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*

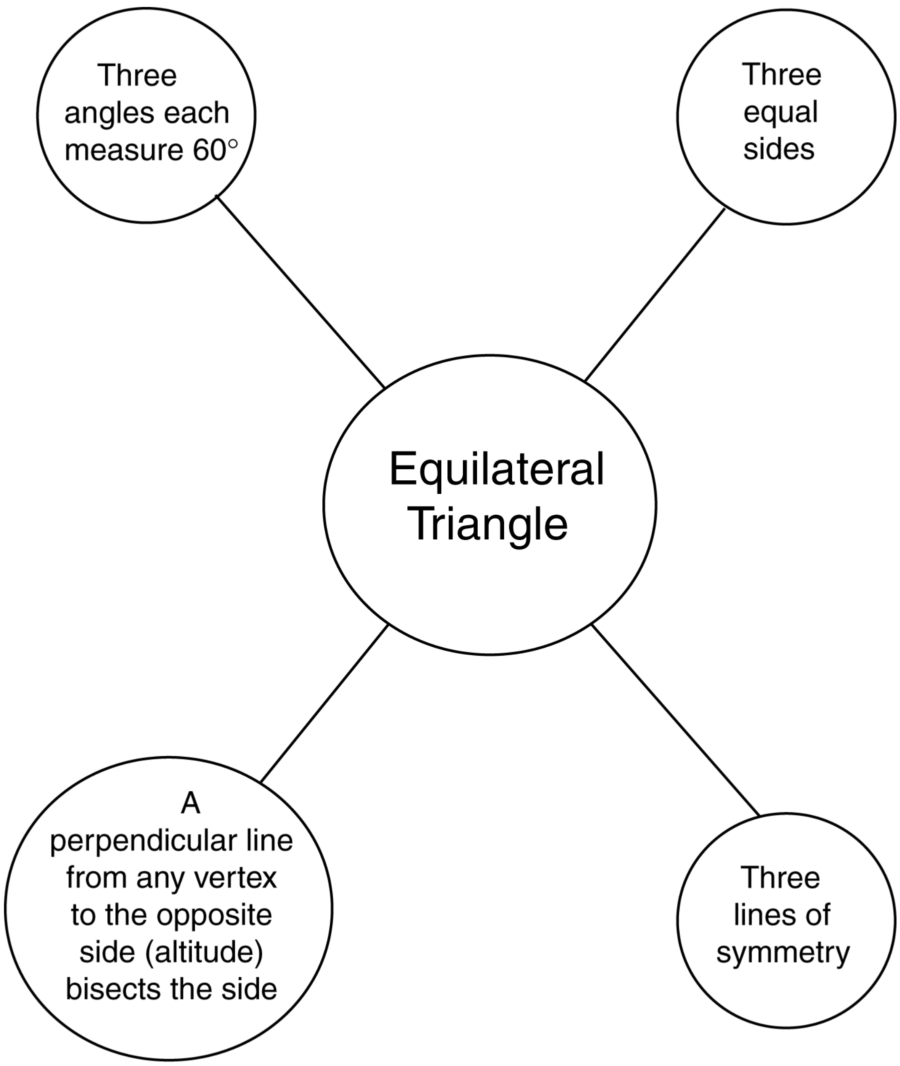


ILLUSTRATION 2: TIME/SEQUENCE PATTERN ORGANIZER *the race for the South Pole*

