6

Nonlinguistic Representations

Identifying Similarities and Differences
Summarizing and Note Taking
Reinforcing Effort and Providing Recognition
Homework and Practice
Nonlinguistic Representations
Cooperative Learning
Setting Objectives and Providing Feedback
Generating and Testing Hypotheses
Cues, Questions, and Advance Organizers

Mrs. Maly asked her 5th graders to put their heads down on their desks and close their eyes. She started reading aloud from the book, *A Street Through Time,* by Anne Millard. The book describes an old street that becomes inhabited by nomadic hunter-gatherers. Throughout the book, the period in which the story takes place keeps changing, as do the demands placed on the people living in the "street through time." As she read the first couple of pages, she described what she saw "in her mind." She asked her students to "see in their mind" what they were hearing her say. She also told students that they could interrupt her reading to ask questions (e.g., What does the roof on the hut look like? Did the people hurt when they got the plague?) When she finished reading the story, Mrs. Maly asked students to work independently drawing pictures of their "favorite scenes" from the images they had created in their minds.

The next day, students shared and explained their pictures in small groups. When they finished, each group drew a semantic web to depict the information from the story they thought was the most important. Mrs. Maly instructed students to use the first layer of the web to choose general terms that were common to all time periods described in the story (e.g., transportation, food, shelter, and work). The next layer of the web was devoted to examples and illustrations of the common terms during specific eras depicted in the book.

Mrs. Maly has made good use of a powerful aspect of learning—generating mental pictures to go along with information, as well as creating graphic representations for that information.

Research and Theory on Nonlinguistic Representations

Many psychologists adhere to what has been called the "dual-coding" theory of information storage (see Paivio, 1969, 1971, 1990). This theory postulates that knowledge is stored in two forms—a linguistic form and an imagery 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).

In this book, the imagery mode of representation is referred to as a *nonlinguistic representation*. The more we use both systems of representation—linguistic and nonlinguistic—the better we are able to think about and recall knowledge. This is particularly relevant to the classroom, because studies have consistently shown that the primary way we present new knowledge to students is linguistic. We either talk to them 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. When teachers help students in this kind of work, however, the effects on achievement are strong. It has even been shown that explicitly engaging students in the creation of nonlinguistic representations stimulates and increases activity in the brain (see Gerlic & Jausovec, 1999). Figure 6.1 summarizes findings from a variety of studies that have attempted to synthesize the research on nonlinguistic representation.

We have found two generalizations that can guide teachers in the use of nonlinguistic representations in the classroom.

1. A variety of activities produce nonlinguistic representations. Though we need to remember that the goal of instructional strategies in this section is to produce nonlinguistic representations of knowledge *in the minds of students*, it is also true that this can be accomplished in many ways. Research indicates that each of the following activities enhances the development of nonlinguistic representations in students and, therefore, enhances their understanding of that content:

- *Creating graphic representations* (Alvermann & Boothby, 1986; Armbruster, Anderson, & Meyer, 1992; Darch, Carnine, & Kameenui, 1986; Griffin, Simmons, & Kameenui, 1992; Horton, Lovitt, & Bergerud, 1990; McLaughlin, 1991; Robinson & Kiewra, 1996).
- *Making physical models* (Welch, 1997).

FIGURE 6.1

Research Results for Nonlinguistic Representation

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

[a] Multiple effect sizes are listed because of the manner in which the effect sizes were reported. Readers should consult those studies for more details.

- *Generating mental pictures* (Muehlherr & Siermann, 1996; Willoughby, Desmarias, Wood, Sims, & Kalra, 1997).
- *Drawing pictures and pictographs* (Macklin, 1997; Newton, 1995; Pruitt, 1993).
- *Engaging in kinesthetic activity* (Aubusson, Foswill, Barr, & Perkovic, 1997; Druyan, 1997).

