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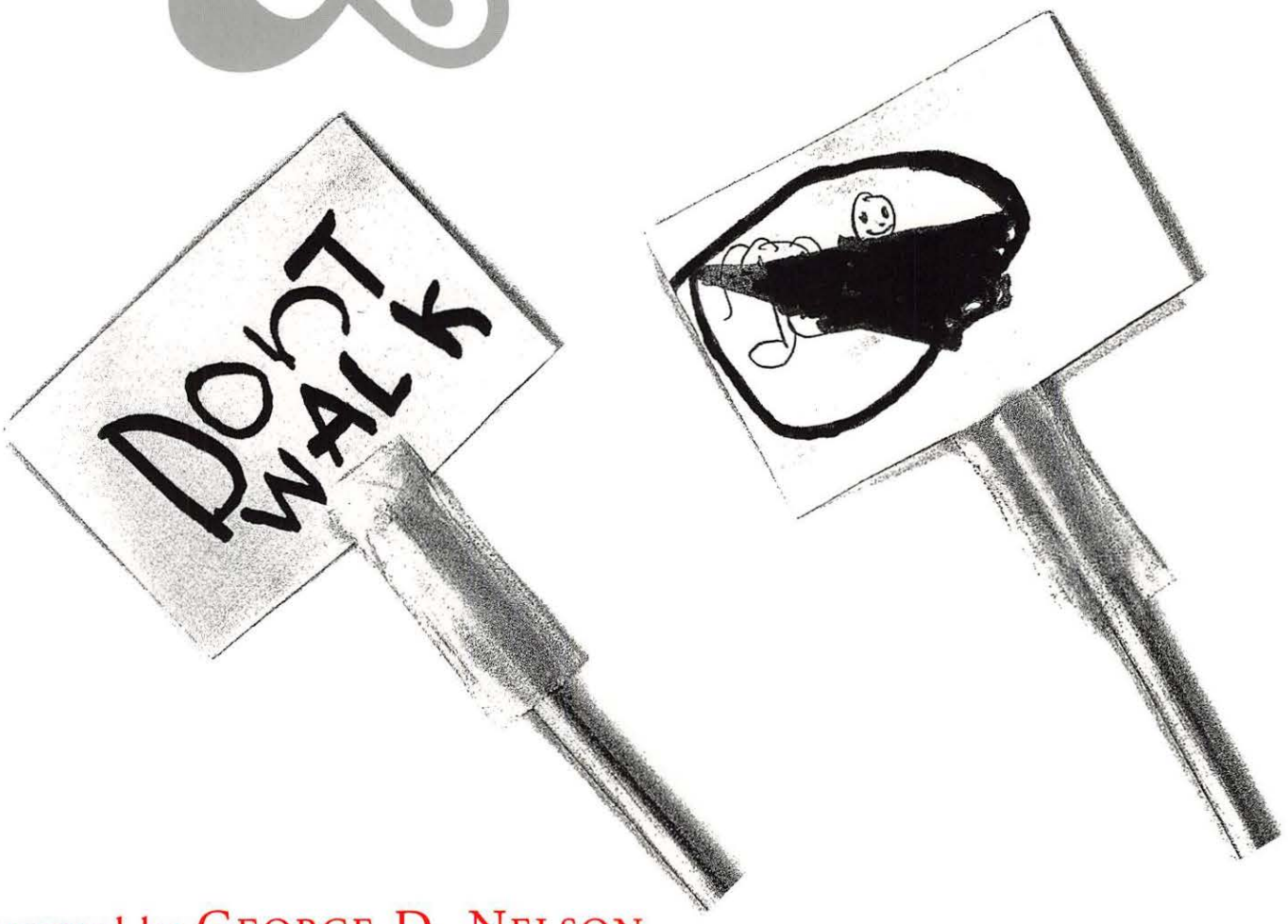
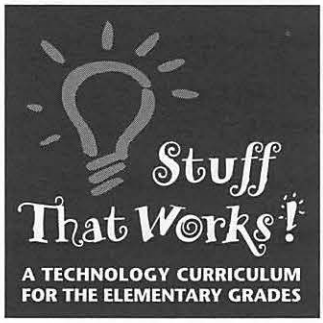
Stuff That Works!
A TECHNOLOGY CURRICULUM FOR THE ELEMENTARY GRADES

Signs, Symbols & Codes



Foreword by GEORGE D. NELSON



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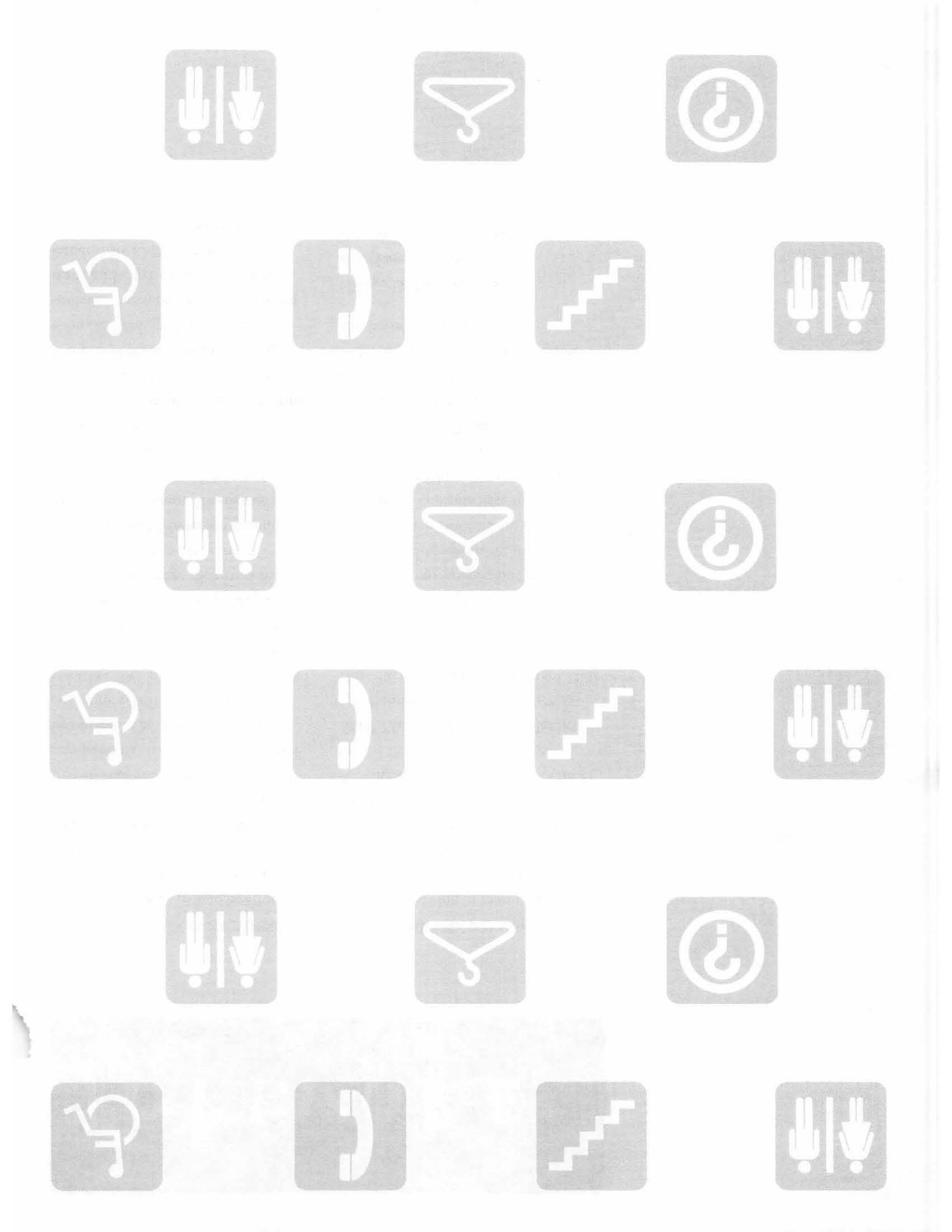
FOREWORD

IN A WORLD INCREASINGLY DEPENDENT ON TECHNOLOGY—where new ideas and tools pervade our personal and civic lives and where important choices hinge on our knowledge of how things and people work—the imperative that all students should learn to understand and use technology well should be obvious. Yet in the American curriculum, still overstuffed with tradition and trivia, there is little room in the day for learning and teaching about important ideas from technology and very few resources for educators who want to engage their students in learning for the 21st century.

Stuff That Works! is a groundbreaking curriculum. It provides a set of carefully chosen and designed activities that will engage elementary students with the core ideas and processes of technology (or engineering, if you prefer). Elementary school is the ideal place to begin learning about technology. It is a time in students' development when they are ready and eager to take on concrete rather than abstract ideas. The concepts and skills presented in ***Stuff That Works!*** will support more advanced learning in mathematics, science, and technology as students move up through the grades.

But there is much more to ***Stuff That Works!*** than a set of activities. As a matter of fact, the activities make up less than a third of the pages. ***Stuff That Works!*** also includes helpful resources for the teacher such as clear discussions of the important ideas and skills from technology that their students should be learning; stories of how the materials have been used in real classrooms; suggestions for outside reading; guidance for assessing how well their students are doing; and tips on implementation. I hope teachers will take time to make full use of these valuable resources as they use ***Stuff That Works!*** If they do, they can help their students take the first, critical steps towards technological literacy and success in and beyond school.

George D. Nelson, Director
American Association for the Advancement of Science (AAAS) Project 2061

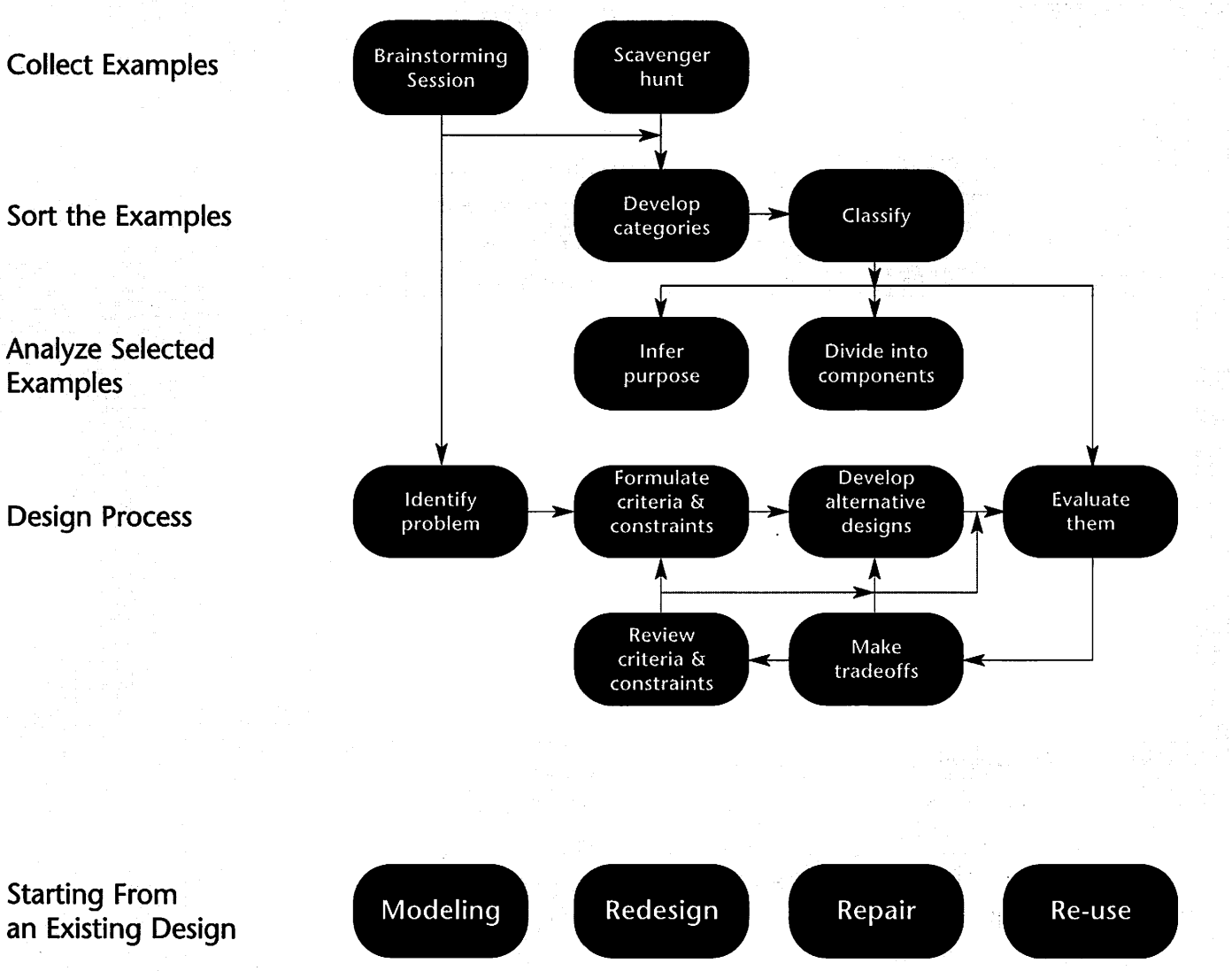


Why Study Technology in Elementary School?

Below is a graphic summary of the process of "doing" technology as we present it in this book. The study of technology challenges students to identify and solve problems, build understanding, develop and apply competence and knowledge in a variety of processes and content areas, including science, mathematics, language arts, and social interaction.

The teachers who field-tested these materials underscored that these activities helped their students to:

- observe and describe phenomena in detail;
- explore real objects and situations by creating models and other representations;
- identify salient aspects of problems;
- solve authentic problems;
- use evidence-based reasoning;
- apply the scientific method;
- ask thoughtful questions;
- communicate in oral, written, and graphic form;
- collaborate effectively with others.



Educational Goals for *Signs, Symbols, and Codes*

Signs, Symbols, and Codes deals with methods of representing information. These methods include graphic devices and gestures, as well as words and numbers. When a set of symbols is organized into a coherent system, it is called a *code.* The contexts and activities presented here will help you meet these goals:

- Develop fundamental themes of information, representation, sign, symbol, and communication;
- Promote literacy by developing a variety of techniques for sending and receiving information;
- Promote numeracy by developing awareness of symbols as media for representing quantitative information;
- Demystify common artifacts, and by extension, technology in general;
- Develop process skills in observation, classification, generalization, communication, and design;
- Develop awareness of immediate environment;
- Provide rich opportunities for group work.

How This Guide Is Organized

Each *Stuff That Works!* guide is organized into the following chapters.

Chapter 1. *Appetizers* suggests some things you can do for yourself, to become familiar with the topic. You can do these activities at home, using only found materials. They will help you to recognize some of the technology that is all around you, and offer ways of making sense of it.

Chapter 2. *Concepts* develops the main ideas that can be taught for and through the topic. These include ideas from science, math, social studies and art, as well as technology.

Chapter 3. *Activities* contains a variety of classroom projects and units related to the topic, including those referred to in Chapter 4. Each activity includes prerequisites, goals, skills, concepts, materials, references to standards, and teacher tips.

Chapter 4. *Stories* presents teachers' narratives about what happened in their own classrooms. Their accounts include photos, samples of children's work, and children's dialog. Commentary by project staff connects the teachers' accounts with the concepts developed in Chapter 2.

Chapter 5. *Resources* provides a framework supporting the implementation of the activities. It includes an annotated bibliography of children's literature and a discussion of assessment opportunities.

Chapter 6. *About Standards* shows how the activities and ideas in this book address national standards in technology, science, math, English language arts (ELA), and social studies.

How to Use This Guide

Different teachers will obviously come to this book with different needs and objectives. However, regardless of your background, instructional approach, and curricular goals, *we strongly recommend that you begin with Chapter 1, "Appetizers."* There is simply no better way to become acquainted with a topic and to understand what your students will be facing than to try out some of the ideas and activities for yourself. Chapter 1 guides you through that process.

The content and approach presented in *Signs, Symbols, and Codes* are based on the premise that processes of design are central to the practice of technology, just as inquiry is the central activity of science. While no two design problems are the same, there are some features that characterize any design task:

- It should solve a problem of some sort.
- It must have more than one possible solution.
- There must be an effort to test the design.

A problem is like a trigger that initiates a design process. Often the problem is not well-formulated, a vague kind of "wouldn't it be nice if ..." In making the problem more specific, it is often helpful to list some criteria the design must address. In trying to satisfy these criteria, the designer is never completely free to do whatever he or she wants. There are always constraints, which could involve cost, safety, ease of use, and a host of other considerations.

There is no one way to do design. It is a non-linear, messy process that typically begins with very incomplete information. Additional criteria become apparent as the design is implemented and tested. New constraints appear that were not originally evident. It is often necessary to backtrack and revise the original specifications. Such a messy process may seem contrary to the work you usually expect to see happening in your classroom. However, we encourage you to embrace the messiness! It will justify itself by improving students' competence in reasoning, problem-solving, and ability to communicate not only what they are doing but also why they are doing it and what results they expect.

A Brief History of *Stuff That Works!*

The guides in the *Stuff That Works!* series were developed through collaboration among three different kinds of educators:

- Two college professors, one from the School of Education of City College of the City University of New York, and the other from the City College School of Engineering;
- Two educational researchers from the Center for Children and Technology of the Education Development Center (CCT/ EDC);
- Thirty New York City elementary educators who work in the South Bronx, Harlem, and Washington Heights.

This last group included science specialists, early childhood educators, special education teachers, a math specialist, a language arts specialist, and regular classroom teachers from grades pre-K through six. In teaching experience, they ranged from first-year teachers to veterans with more than 20 years in the classroom.

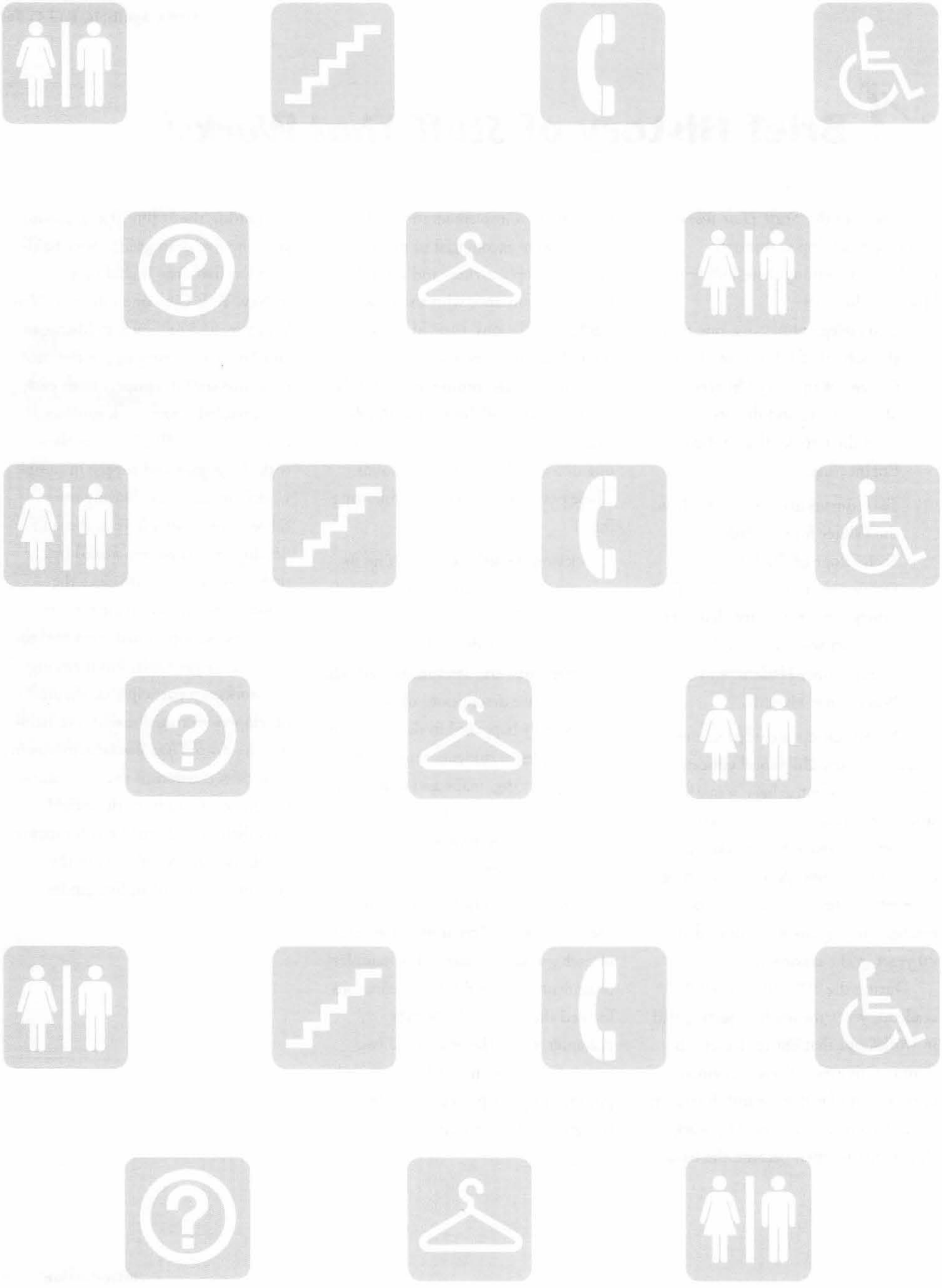
During the 1997-98 and 1998-99 academic years, the teachers participated in workshops that engaged them in sample activities and also provided opportunities for sharing and discussion of classroom experiences. The workshop activities then became the basis for classroom implementation. The teachers were encouraged to modify the workshop activities and extend them in accordance with their own teaching situations, their ideas, and their children's interests.

