consumers and businesses).

How does monetary policy affect inflation in the United States?

If monetary policy stimulates demand too much (so that labor and capital can't keep up in the long run), then salaries and prices will rise at faster rates. If monetary policy keeps short-term rates low, that will eventually cause higher inflation and higher interest rates. [But will this change permanently increase output or decrease unemployment? Better ask about this tomorrow!].

The questions helped students make sense of what they had read. The next day Ms. Bodrova used the questions to guide the class discussion and help students clarify misconceptions and fill in gaps in their understanding.

ILLUSTRATION 3: GIVE STUDENTS ANALYTICAL QUESTIONS *media and society*

During a unit on the media, Mr. Brokaw asked his students to consider the question, Does the media *affect* society or *reflec*t society? He then asked students to construct support for their opinions using facts, evidence, and examples.

As an additional step, he had students identify the limitations of their arguments. For example, if a student argued that the media reflect society, a limitation of her argument might be statistics regarding the higher percentage of violent acts on television compared to the percentage of violent acts in the United States.

Mr. Brokaw also asked students to analyze perspectives by finding a partner who held a perspective that was different from their own, identifying the reasons or logic behind that perspective, and then constructing support for that perspective. Finally, as students presented their arguments to the class, Mr. Brokaw asked the rest of the class to listen to the arguments and identify any errors in reasoning or ways in which the information was misleading. For example, one student said that a presenter used circular reasoning because the presenter argued that the media affect society by saying, "People are clearly influenced by what they see on television"— that is, he backed up his claim with a statement that was simply a restatement of the claim.

ADVANCE ORGANIZERS

1. Present Students with Expository Advance Organizers.
(See Illustration 1)

Expository advance organizers describe, in either written or verbal form, the new content students will be exposed to, as exemplified by Illustration 1. An expository advance organizer may simply provide students with the meaning and purpose of what is to follow. However, it may also give students more detailed information about what they will be learning or an example of what they will be learning, especially for information that may be difficult to understand. As with all advance organizers, an expository advance organizer emphasizes the important information in a lesson or unit.

2. Present Students with Narrative Advance Organizers.
(See Illustration 2)

A narrative advance organizer takes the form of a story. In Illustration 2, the teacher provides the essential ideas of the lesson or unit she plans to teach by telling a story that incorporates some of the key ideas. Advance organizers help students connect what they are about to learn to prior knowledge and focus on what is important.

3. *Use Graphic Advance Organizers.*
(See Illustration 3)

Graphic organizers were discussed in Chapter 6 as a type of nonlinguistic representation. They also can be effectively used as advance organizers, as exemplified by Illustration 3.

4. *Use Skimming as an Advance Organizer.*
(See Illustration 4)

Skimming information before reading can be a powerful form of advance organizer. When a teacher asks students to skim learning materials, he gives them the opportunity to preview the important information that they will encounter later by focusing on and noting what stands out in headings, subheadings, and highlighted information, as exemplified by Illustration 4.

ILLUSTRATION 1: EXPOSITORY ADVANCE ORGANIZER *field trip to a butterfly farm*

Ms. MacKenzie's second grade class was going on a field trip to a butterfly farm. She prepared students for the trip by telling them that their guide would share some information with them about butterflies. She said that the guide would explain the life cycle of a butterfly, show them a big map explaining butterfly migration patterns, and show them where the butterflies live.

Ms. MacKenzie also told her students that the butterflies' home was completely covered with net to keep them from flying away and that they would see butterflies from all over the world and in every color of the rainbow. She asked students to count how many different kinds of butterflies they saw at the farm. Finally, she said if they were really lucky, they'd get to see some butterflies come out of their cocoons!

ILLUSTRATION 2: NARRATIVE ADVANCE ORGANIZER PERSONAL STORY *immigrating from Sweden*

Before beginning a unit about the experience of immigrant groups who moved to the United States, Mr. Anderson told the story of his grandfather, who immigrated from Sweden:

"My grandfather Gustav came here from Sweden in the late 1800s. My name, Anderson, tells you right away that I have Swedish heritage. Anderson means the 'son of Anders.' The Danish use 'sen,' Ander*sen*.

"Anyway, my Grandpa Gus came here with his cousin Nels. They were young kids, 18 or 19 years old. I've often thought what a spirit of adventure they must have had. They had

(Illustration continued on next page.)

ILLUSTRATION 2 *(continued)*

been farmers in Sweden, but there was a potato famine and thousands of Swedes immigrated to the United States around that same time.

"Somehow Grandpa Gus and cousin Nels made it to Minneapolis where Grandpa Gus met a girl named Brynhild, whom he married. Grandma Bryn was also from Sweden. When I was little, we would go to their house to celebrate Santa Lucia Day, near Christmas. One of my cousins would get to wear a beautiful white dress and a garland of lighted candles on her head. There was always a huge table full of food. There was one kind of fish that was very stinky, but there were also lots of delicious cookies and cakes. As a family we were celebrating our Swedish heritage, but also making new traditions in the United States.

"Gus and Nels encountered many obstacles trying to make it in the U.S., but they also had many opportunities here that they didn't have back home in Sweden. We'll talk about some of these obstacles and opportunities throughout this unit."

ILLUSTRATION 3: GRAPHIC ADVANCE ORGANIZER *anthropods*

Mr. Henry's sixth grade class was about to watch a video about anthropods. Before showing the video, Mr. Henry gave students a graphic organizer with the main ideas filled in, which cued students about what they'd be seeing. He asked students to listen and watch carefully so they could add to the organizer as they watched the video. Specifically, he wanted students to add important information related to the ideas on the organizer and perhaps add other main ideas or topics.

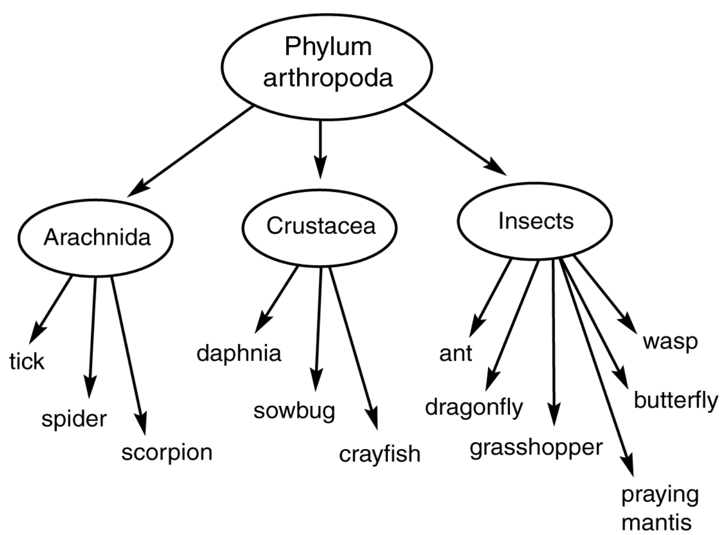


ILLUSTRATION 4: SKIMMING *Genesis space mission*

Mr. Sutton's ninth grade science class was about to read an article on the Genesis space mission — a NASA mission that will send a spacecraft to collect pieces of the sun, called solar wind, to try to determine what the sun is made of.

Before students began reading, Mr. Sutton introduced them to a skimming strategy that involved previewing and questioning before reading to organize the information in the article.

Mr. Sutton asked his students to quickly read over the article about the Genesis space mission, paying careful attention to any headings, subheadings, and the topic sentence of each paragraph. He gave them only 60 seconds to skim the article and cautioned them not to get too bogged down in any one section.

Students made brief notes about the headings and subheadings and wrote down any questions that came to mind any questions that came to mind. Skimming the article and writing questions helped them to know what information they would encounter and what information to look for when they read the article more carefully.