2. Nonlinguistic representations should elaborate on knowledge. In simple terms, elaboration involves “adding to” knowledge. For example, a student elaborates on his knowledge of fractions when he constructs a mental model of how a fraction might appear in concrete form. When students elaborate on knowledge, they not only understand it in greater depth, but they can recall it much more easily (Pressley, Symons, McDaniel, Snyder, & Turnure, 1988; Woloshyn, Willoughby, Wood, & Pressley, 1990). Fortunately, the process of generating nonlinguistic representations engages students in elaborative thinking (see Anderson, J. R., 1990). That is, when a student generates a nonlinguistic representation of knowledge, by definition, she has elaborated on it. Finally, the power of elaboration can be enhanced by asking students to explain and justify their elaborations (Willoughby et al., 1997).

Classroom Practice in Nonlinguistic Representation

Creating Graphic Organizers

Graphic organizers are perhaps the most common way to help students generate nonlinguistic representations. One of the most comprehensive treatments of the use of graphic organizers can be found in the book *Visual Tools for Constructing Knowledge* by David Hyerle (1996). Actually, graphic organizers combine the *linguistic mode* in that they use words and phrases, and the *nonlinguistic mode* in that they use symbols and arrows to represent relationships. The following six graphic organizers have great utility in the classroom because they 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.

Descriptive Patterns. Descriptive patterns can be used to represent facts about specific persons, places, things, and events. The information organized into a descriptive pattern does not need to be in any particular order. Figure 6.2 shows how teach-

FIGURE 6.2
Descriptive Pattern Organizer

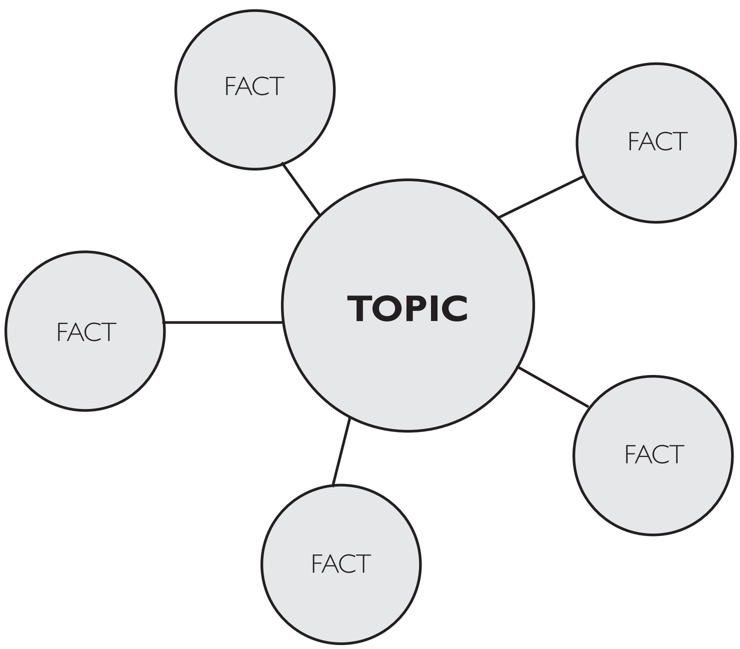
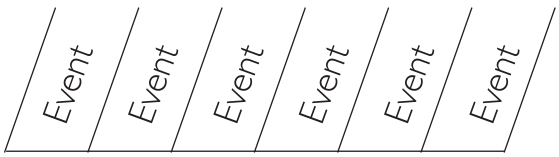


FIGURE 6.3

Time Sequence Pattern Organizer



ers and students can graphically represent a descriptive pattern.

Time-Sequence Patterns. Time-sequence patterns organize events in a specific chronological order. For example, information about the development of the Apollo space program can be organized as a sequence pattern. Figure 6.3 shows how you might represent a time-sequence pattern graphically.

Process/Cause-Effect Patterns. Process/cause-effect patterns organize information into a causal 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 body might be organized as a process/cause-effect pattern. Figure 6.4 shows a graphic representation of a process/cause-effect pattern.

Episode Patterns. Episode patterns organize 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, students might organize information about the French Revolution into an episode pattern using a graphic like that shown in Figure 6.5.