The teachers, project staff, and the research team collaborated to develop a format for documenting classroom outcomes in the form of portfolios. These portfolios included the following items:

- lesson worksheets describing the activities and units implemented in the classroom, including materials used, teacher tips and strategies, and assessment methods;
- narrative descriptions of what actually happened in the classroom;
- samples of students' work, including writing, maps and drawings, and dialogue; and
- the teachers' own reflections on the activities.

The lesson worksheets became the basis for the **Activities** (Chapter 3) of each guide. The narratives, samples of student work, and teacher reflections formed the core of the **Stories** (Chapter 4). At the end of the two years of curriculum development and pilot testing, the project produced five guides in draft form.

During the 1999-2000 academic year, the five draft guides were field-tested at five sites, including two in New York City, one suburban New York site, and one each in Michigan and Nevada. To prepare for the field tests, two staff developers from each site attended a one-week summer institute, to familiarize themselves with the guides and engage in sample workshop activities. During the subsequent academic year, the staff developers carried out workshops at their home sites to introduce the guides to teachers in their regions. These workshops lasted from two to three hours per topic. From among the workshop participants, the staff developers recruited teachers to field-test the *Stuff That Works!* activities in their own classrooms and to evaluate the guides. Data from these field tests then became the basis for major revisions that are reflected in the current versions of all five guides.



Chapter 1

Appetizers

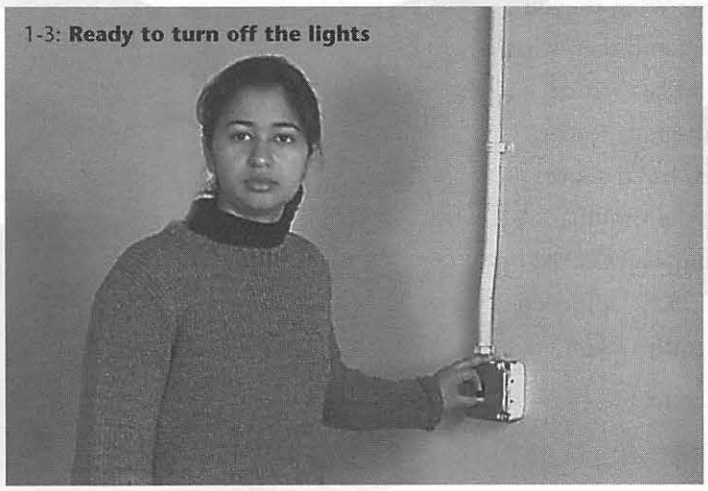
What do you do to gain the students' attention at a moment of transition or when things have gotten out of hand? One technique is shown in Figure 1-1. If that doesn't work, this may be followed by the method shown in Figure 1-2, and then by turning off the lights, as in Figure 1-3.

In this entire sequence, the teacher never says a word. She uses the following signals:

- Makes a face;
- Puts her finger to her cheek;
- Stares intently;
- Stands up straight;
- Makes a "V" sign;
- Walks over to the light switch; and
- Turns off the lights.

1-1: **Finger to cheek**

1-2: **The "V" sign**



1-3: **Ready to turn off the lights**

Every teacher has a variety of methods for getting the attention of a class. These could include words, nonverbal speech, intonations, a raised voice, gestures, facial expressions, posture, writing something on the board, hitting something with a ruler, turning off the lights, and more. All of these are *signals,* or *symbols,* for conveying the same message: "Pay attention!"

"Pay attention!" is only one of the myriad of messages that people try to send one another. Every message is conveyed by a symbol of some kind. The world is so full of symbols that they are largely taken for granted. This book will help you look at symbols in a different way and support you in making signs, symbols, and codes a part of your curriculum.

To begin with, we recommend that you make a survey of symbols in your own experience. How do *you* get the attention of a class? What do you do first, and then what, and then what? What is *your* method of last resort? Minerva Rivera, a fifth-grade teacher, tries all of the methods listed above. If and when they fail, she simply sits down in a chair and stares at the students. "When I do *that,*" Minerva says, "they know I'm really *ticked!*"

There are some symbols you can physically collect, such the symbols embodied in ads, consumer packages, and instruction manuals. Other items containing symbols cannot easily be removed from where they reside. These include street and wall signs, symbols on large appliances, and body language. You will have to capture them another way—for example, by drawing them, taking photographs, or describing them in words.

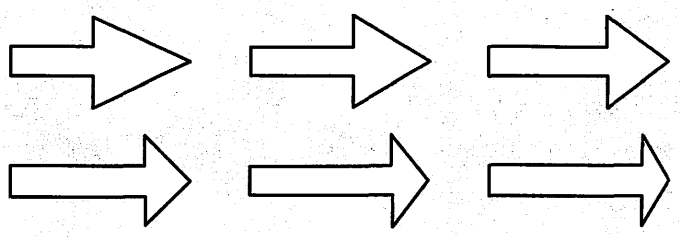
The field of symbols is so vast that it helps to divide them into categories. The sections of this chapter reflect one way of dividing up the world of symbols. Figuring out new ways to classify symbols is a worthwhile activity in itself. As you go through this chapter, be on the lookout for different ways of categorizing them.

Basic Symbols

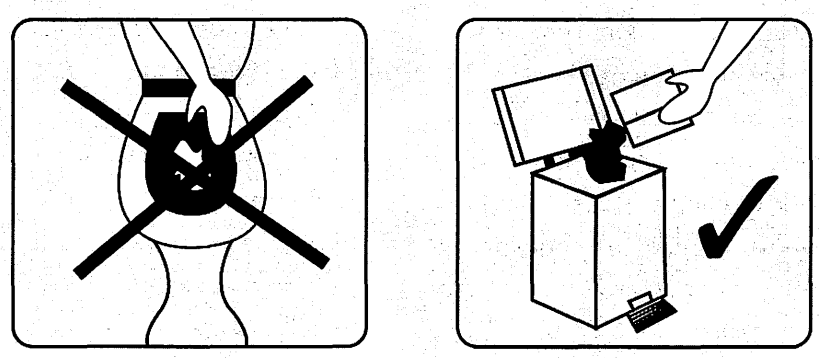
Why are there spaces between words? A period means "this is the end of a sentence," and a comma is a kind of boundary marker within a sentence. A space represents a kind of boundary too—the boundary between words. Apparently, a space—the absence of a symbol—is a symbol too! Spaces were not used for this purpose until around the ninth century A.D. Before that, Greek and Latin manuscripts simply ran all the words together. Inscriptions on Roman statues and buildings sometimes used a raised dot to separate the words. Even the lowly space between words had to be invented by someone!

Look at the list of items on the first page of this chapter. Each one is preceded by a little symbol called a "bullet." This symbol has nothing to with guns. It means simply, "Here is an item in a list." Arrows are sometimes used for bullets, and also for many other purposes. An arrow often says, "Move your eyes in this direction." What does it take to make an arrow convey this message? Figure 1-4 shows a set of arrows that are identical in height and overall length. Can you tell how they differ? Which one looks best? If you don't like any of them, draw a few arrows that seem better to you. What is different about them?

1-4: **Which of these arrows do you like best?**



1-5: **"Don't throw trash in the toilet. Do throw it in the trash can."**



Here is another set of very basic symbols: the √ and X to represent "yes" and "no," "do" and "don't," or "good" and "bad," respectively. As teachers, we use these all the time, and everyone seems to know what they mean. They can also be used in a humorous way; see, for example, Figure 1-5.

The check sign is also a form of the "tally" mark, used for counting. A stroke or check mark means "one of something." Figure 1-6 shows an example of counting by tallying. The first three numbers of the Roman numeral system—I, II, and III—seem to be descendants of the tally system.

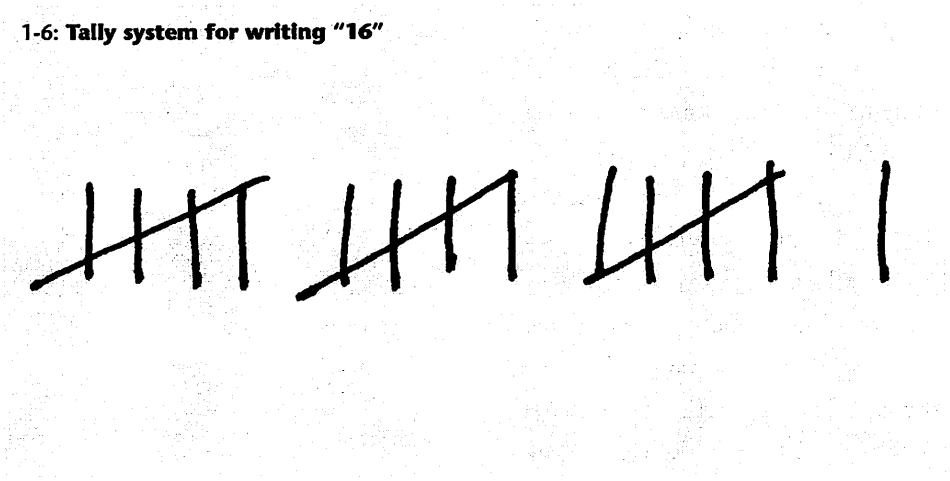
The Arabic number system is much more complex than the tally system, because you have to remember ten different symbols (rather than just two—the vertical line and the slanted line) and because the value of a symbol depends on its position. However, the Arabic system has two great advantages over the tally system:

1. It uses much less space to represent large numbers; and
2. It makes calculation much easier.

As an example of #1, the number in Figure 1-6 is represented by only two Arabic numerals: "16."

In written English, individual symbols—letters—represent sounds rather than concepts. These letter symbols usually have to be combined into words in order to have any meaning. The ampersand—&— is one of the few exceptions; it is a single symbol that has a meaning. In other language systems, many individual symbols stand for entire words or concepts. This is true of Chinese, stenographer's short hand, Braille, and American Sign Language. Can you think of other examples? Can you think of other meaningful individual symbols in English, besides "&"?

1-6: **Tally system for writing "16"**



In this section, we have mentioned the following categories of basic symbol:

- Spaces
- Punctuation marks
- Bullets
- Arrows
- Check marks and "X"s
- Tally marks
- Numerals
- Letters
- Ampersands

What other symbols would you consider basic?

Graphic Symbols for "Don't!"

We turn next to the category of graphic symbols. A graphic expresses an idea using a picture that is related to the idea in some way. Graphic symbols can be much more immediate than words. Also, literacy is not a prerequisite for reading them. Some signs tell you something is not allowed; others warn you that something could be dangerous. Most warning signs are too important to be left entirely to words; they need to be grasped quickly and by virtually anyone.

The most commonly used symbol in prohibitions and warnings is the red circle with a diagonal slash across it. Figure 1-7 is one example.

Because the symbol is so clear, the words are redundant. Figure 1-8 shows a New York City "NO PARKING" sign. This sign has one very clever touch: the broom handle, which indicates "STREET SWEEPING," doubles as the red diagonal slash that means "DON'T." However, the "P" is not a graphic symbol at all. If you don't know that "P" stands for "PARKING," you won't understand the sign. It could even cost you a parking ticket!

"WARNING" signs are more important than prohibitions. They tell you about things that could be harmful or fatal. Additional graphic elements sometimes help to convey this message of "DANGER." Figure 1-9 is a warning sign from a vending machine. Besides the red circle and slash, it shows a triangle and warning exclamation point. These suggest the harm that could result from tipping the machine. Although the message is quite clear, it is undermined somewhat by the words "Vending machine will not dispense free product." In other words, even if the threat of injury or death isn't important to you, you still shouldn't expect a free soda!

1-7: **This sign is intended for people, not dogs**

1-8: **New York City "No Parking" sign**

1-9: **"Never rock or tilt"**

A graphic warning symbol from the sun visor of a car is shown in Figure 1-10. Next to the symbol is a bulleted list of warnings and safety tips, which convey a lot more information than the graphic symbol does. Evidently, the designers of this sign had more to say than they could fit in the graphic symbol, but the graphic is much more immediate than the list. Notice the child seat breaking, and the "action lines" suggesting harm to the baby. This symbol is hard to ignore.

Warning symbols and prohibitions are easy to find. How many can you spot? Good places to look for them are in places where dangers or rules abound, such as airports, government buildings, hospitals, and trains. Children tend to be intrigued by warnings and prohibitions. Given the chance to make their own signs for the school, they usually create prohibition signs.

1-10: **Warning against putting a baby in the front seat**

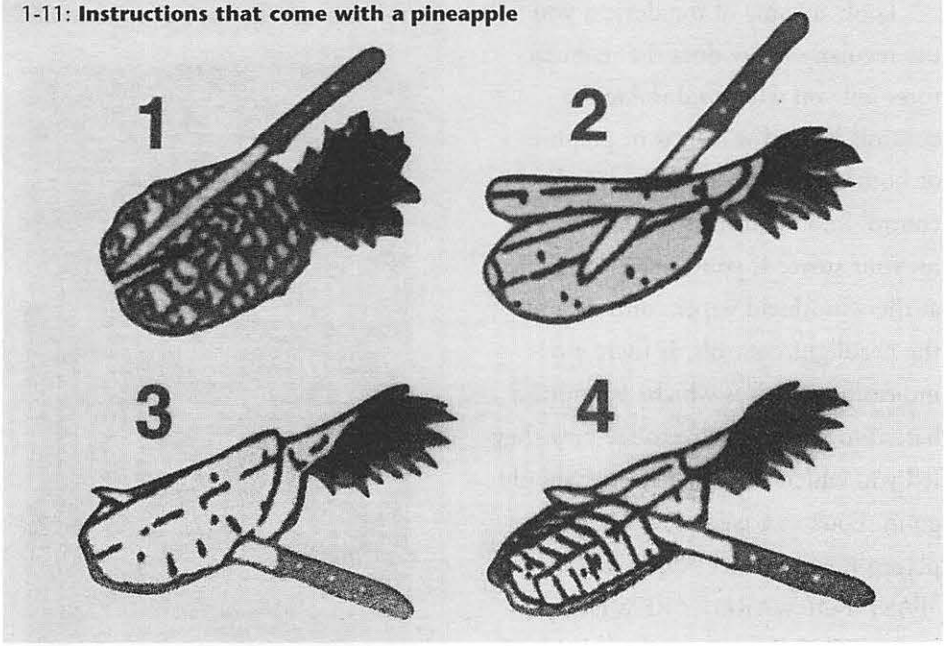
Graphic Instruction Manuals

Graphics are also used to convey information. Many products require some sort of explanation, so the user will know what to do with them. Design of such a product includes the design of a set of instructions. Often, these instructions are best presented in graphic form.

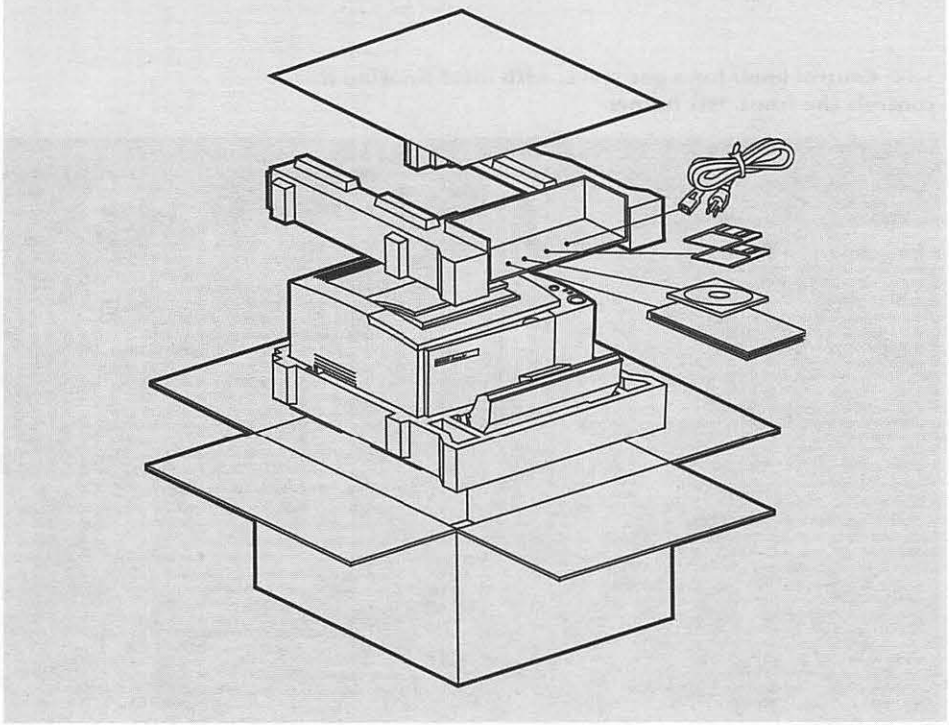
You are likely to find a graphic instruction manual enclosed with the following items:

- an electronic device that has to be hooked up;
- a tool or appliance that comes with attachments;
- a food product requiring special preparation (see Figure 1-11);
- furniture you have to assemble yourself;
- a construction toy.

1-11: **Instructions that come with a pineapple**



1-12: **Graphic instructions for removing the printer and its accessories from the box**



It is worth studying these manuals carefully, and gauging your own reactions to them. How clear are the directions? Do the instructions skip too many steps? Do the pictures correspond clearly with the parts? Can you tell what goes where? What other elements make an instruction manual work or not work?

Instruction manuals come in many forms. The first question about a product is often, "How do I get it out of the box?" Some boxes have the answer to this question printed right on them. For example, Figure 1-12 is a diagram from the side of a box that contained a computer printer. It shows the packing material, accessories, and the printer itself, in the order they should be removed.

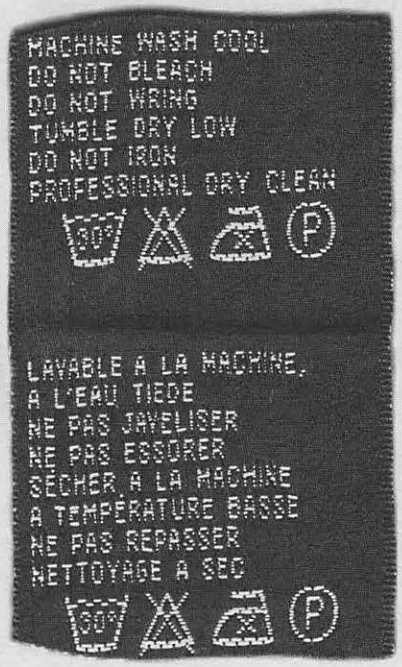
The accessories, including the line cord, disks, and manual, are shown larger than scale, with "callouts" indicating their locations in the box. The diagram also shows how the flaps should be opened. It provides more information than is typical. Too often, the directions for opening the box are buried somewhere inside, making them useless!

Another issue calling for directions is how to clean a product. Nearly every article of clothing has "Care Instructions" sewn onto it, sometimes with graphic symbols for messages like "USE COLD WATER," "NO BLEACH," "MAY BE DRY CLEANED," etc. Figure 1-13 shows an example.