THEORY AND RESEARCH IN BRIEF • • •
Activating prior knowledge

CUES AND QUESTIONS — Findings from some of the studies that have synthesized research on cues and questions are summarized in Table 10.1.

Table 10.1: Research Results for Cues and Questions

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Ross, 1988	Cues	6	.41	16
Walberg, 1999	Questions	14	.26	10
Redfield & Rousseau, 1981	Questions	14	.73	27
Wise & Okey, 1983	Questions	5	.37	14
	Cues	38	.53	20
Stone, 1983	Cues	83	.75	27
Bloom, 1976	Cues	11	1.21	39
Crismore, 1985	Cues	231	.60	23
Hamaker, 1986	Question	100	.75	27
Guzzetti, Snyder, & Glass, 1993	Cues and questions	11	.80	29

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

ADVANCE ORGANIZERS — Findings from some of the studies that have synthesized research on advance organizers are provided in Table 10.2. As the data presented show, there is a fair amount of variability in the effect sizes for the studies we reviewed. Effect sizes range from a low of .09 to a high of .80. Of particular interest relative to classroom practice is the variety of advance organizers reported in the Stone (1983) study. Expository advance organizers had the largest effect, with skimming, narrative advance organizers, and illustrated advance organizers next in order of magnitude.

Table 10.2: Research Results for Advance Organizers

Synthesis Study	Focus	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Walberg, 1999	General effects of advance organizers	29	.45	17
		16	.24	9
Hattie, 1992	General effects of advance organizers	387	.37	14
Lott, 1983[b]	General effects of advance organizers	17	.09	3
		5	.77	28
Stone, 1983	Expository advance organizers	44	.80	29
	Narrative advance organizers	12	.53	20
	Skimming as an advance organizer	15	.71	26
	Illustrated advance organizers	15	.52	20

[a]These are the maximum percentile gains possible for students currently at the 50th percentile.
[b]Two effect sizes are listed for the Lott study because of the manner in which effect sizes were reported. Readers should consult that study for more details.

The activation of prior knowledge has been shown to be critical to learning of all types. Indeed, our background knowledge can influence what we perceive. This was demonstrated in a 1981 study by Brewer and Treyens.

Researchers brought 30 students individually into a room and told them that it was the office of a professor who was conducting an experiment. Each student was asked to wait for a short while. After 35 seconds, the students were taken to another room and asked to write down everything they could recall about the office. Brewer and Treyens hypothesized that students would remember those items they expected to see in a professor's office regardless of whether they were there or not. In other words, Brewer and Treyens hypothesized that students' prior knowledge would influence what they perceived. This is precisely what happened. Twenty-nine of 30 students remembered that the office had a desk and a chair, but only eight recalled that it had a bulletin board and a skull; and nine students recalled that the office had books, which it did not. The students remembered what they expected to see regardless of whether it was there or not. Use of prior knowledge can be a powerful learning tool.

Chapter 11

TEACHING SPECIFIC TYPES OF KNOWLEDGE

In general, the nine categories of instructional strategies described in Chapters 2 through 10 work well with all types of subject-matter knowledge. However, if a teacher wishes, she can use specific instructional strategies to teach specific types of knowledge.

Subject-matter knowledge can be organized into five broad categories: (1) vocabulary terms and phrases, (2) details, (3) organizing ideas, (4) skills and tactics, and (5) processes. The first three categories are informational in nature and are sometimes referred to as *declarative knowledge*. The last two categories are more process oriented and are sometimes referred to as *procedural knowledge*.

VOCABULARY TERMS AND PHRASES

1. Directly Teach Critical Terms and Phrases.
(See Illustration 1)

Direct instruction has a strong influence on student achievement. Given this effect, one obvious instructional activity is to identify terms and phrases that are critical to a topic and directly teach those terms and phrases. It is probably best to limit the number of critical terms and phrases for any given topic. For example, a teacher presenting a three-week unit on a specific topic might identify five key terms and phrases related to that topic. The most straightforward way to directly teach new terms and phrases is to provide students with a definition of each term or phrase and a brief illustration of its use in context, as exemplified by Illustration 1.

2. Actively Engage Students in Learning New Terms and Phrases.
(See Illustration 2)

Perhaps the most powerful way to teach new terms and phrases is to actively involve students in the learning process, as shown in Illustration 2. The following five-step process for teaching vocabulary exposes students to new terms and phrases multiple times in a variety of ways:

Step 1. Give students a brief explanation or description of the new term or phrase.
Step 2. Present students with a nonlinguistic representation of the new term or phrase.
Step 3. Ask students to generate their own explanations or descriptions of the term or phrase.
Step 4. Ask students to create their own nonlinguistic representation of the term or phrase.
Step 5. Periodically ask students to review the accuracy of their explanations and representations.

Illustration 1: Directly Teach Terms and Phrases *geography*

Students in Mr. Mifflin's class were studying about the characteristics and uses of maps, globes, and other geographic tools and technologies. In planning the unit, Mr. Mifflin identified a number of vocabulary terms that he considered important for students to learn: *axis*, *meridian*, *latitude*, *longitude*, *prime meridian*, and *international date line*.

Mr. Mifflin gave students a handout he had created that included the terms, a definition of each term, and a sentence that used each term in context. For example, for the term *international date line*, Mr. Mifflin gave students the following information:

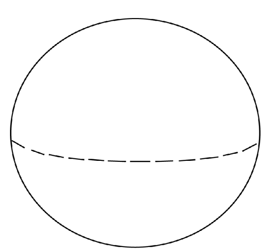
> *International date line*: an imaginary line approximately along the 180th meridian designated as the place where each calendar day begins. The date in the Eastern hemisphere, to the left of the line, is always one day ahead of the date in the Western hemisphere.
>
> *Example:* A ship traveling west from the western coast of the United States to Australia would cross the international date line and be one day ahead of when it left its port.

ILLUSTRATION 2: ENGAGE STUDENTS IN LEARNING NEW TERMS AND PHRASES *equator*

During the same geography unit, Mr. Mifflin decided to actively engage students in the process of learning the term *equator* using the five-step vocabulary process.

Step 1. Give students a brief explanation or description of the new term or phrase. He introduced students to the term by briefly explaining what the equator is: "The equator is an imaginary circle around the Earth that divides the Earth into the northern hemisphere and the southern hemisphere."

Step 2. Present students with a nonlinguistic representation of the new term or phrase. Mr. Mifflin then drew the following picture on the board:



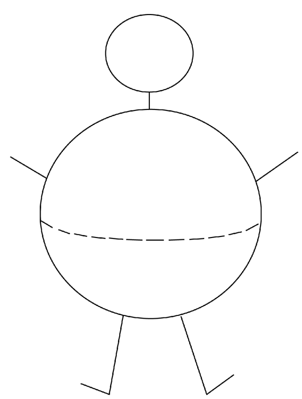
(Illustration continued on next page.)

ILLUSTRATION 2 *(continued)*

Then he asked students to gather around a table in the room. He held up an orange that had a black line drawn around the fattest part. He told students to imagine that the orange was the Earth and the black line was the equator. Then he cut the orange in half on the black line, explaining that the word *equator* contains a clue about what the word means. He asked if anyone knew what that might be. A couple of students said that it was like the word *equal* — the two halves of the Earth are equal on either side of the equator.

Step 3. Ask students to generate their own explanations or descriptions of the term or phrase. Mr. Mifflin's students then made up their own explanations of the term *equator*. Jake wrote in his vocabulary notebook, "The equator is what divides the Earth in half around its waist."

Step 4. Ask students to create their own nonlinguistic representation of the term or phrase. Each student then created a drawing or symbol for the term *equator*. Jake thought he could remember that the equator "cut the Earth in half." But he thought he might forget which direction it cut around the Earth, so he drew the following picture, which was similar to Mr. Mifflin's, but had some important differences.