Generalization/Principle Patterns. Generalization/principle patterns organize information into general statements with supporting examples. For instance, for the statement, "A mathematics function is a re-

FIGURE 6.4

Process/Cause-Effect Pattern Organizer

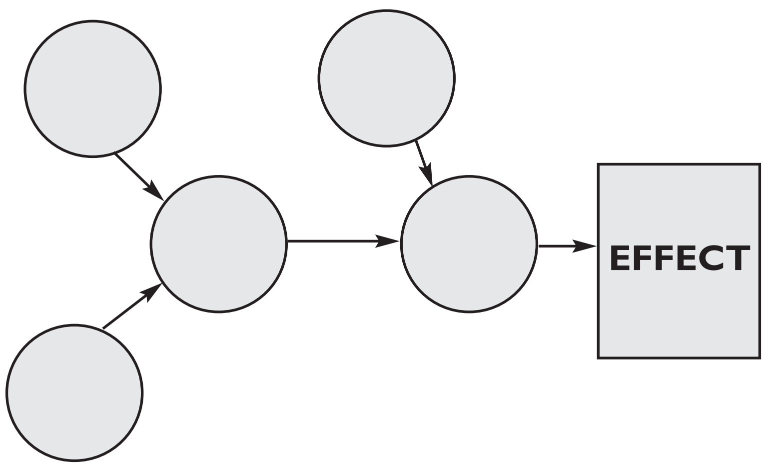
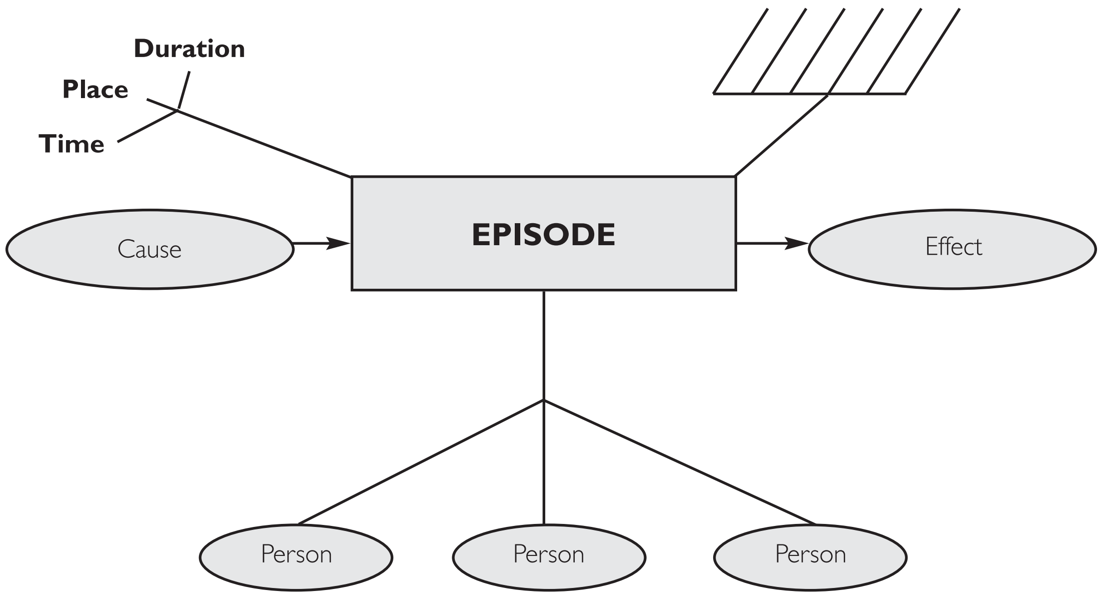


FIGURE 6.5

Episode Pattern Organizer



lationship where the value of one variable depends on the value of another variable," students can provide and represent examples in a graphic like that shown in Figure 6.6.

Concept Patterns. 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. For example, students could use a graphic like the one in Figure 6.7 to organize the concept of *fables*, along with examples and characteristics.

The following example shows how a student might use more than one graphic organizer with a single topic.