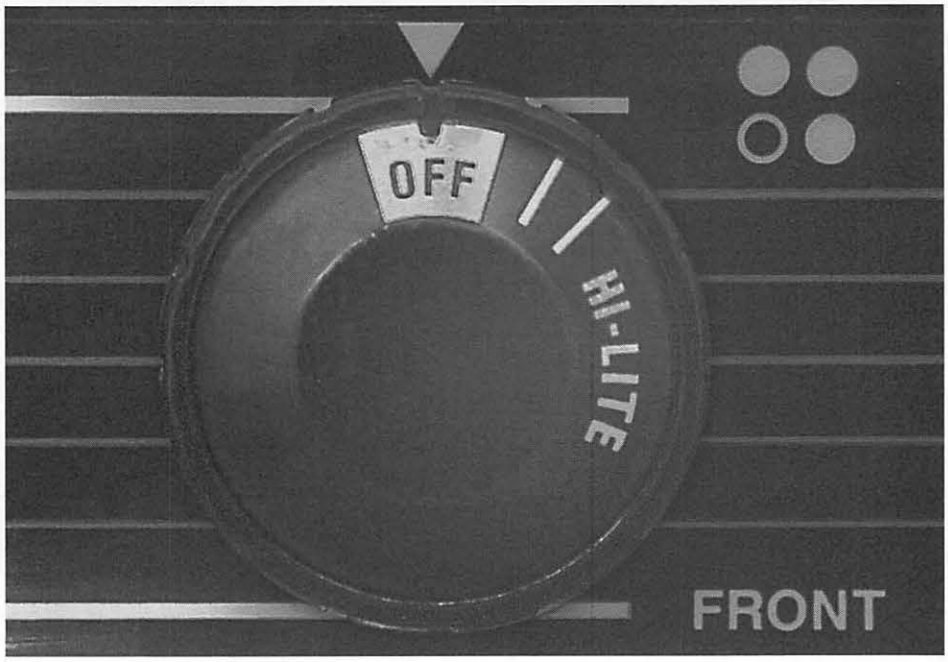
Directions for using an appliance are often printed, painted, or stamped right onto the device itself. Most battery-operated devices have a little graphic showing you which way to insert the batteries. An electric or a gas range typically has a knob for controlling each of four burners. The burners are usually laid out in a square or rectangle, but the control knobs are often arranged in a line. Which control knob is for which burner? Figure 1-14 shows one way of providing this information. There is a little graphic next to each control knob, showing which burner is controlled by that knob.

Look at some of the devices you use regularly. How does the manufacturer tell you what to do? Are the controls labeled with text or graphics or both? How do you know which control knob controls which burner on your stove? If you drive a car, look at the windshield wiper controls and the headlight controls. Is there any indication which is which? Examine a battery-operated device to see how they tell you which way the batteries should go in. Look at a tape player or CD player: how are the "FORWARD," "FAST FORWARD," "REWIND," and "STOP" buttons marked? Each of these markings is an example of a graphic instruction manual.

1-13: **How to take care of a garment**



1-14: **Control knob for a gas stove, with inset showing it controls the front, left burner**



Graphic Persuasion

When you read a sentence or a paragraph, you may or may not accept what it says. As you are reading, you are also thinking. Often as not, the people who promote products and services would prefer that you didn't think too hard about the messages they are sending you. They would rather appeal directly to your emotions and sentiments, which they can control more readily than your thoughts. Graphics are their medium of choice, as you can see by looking at most magazine ads and television commercials. There is little if any text.

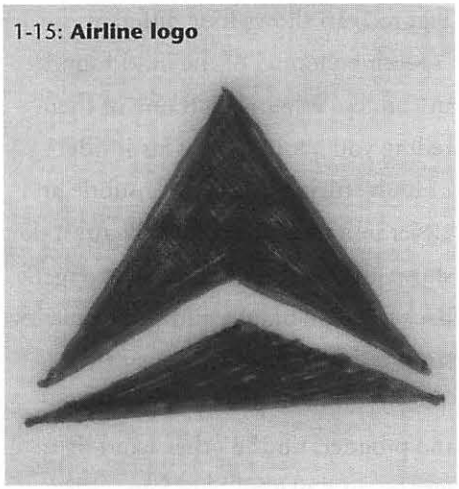
One way a corporation presents itself is through its logo. A corporate logo is like a nation's flag or a team's mascot: it is the symbol that represents the entire collective. Corporations spend huge sums of money to redesign their logos, which they regard as a way to "put their best foot forward." A good logo consists of simple, easily remembered shapes, but also conveys a distinctive message about the company. The symbolism should not be too explicit; it should suggest rather than tell the advantages of the company and whatever it sells.

Figure 1-15 shows the logo of a well-known airline. The two geometrical figures together make an equilateral triangle. The bottom shape is a short, squat isosceles triangle; the top one suggests the swept-back wings of a modern jet airplane.

Several different meanings are suggested by this logo, all of them part of the airline's overall message:

- The outside triangle is the Greek letter "Delta," which helps you remember whose logo it is.
- The upper shape looks like a futuristic airplane, suggesting that this airline is at the cutting edge of technology.
- The bottom shape suggests a mountain, meaning that this airline can take you to exciting places.
- The airplane is headed straight up, implying that company is always ready to fly, with no delays or hassles.

Look at other corporate logos. What messages are they trying to convey?



1-15: **Airline logo**

As in the case of the airline logo, shape can be a subtle and powerful graphic element. In the comics, shapes are used to convey all sorts of moods and feelings. Think about the graphic devices a comic book artist uses to suggest each of the following:

- Dizziness
- Anger
- Frenzy
- Meanness
- Fear

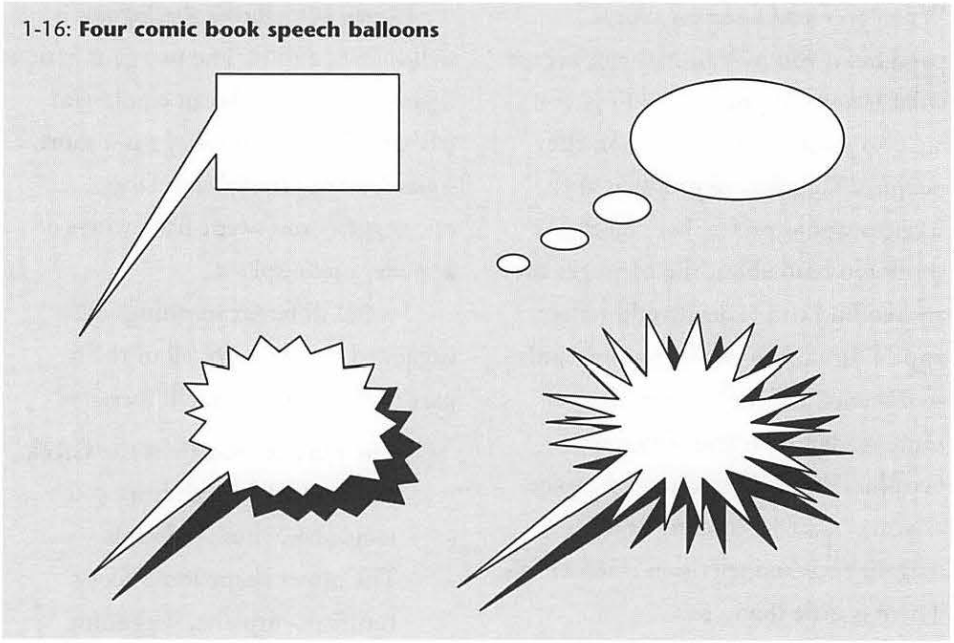
Figure 1-16 shows four different "speech balloons" of the kind found in comics. What is each one of them telling you about the words inside?

Advertising can be very subtle and clever in its use of symbols. Figure 1-17 shows the front of a familiar detergent package. The orange and yellow circles seem to be expanding outward. They symbolize power. The name of the product, on the other hand, is written in a playful blue font, which suggests kindness. The message is: "This detergent is powerful against dirt, but gentle on your clothes." While this translation may convey the same message as the image on the container, it is far less effective. Graphic messages can be powerful.

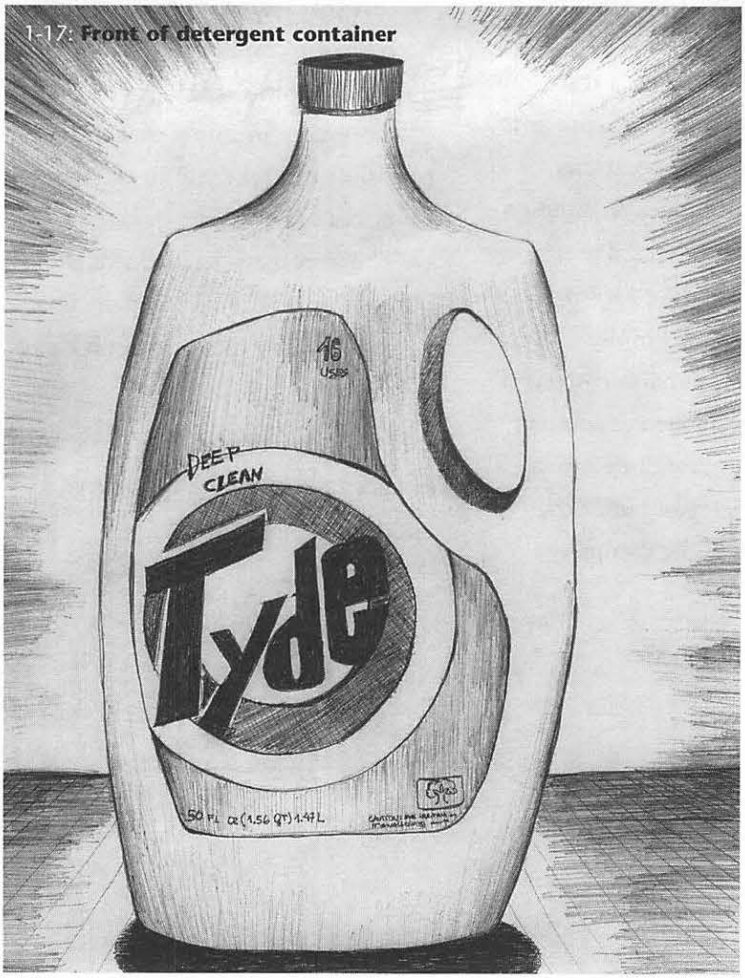
Look at some ads that appeal to you and ask yourself:

- What exactly are they saying?
- What makes them powerful?

1-16: **Four comic book speech balloons**



1-17: **Front of detergent container**



Signals

Not all messages are sent via words or graphics. A catch-all term for any other kind of symbol is a signal. At the very beginning of this chapter, we saw several methods used by a teacher to signal her class for quiet. These signals included several forms of nonverbal communication:

- Gestures
- Facial expressions
- Gaze
- Posture
- Turning off lights

She could also have cleared her throat, said "Shhh!," raised her voice, changed her intonation, slammed a book on the desk, or tapped someone on the shoulder. Each of those would have also been a signal.

Here are some other examples of how gestures are used as signals:

- Shrugging one's shoulders;
- Communication between the pitcher and the catcher in baseball;
- A person on the street guiding a motorist into a tight parking space, or helping them to back up safely;
- Giving directions by pointing; and
- Culturally established gestures, such as the "thumbs down" sign or the thumb-and-forefinger "O.K." sign.

Some other non-verbal signaling systems are discussed in Appendix A: American Sign Language and the Official Football Referee's signals. How many other examples can you think of?

Machines send signals too. For example, vehicles are equipped with the means for sending a variety of signals. Some of them must be manually activated by the driver, such as the turn signals; while others function automatically, such as the brake lights. Other examples are hazard lights, flashing high beams on and off, horns, and back-up lights.

Although these electrical signals have largely replaced hand signals, there are some gestures that are still used by motorists:

- waving another car past when one's car is stopped;
- waving a pedestrian past the front of the car.

Should cars be redesigned to provide signals for these messages?

Vehicles are only one kind of machine that send people signals. Most machines do, because the user of a machine needs information about what it is doing. Some of the common forms of signaling are:

- Indicator lights
- Flashing warning lights
- Beeps
- Bells
- Alarms

What are the signals that a car, a microwave oven, a telephone, or a VCR sends to its user? What message is being sent in each case? How effective is the signal at conveying the information? Are there messages these machines should be sending, but aren't?

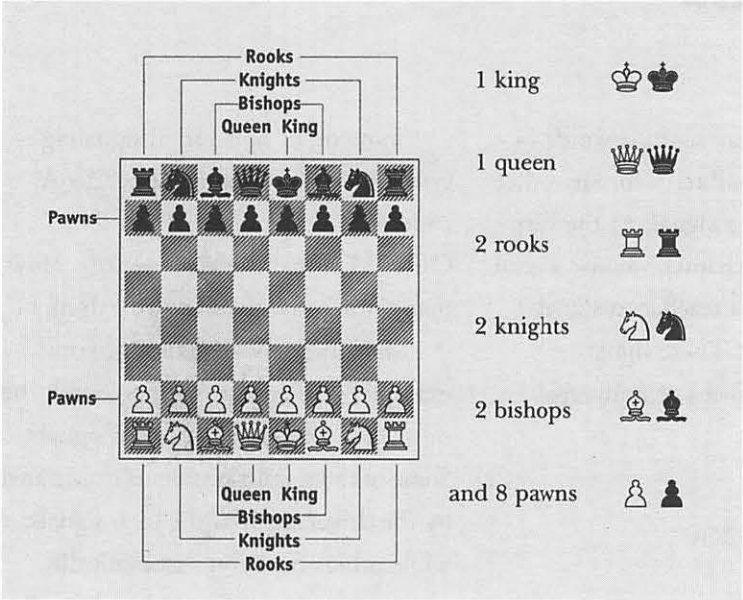
Codes

A *code* is a set of signals or symbols that work together as a unit—in other words, a signal or symbol *system*. An example of a code is the system of signals used by the pitcher and catcher in baseball. To understand a code, you need a *key*, which is a table explaining the symbols in a language you already know.

Most professions, sports, and artistic endeavors use codes of one kind or another to convey information concisely. Most of these codes use graphic symbols. Another term for a graphic code is a *system of notation*. In describing a chess game, it is convenient to have a way to show the positions of the pieces after each move. Chess notation uses a different symbol to represent each type of piece. Figure 1-18 shows the key to chess notation and a map of the starting position.

Musical notation is another example of a code, as is the set of symbols used on a map. (See Figure 1-19.) Some other codes are described in Appendix A.

1-18: **Key to chess notation**



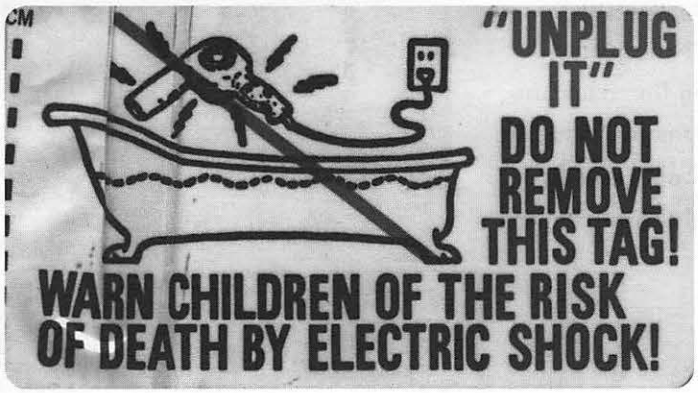
1-19: **Portion of key to Green maps** (©Green Map System, reprinted with permission)

A Gallery of Bad Signs and Symbols

In thinking about the design of signs and symbols, a good place to start is with ones that don't work very well. Figure 1-20 shows a warning tag from a hair dryer. The symbol shows a hair dryer above a bathtub, with lightning strokes coming out from it. The situation it depicts would both violate gravity and not cause a shock. The risk comes from dropping the hair dryer into the bathtub and then trying to remove it before unplugging it. It is better not to use a hair dryer in the bathroom at all, because a sink poses a hazard as great as a bathtub. The symbol and text do not provide any of this crucial information.

Figure 1-21 is a sign commonly found in public buildings. The symbol clearly indicates the use of the stairs during a fire. However, it does not convey the more basic message, which is "DON'T USE THE ELEVATORS." Worse yet, this particular sign is badly misplaced. It is located in the basement of the building, and the person is shown walking down the stairs, which would not be possible for someone already in the basement!

1-20: **Warning tag from a hair dryer**



1-21: **Poorly placed fire safety sign**

Often a symbol is in a position where it is difficult to focus on, because there are too many other signs nearby. This problem might be called "symbol clutter." Figure 1-22 shows a small dumpster for collecting construction debris. Within about two square feet, it has no less than thirteen warning and prohibition symbols. What are the chances anybody would actually read all of them? Surely, some of them could be omitted!

1-22: **Symbol clutter on a small dumpster**

1-23: **Symbol clutter on a shipping box**

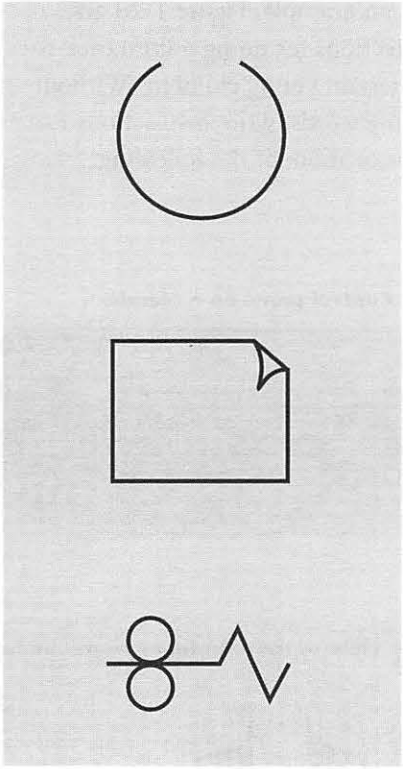
Here is another case of symbol clutter. Figure 1-23 shows a portion of a shipping box for a computer printer. Not counting the five bar codes, it has seven different symbols within a four-by-two-inch rectangle. These symbols are intended for different audiences, but there is no effort to organize them. The "FRAGILE," "KEEP DRY," and "THIS END UP" symbols are fairly obvious, but what does the "14" mean? What are "CE" and "irDA" and who are they for? The important symbols get lost in the clutter.

Mystery Symbols

Some symbols are not so easy to understand. We have already seen examples of symbols that are *designed* to be obscure in order to make them more persuasive. Other symbols may be mysterious for other reasons. These might include: bad design, the message is intended for a machine, or the objective is to create a sense of mystery. In this section we present four symbol puzzles. Solutions appear at the end of this chapter.

1. Find at least four symbols for "ON/OFF SWITCH" and explain the parts of each one.
2. Figure 1-24 shows the symbols next to the three indicator lights on a computer printer. What do they mean?
3. On the back of every dollar bill there is a picture of a pyramid with an eye on top. (See Figure 1-25.) Note how the eye fills in the missing apex of the pyramid. What do these symbols mean?
4. Every manufacturer's refund coupon, like the one in Figure 1-26, has one or more bar codes on it. The bar code at the left is scanned at the checkout counter. The bar pattern represents the number written right below it. What do you think this number represents? What information should it have in it?

1-24: **Icons on a computer printer**



1-25: **Pyramid and eye from the back of a dollar bill**

1-26: **Refund coupon**

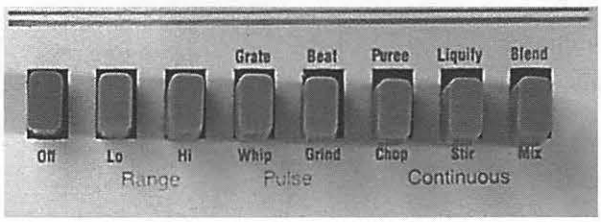
Symbol Design Challenges

In this section, we ask you to design some new symbols of your own. The purpose of a design is always to solve a problem, and we have already seen some problematic symbols. The first two design challenges are related to the bad symbols just considered. The other two present you with specific messages, and ask you to design graphic symbols for conveying them.