Step 5. Periodically ask students to review the accuracy of their explanations and representations. Over the next few days, Mr. Mifflin involved the students in a number of activities he had planned for the unit. At the end of the week, he set aside some time for students to review the definitions and nonlinguistic representations in their notebooks. Some students made corrections or expanded on their definitions to reflect their increased understanding of the terms.

DETAILS

1. Expose Students to Key Details Multiple Times.
(See Illustration 1)

During a unit of instruction, students are exposed to a wide variety of details: facts, time sequences, and so on. Certainly they cannot process all of this information at a deep enough level to remember and use it at a later date. Consequently, a sound instructional strategy is to plan a unit in such a way that key details are identified — details that students are expected to know in depth, as exemplified by Illustration 1. In addition, instruction should be planned in such a way that students are exposed to these details multiple times (at least three) and that these exposures are no more than two days apart.

2. Engage Students in Enactment or Dramatic Representation of Key Details.
(See Illustration 2)

Given the impact on student learning of instruction that involves some form of enactment or dramatic representation of details, instruction should be planned to ensure that it occurs, as exemplified by Illustration 2.

ILLUSTRATION 1: MULTIPLE EXPOSURES TO DETAILS *Greek and Roman mythology*

Ms. Sanders' class at Dry Creek Middle School was beginning a unit on Greek and Roman Mythology. As she planned the unit, Ms. Sanders identified the critical aspects of the unit and the ways in which she would expose the class to these details several different times. She decided she wanted the class to know about significant gods and goddesses and what they represent. She also wanted to expose students to certain key myths and to have them notice how gods, goddesses, and humans interact in the myths.

On the first day of the unit, Ms. Sanders read aloud a myth and engaged the class in a discussion in which she introduced significant gods and goddesses by their Greek and Roman names, talked about their attributes, and showed the class a picture of each. The next day the class watched a film about early Greek architecture, which included numerous examples of the gods and goddesses and the stories that are depicted on early Greek buildings. Ms. Sanders assigned reading about the Trojan War as homework.

Later that week, Ms. Sanders divided the class into small groups of two to three students. She assigned each group a particular god or goddess and had them design a hat that symbolized the god or goddess's attributes. Students presented their hats to the class and explained their meaning.

ILLUSTRATION 2: ENACTMENT *biology — the lungs*

Ms. Siegel's biology class was finishing a unit on the organ systems of the human body. Many students performed poorly on the quiz about how oxygen and carbon dioxide are exchanged in the lungs, even though they had been exposed to the information multiple times. Ms. Siegel decided to try a technique that works well with details — dramatic representation. She told students they were going to act out the process of oxygen leaving the lungs and moving around the body and carbon dioxide being taken from body cells and removed through the lungs.

Students organized themselves into various roles, including lungs, alveoli sacs, red blood cells, plasma, and body cells. They used plastic models of molecules to represent the oxygen and carbon dioxide. Students traded molecules to show the exchange as red blood cells and plasma moved out of the lungs and around the circulatory system, represented by the "body cell" students. At first, many students thought the dramatization was silly, but after they took their unit test, they realized that the enactment had really helped them understand the process.

ORGANIZING IDEAS

1. Provide Clear Statements of Generalizations and Numerous Examples.
(See Illustration 1)

Generalizations and principles are complex enough that teachers should ensure that students are provided with clear statements and examples, as shown in Illustration 1.

2. Help Students Increase Their Understanding of Generalizations and Principles and Clear up Misconceptions.
(See Illustration 2)

When students have apparent misconceptions about organizing ideas, the teacher might present examples that help them understand the flaws in their thinking. If students seem to understand the generalizations accurately, but not in depth, the teacher might present a novel situation in which the generalization would apply. The teacher also might ask students to come up with new examples or situations in which the principle applies, as exemplified by Illustration 2.

ILLUSTRATION 1: PROVIDE GENERALIZATION AND EXAMPLES *fairy tales*

Students in Mrs. Brown's class were studying fairy tales and other types of children's literature. To deepen their understanding about the common themes found in fairy tales, Mrs. Brown gave students the following generalization: "Most fairy tales have a beautiful young girl as a major character who is in peril but eventually saved." Mrs. Brown then provided students with several examples:

Little Red Riding Hood — A woodcutter's daughter goes to visit her grandmother, is attacked by a wolf, but saved by a woodsman.

Sleeping Beauty — A beautiful daughter is born to a king and queen, but a wicked woman casts a spell on her. She is eventually saved by the kiss of a prince.

Cinderella — A beautiful girl is mistreated by her ugly step-sisters and cruel step-mother. She is whisked away to a ball by a fairy godmother where the handsome young prince falls in love with her and marries her.

Rapunzel — A beautiful child is locked in a tall tower by a wicked witch. A prince falls in love with her and tries to rescue her. Rapunzel is taken to a desert by the witch, but the prince finds her and takes her away to his kingdom.

Mrs. Brown then asked students class to think of other examples that exemplify the generalization about fairy tales.

ILLUSTRATION 2: INCREASE UNDERSTANDING & CLEAR UP MISCONCEPTIONS *properties of metals*

When grading lab reports, Mrs. Walton, an eighth grade science teacher, noticed that her students had some misconceptions about the properties of metals. For example, some of them thought that metals shrank when exposed to heat. To help clear up their misconceptions, Mrs. Walton wrote the following principle on the blackboard:

> *"When metals are heated, they expand. The magnitude of the expansion depends on the properties of the metal."*

Then Mrs. Walton demonstrated the effects of heat on aluminum by first measuring a cylinder of aluminum with a caliper and then heating the cylinder in a beaker of boiling water for several minutes. When she removed the aluminum cylinder, she asked a student to

(Illustration continued on next page.)

ILLUSTRATION 2 *(continued)*

quickly try to slip the cylinder back into the caliper without readjusting it. Students observed that the heat caused the aluminum to expand.

To further increase their understanding of the principle that metals expand when heated, the class discussed some facts about other metals:

> *Lead expands at 28.9 parts per million for every degree centigrade of temperature change.*
>
> *Copper expands at 16.5 parts per million for every degree centigrade of temperature change.*

Mrs. Walton asked students to create a graph showing the relationship between temperature and expansion for aluminum, lead, and copper. Then she asked students to choose two other metals, research the rate of expansion for each metal, graph the relationship between the rate of expansion and temperature, and explain how the principle applied to each metal. Finally, she led a class discussion in which students talked about previous misconceptions that they had, explained how the task helped clarify these, and asked any remaining questions.

SKILLS AND TACTICS

1. *Facilitate the Discovery Approach to Skills.*
(See Illustration 1)

When a discovery approach is used to teach a specific skill or tactic, examples should be organized so that different types of strategies are represented. As students progress through each category of examples, they should be asked to design strategies for the examples, as exemplified by Illustration 1. When students have worked through the examples, they might also be asked to contrast the strategies developed for the different categories.

2. *Plan for and Emphasize the Importance of Distributed Practice.*
(See Illustration 2)

When designing lesson plans for teaching a skill, teachers commonly build in class time and homework for students to practice the skill initially (referred to as *massed practice*). It is not as common for teachers to plan for distributed practice, which occurs over a longer period of time and helps students achieve automaticity with the skill. Establishing a schedule on a planning calendar and sharing this schedule with students emphasizes the importance of distributed practice. Further, when students learn a skill near the end of the year, the teacher might recommend to students a specific summer schedule for distributed practice and explain the role of practice in achieving automaticity. Some students will not follow the schedule; however, the idea of distributed practice might help them better understand the process of learning a skill, as exemplified by Illustration 2.

ILLUSTRATION 1: DISCOVERY APPROACH TO SKILLS *driver's education*

Students in Mr. Prado's driver's education class were skilled enough in their driving that he thought that they were ready to learn to drive on different surfaces. To capture their attention and interest, Mr. Prado decided to have students discover some rules for the road, so to speak.