When Ty Crocker studied for his test on Law and the Legal System, he found a good way to remember the three common methods for solving disputes out of court. He matched each of the three methods, *ar-*

FIGURE 6.6

Generalization/Principle Pattern Organizer

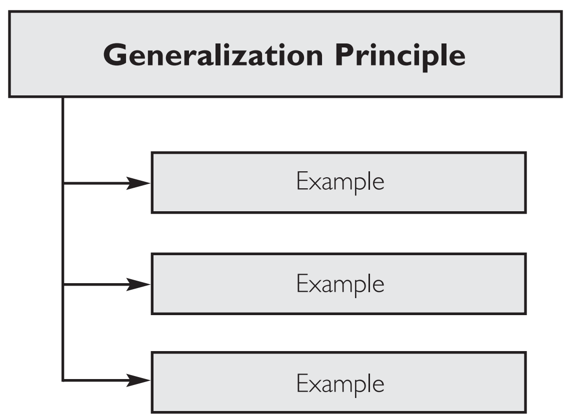
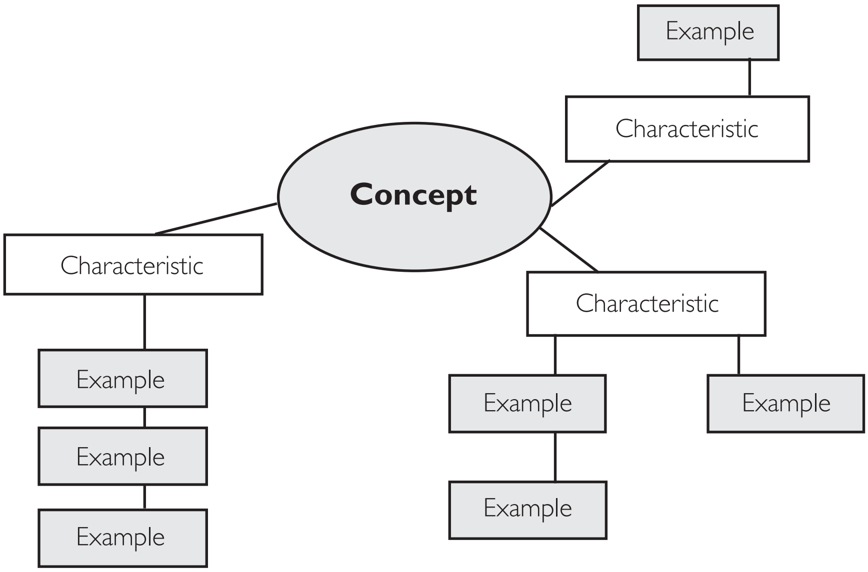


FIGURE 6.7

Concept Pattern Organizer



bitration, negotiation, and *voluntary mediation,* to a different kind of graphic organizer he had learned in his English class. For the topic of *arbitration*, he used a "time-sequence pattern." For *negotiation*, he used a "process or cause-effect pattern." He created a "concept pattern" for *voluntary mediation.* Figures 6.8–6.10 (pp. 79–80) show these graphic representations.

Using Other Nonlinguistic Representations

Making Physical Models. As the name implies, physical models are concrete 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. The following example illustrates this process in the context of a science class.

> Mrs. Allison helped her 4th grade class to understand why we see different phases of the moon by presenting a concrete representation of the moon's monthly journey around the earth and its relationship to the sun. For the moon, Mrs. Allison gave each student a white Styrofoam ball and had them stick it on the end of a pencil. For the sun, she used a lamp with the shade removed. She told her students each of them would be the earth.
>
> Mrs. Allison placed the lamp in the middle of the room, pulled down the window shades, and turned off the lights. Then she had each student place the ball at arm's