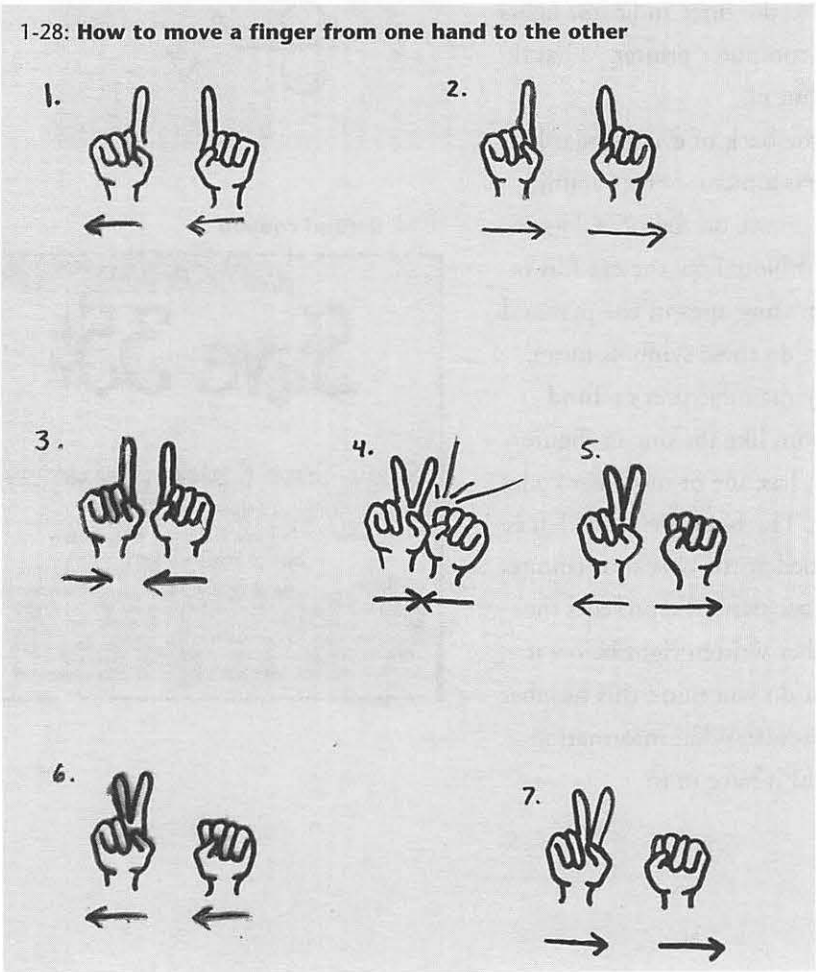
1. Come up with better designs, to replace the bad symbols shown in Figures 1-20, 1-21, and 1-22.
2. Make up new graphic symbols for shipping cartons. Some of the symbols on the box in Figure 1-23 represent the following messages:
   - "THIS END UP"
   - "FRAGILE"
   - "KEEP DRY"

   Other messages you can try are:
   - "RUSH DELIVERY"
   - "DO NOT FREEZE"
   - "OPEN THIS END ONLY"
   - "OPEN OTHER END ONLY"
   - "DO NOT BEND"
3. Figure 1-27 shows the control panel of a blender. Design a graphic symbol for each of the words.
4. Create a graphic instruction manual. As an example, Figure 1-28 gives directions for doing a little trick to entertain young children. Without using words, write instructions for one or more of the following:
   - tying shoelaces
   - making a peanut-butter-and-jelly sandwich
   - making a pop-up
   - fastening a seat belt and shoulder strap
   - gift-wrapping a package
   - doing a magic trick

1-27: **Control panel on a blender**



1-28: **How to move a finger from one hand to the other**



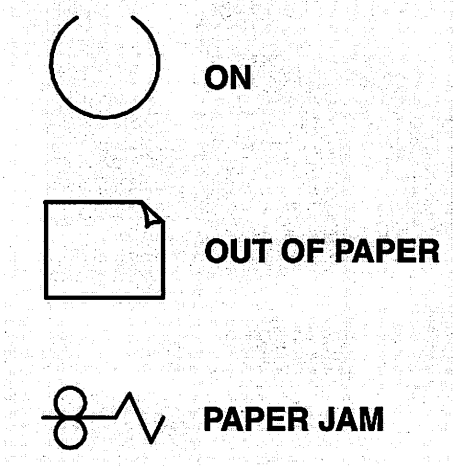
Solutions to Mystery Symbols

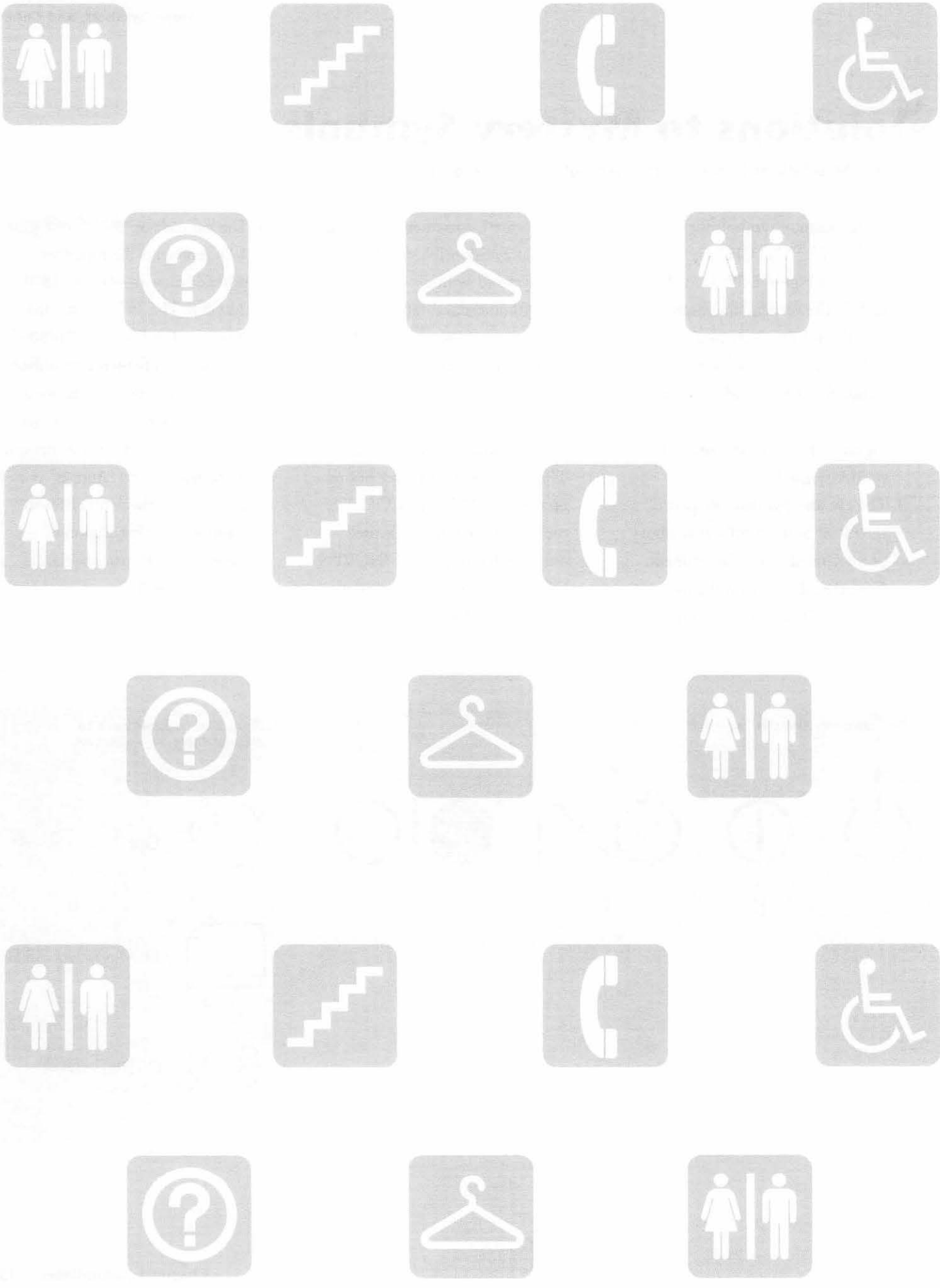
Here are the solutions to the mystery symbols presented on page 21.

1. Four common symbols for "ON/OFF SWITCH" are shown in Figure 1-29. In A, B, and C, the vertical line means "OFF" and the circle means "ON." In D, the dark circle stands for "OFF" and the open circle stands for "ON."
2. Figure 1-30 shows the key to the printer symbols.
3. The eye and pyramid are part of the Great Seal, an official symbol of the United States Government. Note that the date on the pyramid is 1776. According to the U.S. State Department, which is officially responsible for the Seal, the pyramid symbolizes the strength and durability of the new country. The unfinished top of the pyramid represents the work left to be done in building the country. The eye suggests divine guidance in this work. There are two Latin inscriptions on the seal: "ANNUIT COEPTIS" means "He [God] has favored our undertakings"; and "NOVUS ORDO SECLORUM" translates as "A new order of ages."
4. The bar code on the left of Figure 1-26 represents the nunmber printed below it—i.e., 5 14800 22035 8. The "5" indicates that this is a refund coupon. "14800" is a code signifying the manufacturer. "220" represents the item the refund is for, single-serve six packs. "35" stands for the amount of the refund, 35¢. And "8" is a digit used to check for errors in scanning. The last section of Appendix A discusses bar codes in greater detail.

1-29: **Common "ON/OFF" symbols**

1-30: **Key to symbols next to indicator lights on a printer**





Chapter 2

CONCEPTS

How People Develop Symbol-Sense

By definition, every symbol "stands for" something else. A common error, especially among small children, is to think that the symbol is actually inherent in the thing it represents. For example, a child may ask, "How did they know the names of all the animals?" This question reveals the view that, for example, the word *dog* is part of the concept of a dog. As children become older, they realize that there is more than one word for dog, and that people invented all of these words.

According to Piaget (1981), children first distinguish between a concept and its symbol when they are between one and two years old. Some of the early reflections of this distinction are:

- Talking about people or things;
- Using dolls or action figures as substitutes for real people; and
- Re-enacting an event that has already happened

Here is a true story:

A little girl of about a year old is in a room with some adults who haven't seen her for a while. They are gushing over how cute she is, and several people walk over to her to pinch her cheek, laughing excitedly as they do so. A few minutes later, after most of the adults have left, the little girl tries pinching her own cheek. As she does so, a look of puzzlement seems to come over her face, as if to say, "What was all that fuss about?"

This child has replaced the adults' act of cheek-pinching with her own imitation. A younger child would not have been able to make this separation.

The confusion between the concept and the sign is the basis for some jokes, such as puns and "plays on words." Here is an example:

- *"Waiter, there's a needle in my soup!"*
- *"I'm sorry, sir. That's a spelling error. It's supposed to be a noodle!"*

Could a needle and a noodle be confused with each other, just because the words *needle* and *noodle* are similar?

Because a symbol is different from what it stands for, it is possible to have one without the other. Use of a symbol absent the corresponding reality is called *deceit.* Lying is an obvious example, but deceit is not always a bad thing. Charades, magic shows, dramatic performances, and many forms of politeness are all situations where a symbol is not matched by the reality it is supposed to represent.

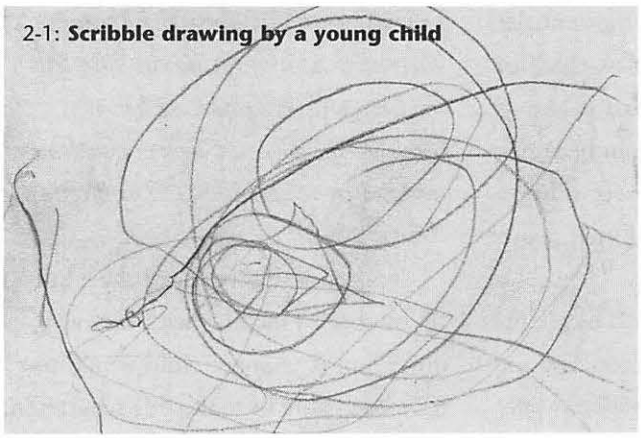
Can animals other than humans use symbols to represent concepts? There is considerable debate on this issue. There have been well-publicized efforts to teach sign language to monkeys and to teach talking birds to name objects and make simple sentences. Apparently, animals can learn to use symbols created by humans, but not to create them, let alone express complex ideas. Very young children are far better than any animal at inventing and manipulating symbols. According to Donald (1991), languages and other symbol systems permit us to manage the complex social interactions that are uniquely human.

Young children have an amazing facility for acquiring spoken language. Based on his studies of Creole languages, Bickerton (1996) extends this point even further. A Creole language arises after a large number of immigrants from many different parts of the world come to an island, such as Hawaii or Jamaica, within a short period of time. Bickerton discovered that these immigrants never develop a common language, but their children develop a Creole language within a single generation, so they can communicate with one another. Creole languages from different parts of the world have similar structures, suggesting some sort of innate human language facility.

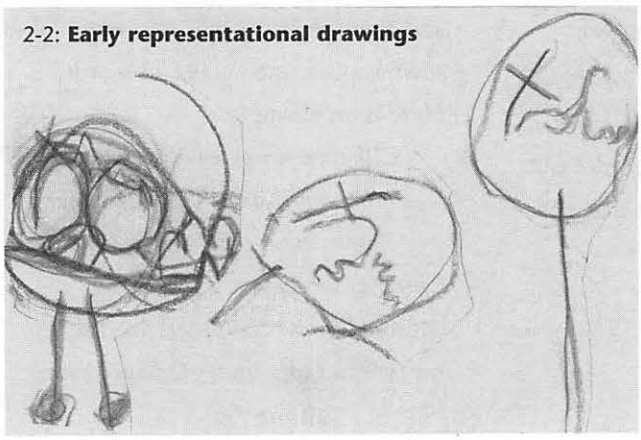
Based on the evidence about Creole languages, Thomas (1996) proposes that children may have invented all spoken languages. He connects the development of language with humans' relatively long period of childhood, compared with that of other animals. Language is so essential to social interaction that without it human society would not be possible. The long period of human childhood, Thomas suggests, may have evolved to nurture the development of language.

Languages are only one category of symbol systems. How do children develop other forms of symbolic expression? Nearly all children enjoy drawing, which they begin doing without much training or prompting. According to Arnheim (1974), the earliest scribbles, starting around age two, are not symbolic at all, but just a way of recording hand motions. (See Figure 2-1.) Some monkeys also produce these kinds of scribbles.

At about age three, however, children begin to do something monkeys apparently can't do. Near-circles appear among the zigzags and scribbles, and the young artist explains that these are faces, dogs, the sun, the moon, or other circular things in the environment. (See Figure 2-2.) Although apes have the manual dexterity to make marks on a page, they seem unable to represent things on paper. According to Bickerton (1996), this is evidence that humans alone have the ability to create mental categories. You can draw a dog because your brain can represent the concept of a dog. Symbolism is built into the way humans think.



2-1: **Scribble drawing by a young child**

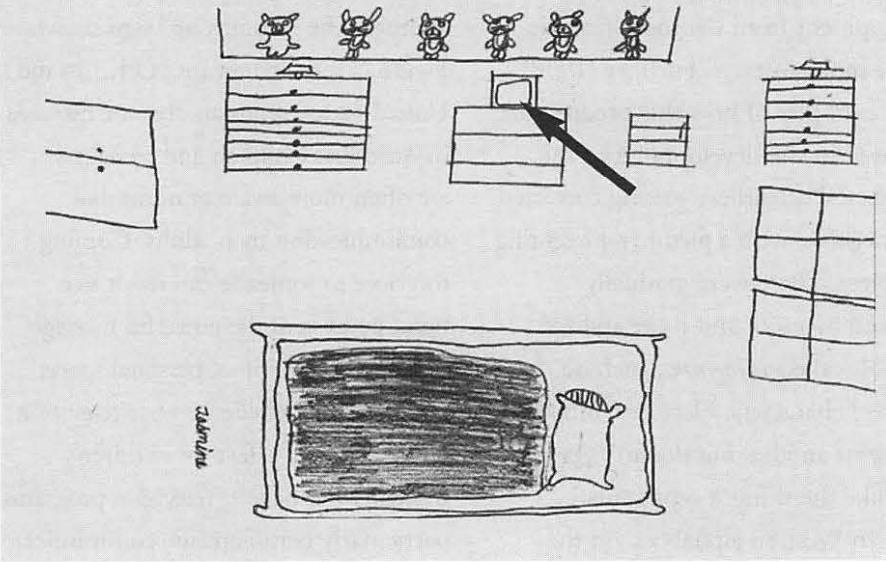


2-2: **Early representational drawings**

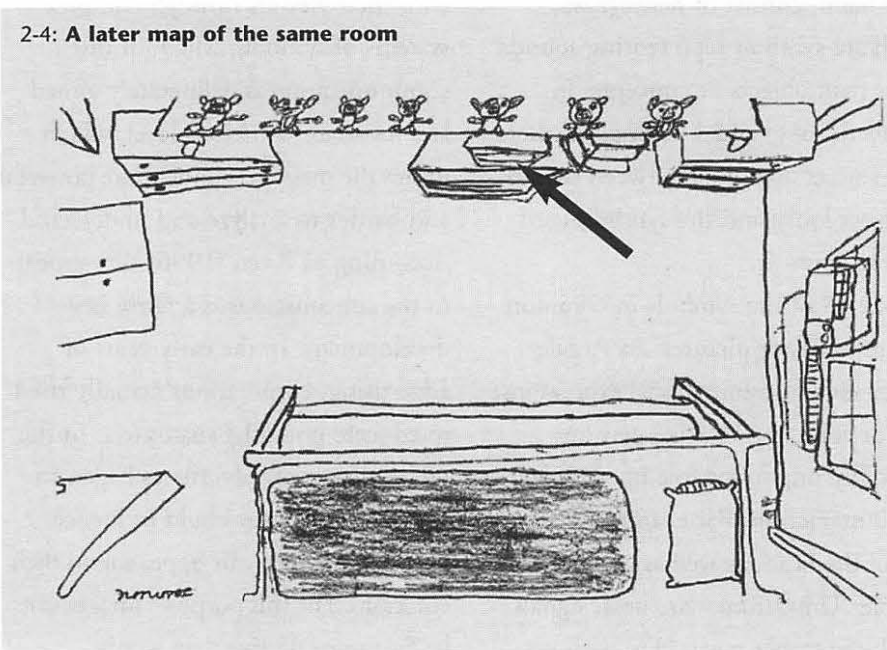
Thomas and Silk (1990) show that children's earliest drawings of real things are more like abstract symbols than they are like pictures. The sun is represented by a quarter circle or triangle at the top left corner of the page, with a smiley face inside and a few rays sticking out. Similarly, every house has a door in the middle, a window on either side, and a smokestack, regardless of whether or not the house really looks that way.

Figure 2-3 shows a fifth-grader's map of her room from a bird's-eye view. The TV set, marked by the arrow, is represented by a rectangle with an oval inside, which is a conventional symbol for a television, but is not how it would look from above. As children become more proficient at drawing, they gradually modify these formulas, and come up with more realistic ways of representing things. As they look at things more carefully, they represent more of what they actually see. Figure 2-4 shows a map of the same room, which the same child drew after some discussion in the class about points of view. The TV set is now drawn as it might actually look from a "birds-eye" view of the room. Goodnow (1977) describes this process as moving "from old to new equivalents."

2-3: **Fifth-grader's first map of her room**



2-4: **A later map of the same room**



Symbols used for written language have generally gone through a pattern of development from the more realistic to the more abstract. Furtiger (1998) gives examples of how this progression occurred in the development of the alphabet. The earliest writing consisted of *pictograms,* with a picture representing an object. These were gradually replaced by more and more stylized symbols called *ideograms,* such as Chinese characters. Here, a symbol represents an idea, but doesn't necessarily look like the thing it represents. Modern Western alphabets, on the other hand, consist of *phonograms,* which are symbols representing sounds rather than objects or concepts. In alphabetic languages like English, there is no connection at all between the way an object looks and the symbols used to write about it.

Not all of the symbols in common use are words or pictures. As Argyle (1975) shows, gestures, facial expressions, tone of voice and the like play an incredibly important role in everyday social interaction. For example, a slight nod of the head, as well as a barely audible "Um-Hmm," are both signals by a listener that mean "I'm with you, keep going." Most conversations would fall apart without these subtle forms of nonverbal communication.

Many of these signals vary drastically in their meaning from one culture to another. The "thumbs-up" sign shown in Figure 2-5, which means "O.K." in the United States, sends an obscene message in Australia. Children and teenagers are often more aware of nonverbal communication than adults. Coming too close to someone can result in a fight, because of the powerful message sent by an invasion of personal space.

It is widely believed that television has a powerful effect on children's thoughts and beliefs. Television programs, particularly commercials, communicate with their viewers through complex systems of symbols. Much of this communication is deliberately aimed at a less-than-conscious level, which makes the messages all the more powerful and harder to analyze and understand. According to Ewen (1996) this appeal to the subconscious is a fairly new development. In the early years of advertising, corporations actually tried to educate potential customers. In the 1920s, however, advertisers began to recognize that they could influence people more surely by appealing to their emotions. For this purpose, images can be far more effective than words.

To cite one example, Marlboro cigarettes are now the largest selling product in the world, ahead even of

2-5: **"Thumbs-up" sign**

Coca Cola. Currently, more than half of all young smokers use Marlboros. According to Hine (1995), the success of Marlboro is a direct result of clever use of symbolism. Prior to 1955, Marlboro was a little-known brand, targeted primarily at wealthy women. That year, Phillip Morris launched the "Marlboro Country" campaign, featuring the "Marlboro Man." They also changed the package colors to white and red, and introduced the "flip-top" box. Although Marlboros are basically the same as other filter cigarettes, these innovations turned the product into a symbol for manliness, comfort, the outdoors, and (ironically) fresh air.