With the help of the administration, he set up a concourse with several different driving surfaces — dry pavement, wet pavement, oil-slicked pavement, snow-covered pavement, gravel, and a rutted dirt surface. He had students drive on all six surfaces. Then he asked students to form small groups and discuss what driving on all surfaces had in common, what was different, and, finally, articulate a strategy for driving safely and effectively on each surface.

ILLUSTRATION 2: DISTRIBUTED PRACTICE *letters of the alphabet*

Ms. Fontana's first grade students were excited about learning to write the alphabet. Once students learned to print a set of related letters, Ms. Fontana set up a practice schedule for that set.

At first, students printed the letters over and over for an entire lesson. They also practiced the letters for homework. The next day they again practiced a lot, but not for the entire lesson. Over the next two days, Ms. Fontana decreased the number of times students printed each letter. Then she had students practice every other day, then every third day, and so on. However, students never completely stopped practicing the alphabet.

Ms. Fontana planned for distributed practice throughout the year. At least once every two weeks, students practiced printing the alphabet, either in class or for homework. In this way, students learned to print the letters automatically, accurately, and quickly.

PROCESSES

1. Give Students a General Model of the Overall Components and Subcomponents of New Processes.
(See Illustration 1)

Students need a fair amount of guidance when first learning a complex process. One of the best ways to provide this guidance is to give them a model of the overall components and subcomponents of the process, as exemplified by Illustration 1.

2. Have Students Focus on a Specific Subcomponent in the Context of a Process.
(See Illustration 2)

In general, students should not practice the subcomponents of a complex process in isolation. It's much more useful to practice them in the context of the entire process. To facilitate this type of practice, tasks should be structured to emphasize a specific subcomponent, as shown in Illustration 2. The following activities can help students focus on specific subcomponents of a process:

- Help students clearly identify the specific subcomponent (e.g., skill, strategy) they are going to practice and set criteria for evaluating their own progress.
- Give students a variety of assignments over time that require them to use the targeted skill or strategy within the context of the process.
- Encourage students to self-assess, but also give them feedback on the targeted skill or strategy. To help students focus, avoid giving feedback on other aspects of the process.

ILLUSTRATION 1: GIVE STUDENTS A GENERAL MODEL *the research process*

At the beginning of each school year, teachers at Andrew Lewis Middle School presented students in each grade with the following model for the research process:

Define your topic.
- State your topic as a question.
- Identify keywords to help you search for information.
- Develop your thesis statement.

Locate resources.
- Determine what kind of information you need to look for.
- Use your keywords to search for books, articles, and other resources.

(Illustration continued on next page.)

ILLUSTRATION 1 *(continued)*

Evaluate the information you find.
- Determine if the information presented is fact or opinion.
- Determine if the information is well-supported by evidence.
- Determine if the information presented has a particular bias or is misleading.
- Determine if there are any errors in reasoning in the information.

Organize your information.
- Synthesize information.
- Prepare quotations from sources to use.
- Determine the best way to present your information.

Cite your information.
- Check all references within the text.
- Cite your sources completely and accurately.
- Create a list of works cited.

The components of the research process were new to sixth grade students, but became more familiar as each year passed. At every grade level, students learned and reviewed the overall process and its major components and focused on specific subcomponents designated for their grade level.

In one sixth grade classroom, as David worked on organizing his information, Ms. Waniki suggested that he review his topic question and then refine his thesis if he thought it was necessary. When Shana evaluated the information she had gathered, Ms. Waniki suggested that it might be a good time to make sure she had all the necessary information for her list of works cited. Teachers at Andrew Lewis Middle School used the research process consistently so that by the time students left sixth grade, they were very familiar with the interrelated components of research and used the individual components easily.

ILLUSTRATION 2: FOCUS ON A SPECIFIC SUBCOMPONENT *the research process*

At Andrew Lewis Middle School, teachers at each grade level took responsibility for teaching specific subcomponents of the research process. For example, the sixth grade teachers worked with students on five subcomponents throughout the year — state your topic as a question, identify keywords to help you search for information, use your keywords to search for books, articles, and other resources; determine if the information presented is fact or opinion, and prepare quotations from sources to use. The sixth graders practiced these subcomponents in various assignments all year long, so that when they reached the seventh grade, they could use these subcomponents.

THEORY AND RESEARCH IN BRIEF • • •
Teaching specific types of knowledge

VOCABULARY TERMS AND PHRASES — One of the most generalizable findings in the research about vocabulary development is the strong relationship between vocabulary and a number of important factors, such as intelligence (Thorndike & Lorge, 1943; Davis, 1944; Spearitt, 1972), one's ability to comprehend new information (Chall, 1958; Harrison, 1980), and one's level of income (Sticht, Hofstetter, & Hofstetter, 1997). Expending time and resources on vocabulary instruction, therefore, seems justified, given the importance of vocabulary development.

In a major review of the research on vocabulary, researchers Stahl and Fairbanks (1986) found that teaching general vocabulary directly had an overall effect size of .32. Although this is not a huge effect size, it has practical significance. It means that teaching vocabulary directly increases student comprehension of new material by 12 percentile points.

To illustrate, assume that two students of equal ability are asked to read and understand new information. However, student A is in a program where about 10 to 12 new vocabulary words are taught each week. According to Nagy and Herman (1984), this is the typical number of words provided to students in vocabulary programs. Student B does not receive this instruction. Now assume that students A and B take a test on the new content and that student B receives a score that places him at the 50th percentile relative to other students in the class. All else being equal, student A will receive a score that places her at the 62nd percentile on that same test simply because she received systematic vocabulary instruction. A 12 percentile-point increase in achievement is not insignificant in a practical sense.

The effects of vocabulary instruction are even more powerful when the words selected are those that students most likely will encounter when they learn new content. Specifically, research by Stahl and Fairbanks (1986) indicates that student achievement will increase by 33 percentile points when vocabulary instruction focuses on specific words that are important to what students are learning. To illustrate, again consider students A and B who have been asked to read and understand new content. Student B, who has not received systematic vocabulary instruction, receives a score on the test that puts her at the 50th percentile. Student A, who has received systematic instruction on words *that have been specifically selected because they are important to the new content,* will obtain a score that puts him at 83rd percentile.

DETAILS — As the name implies, details are very specific pieces of information. This category of knowledge includes facts, time sequences, cause/effect sequences, and episodes.

Facts

Facts are a very specific type of informational content. Facts convey information about specific persons, places, living and nonliving things, and events. They commonly articulate information such as the following:

- The characteristics of a specific person (e.g., Ronald Reagan served as president of the United States from 1981–1989).
- The characteristics of a specific place (e.g., Richmond is the capital of Virginia).
- The characteristics of specific living and nonliving things (e.g., my cat, Fluffy, weighs more than 20 pounds; the Golden Gate Bridge stretches 4,200 feet and the suspended towers are 746 feet above the water).
- The characteristics of a specific event (e.g., the Soviet Union's Sputnik I, the first manmade satellite, launched on October 4, 1957).

Time Sequences

Time sequences include important events that occurred between two points in time. For example, the events that occurred between Iraq's invasion of Kuwait on August 2, 1990, and the United States' air attacks on Baghdad, Iraq, on January 16, 1991, can be organized as a time sequence. First one thing happened, then another, then another.

Cause/Effect Sequences

Cause/effect sequences involve events that produce a product or an effect. A causal sequence can be as simple as a single cause for a single effect. For example, the fact that the game was won because a certain player passed the ball to another player, who kicked in the winning goal, can be organized as a causal sequence. More commonly, however, effects have complex networks of causes; one event affects another, which combines with a third event to affect a fourth, which then affects another, and so on. For example, the events leading up to the French Revolution can be organized as a casual sequence.