FIGURE 6.8

Time-Sequence Pattern in Arbitration

FIGURE 6.9

Process/Cause-Effect Pattern for Negotiation

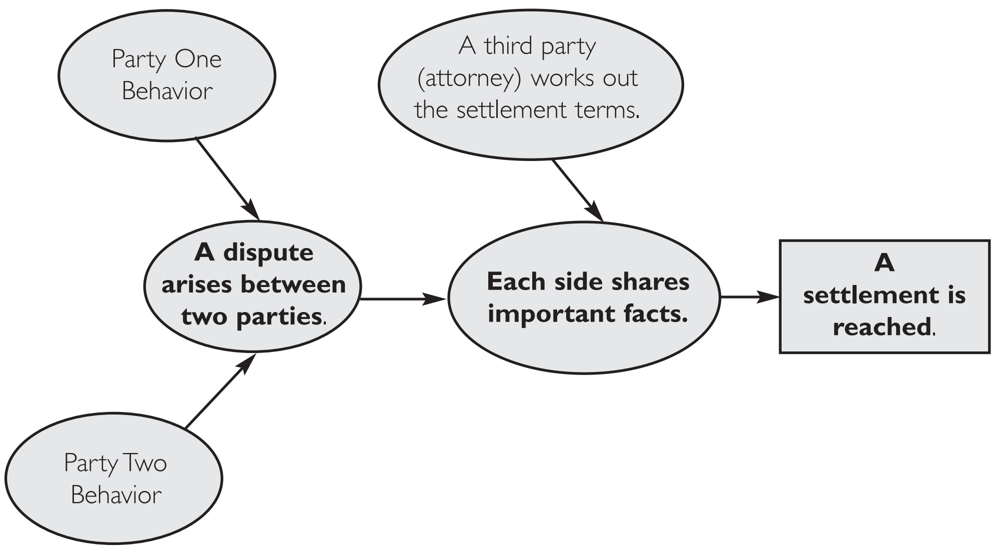
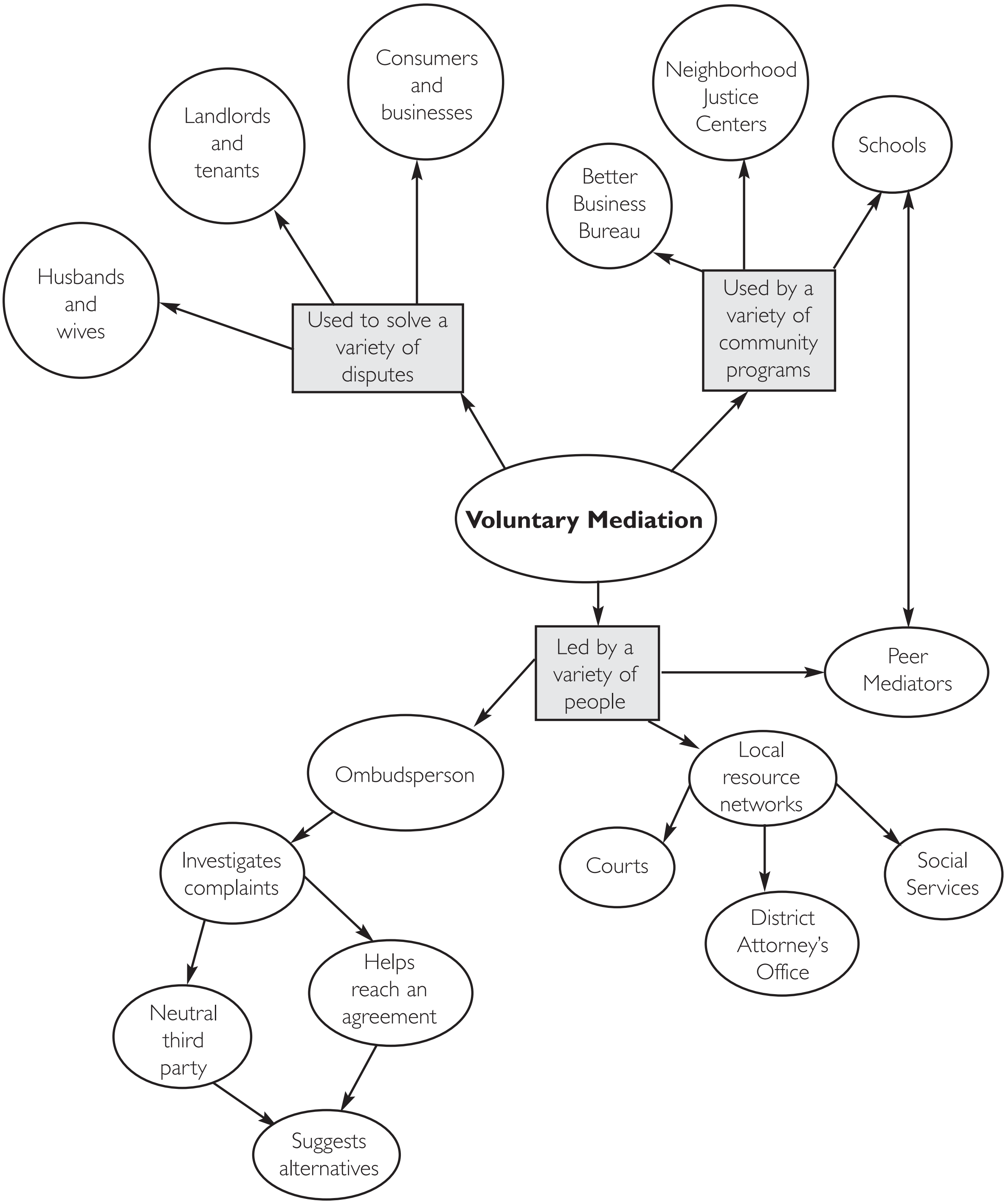