If symbols are such an important part of daily life, why aren't they studied explicitly as part of the curriculum? There is an academic field called

How Symbols Work

What It Takes to Communicate

semiotics, which is described as the science of symbols. Although the subject of semiotics is communication, few in the field have actually tried to communicate with general audiences, let alone teachers or children. It is a shame that nearly every work on semiotics is so obscure, because the field offers insights that could be really helpful in revealing the powerful and often covert work of symbols. Thankfully, there are a few clear expositions of semiotics, such as those by Guiraud (1975), Berger (1984), and Sebeok (1986).

Symbols are everywhere. Much of education consists of learning what symbols mean and how to use them. These symbols include written and oral language, mathematical notation, and graphic devices such as maps, diagrams, and graphs. Specialized pursuits, such as music, architecture, and proofreading, have developed their own systems of symbolism. On an everyday basis, symbols govern every form of social interaction, from the most casual encounters to formalized events, such as sports matches, business meetings, and professional appointments.

Corporations, politicians, and government agencies routinely use symbols in their efforts to influence public opinion and behavior. The importance and power of symbols make them an essential object of study.

Here is an excerpt from Theresa Luongo's narrative in Chapter 4 (pp. 64-69):

> **In the Block Area, students started using the small broken wooden signs we have. One sign meant, "NO U-TURN." (See Figure 2-6.) Shaquill, a kindergarten student, had built an arch. He placed the sign on top of his structure. When I asked him what it meant, he said "Don't go underneath." Because the "U" was upside down, it looked like an arch instead of a "U!"**

2-6: **"NO U-TURN" sign**

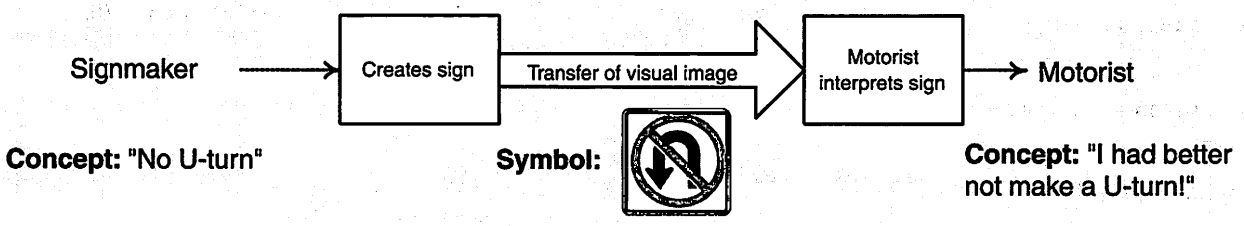
This kind of thing happens all the time. A sign or symbol created for one purpose winds up serving a totally different function. Surprises in communication call attention to the communication process itself, which is normally taken for granted. Figure 2-7 shows in detail what happens in the typical case, where the "NO U-TURN" sign is interpreted correctly.

An anonymous sign maker has created a sign that uses a standard symbol for "NO U-TURN." This symbol has three components:

1. A circle with a diagonal slash through it, which is a widely recognized symbol for "DON'T!"
2. An inverted "U" that looks like the path of a U-turn, from the point of view of a driver; and
3. An arrow showing the direction of the forbidden maneuver.

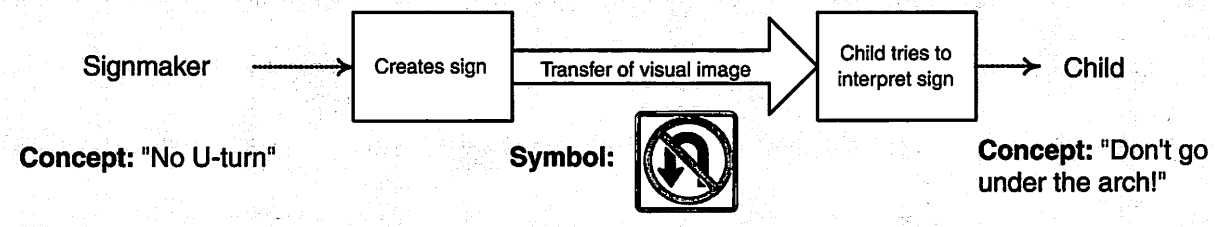
When people learn to drive, they must be able to interpret this symbol the way the sign-maker intended; otherwise, it would be useless as a road sign.

2-7: **How the typical motorist understands the "NO U-TURN" sign**



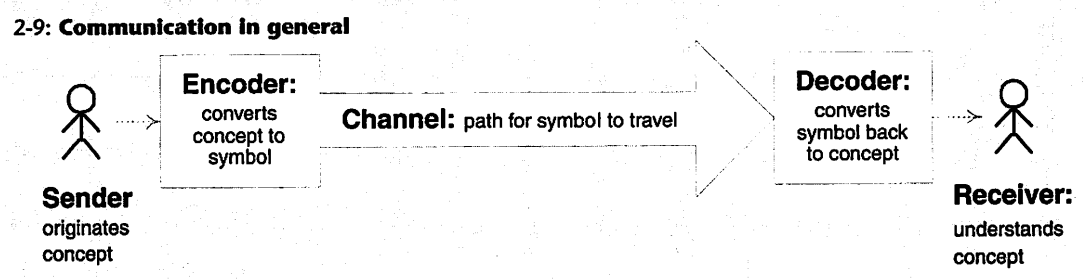
Now let's consider what happened when Shaquill, the kindergarten student, looked at the sign. He knew that the circle and diagonal line meant "DON'T," but had no way of knowing what the sign maker meant by the upside-down "U." At the same time, he had a problem to solve—i.e., protecting his arch from being knocked down. Furthermore, the inverted "U" shape in the sign looked very much like the arch. So Shaquill simply put these concepts together and concluded that that the sign could mean, "DON'T GO UNDER THE ARCH!"

2-8: **Diagram of how Shaquill understood the "NO U-TURN" sign**



Generally, there is no way for one person to know what another is thinking, unless the first person finds a way to send a message to the second. Ideas and concepts develop somehow within the brain, but not in a form that anyone else can access. To make them understood, the originator must express these ideas through symbols that are intelligible to another person. A sign or symbol is a device designed to transfer information. This general process is summarized in Figure 2-9.

2-9: **Communication in general**



Getting the Message from Here to There

Human beings have a limited number of routes through which they can receive information. The medium through which a message passes is called the *channel.* The most commonly used channels are sound and sight. Speech, music, alarm clocks, whistles, and sirens all use the auditory channel to convey information; while writing, gestures, dance, signs, traffic lights, sign language, and referees' signals use the visual channel. The channels of touch, taste, and smell are far less frequently used than hearing or vision. Table 2-1 compares the five communication channels.

Table 2-1
THE FIVE COMMUNICATION CHANNELS COMPARED

Channel	Advantages	Disadvantages	Examples
Sight	Operates at a distance; very high information capacity; all humans can produce images, and most can receive them; images persist over time, unless there is motion	Receiver's gaze must be directed at sender; nothing can be blocking "line of sight"; ambient light is required	Writing, drawing, graphic images, gestures, facial expressions, photos, films, computer screens
Sound	Operates at a distance; high information capacity; orientation of the receiver's head is not important; most people can produce and receive sounds	Sounds do not persist after being generated; it is hard to distinguish among simultaneous sounds; noise can interfere with messages; human voice has limited range	Speech, tone of voice, emphasis, nonverbal utterances, radios, alarms, bells and sirens
Touch	Interpreted as strong expression of feeling; high sensitivity of human body	Requires close proximity; culture prohibits some forms of physical contact	Taps, pats, punches, kicks, pinches, kisses, handshakes
Smell	Persists over time; conveys strong meanings	Low information capacity; requires fairly close proximity; humans cannot produce smells at will (with a few unpleasant exceptions)	Perfume, flowers, deodorant, smell added to natural gas to warn of gas leak
Taste	Association with food	Low information capacity; requires close physical proximity; risk of poisoning	Gourmet foods and beverages

Encoding and Decoding

Suppose a person with an idea wants to convey it to someone else. Most likely, he or she will use the visual or auditory channel, or both. The sender may send the message directly, for example by a gesture or speech, or may instead employ a form of technology to produce sounds or images. The process of converting a concept into a visible or audible message is called *encoding.* Table 2-2 shows some technological devices for encoding messages as sounds or images.

Table 2-2
TECHNOLOGIES FOR PRODUCING AUDIO/VISUAL MESSAGES

Produce audio messages:	Produce visual messages:
Whistle	Paper & pencil
Musical instrument	Paint & sign board
Car horn	Signal flag
Megaphone	Blackboard & chalk
Beeper	Automobile turn signal
Audio tape player	Printing press
Telephone	Camera
Radio transmitter/reciever	Slide projector/screen

At the receiving end of the channel, there is the opposite problem of *decoding:* changing the sign back into a concept in the receiver's mind. The goal of the whole process, of course, is that the concept that is received should be identical to that intended by the sender. Often, this doesn't occur, as in the example of Shaquill's interpretation of the "NO U-TURN" sign.

How does the receiver figure out the meaning of the symbol? There are two basic ways:

- Some symbols express their own meaning, because they share important characteristics with the concepts they represent. For example, the symbol for "Wheelchair Access" would probably be understood by nearly anyone who had ever seen a wheelchair. (See Figure 2-10.) This type of sign is more-or-less self-explanatory. We will call these *expressive symbols.*
- Other symbols have no logical connection with the concepts they represent, and their meanings must simply be memorized. In contrast with the wheelchair symbol, the symbol "H" for "Hospital" would not mean very much to someone who had never been told what it means. (See Figure 2-11.) A symbol that needs to be learned, because its meaning is not obvious, we call an *arbitrary symbol.*

2-10: **Symbol for "WHEELCHAIR ACCESS"**

2-11: **Symbol for "HOSPITAL"**

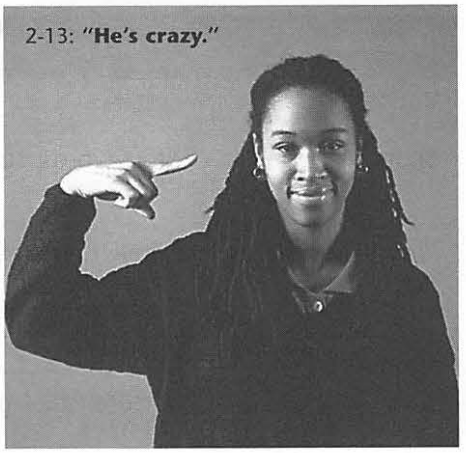
2-12: **Road sign meaning "SLIPPERY ROAD"**

In nearly every category of common signs and symbols, there are both expressive and arbitrary types.

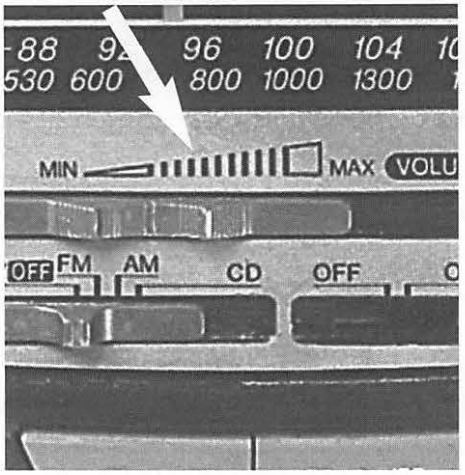
Arbitrary signals have no logical connection with the concepts they represent. There is no way you can "figure them out." They simply have to be memorized. The alphabet, punctuation marks, and numerals (except perhaps for "0" and "1") are all arbitrary symbols. The sound represented by a letter such as "F" seems obvious to anyone who can read, but the connection between the letter and the sound is purely arbitrary. Nobody would know this connection unless they had memorized it at some point.

Expressive symbols, sometimes called *icons,* have some kind of physical resemblance to the things or actions they stand for. A symbol never represents *everything* about the concept, but only some aspect that is easy to remember. For example, the "Slippery Road" sign in Figure 2-12 suggests its meaning by the tilt of the car and the skid marks. The "He's crazy!" gesture in Figure 2-13 implies that something is whirring around in the head. The volume control icon in Figure 2-14 uses a metaphor: increasing the volume is like increasing the size of the little vertical lines because it "makes the sound bigger."

2-13: **"He's crazy."**



2-14: **Volume control icon using lines of increasing size to symbolize "increased volume"**



Arbitrary and expressive symbols are summarized in Table 2-3.

Table 2-3

EXAMPLES OF ARBITRARY AND EXPRESSIVE SYMBOLS

Category	Arbitrary Symbols	Expressive Symbols
Writing	Letters	Pictograms (icons)
Speech	Most words, such as: "dog," "cat," "house"	Onomatopoetic words, like: "bang," "zoom," "chirp"
Number symbols	Arabic numerals: "2," "3"	Roman numerals: "II," "III"
Road signs	Traffic light, "STOP" sign	Symbol for "Slippery Road" (figure 2-12)
Gestures	Nod, shrug of shoulders, "thumbs-up" gesture (see Figure 2-5)	Bowing (to indicate humility), pointing, circular motion of finger near head to say "Crazy!" (see Figure 2-13)
Computer software commands	Keystroke combination	Computer icon
Appliance	Written instruction manual	Graphic instructions (see Figure 2-14)
Car alarm	Siren	"Talking" alarm which says "Burglar! Burglar!"
Tactile symbols	Braille	Child's early reader, showing the word "rough" next to a piece of sandpaper and "smooth" next to a piece of felt

What Can Go Wrong with Symbols

Kathy Aguiar, a third-grade special education teacher who is featured in Chapter 4 (pp. 70-72), asked a group of students to make up a graphic symbol for "TELEPHONE." Here is what happened:

> **Each group member began to draw his or her own symbol. Three students drew conventional pay phones.... One person drew what looked like a cell phone. ... José had no idea what Natalie had drawn, because he had never seen that kind of cell phone. As we continued to talk, I asked them about the types of phones they had at home. Out of this discussion, several other types of phone emerged.**

This story uncovers a basic fact about expressive symbols. Because a symbol is used to communicate, it can work only if the creator of the symbol and the person trying to interpret it share a common context. In this case, Natalie had represented the idea "phone" by a cell phone. José had never seen a cell phone of that type, so he couldn't recognize it as a phone. Their teacher, Kathy, recognized the need for a common context for the symbol to be mutually understood. To establish such a context, Kathy asked the students to describe the phones they had at home. Even expressive symbols, such as a pictorial symbol for a phone, have an arbitrary aspect to them. There are no symbols that are entirely self-evident.

Same Symbol, Many Meanings

When a single word has more than one meaning, the word is called a *homonym.* Many puns are based on homonyms

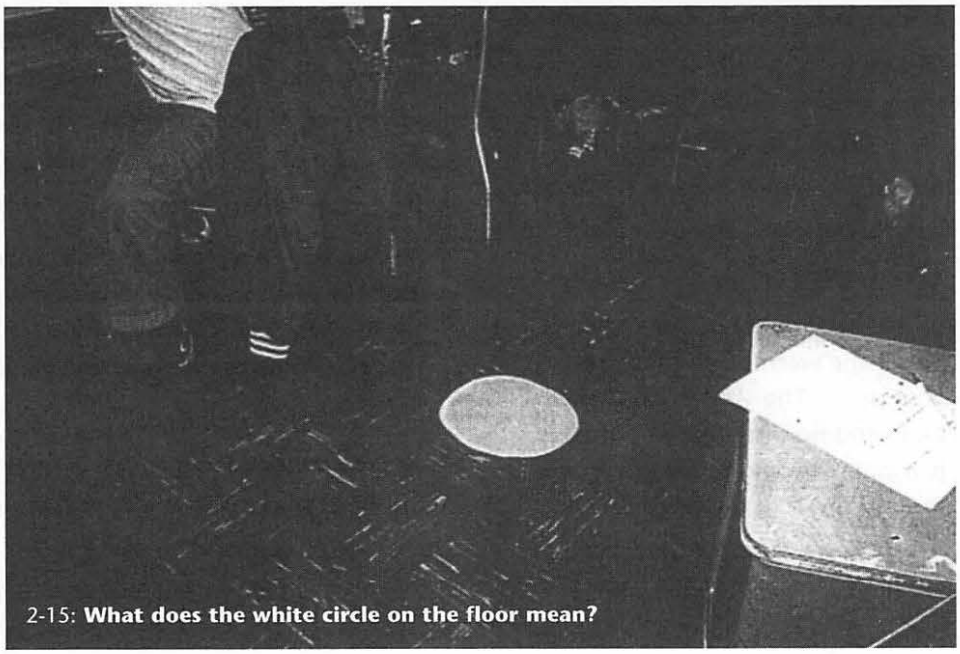
Q: Why does an empty wallet stay that way?

A: Because there isn't any *change* in it!

This joke exploits the fact that "change" is a homonym that could mean either "loose coins" or "alteration."

The term homonym is usually applied to words, but it could be used with other kinds of symbols as well. In one of the stories told in Chapter 4 (pp. 73-79), Gullermina Montano describes how her third-graders interpreted a new symbol she had just invented:

At the beginning of the day, I taped a white circle, about 20 inches in diameter, to the floor in the front of the classroom... (See Figure 2-15.) That afternoon, when the prep teacher [relief teacher during a preparation period] relieved me for my prep period, I secretly stayed outside the room. I waited there to see how [my students] would behave with the prep teacher. Of course, they started to "act out." I immediately re-entered the classroom, and stood inside the white circle with my arms behind my back, not saying a word. The children immediately quieted down.



2-15: **What does the white circle on the floor mean?**

Afterwards, Guillermina asked her students what the white circle could mean.

Karen listed a variety of possible meanings for the circle on the floor:

- **A happy face**
- **A shape with a figure inside**
- **A symbol**
- **A sign**
- **A sphere for world peace**
- **A clock**
- **A map**
- **A sign to be silent**

The same white-circle symbol could represent more than one concept. Which of these meanings was intended by Guillermina, the creator of the symbol? When Guillermina stood in the circle, the students knew that they were misbehaving. They decided correctly that the circle must be a place where she would stand to get their attention. The context—in this case, their bad behavior—provided the missing clue to interpreting the symbol. Many errors in communication occur because a symbol has more than one possible meaning.

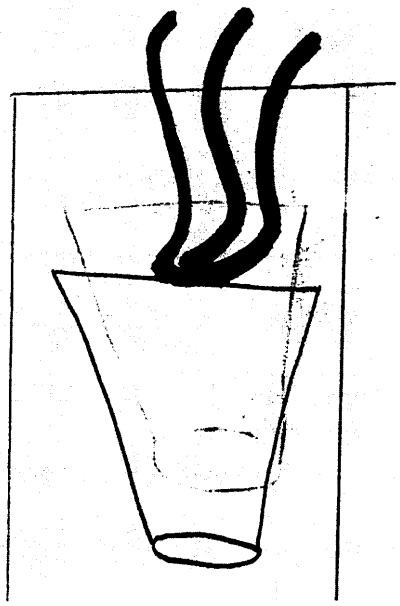
In the design of signs and symbols, it is important to provide enough context so that the intended meaning

becomes clear. Christine Smith, another teacher featured in Chapter 4 (pp. 99-104), asked a group of sixth-graders to symbolize "WARNING! HOT LIQUID!" without using words. One of their designs is shown in Figure 2-16. Christine tested the design by showing it to the other students. They had trouble with the wavy lines:

We spent a lot of time talking about the warning sign for hot liquids. . . . The steam was drawn in blue, and no one figured out what it was. Edwin suggested using red around the cup, to indicate heat.

Wavy lines could mean "hair," "string," or a host of other things besides "steam." Edwin's idea was to make some lines red to narrow down the meaning.

2-16: **Sign for "WARNING! HOT LIQUID!"**



Many Symbols, Same Meaning

We have just seen some examples in which the same symbol could represent a variety of concepts. The opposite situation can also occur. When more than one word means the same thing, the words are called *synonyms.* Generalizing this idea, two symbols that represent the same concept could also be called synonyms. Here is a further excerpt from Guillermina Montano's narrative:

At the end of my prep period, we did another experiment. My prep teacher tried standing in the white circle to see how the children would respond. They immediately told him to step out of the circle, because I was the only one allowed in it!

Teachers use many signals to ask for students' attention. These are synonyms, because they are different symbols that represent the same concept. Children have strong expectations about who will use a particular symbol to represent a concept. Guillermina's students believed that she alone could use "standing in the circle" as a signal for quiet. If the prep teacher wanted quiet, he would have to use some other symbol, such as turning off the lights.