Episodes

Episodes are specific events that have (1) a setting (i.e., a particular time and place); (2) specific participants; (3) a particular duration; (4) a specific sequence of events; and (5) a particular cause and effect. For example, the events of Shay's Rebellion (1786–1787) can be organized as an episode. The rebellion occurred at a particular time and place; it had specific participants; it lasted for a specific duration of time; it involved a specific sequence of events; it was caused by specific events; and it had a specific effect on the country.

Perhaps the most striking findings from the research on details is that students must encounter details frequently if they are to learn them at a deep enough level to understand and recall them.

Specifically, research by Nuthall (1999; Nuthall & Alton-Lee, 1995) indicates that students should be exposed to details at least three or four times before they can legitimately be expected to remember those details or use them in any meaningful way.

In addition, it has been found that, in general, the time between exposures to details should not exceed about two days. The need for multiple exposures to details and for those exposures to be relatively close in time has been called the "time window" for learning (Rovee-Collier, 1995). To illustrate, assume that the topic of the Battle of Gettysburg has been introduced to students in a section of a textbook. The teacher and the students read the section aloud and discuss it. Within two days, this same topic must be revisited in some way. The teacher can simply engage students in a discussion of the content, or he might present more information in the form of a brief presentation by having students read another section in the textbook, by showing a film, and so on. Within another two days, the information must be revisited again, and again within another two days, and then again within two days after that.

Another interesting finding on teaching details is that different types of instruction produce different effects on student learning. Specifically, students' understanding and recollection of details is different depending on whether instruction is verbal, visual, or dramatic. These differences can be seen in Table 11.1.

As its name implies, *verbal instruction* involves telling students about details or having them read about details. Although verbal instruction has fairly impressive effects on students' understanding and recall of details immediately after instruction and a year later, it has the weakest effect of the three.

Table 11.1: Types of Instruction and Effect on Learning

Type of Instruction	Effect Size Immediately After Instruction	Effect Size After 12 Months
Verbal instruction	.74	.64
Visual instruction	.90	.74
Dramatic instruction	1.12	.80

Note: Data computed from "The Way Students Learn: Acquiring Knowledge from an Integrated Science and Social Studies Unit," by G. Nuthall, 1999, *Elementary School Journal, 99*(4), 303–341; and from "Assessing Classroom Learning: How Students Use Their Knowledge and Experience to Answer Classroom Achievement Test Questions in Science and Social Studies," by G. Nuthall, & A. Alton-Lee, 1995, *American Educational Research Journal, 32*(1), 185–223.

Visual instruction emphasizes some form of nonlinguistic representation. We saw in Chapter 6 that this might involve graphic representations, pictures and pictographs, creating mental pictures or concrete representations, or engaging in some kind of kinesthetic activity. The effects on learning for visual instruction are better than verbal instruction both immediately after instruction and one year later. However, its effects are not as strong as the effect for the third category of instruction: dramatization.

When instruction emphasizes *dramatization*, students either observe a dramatic enactment of the details or are involved in a dramatic enactment of the details. As Table 11.1 illustrates, in studies by Nuthal and his colleagues this type of instruction had the strongest effects both immediately after instruction and one year later.

ORGANIZING IDEAS — Organizing ideas, such as generalizations and principles, are the most general type of informational knowledge.[2] Generalizations are statements for which examples can be provided because they apply to many different situations. For example, the statement, "U.S. presidents often come from families that have great wealth or influence" is a generalization for which examples can be provided. Principles are specific types of generalizations that articulate rules or relationships that can be applied to a number of specific situations. For instance, "water seeks its own level" is a scientific principle.

Generalizations

Although vocabulary terms and details are important, generalizations help students develop a broad knowledge base because they transfer more readily to different situations. For instance, consider the generalization, "Specific battles sometimes disproportionately influence the outcome of a war." This generalization can be applied across countries, situations, and time periods, whereas a fact about the Battle of Gettysburg is a specific event that does not directly transfer to other situations. This is not to say that details are unimportant. On the contrary, to truly understand generalizations students must be able to support them with exemplifying facts. For instance, to understand the generalization about the influences of specific battles, students need a rich set of illustrative facts, which may include facts about the Battle of Gettysburg.

It is easy to confuse some generalizations with some facts. Facts identify characteristics of specific persons, places, living and nonliving things, and events, whereas generalizations identify characteristics about *classes or categories* of persons, places, living and nonliving things, and events. For example, the statement, "My Portuguese Water Dog, Sparky, is a good swimmer," is a fact. However, the statement, "Portuguese Water Dogs are good swimmers" is a generalization.

Generalizations also articulate characteristics about abstractions. Specifically, information about abstractions is always stated in the form of generalizations. Below are examples of the various types of generalizations:

- Characteristics of classes of persons (e.g., It takes at least eight years of training to become a doctor.)
- Characteristics of classes of places (e.g., Humid climates have a lot of mosquitos.)
- Characteristics of classes of living and nonliving things (e.g., The states in the western United States have a high population of immigrants from Mexico.)

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[2]*Note:* We have not included *concepts* as organizing ideas because, technically defined, they are synonymous with generalizations (see Gagne, 1977).

- Characteristics of classes of events (e.g., Fourth of July celebrations have the best fireworks displays.)
- Characteristics of abstractions (e.g., Love is one of the most powerful human emotions.)

Principles

In general, there are two types of principles found in school-related declarative knowledge: *cause/effect principles* and *correlational principles*.

Cause/effect principles — Cause/effect principles articulate causal relationships. For example, the statement, "germs cause many diseases" is a cause/effect principle. Understanding a cause/effect principle involves understanding the specific elements in the cause/effect system and the exact relationships those elements have to one another. To understand the cause/effect principle regarding germs and diseases, students would have to understand the sequence of events that occur, the elements involved, and the type and strength of relationships between those elements. In short, understanding a cause/effect principle involves understanding a great deal of information.

Correlational principles **—** Correlational principles describe relationships that are not necessarily causal in nature, but in which a change in one factor is associated with a change in another factor. For example, the following is a correlational principle: "The decrease in prostate cancer deaths among men is directly proportional to the increase in the number of men who take screening tests."

Again, to understand this principle, a student would have to know the specific details about this relationship. Specifically, a student would have to know the general pattern of this relationship, that is, that the number of men who die from prostate cancer decreases as the number of men who get tested increases.

These two types of principles are sometimes confused with cause/effect sequences. A cause/effect sequence applies to a specific situation, whereas a principle applies to many situations. The causes of the French Revolution taken together represent a cause/effect sequence. They apply to the French Revolution only. However, the cause/effect principle linking germs and diseases can be applied to many different diseases and many different people. Physicians use this principle to make judgments about a variety of situations and a variety of people. The key distinction between principles and cause/effect sequences is that principles can be exemplified in a number of situations, whereas cause/effect sequences cannot — they apply to a single situation only.

The research on teaching generalizations and principles is fairly extensive. One of the more extensive reviews was done by Ross in 1988. Of the many findings in that review, one of the most useful to the classroom teacher is that students should be provided with more opportunities to apply generalizations and principles once they understand them. This seems counterintuitive to some educators who put the majority of their energies into helping students initially understand generalizations and principles. In fact, some teachers insist on having students discover generalizations and principles as opposed to presenting them in a rather direct fashion at first, but then structure activities so that students can apply their new knowledge.

Nonetheless, structured discovery lessons are very powerful learning experiences for generalizations and principles. However, they are very time consuming to implement and very difficult to design. In many situations, students might be better served if teachers presented generalizations and principles in a somewhat direct manner but then gave students plenty of opportunities to apply the generalizations and principles to new situations.