FIGURE 6.10

Concept Pattern for Voluntary Mediation



length between the bulb and their eyes, simulating a total solar eclipse, which, she explained, is quite rare. Because the moon usually passes above or below the sun as viewed from Earth, Mrs. Allison then had her students move their moon up or down a bit so that they were looking into the Sun. From this position the students could observe that all the sunlight was shining on the far side of the moon, opposite the side they were viewing, simulating a new moon.

Mrs. Allison guided her students to move their moons in such a way that they observed first a crescent moon, then a half moon, a full moon, and a three-quarter moon. At each point, Mrs. Allison pointed out that the sun was always illuminating half of the moon (except in the case of a lunar eclipse) and that the appearance of the these fractions of moon was due to the moon's changing position in relationship to the earth over the course of a month.

Generating Mental Pictures. The most direct way to generate nonlinguistic representations is to simply construct (i.e., imagine) a mental picture of knowledge being learned. 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:

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

The 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 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).

The following example shows how a teacher might facilitate the construction of mental pictures in the context of a social studies class.

Mr. Williams's 5th grade class is beginning a unit on the history of Native American cultures in the southwest United States. To begin, Mr. Williams introduces his students to the strategy of creating mental pictures of information and ideas. He tells them to imagine that they are early European explorers who have stumbled on the abandoned cliff palace of Mesa Verde. He has them close their eyes and imagine they are traveling by horseback through the canyon lands. He has them "feel" the hot desert sunlight, "see" the scrubby vegetation, and "smell" the junipers and piñon pines.

"Imagine," Mr. Williams says, "that you suddenly see something in the distance that looks like an apartment building carved into a cliff. Would you be puzzled? Curious? Frightened? Now imagine that you gallop your horse to the edge of the cliff and peer across at the black and tan sandstone and yes, it is something like an apartment building. There are ladders, black hole 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?"

Drawing Pictures and Pictographs. Drawing pictures or pictographs (i.e., symbolic pictures) to represent knowledge is a powerful way to generate nonlinguistic representations in the mind. For example, most students have either drawn or colored the human skeletal system or have seen a picture of one in the classroom. Similarly, most students have drawn or colored a representation of the solar system. A variation of a picture is the pictograph, which is a drawing that uses symbols or symbolic pictures to represent information. The following example shows how a 1st grade teacher uses symbolic pictures in a geography lesson.

Allison Mason's 1st graders always have a hard time understanding the abstract idea that the northern hemisphere tilts toward and away from the sun, causing summer and winter. She asks the students to draw a picture of the earth's movement as she describes each season. Zach draws the picture shown in Figure 6.11. Based on the picture, Ms. Mason and Zach have a conversation about the earth's tilt. When Zach draws in the equator, he finally begins to understand what she means about the earth "tilting."