A common source of error in communication is the expectation that a particular symbol—not a synonym—will be used in a particular situation. As every teacher and parent knows, children make up many of their own expressions. For example, a rich code language has taken root in kids' online messages. How many adults could translate "g2g" as "Got to go" or "brb" as "Be right back"? These online abbreviations are synonyms that children have reserved for their own use.

When there are synonyms for representing the same concept, it is possible to translate from one symbol to another. The *key* to a map or diagram shows the translation between graphic symbols and words. Appendix A (pp. 149-156) provides several examples of keys.

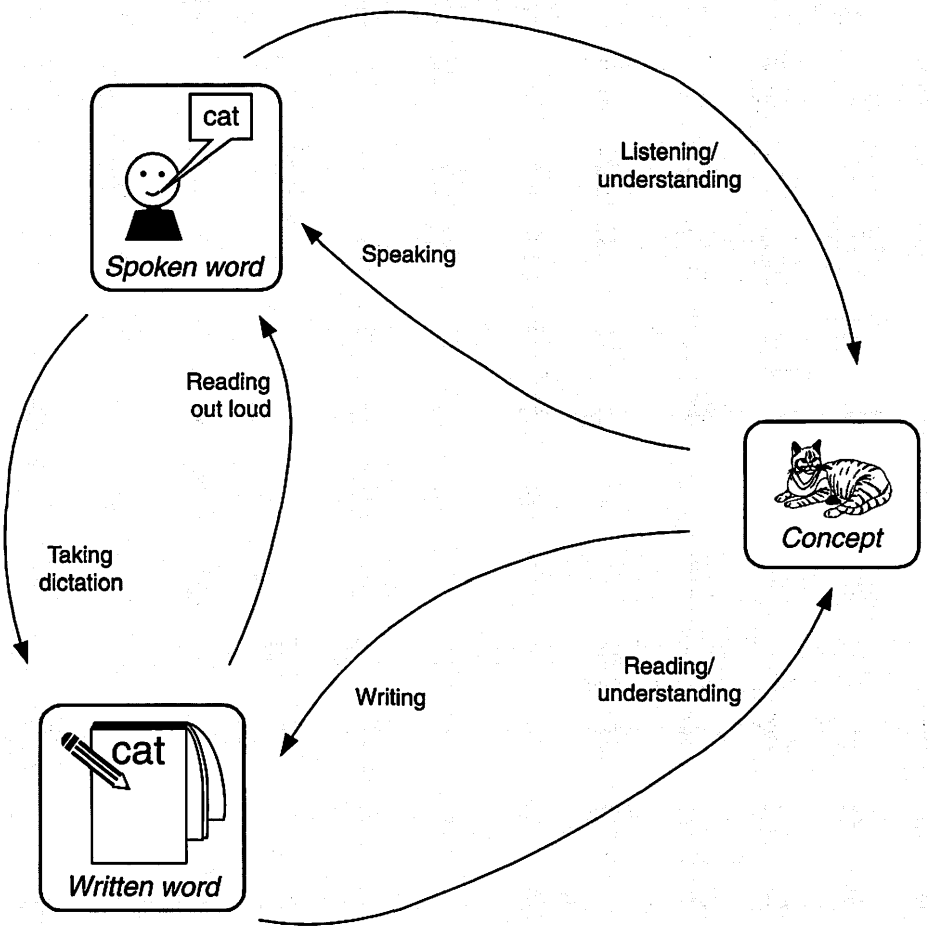
Symbols Are Fundamental

Much of education is concerned with learning to interpret and create (or "read" and "write") in various symbol systems, such as written and spoken language, and mathematical notation. Writing and speech are two very different symbol systems for representing concepts. Figure 2-17 shows some of the relationships between written language, spoken language and concepts, using "cat" as an example. The concept of a cat can be represented by the spoken word and/or the written word. The arrows indicate the six possible ways of moving between symbol and symbol or symbol and concept. Each of these transformations is a fundamentally different operation.

Going from one symbol system to another—for example, from written to spoken language—is a form of *translation.* Starting with a concept and expressing a symbol for it—e.g., by saying its name—is an example of *encoding.* Taking the symbol and interpreting the concept behind it is what we have called *decoding.*

A classic controversy in the teaching of reading is between advocates of the "phonics" method and proponents of the "sight vocabulary" method. The phonics approach is to translate one or a few letters at a time into their corresponding sounds, and then combine the sounds into words. The sight vocabulary approach involves interpreting entire words (or even larger units) into their corresponding concepts.

2-17: **The concept of a cat and two ways to represent it**



As Frank Smith (1997) points out, both approaches are hampered by the fact that the correspondences are not one-to-one. For example, phonics assumes that one can uniquely associate sounds with letters. Smith counts eleven different ways the letters "ho" can be pronounced, using only cases where they appear at the beginning of a word:

> **ho**t **ho**pe **ho**ok **ho**ot **ho**use **ho**ist **ho**rse **ho**rizon **ho**ney **ho**ur **ho**nest

Similarly, the existence of word homonyms and synonyms makes it impossible to assign unique meanings to words or particular words to concepts. Children do learn to read, but only because they bring a knowledge of the context with them. Much of reading is predicting what the words will mean, not simply decoding them. Frank Smith argues that reading makes the same sorts of demands on the eyes and brain as recognizing faces, objects, and places. His definition of "reading" includes making sense of signs, posters, graphic instructions, Morse code, Braille, maps, and mathematical formulas.

As in reading and writing, the learning of mathematical symbols is complicated by the fact that there are many homonyms and synonyms. As an example of a synonym problem, beginning algebra students find it hard to accept that these all mean the same thing:

- 2x
- x + x
- two times x

The symbol "x" is an example of a homonym. It could represent a variable or it could be a symbol for multiplication. As a variable, it could represent a wide variety of numbers. These potential areas for confusion need to be addressed explicitly.

Every language or symbol system has two major components: *semantics* and *syntax*. The semantics of the language answers the question, *What do the symbols mean?* The syntax is the *set of rules for organizing and manipulating the symbols*. This distinction is important, not only for learning verbal languages such as English, but also other symbol systems, such as mathematical notation. Traditional mathematics education emphasizes syntax at the expense of semantics. It focuses on the rules for manipulating the symbols, rather than on what the symbols actually mean. According to Herscovics (1989), the overemphasis on syntax leads to many of the common errors in elementary math. The following example has been studied extensively:

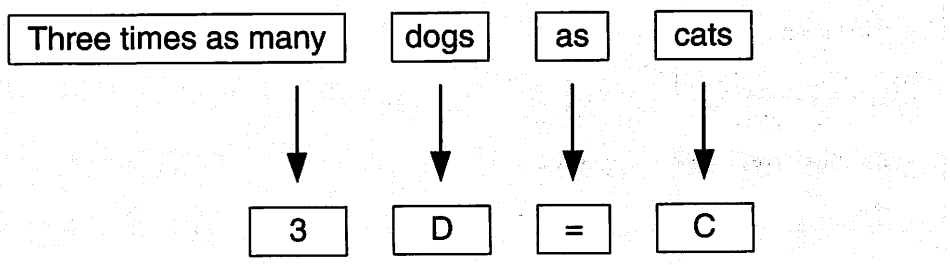
> *Write an equation that expresses the fact that there are three times as many dogs as cats, using "D" to represent the number of dogs, and "C" for the number of cats.*

Given a problem of this type, a large majority of college freshmen write:

3D = C

This answer could not be correct, because the statement says there are more dogs than cats, while the equation implies the opposite. The correct answer is D = 3C. The error arises from copying the syntax of "three times as many dogs as cats" directly into the equation "3D = C," as shown in Figure 2-18. This obvious (but invalid) solution preserves the syntax while ignoring the meaning (semantics) of the symbols.

2-18: **Obvious but incorrect translation of "three times as many dogs as cats"**



A major focus of math education is the translation among symbol systems. In middle school, students learn at least four ways to express simple relationships between variables:

- A statement in words;
- A table showing sets of values of both variables;
- A graph showing these values plotted on a two-dimensional grid; and
- An algebraic equation.

Although all four systems can express the same ideas, they are very different in the symbols they use. Learning to make these translations is a matter of understanding the semantics and syntax of the various symbol systems.

Analyzing Signs and Symbols to See How Well They Work

Humans invent technologies for practical purposes. Any technology can be evaluated according to how well it serves the purpose, and it can be redesigned if found to be wanting. Many symbols and symbol systems fit this description of technology. Others are so firmly entrenched that it would be very difficult to replace them, like the punctuation marks and arithmetic operators.

However, new symbols are being designed, tested, and adopted every day. There are many situations where an existing symbol could be improved upon or where no symbol exists but one is needed.

Have you ever found it difficult to figure out how to operate a shower in a motel bathroom or a faucet in an airport restroom? Are you sometimes mystified by whether a door should be pushed or pulled? Is it sometimes less than obvious how to operate a new telephone, camera, remote control device, alarm system, copy machine, projector, coffee maker, or steam iron? These kinds of problems abound in daily life. Perhaps a symbol is needed, or an existing symbol fails to express its meaning. The first step in designing something is often becoming aware that something doesn't work very well and needs to be redesigned.

Here are some questions worth asking about any sign or symbol:

1. **What does this sign or symbol say?** This question gets at the heart of what a symbol is—a way of representing a concept. Once you have identified something as a symbol, you probably have some idea of the message it is supposed to convey. At this point it is also worth asking, *Could this symbol be conveying more than one message?* In other words, is it a homonym? If so, *are there clues that will help users select the intended meaning?*
2. **For whom is this sign or symbol intended?** Another way of asking this question is to turn it around: *Are there people who would not understand this symbol?* For example, a child who had not yet learned to read would not understand a sign that uses words rather than pictures. The question also gets at the issue of the *channel* used to send the signal. If the symbol must be seen to be understood, a visually impaired person might not be able to receive it. Also, a symbol may not be understood because the receiver lacks some of the necessary context, as in the example above of the cell phone symbol for a telephone.

3. **What components of this symbol contribute to its message?** In Chapter 4 (pp. 80-92), Mary Flores describes how her special education students analyzed symbols they found in the school building, the subway, and the street, before designing new ones of their own. One student, Moises, recognized the meanings of colors in road signs: red means "STOP" while yellow represents "SLOW DOWN." The shape of a sign has meaning too. A red circle with a diagonal bar across it tells you about something you CAN'T do (see Figure 2-19), while a yellow warning sign is usually triangular like the "SLIPPERY ROAD" sign in Figure 2-12.
4. **How well do the components work together to convey the message to the audience?** This question may be open to considerable interpretation and debate. For example, some people might consider the "NO PARKING" sign in Figure 2-20 to be clever for the way in which it uses the broom handle as the diagonal "prohibition" sign. Others might find this feature confusing. Another problem is the "P," which might be an obvious symbol for "Parking" in English, but not in another language.

2-19: **No dogs**

2-20: **"NO PARKING" sign**

Redesigning Existing Symbols and Designing New Ones

The fundamental activity in technology is *design:* the creation of something new in order to solve a problem. To find out whether a design is successful, it needs to be evaluated to see whether it did achieve its purpose. In industry, symbol designs such as logos, road signs, product packages, and software icons are tested extensively to determine their effectiveness. Horton (1994) describes how software companies employ typical computer users to evaluate newly designed icons. Children should also evaluate their sign-and-symbol designs to find out how effective they really are. The basic evaluation question is: *How well does it work to convey the message to the audience?* Professional designers use three basic techniques to see how well their symbols work:

1. **The Meaning-for-Symbol Test:** In this test, the designer creates a symbol and then asks people, "Do you know what this symbol means?" Guillermina Montano's third-graders designed graphic symbols asking students not to run on the stairways and not to flood the water fountains (pp. 73-79). They posted these symbols on stairways and over water fountains, and surveyed students from other classes to see if they could tell what the symbols meant. Working with a sixth-grade science class, Christine Smith asked each group to create a graphic symbol for a different message, which was kept secret from the other students in the class (pp. 99-104). For example, one group had to symbolize "SUN GLASSES FOR SALE" without using words. Christine then showed each sign to the entire class, and asked them what they thought it meant.
2. **The Function Test:** The idea here is to place the symbol in its intended context and observe to see whether people interpret the symbol correctly. Felice Piggott's fourth-graders posted "DANGER" signs on bathroom doors and in hallways (pp. 93-98). Then they watched covertly to determine if students from other classes used these bathrooms or not. Angel Gonzalez's fifth-graders designed competing "brands" for identical snack packages sold to raise money for hurricane relief (pp. 108-115). Then they collected sales data to see which "brand" was the most successful.
3. **The Symbol-for-Meaning Test:** This is the most difficult test to do. It consists of creating a variety of symbols for expressing the same idea and then asking people which of the symbols works best. For example, a software company might create a variety of icons for the message "You have mail," and ask users to rate them.

The data from any of these tests usually provides clues for improving the design. In Christine Smith's class, the question was put directly to the students: "What would you do to improve this design?" One of the students said that the "WARNING! HOT LIQUID!" sign in Figure 2-16 would work better if some lines were red instead of blue. The next logical step would be to redesign the symbol and then test the new design. Symbols are an excellent topic for teaching design because the sequence of design-test-and-redesign can take place relatively quickly.

Chapter 3

ACTIVITIES

The activities in this chapter are designed to give students direct experience with signs, symbols, and codes. The activities were created and tested by classroom teachers. Many of their experiences with these or similar activities are described in Chapter 4, "Stories."

Activities 1-3 introduce students to the concepts and fundamental issues related to the purposes and design of signs and symbols. In Activities 2-7, students apply the concepts to a variety of real-world situations. All of the activities are designed to give students experience with many of the concepts discussed in Chapter 2.

The activities are correlated to standards in Science, Mathematics, English Language Arts, and Social Sciences. The standards are listed by number or letter with each activity; the standards themselves are listed at the end of the chapter.

OVERVIEW OF SIGNS, SYMBOLS, & CODES ACTIVITIES

Activity	Description	Analysis	Design	Classroom Story about this activity
	Beginning/Getting Started			
1.	We See Them Here, There, and Everywhere!	x		Pp. 64-69
2.	New Signs for the Classroom	x	x	Pp. 80-92
3.	Signals for Getting Everyone's Attention	x	x	Pp. 73-79
	Intermediate/Advanced			
4.	Symbols on a Map or Floor Plan	x		Pp. 70-72
5.	Mystery Messages	x	x	Pp. 93-103
6.	Hand Signals for Classroom Use	x	x	Pp. 104-108
7.	Design Your Own Brand!	x	x	Pp. 108-115

Activity №1

We See Them Here, There, and Everywhere

Grade Level
K-2

Prerequisite
An understanding of what signs and symbols are

Overview
In this early childhood activity, students look for signs and symbols in their environment and try to figure out what they mean.

Concept
Symbols, words, and graphics are all forms of communication.

Skills
- Observing and recording
- Classifying and sorting

Standards
- Benchmarks for Science Literacy: 2A, 8D, 12D
- National Science Education Standards: A
- Principles and Standards for School Mathematics: A1
- Standards for the English Language Arts: 3, 12

Time Needed
Three to five 45-minute periods plus at least two field trips

Materials
- Camera
- Collection of pictures of signs and symbols, including Worksheet #1 (p. 46)
- Chart paper
- Drawing paper
- Pencils
- Crayons
- Tape or thumb tacks
- Small sheets of paper
- Binder clips and stiff cardboard (for making clipboards)

Procedure
1. Take the class on a field trip or neighborhood walk to look for signs. Take a camera with you. During the course of a field trip or neighborhood walk, ask the students to look for as many signs as they can find. If they have difficulty, point out some of the more common and familiar signs, such as "Stop," "Walk/Don't Walk," "McDonald's," "No Smoking," etc. Take photos of the signs they notice.
2. Bring the photos to class. Add pictures from magazines and catalogs, as well as Worksheet #1 so that your collection includes:
   - signs with graphic symbols but no words
   - signs that use words only
   - signs that use both words and symbols

   Ask the students to describe the signs and discuss how they are different from one another. Help students see that some signs have words, some signs have only pictures or symbols, and some have both words and pictures or symbols.
3. Ask students why a sign with only pictures or symbols might sometimes be better than a sign with words. (For example, you don't have to know how to read to figure out what the symbols mean.) Why are pictures with words sometimes better? (For example, it can be hard to make the meaning clear with only symbols or images.)
4. Divide the students into groups. Distribute copies of Worksheet #1, photos, and other pictures of some signs that use only words and some

that only have pictures. If a sign has words only, read it for the group (if necessary) and then ask group members to try to draw a single picture that says the same thing. For signs that have pictures or symbols only, ask the group members to try to figure out what the sign is saying and why the message is important.

5. Announce that the class is going on a Signs and Symbols Scavenger Hunt in and around the school. Provide each child with a clipboard made from stiff cardboard, a binder clip, and blank pieces of paper. Walk through the school with the homemade clipboards. Ask students to sketch at least one sign that they see along the way, including any words and graphic symbols included in the sign.
6. Back in the classroom, ask students to share their drawings with the class and try to figure out what the sign means. As the group discusses each sign, ask students to explain why the sign is needed.
7. Use students' sign drawings to make a bulletin board display.

Strategies/Tips

Have students make a Signs and Symbols Book using their own drawings and/or pictures from magazines and other sources.

Extension

When you have a collection of signs and symbols displayed in the room, use them as the basis for a game of "I Spy." The first student might say, "I spy with my little eye a sign that means 'No Dogs Allowed.' Can you guess which it is?" Play continues as each child has a turn.

For Special Needs Students

Make puzzles out of common wordless signs and symbols. Glue large pictures of the signs to pieces of cardboard, laminate them, and then cut them up into puzzle pieces. Place these in a learning center. When a student successfully puts a puzzle together, ask him or her to tell you what the symbol means.

Worksheet #1

We See Them Here, There, and Everywhere

Activity №2

New Signs for the Classroom

Grade Level
1-5

Prerequisites
- Knowledge of what signs and symbols are
- Ability to use art supplies

Overview
In this activity, students design and make signs that are needed for their classroom.

Concept
Words and pictures are both ways to communicate.

Skills
- Observing and recording
- Identifying problems
- Designing solutions

Standards
- Benchmarks for Science Literacy: 3B, 7C, 7D, 8D, 12D
- Curriculum Standards for Social Studies: X
- National Science Education Standards: E
- Principles and Standards for School Mathematics: R3
- Standards for the English Language Arts: 1, 3, 4

Time Needed
- Two 45-minute lessons, then ongoing

Materials
- Chart paper
- Pencils
- Paper
- Crayons
- Markers
- Oak tag
- Student journals
- Optional: book of signs, sign posters, camera and film

Procedure
1. With the whole class, brainstorm a list of signs students commonly see in their daily lives. Record students' responses on chart paper.
2. Referring to the list, invite students to discuss the reasons they see so many signs in school, on the street, and in other places such as stores, bus stations, airports, and so on. What purposes do they serve? What would happen if they weren't there?
3. For homework, ask students to search for signs and symbols at home, on their way to and from school, in magazines, etc. In each case, they should try to figure out what the sign is saying and why it is needed in a particular place. Encourage students to draw signs in their journals and make notes on their meanings and uses.
4. Bring the whole class together and ask, "How could signs help us organize and use our classroom? What problems could be solved by having signs in the classroom?" Record students' ideas on chart paper.
5. Divide students into small groups of 3 or 4. Have the groups look at the list of classroom needs and choose one problem for which they will make a sign.
6. Students work together in each group to design a sign to address a classroom need. Individual students within a group can each create a sign to help solve the problem.
7. Bring the class together and have students share their work. They should describe the problem their sign is intended to address and explain how they think their sign does that.

8. For homework, students can make signs either for their homes or outdoors to meet a particular need. Encourage them to use symbols in their signs.

Strategies/Tips

- Photographs of signs and symbols from familiar locations are very helpful in putting together a good assortment of signs and symbols. If at all possible, take a camera on scavenger hunts both inside and outside the school.
- Display photos and other pictures of signs around the room so students can refer to them freely. Invite everyone in class to contribute to the collection. From time to time, examine the classroom collection with the whole class and have students explain what a particular sign says, where it might be used, and why it is needed.
- Give students lots of time to read signs in their environment, to talk about signs in and around the classroom and school, and to discover what signs are used for. Allow this activity to happen naturally. The signs they make should fulfill real needs that the children themselves perceive.
- Model the process of designing a sign for the students by choosing an area of the classroom to make a sign for. Describe what you are doing and why, at each step in the process.

For Special Needs Students

Design a game like "Concentration" where the students match the picture used in a sign with a word that means the same thing.

Activity №3

Signals for Getting Everyone's Attention

Grade Level
K-4

Prerequisites
None

Overview
Students devise and test signals for getting the attention of students in class and outdoors.

Concept
Signals are used to communicate without using words or pictures.