SKILLS — There are two forms of mental skills: *tactics* and *algorithms* (see Snowman & McCown, 1984). *Tactics* are general rules governing an overall flow of execution, rather than a set of steps that must be performed in a specific order. For example, a tactic for reading a histogram might address (1) identifying the elements defined in the legend, (2) determining what is reported on each axis of the graph, and (3) determining the relationship between the elements on the two axes. Although there is a general pattern in which these rules are carried out, there is no rigid or set order. *Algorithms* are mental skills that have very specific outcomes and very specific steps. Performing multi-column subtraction is an illustration of an algorithm. Although the steps in a tactic do not have to be performed in a set order, the steps in an algorithm do. Obviously, changing the order in which the steps of multi-column subtraction are performed will dramatically change the answer that is computed.

A common misconception in education is that "discovering" how to perform a skill or tactic is always better than being directly taught the skill or process. This misconception probably gained favor in reaction to the long-held misconception that drill and practice in specific steps is always the best way to teach skills and tactics (for a discussion, see Anderson, Reder, & Simon, 1997). The truth about instruction on skills and tactics lies somewhere in the middle. Some skills are best learned through discovery. Some are best learned through direct instruction. For example, consider the skills of addition, subtraction, multiplication, and division. To have students discover the steps involved in addition, subtraction, multiplication, and division makes little sense. Although it is probably true that students would certainly understand these skills well if they were required to discover the steps to addition, it is also true that this would take an inordinate amount of time. However, it might make good sense to have students discover strategies for solving specific types of addition problems.

Although there is no magic list of the algorithms and tactics that are best suited for a discovery approach, a useful rule of thumb is that the more variation there is in the steps that can be used to effectively execute a skill or a tactic (e.g., in the order of the steps, the number of steps, and even the steps themselves), the more amenable the skill or tactic is to discovery learning. For example, if five steps must be followed in a specific order to properly use a piece of equipment in a science lab, then it is questionable whether the best approach is for students to discover these five steps and their order of execution. It might be better to demonstrate those steps and then provide opportunities for students to alter them to suit their individual needs and styles. On the other hand, a tactic that can be executed in a number of ways is probably a good candidate for discovery learning.

One of the best examples of using a discovery approach with skill-based knowledge is Cognitively Guided Instruction (see Carpenter, Fennema, & Franke, undated; Carpenter, Fennema, & Peterson, 1987; Carpenter et al., 1989; Fennema, Carpenter, & Franke, 1992; Fennema, Carpenter, & Peterson, 1989; Peterson, Carpenter, & Fennema, 1989; Peterson, Fennema, & Carpenter, 1989). Using this approach, primary students are encouraged to "design" their own strategies for solving problems. As described by Fennema, Carpenter, and Franke (1992):

> Children are not shown how to solve the problems. Instead each child solves them in any way that s/he can, sometimes in more than one way, and reports how the problem was solved to peers and teacher. The teacher and peers listen and question until they understand the problem solutions, and then the entire process is repeated. Using information from each child's reporting of problem solutions, teachers make decisions about what each child knows and how instruction should be structured to enable that child to learn. (p. 5)

Key to the success of this highly discovery-oriented approach is teachers' awareness of the types of problems that are the basis for a more complex understanding of computational facts and problem-solving strategies. These problem types are shown in Table 11.2.

Table 11.2: Types of Word Problems

Join	(*Result Unknown*) Connie had 5 marbles. Juan gave her 8 more marbles. How many marbles does Connie have altogether?	*(Change Unknown)* Connie has 5 marbles. How many more marbles does she need to have 13 marbles altogether?	(*Start Unknown)* Connie had some marbles. Juan gave her 5 more marbles. Now she has 13 marbles. How many marbles did Connie have to start with?
Separate	(*Result Unknown)* Connie had 13 marbles. She gave 5 to Juan. How many marbles does Connie have left?	*(Change Unknown)* Connie had 13 marbles. She gave some to Juan. Now she has 5 marbles left. How many marbles did Connie give to Juan?	(*Start Unknown)* Connie had some marbles. She gave 5 to Juan. Now she has 8 marbles left. How many marbles did Connie have to start with?
Part-Part-Whole	(*Whole Unknown)* Connie has 5 red marbles and 8 blue marbles? How many marbles does she have?	(*Part Unknown)* Connie has 13 marbles. 5 are red and the rest are blue. How many blue marbles does Connie have?	
Compare	(*Difference Unknown)* Connie has 13 marbles. Juan has 5 marbles. How many more marbles does Connie have than Juan?	(*Compare Quantity Unknown)* Juan has 5 marbles. Connie has 8 more than Juan. How many marbles does Connie have?	(*Referent Unknown)* Connie has 13 marbles. She has 5 more marbles than Juan. How many marbles does Juan have?

Note: Reprinted (adapted) from *Children's Mathematics: Cognitively Guided Instruction*, by T. P. Carpenter, E. Fennema, M. L. Franke, L. Levi, and S. B. Empson, 1999, Portsmouth, NH: Heinemann.

With a knowledge of these problem types, a teacher can effectively guide student inquiry. The teacher would provide students with more practice in the specific problem type when needed and introduce the next problem type when appropriate. As students practiced a specific type of problem, they would devise and test out strategies for that type. In short, for inquiry to be effective, examples of the skill or tactic that is the target of the discovery approach should be in well-organized categories that represent different ways of executing the skill or tactic. As students work through the different categories, they are developing different ways of performing the skill or tactic.

PROCESSES — Processes are similar to skills and tactics in some ways and different in other ways. They are similar in that they produce some form of result or product. For example, the tactic of reading a bar graph leads to a new understanding of the relationship between two variables. The process of writing produces a new composition. However, processes have a much higher tolerance for variation relative to the steps involved than do tactics or skills. For example, there are not many ways to go about reading a bar graph. However, there are many different ways to engage in the process of writing. We might say that processes are more "robust" than skills and tactics in terms of how they can be performed.

By definition, processes are not amenable to a "step-by-step" instructional approach. But this does not mean that teachers should not give students guidance in the general aspects of the process. For example, it is common to provide a description of the various components involved in writing. Occasionally, such an approach is referred to as the "process writing approach." To illustrate, the following phrases (or adaptations of them) are commonly presented to students as components of the writing process:

- Prewriting
- Writing
- Revising

Within each of these major components of the writing process, more specific subcomponents are identified. For example, within the revising component of the writing process, the following subcomponents might be presented to students:

- Revising:
  - Revising for the overall logic of the composition
  - Revising for effective transitions
  - Revising for word choice and phrasing
  - Revising for subject-verb agreement
  - Revising for spelling and punctuation

Obviously, students must be presented with the components and subcomponents of a process and practice those components and subcomponents. The research on writing offers an insight into how this is best accomplished. Specifically, Hillocks (1986) examined four approaches to teaching writing, which can be described as follows:

- *Presentation:* The teacher explains what good writing is and gives examples.
- *Natural process:* The teacher has students engage in a great deal of free writing, individually and in groups.
- *Focused practice:* The teacher engages students in the entire process of writing but focuses on specific aspects of writing. Skills are not taught in isolation.
- *Skills:* The teacher breaks writing down into its component parts and then gives students opportunities to practice each part, commonly in isolation.

The effect sizes for each of these approaches is reported in Table 11.3. As Table 11.3 shows, the approach that most powerfully influences students' writing ability is focused practice.

Table 11.3: Effect Sizes for Various Approaches to Writing

Approach	No. of Effect Sizes	Ave. Effect Size	Percentile Gain[a]
Presentation	4	.02	1
Natural process	9	.19	8
Focused practice	10	.44	17
Skills	6	.17	6

Source: Research on Written Composition, by G. Hillocks, 1986, Urbana, IL: ERIC Clearinghouse on Reading and Communication Skills and National Conference on Research in English.
[a]These are the maximum percentile gains possible for students currently at the 50th percentile.