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*

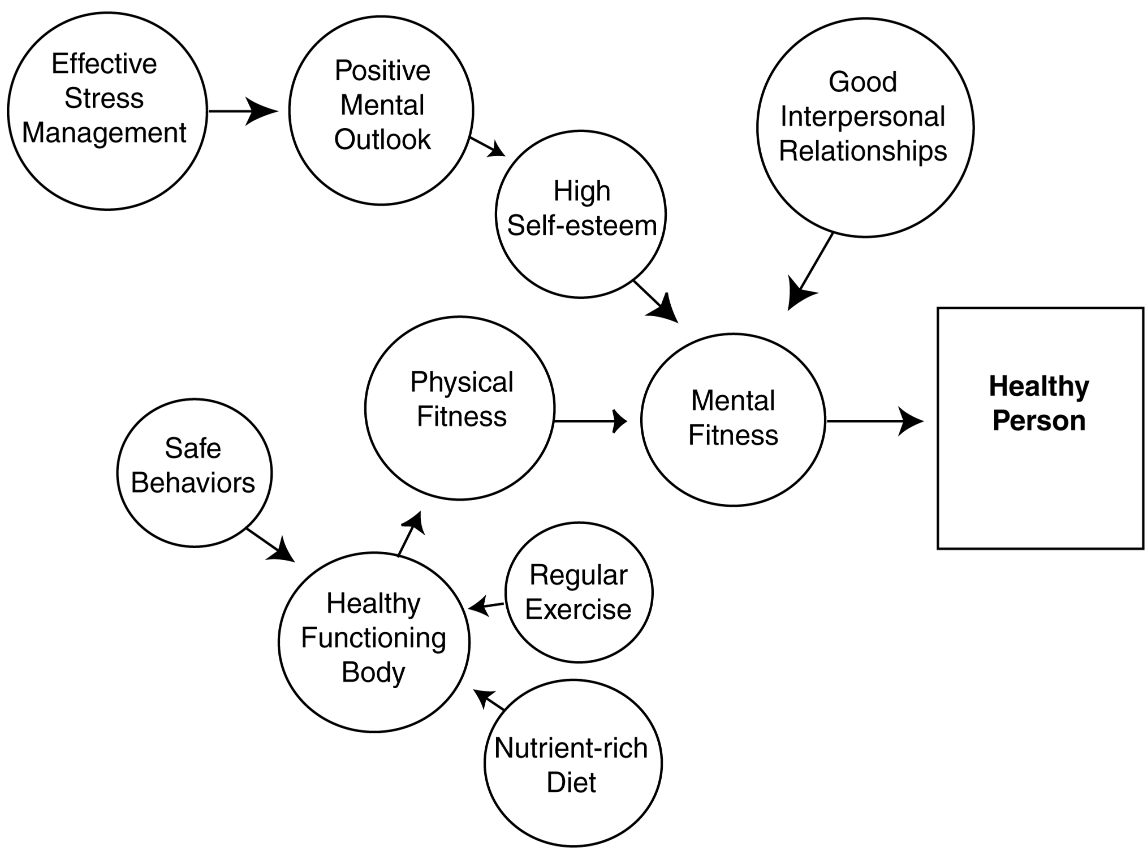


ILLUSTRATION 4: EPISODE PATTERN ORGANIZER *stock market crash 1987*

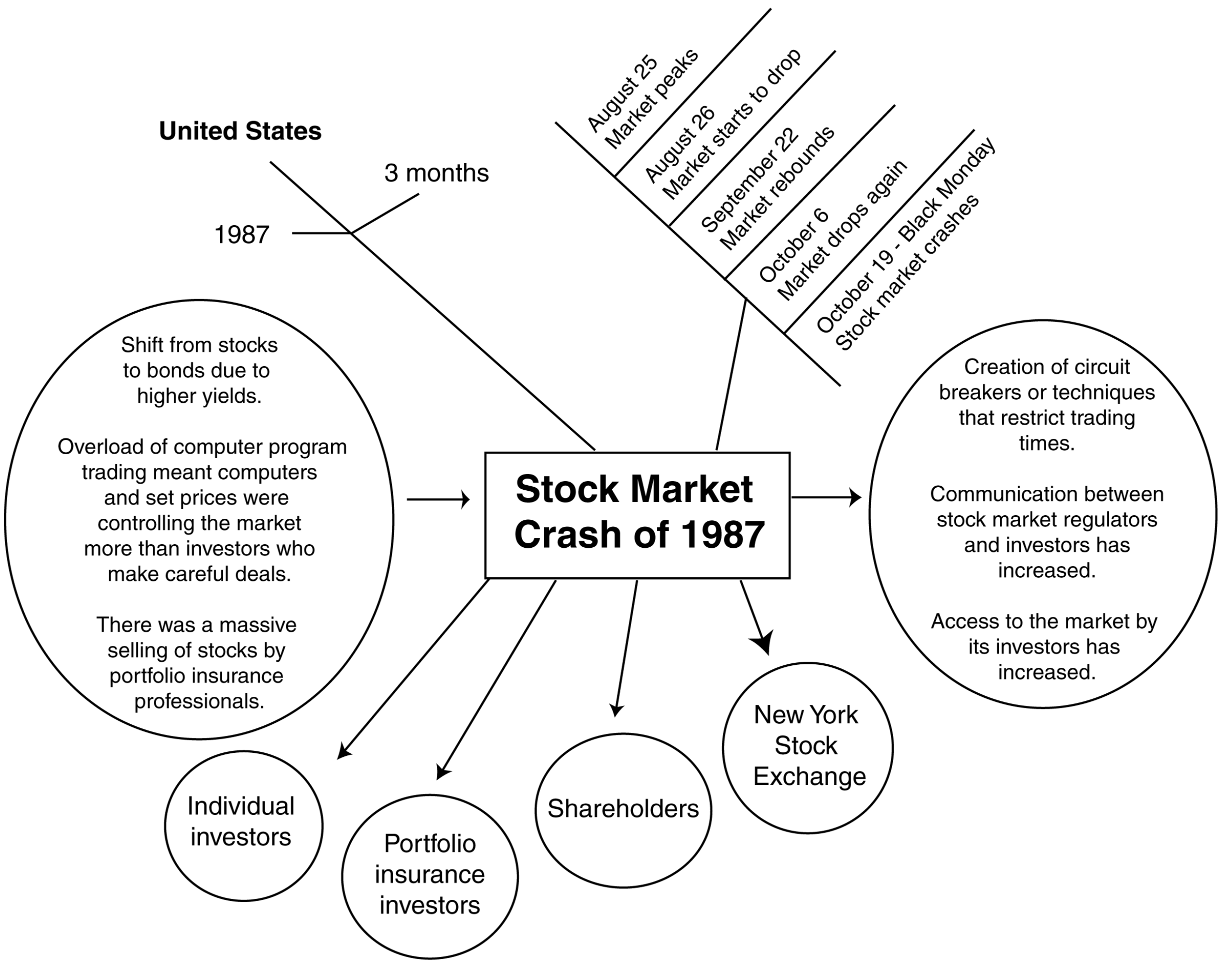


ILLUSTRATION 5: GENERALIZATION/PRINCIPLE PATTERN ORGANIZER *mathematics function*