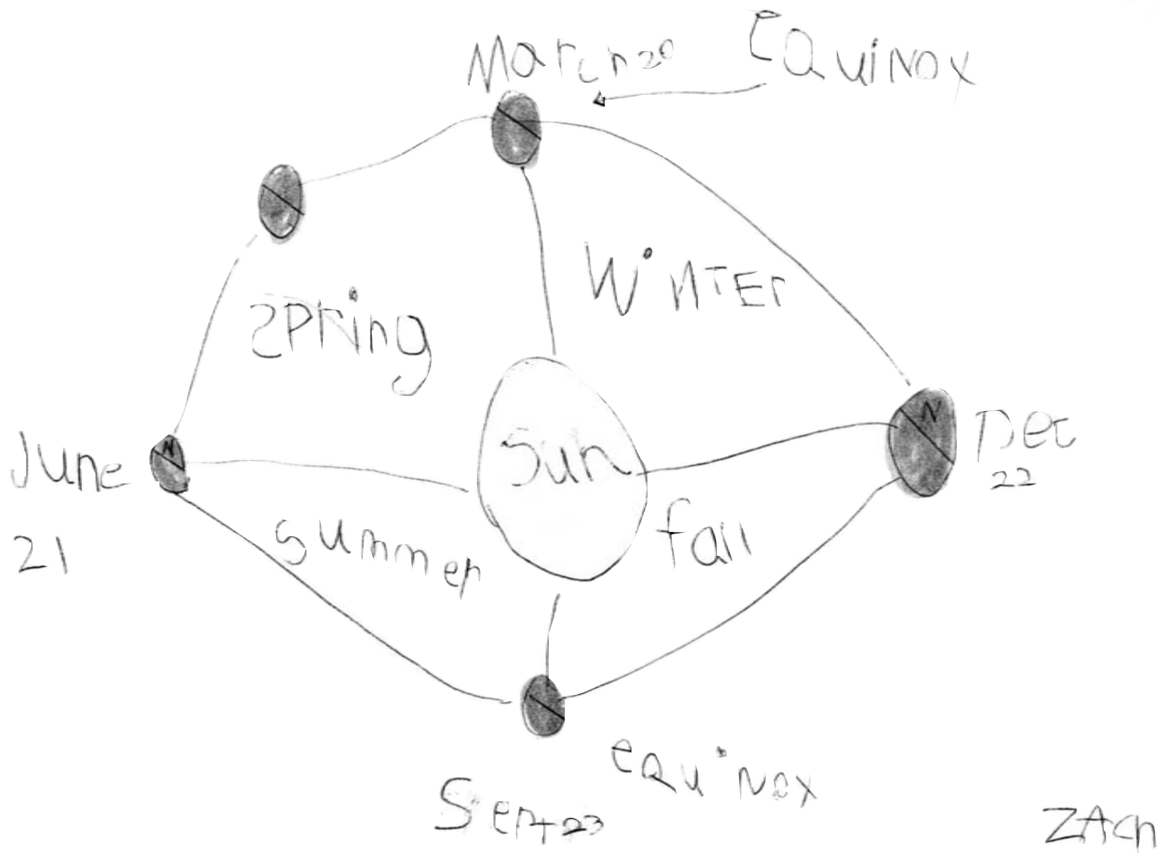
Engaging in Kinesthetic Activity. Kinesthetic activities are those that involve physical movement. By definition, physical movement associated with specific knowledge generates a mental image of the knowledge in the mind of the learner. (Recall from the previous discussion that mental images include physical sensations.) Most children find this both a natural and enjoyable way to express their knowledge. The following example below illustrates this in the context of a math class.

Often, to take a brief pause in math class, Ms. Jenkins asks her 4th grade students to think of ways they can represent what they are learning. For example, during the lesson on radius, diameter, and circumference of circles, Barry uses his left arm outstretched to show radius, both arms outstretched to show diameter, and both arms forming a circle to show circumference. During a different lesson on angles, Devon depicts obtuse and acute angles by making wide and not-so-wide "Vs" with her arms as the children yell out the degrees. They even have ways to show fractions, mixed numbers, and turning fractions into their simplest forms.

Ms. Jenkins started the activity she called *Body Math* just to give the students a break

FIGURE 6.11

Student Pictograph



from the routine of doing math drills, but then realized that it was a powerful way for students to show whether or not they understood the concept behind the problems. Once the word got around, other students could be seen peeking in the classroom to see what they were doing that day with body math.

♦ ♦ ♦

Probably the most underused instructional strategy of all those reviewed in this book—creating nonlinguistic representations—helps students understand content in a whole new way. As we have seen, teachers can take a variety of approaches, ranging from graphic organizers to physical models.