To use the focused practice approach, a teacher presents students with the components and subcomponents of the process and then structures tasks that emphasize a specific component or subcomponent. For example, a teacher might assign a composition that emphasizes the subcomponent of revising for overall logic or revising for transitions. It is interesting to note that simply explaining to students what good writing is (i.e., the "presentation" approach) resulted in the lowest effect size in the studies reviewed. It is also interesting to note how small the effect sizes were for simply asking students to write a great deal (i.e., the "natural process" approach) and to practice the components and subcomponents in isolation (i.e., the "skills" approach).

Chapter 12

USING INSTRUCTIONAL STRATEGIES IN UNIT PLANNING

The strategies presented in Chapters 2 through 11 can be used at any time during a unit of instruction. However, in general some strategies are more useful at the beginning of a unit, while others are best used during a unit or at the end of a unit. One way, then, to think about using the strategies reviewed in this guidebook is to organize them into the following categories:

- Strategies to use at the beginning of a unit
- Strategies to use during a unit, including
  - strategies for monitoring and reaching learning goals
  - strategies for introducing new knowledge
  - strategies for knowledge being reviewed or applied
- Strategies to use at the end of a unit

This chapter exemplifies how a teacher might use these strategies during a unit on weather.

AT THE BEGINNING OF A UNIT OF INSTRUCTION

A unit of instruction should begin with at least two distinct activities:

- Identify clear learning goals. (See Chapter 8.)
- Allow students to identify and record personal learning goals. (See Chapter 8.)

To illustrate, consider Mrs. Becker, a sixth grade teacher who is teaching a unit on weather. She begins the unit by presenting students with six learning goals. Five of these deal with science; one deals with communication skills:

- *Learning Goal 1: Science* — We will learn that weather includes the elements of temperature, humidity, cloudiness, wind, pressure, and precipitation.

- *Learning Goal 2: Science* — We will learn that there are different types of weather systems that the Earth experiences (e.g., hurricanes, tornadoes, and monsoons). We also will learn how the elements of weather interact to cause each system.

- *Learning Goal 3: Science* — We will learn about the composition and structure of the Earth's atmosphere (e.g., the temperature and pressure in different layers of the atmosphere, the circulation of air masses).

- *Learning Goal 4: Science* — We will learn about the ways in which clouds affect weather and climate (e.g., through precipitation, reflection of light from the sun, retention of heat energy emitted from the Earth's surface).

- *Learning Goal 5: Scientific Inquiry* — We will learn how to keep systematic records of temperature, precipitation, cloud cover, and other weather information to formulate hypotheses.

- *Learning Goal 6: Communication* — We will learn how to write compositions that reflect your knowledge about a topic. We also will learn how to organize and present information in a logical way.

Mrs. Becker gives a copy of the goals to each student and posts them in the room in a place that is clearly visible to all students. She then asks students to write two or three *personal* learning goals based on the goals she gave them. She explains that these personal goals can be a bit more specific than the learning goals she identified, for example, "I want to know why there are hurricanes in Florida and not in California," "I want to learn to write longer compositions," or "I want to learn how to formulate hypotheses." After students identify their personal goals, Mrs. Becker asks students to pair up to do the following:

- Share their goals with one another.
- Set up a learning journal in which to write questions about a lesson, areas of confusion, or assignments they are having difficulty completing.

DURING A UNIT OF INSTRUCTION

During a unit of instruction, three things typically occur: teachers introduce knowledge; teachers review and help students practice and apply knowledge; and students continually monitor how well they are progressing on identified learning goals. Specific instructional strategies are useful for each aspect of the unit:

- Introducing new knowledge
  - Have students identify what they already know about the topic. (See Chapter 10.)
  - Provide students with ways of thinking about the topic in advance. (See Chapter 10.)
  - Have students make inferences about new knowledge. (See Chapter 10.)
  - Have students keep notes as knowledge is introduced. (See Chapter 3.)
  - Have students represent the knowledge in their notebooks in linguistic and nonlinguistic ways. (See Chapters 3 and 6.)
  - Have students work in cooperative groups. (See Chapter 7.)
  - Have students identify similarities and differences between items. (See Chapter 2.)

- Reviewing, applying, and practicing knowledge
  - Assign homework that requires students to review, apply, and practice what they have

learned. (See Chapter 5.)
   - Engage students in projects that involve generating and testing hypotheses. (See Chapter 9.)
   - Have students revise the linguistic and nonlinguistic representations of knowledge in their notebooks as they refine their understanding. (See Chapters 3 and 6.)

- Monitoring learning goals
   - Provide students with feedback and help them assess their progress. (See Chapter 8.)
   - Provide recognition of legitimate progress toward goals. (See Chapter 4.)

Introducing Knowledge

A number of instructional strategies are very effective when teachers are introducing students to knowledge:

- Have students identify what they already know about the topic. (See Chapter 10.)
- Provide students with ways of thinking about the topic in advance. (See Chapter 10.)
- Have students make inferences about new knowledge. (See Chapter 10.)
- Have students keep notes as knowledge is introduced. (See Chapter 3.)
- Have students represent the knowledge in their notebooks in linguistic and nonlinguistic ways. (See Chapters 3 and 6.)
- Have students work in cooperative groups. (See Chapter 7.)
- Have students identify similarities and differences between items. (See Chapter 2.)

As a way of introducing new information about hurricanes, Mrs. Becker distributes two 3 x 5 index cards to each student. She asks students to write a phrase or sentence on one card that describes something they already know about hurricanes and their effects. Mrs. Becker collects the completed cards and asks for two student volunteers to write the responses on the board.

After reviewing the responses as a class, students discover that collectively they know that hurricanes involve very strong winds, that they cause a lot of damage, and that they often are represented on weather maps as swirling circles. Then Mrs. Becker asks students to write a statement on the second card that describes what they would like to learn about hurricanes.

Mrs. Becker shows a videotape about Hurricane Andrew. The videotape covers new information about hurricanes in general and about Hurricane Andrew specifically. Before the videotape starts, Mrs. Becker asks students to make inferences about hurricanes based on what they already know. To stimulate students' thinking, Mrs. Becker asks them a series of questions, such as "During what season of the year do hurricanes usually happen?" "How long do they usually last?" "What changes usually occur as a result of a hurricane?" She also asks students to keep in mind what they want to learn about hurricanes as they watch the videotape.

After students watch the videotape, Mrs. Becker asks them to reflect on what they have learned by making notes in their learning journals. At the end of class, she gives students a reading assignment that explains how weather elements interact to create hurricanes, tornadoes, and monsoons. She asks students to use their journals to record their observations, questions, and any new connections they have made from the reading.

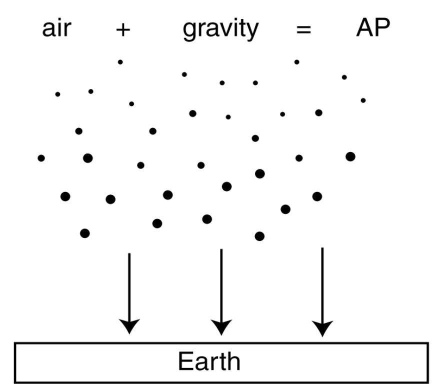
Because new information is often very detailed, Mrs. Becker encourages students to use drawings, pictures, and other graphic representations to complement their written notes. For example, some students divide the page in half and draw symbols and pictures on the right-hand side of the page. A sample of a student's notes about air pressure appears in Illustration 1.

ILLUSTRATION 1: NOTE TAKING USING GRAPHIC REPRESENTATIONS *air pressure*

Air pressure = the amount of force exerted on an area
(Force of air ÷ area of surface)

Weight of column of air ÷ area of column

Gravity -
- Holds air to the earth
- A strong, invisible force - pulls air down. Gives the air molecules weight.
- This weight exerts a force on the earth



There would be no air pressure without gravity. Gravity causes the air to have weight and to press on the earth.