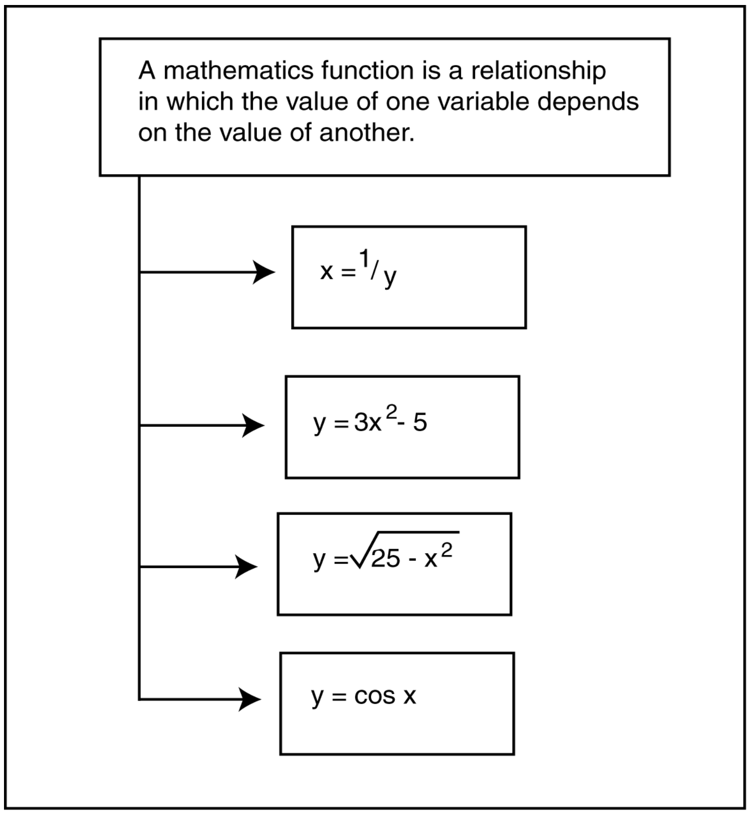


ILLUSTRATION 6: CONCEPT PATTERN ORGANIZER *fables*

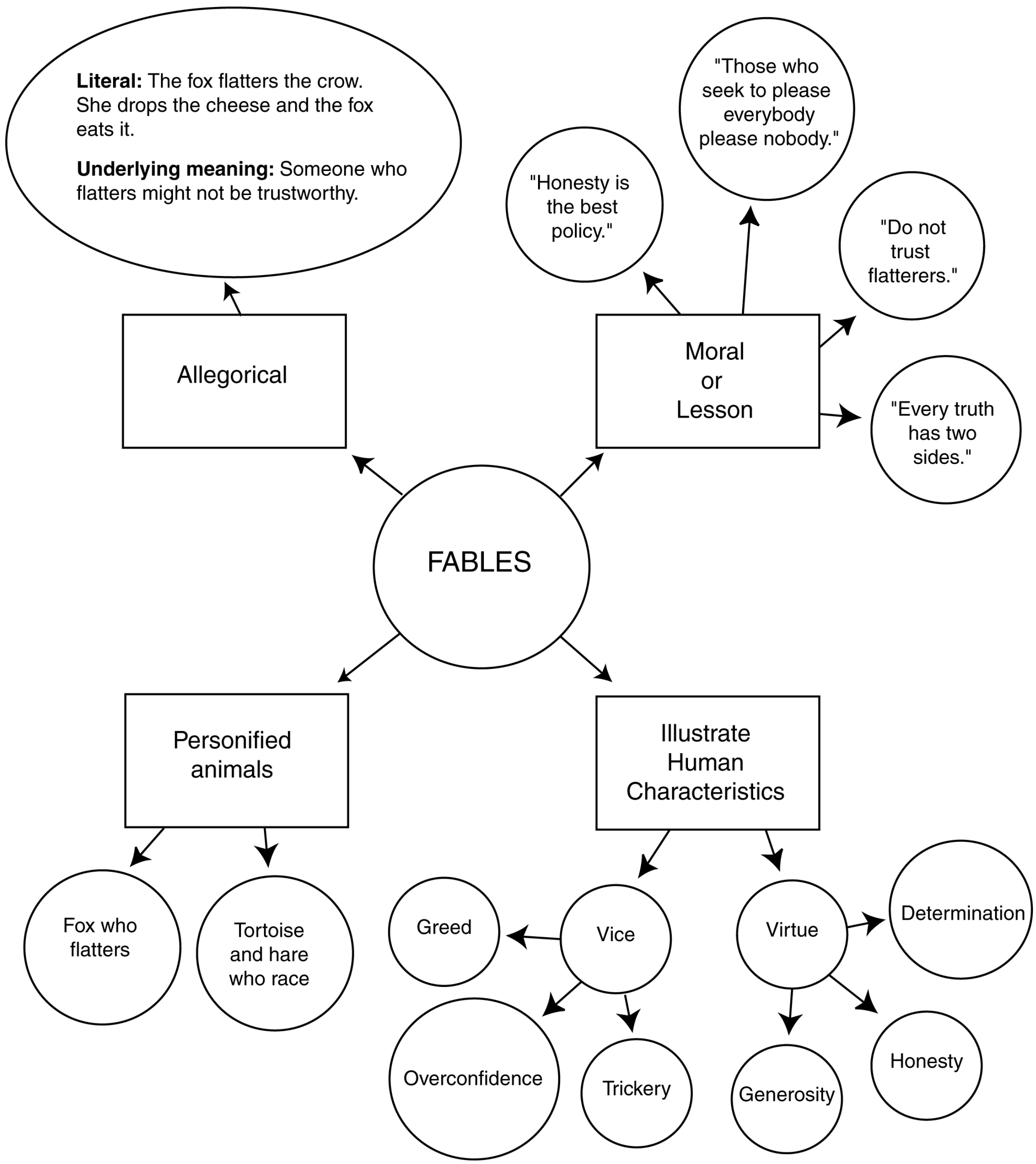


ILLUSTRATION 7: USING MULTIPLE ORGANIZERS FOR THE SAME TOPIC *the Vietnam War*

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.