Skills
- Observing and recording
- Designing solutions to a problem
- Collecting and analyzing data

Standards
- Benchmarks for Science Literacy: 3B, 7C, 7D, 8D, 12D
- Curriculum Standards for Social Studies: VI, X
- National Science Education Standards: A, E
- Standards for the English Language Arts: 4, 12

Time Needed
Three or four 45-minute class periods, plus neighborhood or school-grounds walks

Materials
- Pencils
- Pads
- Markers
- Chart paper
- Binder clips and stiff cardboard (for making clipboards)

Procedure
1. Ask the class, "What do you see or hear me doing when I want to get your attention in the classroom?" On chart paper, list all the methods they mention. Invite volunteers to demonstrate the actions they are describing. Follow-up with questions such as:
   - Which method of getting your attention works best?
   - Why do you think it works so well?
   - Are there some methods that don't seem to work?
2. Tell the class that they will be taking a walk in the neighborhood or on the school grounds, and that you will need to get their attention at various times during the walk. Ask: "What can I do to get your attention outdoors?" Record their responses on chart paper. Encourage students to discuss the pros and cons of each attention-getting method.
3. Select several of their ideas to try out on the next trip. Ask for two or three volunteers to collect data about each of the methods. Brainstorm possible ways of recording this data—e.g., counting the number of children who pay attention and the number who don't.
4. Just before the next trip, remind the data collectors what their jobs will be. During the trip, try to get the students' attention using each of the methods at least two or three times.
5. Back in class, analyze the data from the trip to see which of the methods seemed most effective. Discuss the pros and cons of each method.

Strategies/Tips
Review the various proposals before taking the walking trip. Make sure the recorders know how they will collect the data.

Extension
Have students write a creative story about "The Day the Teacher Couldn't Get the Class's Attention."

Activity №4

Symbols on a Map or Floor Plan

Grade Level
3-6

Prerequisites
Knowledge of the uses of signs and symbols; ability to read maps

Overview
Students try to interpret the symbols on a park or zoo map, or a museum floor plan

Concepts
- Symbols are used to represent real places and objects.
- To be effective, a symbol must be understood by its intended audience.

Skills
- Problem-solving
- Interpreting symbols
- Observing and recording
- Reading a map
- Using a map key

Standards
- Benchmarks for Science Literacy: 8D, 12D
- National Science Education Standards: A
- Principles and Standards for School Mathematics: G4, R3
- Standards for the English Language Arts: 1, 3, 12

Time Needed
Three or four class periods, plus a field trip (optional)

Materials
- Copies of a floor plan of a museum or a park or zoo map that uses symbols to represent familiar places and services, such as telephones, bathrooms, exits, etc.
- Chart paper
- Large drawings of symbols used on the floor plan or map
- Paper
- Pencils
- Binder clips and stiff cardboard (for making clipboards)

Procedure
1. Cover the key or legend on the floor plan or map. Then let students examine the floor plan or map closely, looking for symbols. As they are studying it, initiate a discussion using questions like these:
   - What is this little picture?
   - What is it used for?
   - How can this help you find your way around the museum (or other place represented by the map)?

   Encourage students to speculate. Record all answers on chart paper without labeling them as right or wrong.
2. Show students the large drawings of symbols found on the floor plan or map, one at a time. Ask students what each symbol means, encouraging them to give reasons for their interpretations. Again, write their ideas on chart paper.
3. When students have considered all of the symbols, uncover the map key. Go through the symbols again, one at a time, and confirm what they stand for.

4. Next, place the symbols in context again by asking individual students to locate the places, objects, or services represented by the symbols on the map. For example:
   - Where in the museum will I find a telephone?
   - Where is the boys' restroom?
   - Where is the elevator?
   - Where is the cafeteria?
5. If possible, visit the museum or other place represented by the floor plan or map and let students find the real things represented by the map symbols.

Strategies/Tips

If you are able to arrange a class visit to the museum, park, or zoo, prepare for the trip by re-examining the maps or floor plans with the class. Use the maps to plan your route, identifying landmarks you expect to pass on the way. Bring homemade clipboards and the maps or floor plans along on the trip. At the site, show the students how to orient themselves using the maps. Then ask the students to list the items represented by the map symbols as they pass them. After the trip is over, conduct a sharing session to discuss the relationships between the symbols on the maps and the real things they represent. Pose the following questions:

- Are there symbols on this map that are difficult to understand?
- Are there items in the museum that should be represented by symbols, but are not?
- Can you improve the map by adding new symbols or redesigning ones that are already there?

Extensions

- Have students make a map of the classroom, cafeteria, or other area in the school and create symbols to represent meaningful parts of that space.
- Invite students to make maps of an imaginary place they've read about in a book, using symbols to stand for landmarks and other important features.

Activity №5

Mystery Messages

Grade Level
4-6

Prerequisite
Understanding of the meaning and uses of signs and symbols

Overview
Students create graphic symbols to express secret messages so others can understand them.

Concepts
- Signs and symbols are only effective if they can be understood by the audience for which they are intended.
- Good design involves a process of evaluation and, often, redesign.

Skills
- Brainstorming
- Collaboration
- Observing and collecting data
- Communicating in written, graphic, and spoken form
- Analyzing and evaluating designs
- Modifying designs based on evaluation results

Standards
- Benchmarks for Science Literacy: 3B, 8D, 9A, 9B, 12D
- National Science Education Standards: E
- Principles and Standards for School Mathematics: R3
- Standards for the English Language Arts: 3, 4, 5, 12

Time Needed
Five to ten 45-minute class sessions

Materials
- Index cards
- Drawing paper
- Markers
- Chart paper

Procedure
1. Have a brainstorming session to review what students know about signs and symbols, starting with questions like these:
   - What is a sign?
   - Why do we have signs?
   - What are some examples of signs intended for different purposes?
   - What is a symbol?
   - What purpose does a symbol serve?
   - What's the difference between a sign and a symbol?
   - What do signs and symbols have in common?
   - Record students' responses on chart paper.
2. Pretend that you are from a planet where there are no signs or symbols. The students' job is to write a definition of those terms so you can understand what a sign is, what a symbol is, including how they are similar and how they are different.
3. Divide students into groups of two or three. Give each group an index card with a "secret message" on it. Examples of messages you might use are:
   - NO WALKMANS ALLOWED
   - DANGER! DEEP HOLE!
   - SUNGLASSES FOR SALE
   - SCHOOL IS CLOSED
   - WET PAINT
   - SCIENCE LAB (or LIBRARY or CAFETERIA) THIS WAY

   Tell them not to show their message to any other groups. They are to create a sign that expresses the message without using words.

4. When students have finished their signs, collect them and assign a number to each one. Have each student number a sheet of paper from 1 up to the total number of signs. Hold up the numbered signs one at a time so students can see them clearly. Ask students to write in words what they think each sign is saying.
5. Then go through the signs again and ask students to read their translations. Then have the sign's creators give the original message. For each sign, discuss what worked well and what didn't work, starting with questions like these:
   - What was confusing about this sign?
   - Which symbols made the sign's meaning clear?
   - What could you have done to make the sign easier to understand?
6. Based on the translations and subsequent discussion, encourage the groups to redesign their signs to make them clearer.

Strategies/Tips

Analyzing the signs can lead to some general questions, for example:

- What does each color represent on a sign?
- What are some different ways of indicating, "DON'T," "NO," or "WARNING" on a sign?
- When is it necessary to use words as well as pictures?

Extension

Have students create a graphic instruction manual (using no words) for a simple task, such as:

- How to tie shoelaces, a bow, or a necktie;
- How to make a peanut-butter-and-jelly sandwich;
- How to shuffle a deck of cards;
- How to play cat's cradle;
- How to sew on a button;
- How to make a paper airplane

Then test each manual by seeing if another group of students can perform the task correctly, just by following the instructions.

Activity №6

Hand Signals for Classroom Use

Grade Level
3-6

Prerequisites
- Understanding the uses of signs and symbols
- Familiarity with classroom routines and rules

Overview
Students devise hand signals for communicating with the teacher during class.

Concepts
Signals make it possible to communicate without using words.

Skills
- Representing ideas non-verbally
- Designing solutions to a problem
- Evaluating possible designs

Standards
- Benchmarks for Science Literacy: 3B, 7C, 7D, 12D
- Curriculum Standards for Social Studies: VI, X
- National Science Education Standards: A, E
- Principles and Standards for School Mathematics: DA&P1, DA&P3, R3
- Standards for the English Language Arts: 4, 11, 12

Time Needed
Three to five 45-minute class periods

Materials
- Chart paper
- Marker
- Paper
- Pencils

Procedure
1. Start with a discussion about the different uses for hand signals, e.g.:
   - referees' and umpires' signals in soccer, football, basketball, baseball;
   - American Sign Language;
   - what orchestra conductors do;
   - signals used by animal trainers;
   - how police direct traffic; etc.
2. Then, with the whole class, brainstorm a list of reasons students need to communicate with the teacher during class, e.g.:
   - to ask permission to go to the restroom;
   - to get a drink of water;
   - to go to the pencil sharpener;
   - to ask a question;
   - to indicate they're not feeling well; etc.

   Discuss the possible benefits of such a signal system, such as reducing noise in the room and being able to communicate from across the room so that interruptions are minimized. Record students' ideas on chart paper.

3. Divide students into pairs or small groups. Assign each group one of the student-teacher communication examples from the brainstorming list. Explain that they are to create a hand signal that students could use for that purpose.
4. Have pairs or groups share the hand signals they came up with. As a class, choose the hand signals that seem to be most effective.
5. Challenge students to figure out a way to record the new signals so they can be taught and learned—for example, tracing hands in a particular position or taking a Polaroid picture.
6. Adopt the use of the hand signals for a week, with students observing and collecting data on how effective they are. After a week, bring the class together to analyze, evaluate, and discuss the results.
   - Were the hand signals understood when they were used?
   - Did they have the intended effect in the classroom? If not, why not?
   - Should a system like this be adopted in the class on a permanent basis? Why or why not?
   - Should any of the signals be redesigned to make them more effective? If so, how?
7. Students can create a "key" for the hand signals that worked best and distribute it to other classes.

Strategies/Tips

To test their designs, have students establish criteria for evaluating their hand signals. These might include:

- How clear is the message?
- How easy is it to perform the signal?
- How long does it take to learn?
- How effective are the signals at minimizing interruptions? etc.

As other classes adopt the signals, the group that created them can come up with ways of collecting data to see how well the criteria are being met. These tests can serve as a basis for redesigning the signals, if necessary.

Activity №7

Design Your Own Brand!

Grade Level
4-6

Prerequisite
Understanding of signs and symbols as ways of communicating without words

Overview
Students analyze advertisements and package designs to determine what symbols they use to convey their messages. Then they create their own ads and/or package designs.

Concepts
Many nonverbal aspects of design can be used effectively to attract people to a product.

Skills
- Problem-solving
- Observing and recording
- Collecting and analyzing data
- Designing and testing solutions to a problem

Standards
- Benchmarks for Science Literacy: 1B, 9B, 12D
- National Science Education Standards: A, E
- Principles and Standards for School Mathematics: DA&P1, DA&P3, R3
- Standards for the English Language Arts: 1, 3, 5, 11, 12

Time Needed
Eight to twelve 45-minute class periods

Materials
- An assortment of ads from magazines
- Discarded packages for popular consumer products (cereal, toys, etc.)
- Markers, crayons, colored pencils
- Oaktag
- Drawing paper
- Worksheet #7a
- Worksheet #7b

Procedure
1. Have a discussion with the whole class about the role of advertising and product packaging design in getting consumers to buy specific products. Use questions like these to get the discussion going:
   - Do you have a favorite commercial or ad?
   - What makes it so appealing?
   - Do you make decisions about what to buy based on how packages are designed?
   - Why do companies advertise their products?
   - What techniques do advertisers use in their ads and packages to get people to notice and want their products?
2. Divide the class into pairs or small groups. Give each group one of the ads or product packages you've collected. Distribute Worksheet #7a (page 58) to each group and ask them to fill out the worksheet with reference to their ad or package.

3. Bring the class together and discuss students' analyses of the ads and packages in terms of the questions on the worksheet. Do other students agree with the analysis of each group? Why or why not?
4. Next, brainstorm a list of the kinds of products children buy most often. Have students think about categories of products rather than brand names. Write the categories on chart paper.
5. Divide the class into pairs or small groups again. Assign each group one of the categories of products from the list they've just made.
6. Explain to students that their job is to create an ad for a brand new product in the category they've been assigned. Part of their job is to give the product a name.
7. Distribute copies of Worksheet #7b (page 59) to each group. Have them use the worksheet as a way to organize their thinking about the product name and how to advertise it.
8. Give students sufficient class and homework time to work on their ad projects. When the ads are ready, set aside class time to look at all the ads and discuss them individually.
9. Have each group present its ad to the class. Their presentations should include answers to the questions on the worksheet and the reasons for their design choices. As the class discusses the ads, guide them to recognize how colors, shapes, and images work together as symbols in advertisements.
10. To follow up, have students watch for new ads and bring in examples that they think are particularly effective or ineffective. Set aside class time on a regular basis to discuss the ads. Create a classroom display of what students consider good and bad advertising and/or package design.

Strategies/Tips

If a fundraising sale is taking place in the school, students could create their own "brands," ads and/or packages for identical products. Then they could test their designs by seeing how well each "brand" sold, and why.

Worksheet #7a

Analyze This

Name/Group _____ Date _____

1. What kind of product is this?

2. Who is the "audience" for this product—that is, who does the manufacturer think will buy it?

3. What are the main colors used in this ad or package?

4. Does this ad or package show people? If so, describe them. What do they look like and what are they doing?

5. What images other than people are shown in this ad/package?

6. What is this ad trying to say about the product? How does it get its message across?

7. Do you think this is a good/effective ad or package design for the target audience? Why or why not?

Worksheet #7b

Creating Your Own Design

Name/Group _____ Date _____

1. What kind of product are you creating an ad for?

2. What is the name of your product?

3. Who is the target audience for your product?

4. What colors do you think will appeal to your target audience in an ad for this kind of product?

5. Will you include people in your ad? If so, describe them. If not, why not?

6. Will you include other images in your ad? If so, describe them.

7. What message are you trying to send about your product?

8. Why do you think your ad will appeal to its audience?

Standards References for Signs, Symbols, and Codes Activities

Benchmarks for Science Literacy

Benchmark 2A: Patterns can be made by putting different shapes together or by taking them apart.

Benchmark 3B: People can use objects and ways of doing things to solve problems; designs that are best in one respect may be inferior in others.

Benchmark 7C: Rules and laws can sometimes be changed by getting most of the people they affect to agree to change them.

Benchmark 7D: In making decisions, it helps to take time to consider the benefits and drawbacks of alternatives; [these] can be taken into account more effectively if the people who will be affected are involved.

Benchmark 8D: Information can be sent and received in many different ways. Each way has advantages and disadvantages. Communication involves coding and decoding information. In any language, both the sender and the receiver have to know the same code.

Benchmark 12D: Students should be able to write instructions that others can follow in carrying out a procedure [and] make sketches to aid in explaining procedures or ideas.

Curriculum Standards for the Social Sciences

Performance Expectation VI: Social studies programs should include experiences that provide for the study of how people create and change structures of power, authority, and governance.

Performance Expectation X: Social studies programs should include experiences that provide for the study of the ideals, principles, and practices of citizenship in a democratic republic.

National Science Education Standards

Content Standard A: Students should develop abilities to do scientific inquiry.
Content Standard E: Students should develop understanding about science and technology.

Principles and Standards for School Mathematics

Algebra Standard (A1): Understand, patterns, relations, and functions.

Geometry Standard (G4): Use visualization, spatial reasoning, and geometric modeling to solve problems.

Data Analysis and Probability Standard (DA & P 1): Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

Data Analysis and Probability Standard (DA & P 3): Develop and evaluate inferences and predictions that are based on data.

Representation Standard (R1): Use representations to model and interpret physical, social and mathematical phenomena.

Standards for the English Language Arts

1. Students read a wide variety of print and non-print texts to build an understanding of themselves, and of the cultures of the United States and the world ...

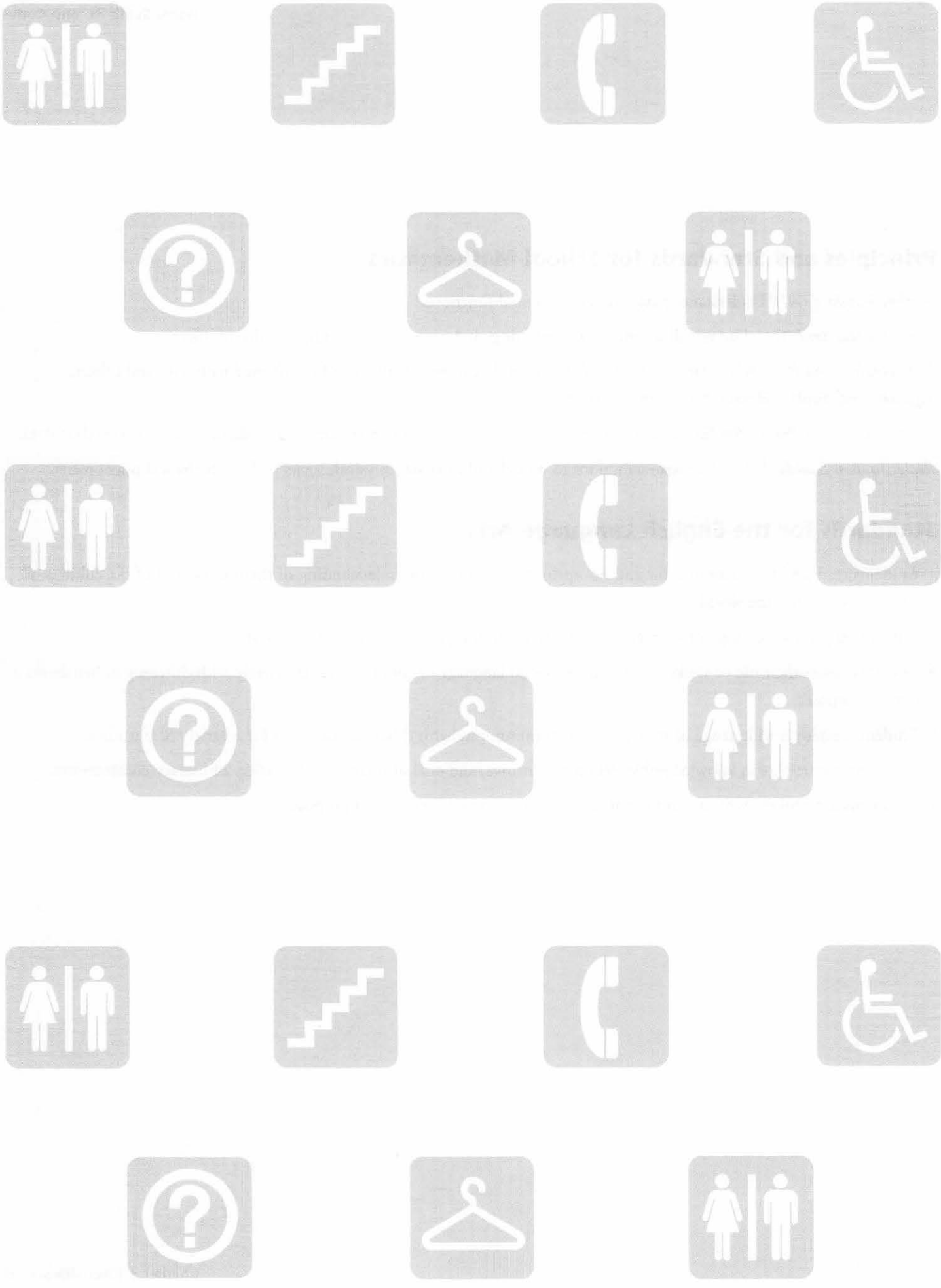
3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts ...

4. Students adjust their use of spoken, written, and visual language to communicate effectively with different audiences for a variety of purposes.

5. Students employ a wide range of strategies ... to communicate with different audiences for a variety of purposes.

11. Students participate as knowledgeable, reflective, creative, and critical members of a variety of literacy communities.

12. Students use spoken, written, and visual language to accomplish their own purposes.



Chapter 4

STORIES

Words and letters—the stuff of conventional literacy—are only one category of signs and symbols. These are not the first kinds of symbols people learn to read and write. Children are able to interpret and create other kinds of symbols—such as gestures and graphics—long before they can read or write words and sentences. Consequently, teachers of pre-literate children see work with signs and symbols as integral to the process of developing literacy. The first section of this chapter reflects this approach. Two teachers describe their work on developing literacy through signs and symbols.