The next day, Mrs. Becker divides the class into teams of three. Each person is assigned a topic about either hurricanes, tornados, or monsoons. Using classroom resources, each person finds information about specific effects their phenomenon has on the environment. Together, the group of three creates a poster that shows the similarities and differences between and among the three phenomena. When the groups are finished, each group exchanges its poster with another group and gives feedback to one another. Finally, Mrs. Becker displays the completed posters on the walls of the classroom.

Reviewing, Applying, and Practicing Knowledge

Once knowledge has been introduced, declarative knowledge must be reviewed and applied, and procedural knowledge must be practiced. There are a number of instructional strategies that a teacher might engage students in to help them deepen their knowledge:

- Assign homework that requires students to review, apply, and practice what they have learned. (See Chapter 5.)
- Engage students in projects that involve generating and testing hypotheses. (See Chapter 9.)
- Have students revise the linguistic and nonlinguistic representations of knowledge in their notebooks as they refine their understanding. (See Chapters 3 and 6.)

As the unit progresses, Mrs. Becker assigns different types of homework assignments, depending on the type of knowledge being reinforced. For example, she asks students to use the Internet to keep a daily record for two weeks of temperature, precipitation, cloud cover, and other weather information for a city of their choice. Using this skill each day gives students the practice they need to become proficient in keeping clear, organized, and complete records. They also become more skilled at using the Internet as a resource for finding information.

After students have kept records for the two-week period, Mrs. Becker assigns a short project to help them apply their knowledge by making and testing hypotheses. She asks students to predict what the weather will be the next day in the city for which they kept records. Students write an explanation of the basis for their prediction. The next day they use the Internet to check their predictions, then write an explanation of how close their prediction was, including any reasons for inaccuracies in their prediction.

Near the end of the unit, Mrs. Becker assigns a project in which students further apply and review their knowledge about the various weather systems studied during the unit. This application of knowledge is time consuming, so Mrs. Becker structures opportunities for cooperative learning, as well as time for students to work alone or conference with her. She asks students to work in groups and choose one of the weather systems (hurricane, tornado, monsoon) and use historical data about the system available on the Internet (e.g., Hurricane Agnes of 1972) to track its progress for several days. As students work on the assignment, they periodically review the notes they made earlier in the unit and make revisions, if necessary, to reflect their new understanding of the topic.

After students are familiar with the system they have been studying, Mrs. Becker asks them to consider how changing one element of the system — for example, ocean's temperature near the Florida coast or the approach of a strong cold front — might have affected the amount of damage done by the storm. Individually, students write an hypothesis about what might have happened as a result of the change. They then work in groups and discuss their hypotheses, "testing" them by considering the effects of the change on the system. Students modify their hypotheses when necessary and make suggestions to one another about the "testing" phase of the systems analysis. To fulfill the communication aspect of the project, Mrs. Becker asked students to complete the following writing assignment:

> *Write a weather report for the evening news that describes the new scenario. Include all the parts of your system, and explain how those parts are interacting. Use the correct weather terms, such as "cold front" or "low pressure system," but also be sure that people watching the news will be able to understand your weather report.*

Monitoring Learning Goals

Monitoring progress toward goals happens throughout the course of introducing and reviewing knowledge. Monitoring progress reinforces the importance of setting goals, students' sense of accomplishment, and the goal itself. The following strategies give students more information about their learning and contribute to their development as lifelong learners:

- Provide students with feedback and help them assess their progress. (See Chapter 8.)
- Provide recognition of legitimate progress toward goals. (See Chapter 4.)

Periodically throughout the unit, Mrs. Becker asks students to make notes of their progress on the six learning goals, using a worksheet like that in Illustration 2. The worksheet is designed so students can make rate their progress on each goal and make comments. To help students do this, Mrs. Becker gives them rubrics to assess their understanding and skill, explaining that the rubrics are a means of giving them feedback about their progress. As she reviews the rubrics with students, she clarifies what each score means in terms of the six learning goals. She periodically meets with students to give them individualized feedback, recognize specific accomplishments, and clarify misconceptions.

Sample Rubric for Assessing Understanding (Goals 1–4)

4	**Advanced performance:** I completely understand the important information related to the topic. I give detailed examples that show I understand the information. I also explain complex relationships and distinctions between concepts.
3	**Proficient performance:** I completely understand the important information related to the topic. I give detailed examples that show I understand the information.
2	**Basic performance:** I understand some of the important information related to the topic, but I can't give detailed examples that show I understand the information.
1	**Novice performance:** I understand very little of the important information related to the topic.

Sample Rubric for Assessing Skill Development (Goals 5 and 6)

4	**Advanced performance:** I do the major processes and skills that are important to the procedure easily and automatically.
3	**Proficient performance:** I do the major processes and skills that are important to the procedure without making any significant errors, but I don't necessarily do them automatically.
2	**Basic performance:** I make a number of errors when I do the major processes and skills that are important to the procedure, but I accomplish the purpose of the procedure.
1	**Novice performance:** I make so many errors when I do the major process and skills that are important to the procedure that I don't accomplish the purpose of the procedure.

ILLUSTRATION 2: STUDENT SELF-ASSESSMENT WORKSHEET

Student: Brian Bahney	**Self-Assessment**			**Unit:** Weather
PERSONAL GOALS (A) Learn whether hurricanes are really just big, wide tornadoes. (B) Learn what caused the big floods in the Midwest in the recent past.	**1**	**2**	**3**	
	3/2			
1 - Comments: Hurricanes & tornadoes are dangerous, but how they're formed is exciting.				
2 - Comments:				
3 - Comments:				
Goal 1: ELEMENTS OF WEATHER	3			
1 - Comments: One element I know about is "precipitation." Others I'm not sure about. What about frost?				
2 - Comments:				
3 - Comments:				
Goal 2: WEATHER SYSTEMS	2			
1 - Comments: I don't fully understand the role that temperature plays in forming tornadoes.				
2 - Comments:				
3 - Comments:				
Goal 3: EARTH'S ATMOSPHERE	4			
1 - Comments: I thought this was easy.				
2 - Comments:				
3 - Comments:				
Goal 4: CLOUDS	3			
1 - Comments: I see clouds much differently now!				
2 - Comments:				
3 - Comments:				
Goal 5: SCIENTIFIC INQUIRY	3			
1 - Comments: Keeping records is easy, but I have trouble identifying a hypothesis to test.				
2 - Comments:				
3 - Comments:				
Goal 6: COMMUNICATION	4			
1 - Comments: I feel good about my writing and how it's improved.				
2 - Comments:				
3 - Comments:				

AT THE END OF A UNIT OF INSTRUCTION

Teachers can use specific strategies and activities to bring a unit to completion in a way that enhances the learning process for every student:

- Provide students with clear assessments of their progress on each learning goal. (See Chapters 4 and 8.)
- Have students assess themselves on each learning goal and compare these assessments with those of the teacher. (See Chapter 8.)
- Have students articulate what they have learned about the content and about themselves as learners. (See Chapter 8.)

Mrs. Becker has provided multiple and varied opportunities to assess students on their progress toward each of the learning goals. In addition, Mrs. Becker schedules an assessment conference with each student toward the end of the weather unit. During the conference, students give Mrs. Becker their own assessments of how well they think they have met each of the learning goals. Mrs. Becker compares students' self-assessments to her assessment of their progress, which she recorded in her grade book over the course of the unit. Mrs. Becker and each student thoroughly discuss any gaps between her evaluation and the student's self-assessment. She asks students to review the concepts and information they understand and talk about what they have learned about themselves as learners. She validates each student's performance of skills and offers positive comments or specific suggestions that might enhance the student's learning in the future. In short, Mrs. Becker uses the assessment conference at the end of the unit as an opportunity to reinforce each student's efforts during the unit and to validate his or her achievements and sense of accomplishment.

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