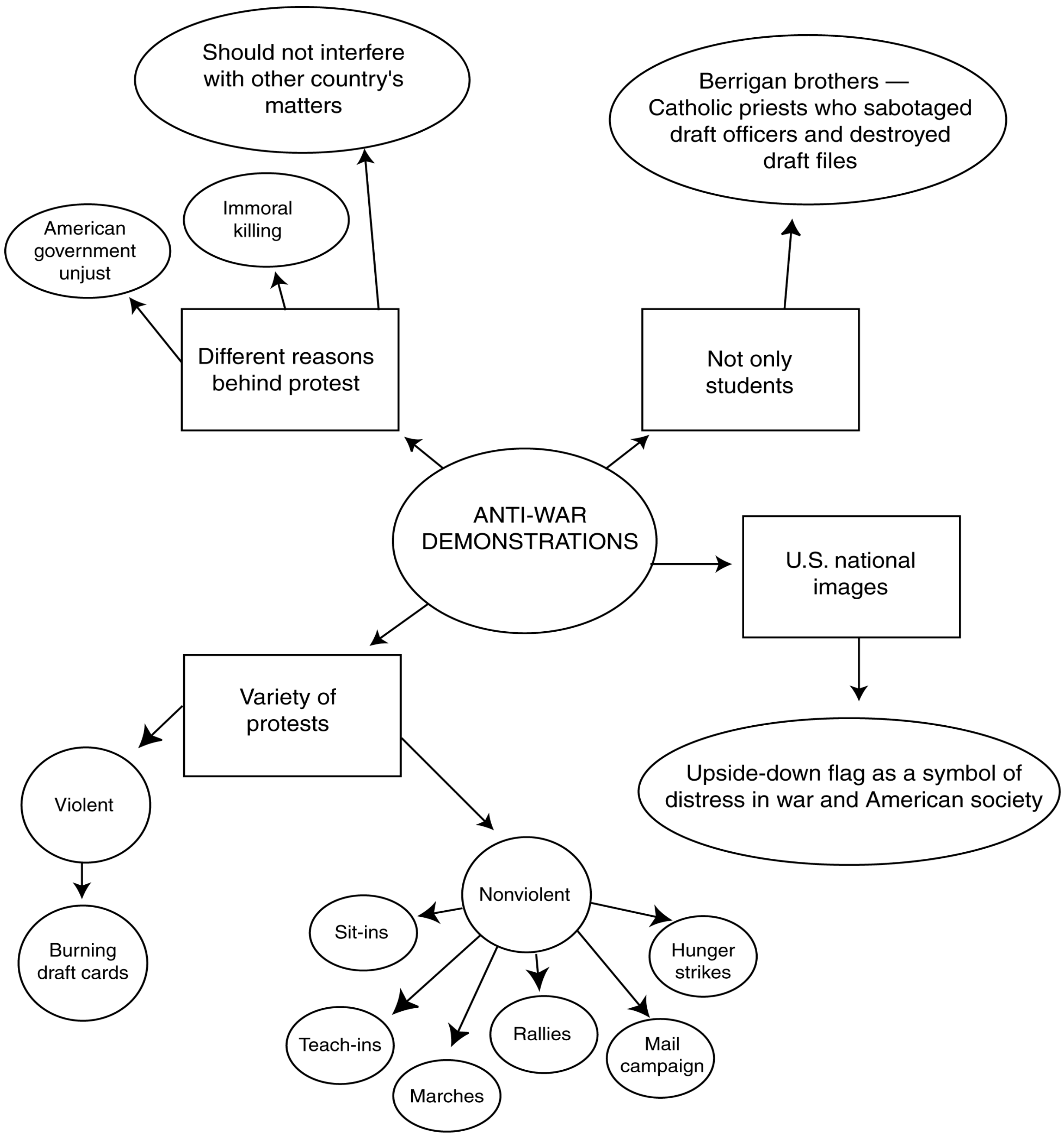
May 4, 1970
Four Kent State college students shot to death by Ohio National Guardsmen during an anti-war protest on campus.

January 1973
Treaty signed by North Vietnam, South Vietnam, Viet Cong, and U.S.

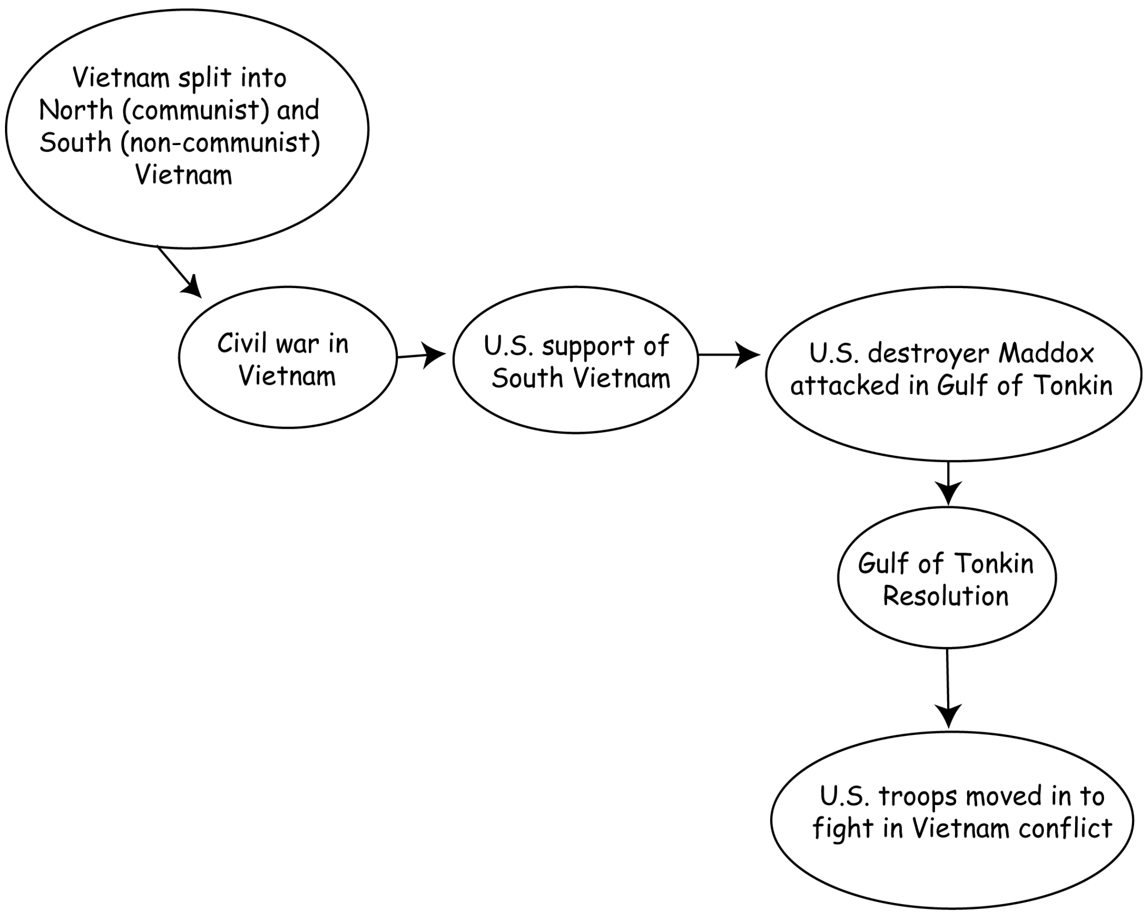
March 23, 1973
U.S. combat forces withdrawn.

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

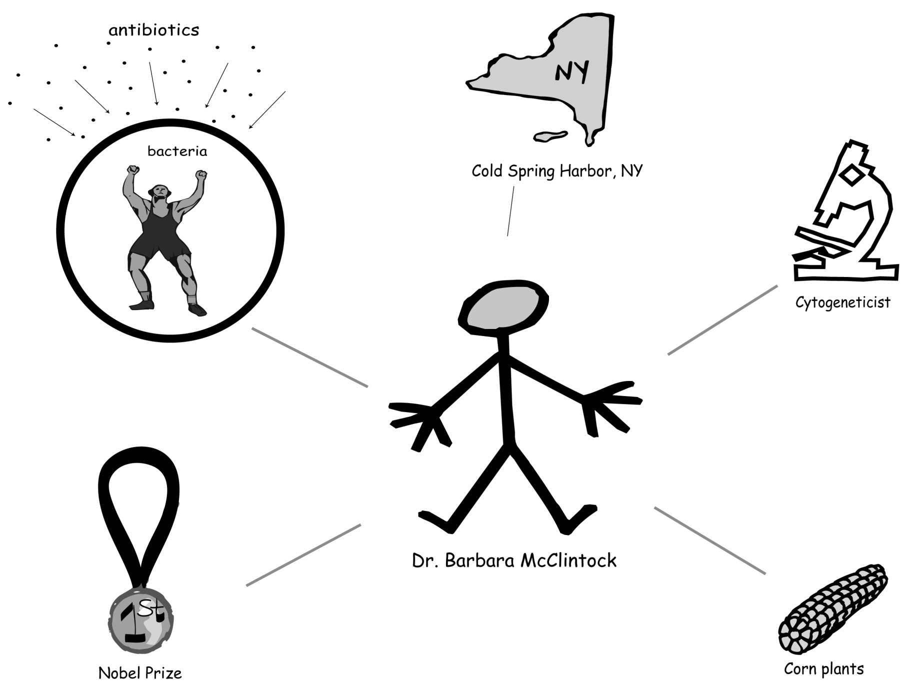
(See Illustration 1)

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.