For teachers of children who are emergent readers and writers, the focus shifts slightly. Although literacy is still a major concern, so are socialization and classroom behavior. Signs and symbols are used to express the rules and practices needed to guarantee an orderly classroom environment. In the second section of this chapter, two teachers discuss how their students explored the use of signs and symbols to communicate classroom rules and procedures.

For older children who have already acquired basic literacy, work on signs and symbols offers a new set of possibilities. These students come to see gestures and graphics as alternatives to words for the purpose of conveying a message. They explore how the elements of a graphic symbol work together to make its meaning clear. However, not all symbols are intended to be obvious. It is intriguing to search for the hidden symbols used in advertising and popular culture. Because symbol systems can be tested easily and rapidly, the topic offers excellent opportunities to engage in design. The third section of this chapter reflects this range of possibilities.

Signs and Symbols on the Road to Literacy

This section includes classroom narratives by two teachers, one who works in an early childhood classroom and another who teaches special education. Theresa Luongo, a pre-K/K teacher, engaged her students in examining signs in their environment and in creating signs for use in their classroom. Drawing on the work of Frank Smith, Theresa came to see these activities as early experiences in reading and writing. Kathy Aguiar, in her work with third-grade bilingual special education students, had a similar approach. She used symbols from a museum floor plan to help her students regard reading and writing as natural, non-threatening activities.

Don't Step on the Beetles!

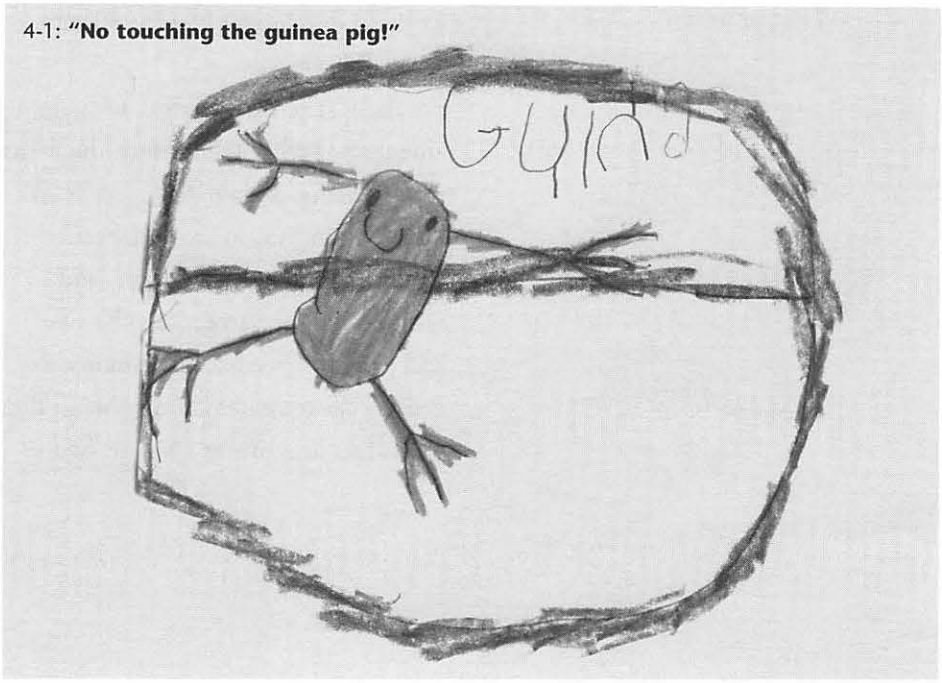
by Theresa Luongo

Theresa Luongo teaches a pre-K/K class at Central Park East II, an alternative school in East Harlem, New York City. In her class, signs and symbols quickly became an engaging topic that raised the children's awareness of basic communication issues and helped to develop early literacy.

Theresa began by conducting a walk around the neighborhood to look at signs and to discuss them. Next she had her students design signs that they thought might help to address problems in the classroom. Here is Theresa's account:

The early childhood classroom is filled with signs, as is the world we live in. After walking around the neighborhood and discussing signs, I asked the children to think of signs we could use in our classroom. Interestingly, the first signs the students made all had to do with our pets. I continually ask the children to be gentle with the guinea pig, and to try to whisper near him. Marlon made a sign that meant, "No touching the guinea pig!" (See Figure 4-1.) When I asked Marlon why he made his sign, he said, "You shouldn't touch the guinea pig, because he will get scared." Many of the other signs also came from real needs. Previously, a beetle from our collection had been stepped on. Michelle made a sign that meant, "Don't step on the beetles."

4-1: **"No touching the guinea pig!"**



We had a sharing session. As each child explained his or her sign, I asked why they had made that particular kind of sign. I think it inspired other children to make signs. Because the signs seemed to be for "real" purposes, they made sense to the kids as they were both making them and reading them.

Although our classroom was already full of signs, I realized that the students hadn't made any of them. Often, the children copy things from around the room, but when it came to making signs, they thought of new signs that they thought were needed. They had somehow internalized that signs can play a role in controlling people's behavior. Therefore it seemed natural to make signs about not stepping on the beetles or not letting the ladybugs out, because these were issues that mattered to them.

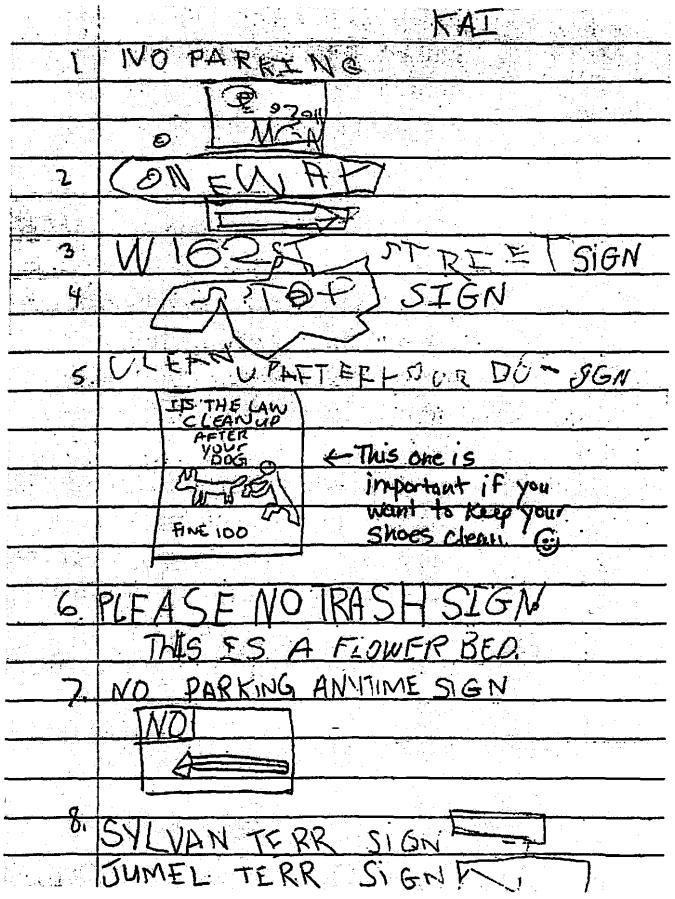
Theresa also gave her students a homework assignment:

Draw signs that you think are necessary at home or outside.

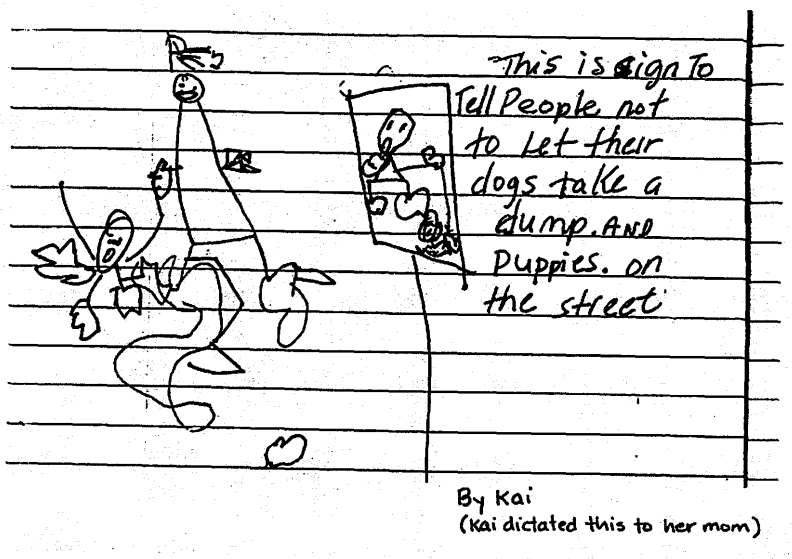
Kai made drawings of some signs she saw on the street: "NO PARKING," "ONE WAY," "CLEAN UP AFTER YOUR DOG," etc. (See Figure 4-2.) Then she made a sign of her own, which is shown in Figure 4-3. Kai's mother wrote down Kai's explanation:

This is a sign to tell people not to let their dogs (and puppies) take a 'dump' on the street.

4-2: **Kai's drawings of signs she saw on the street**



4-3: **The sign Kai designed to keep the street clean**



In Theresa's classroom, children have many opportunities to pursue their own interests and to make choices about their own learning. She regards technology as a subject that will arise naturally, as children encounter problems they want to solve. As the topic of signs began to catch on, some children found new ways to use them. Often, Theresa sees the potential in a child's idea and turns it into an activity for the whole class. This is how she discovered that Shaquill was inventing new uses for signs in the Block Area:

In the Block Area, students started using the small broken wooden signs we have. One sign meant "NO U-TURN." (See Figure 4-4.) Shaquill, a kindergarten student, had built an arch. He placed the sign on top of his structure. When I asked him what it meant, he said, "Don't go underneath." Because the "U" was upside down, it looked like an arch instead of a "U"!

I was lucky to have been in the Block Area at that moment. I learned how thoughtful Shaquill had been in trying to protect his arch by placing the sign on top. His use of the sign made perfect sense, and it showed me how connected he was to the study of signs.

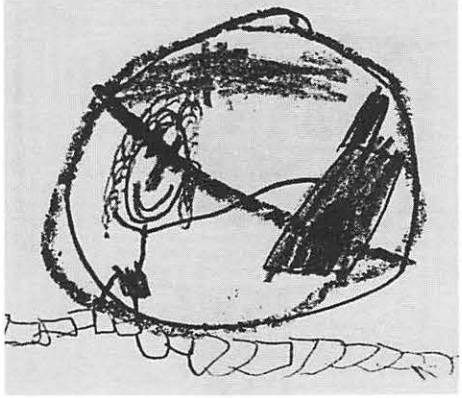
I learned something else from Shaquill. It dawned on me that the children could be making signs for the Block Area on a daily basis. The next day, I put together a large box for sign-making. Inside the box are various pieces of wood, sticks, glue, tape, paper, markers, crayons, and pencils.

4-4: **"NO U-TURN" sign**

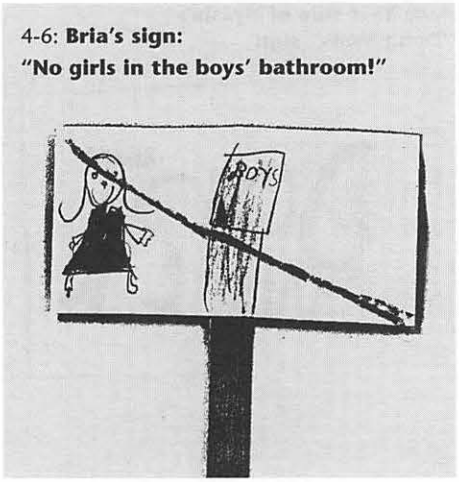
Now the students are making signs for their block structures. These structures are important to them, and now they can extend their block work by adding signs to them. The students clearly understand what signs are used for. Also, a lot is said using a little bit of language or by using a simple picture. I realized that most of the signs were about controlling social behavior. (See Figures 4-5 and 4-6.)

Many of the children saw the need to plan their signs on paper first, before making the final version. Figure 4-7 shows Ana's initial plan for a sign to identify the Listening Center. Figure 4-8 is a picture of the sign that was actually posted. Planning is usually an essential step in design.

4-5: **Ana's sign for the Block Area: "Don't knock down the building!"**

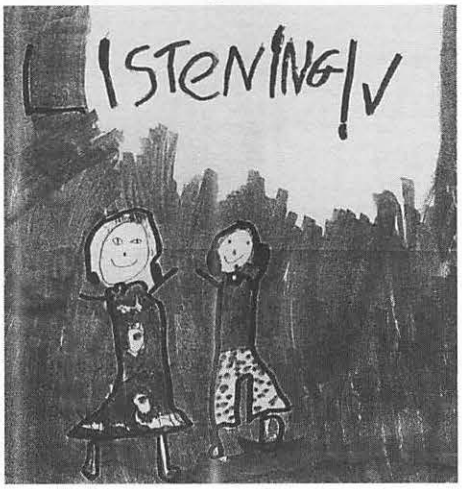


4-6: **Bria's sign: "No girls in the boys' bathroom!"**

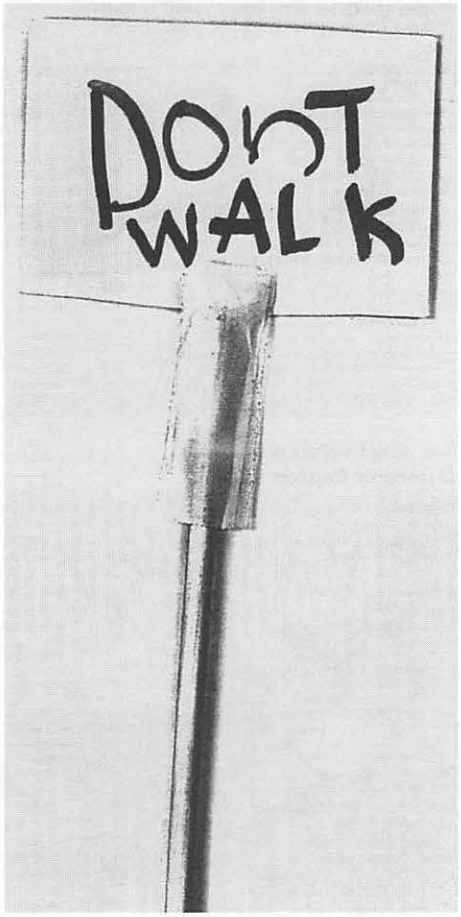


4-7: **Ana's preliminary design for a sign for the Listening Center**

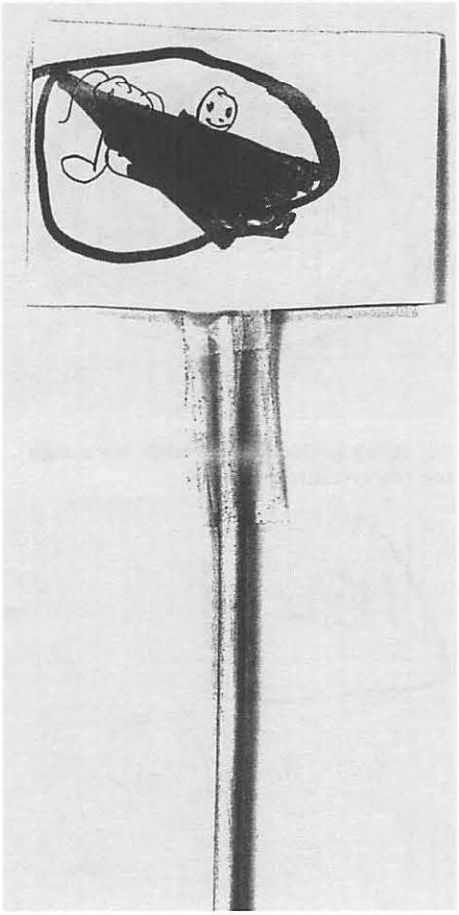
4-8: **Final version of Ana's Listening Center sign**



4-9A: **Text side of Nyasia's "Don't Walk" sign**



4-9B: **Graphic side of Nyasia's "Don't Walk" sign**



One of the basic ideas about signs and symbols is that there is more than way to represent any concept. Some children became intrigued with the idea of multiple representations. Nyasia made a two-sided sign that said "Don't walk!" on both sides. One side used words (see Figure 4-9A), while the other expressed the same thing graphically (see Figure 4-9B).

As an outcome of these activities, Theresa's students started noticing and reading signs everywhere. Drawing on the work of Frank Smith, Theresa recognized their decoding of signs as a developing form of literacy. In his book *Reading Without Nonsense,* Smith offers a broad definition of "reading," which includes reading signs, maps, and clocks as well as books and poems (1997; see references for Chapter 2, pp. 159). Theresa writes:

The understanding and awareness of signs became quite obvious during a recent trip to the Bronx Zoo. Every time we encountered a sign, such as "NO SMOKING," the children would run over to it and point it out to me. Some weren't sure what the "WHEELCHAIR ACCESS" sign meant. It was interesting to listen to the students negotiate the meaning. The children really worked at understanding the signs they encountered. Frank Smith talks about words being merely one type of symbol. I agree with him and his approach to reading. Keeping that in mind, I see the reading of signs as a form of literacy.

Graphic images are only one category of signs and symbols. As we have noted in Chapter 1, every teacher has a method for getting the attention of the class. Nearly always, this method consists of using one or more signals that the teacher has selected and taught to the children. Theresa's signal was turning off the lights. As part of the study of signs and symbols, she wanted her students to come up with their own ideas about signals for getting their attention. Theresa describes her work in this area:

From the very first day of school, I have established the rule that when the lights go out, everyone must stop what they are doing, be silent, and put their hands on their heads. As soon as the lights go on again, the children may resume what they were doing. Often, I turn out the lights in order to give instructions, or to give a "five-minute warning" before the end of an activity.

Now that the classroom routines are established, I feel that a safe environment exists. I therefore feel more comfortable about changing some of the rules. So now I will ask the class, "What can I do in the classroom to get your attention without shutting the lights off?"

I'll be sure to write down the students' responses, and test them to see which one will work to get their attention. We'll have group meetings to decide which one I will implement to take the place of turning off the lights.

New Symbols for the Museum

by Kathy Aguiar

Kathy's work on signs and symbols took place towards the end of the year, when these children were much more willing to express themselves in all ways. She began with a "symbols puzzle," based on the floor plan for the American Museum of Natural History (Figure 4-10).

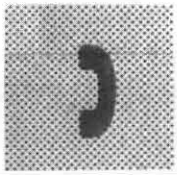
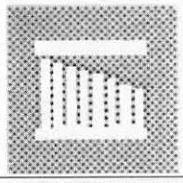
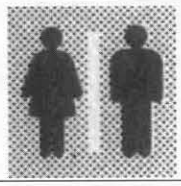
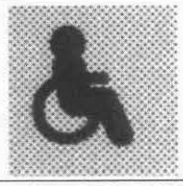
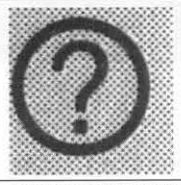
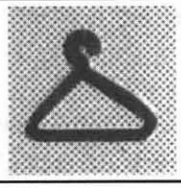
Kathy made large drawings of six of the symbols from the key to the museum floor plan and asked her class what each of these represented. Their responses, with English translations, are shown in Table 4-1.

Kathy Aguiar taught a third-grade bilingual special education class in the South Bronx, New York City. Kathy began the year with a group of students who were in Special Education for the first time. Many of them had been marginalized in general education classrooms and they were reluctant to expose their difficulties in reading and writing. As Kathy worked with them, they gradually overcame some of these barriers. Some of this work was done in the context of studying mechanical devices and electric circuits, and is described in the ***Stuff That Works!*** *guide,* Mechanisms and Other Systems.

4-10: **Portion of museum floor plan, including key** (© American Museum of Natural History; reprinted with permission.)

Table 4-1

HOW KATHY'S STUDENTS INTERPRETED THE SYMBOLS FROM THE MUSEUM FLOOR PLAN

Symbol	Sample Responses
	José: Entrada (Entrance) Freddy: Teléfono (Telephone) Raúl: Algo para el oído (Something for the ear) Jan: Dinosaurio (Dinosaur)
	Marina: Escalera (Stairway) Jan: Algo para el elevadór (It stands for the elevator) Andrew: Alguien bajando escaleras (Someone walking down the stairs)
	Marina: Sitio para comer (Place to eat) Stephanie: Baño (Bathroom) José: Haz una linea. (Make a line.) Natalie: Ayuda (Help)
	Lionel: Espere para el autobús. (Wait for the bus.) Marina: Silla de rueda (wheelchair) José: Pasan gente con sillas de ruedas. (People with wheelchairs can go here.)
	Raúl: Alguien perdió algo aquí. (Someone lost something here.) Freddy: Información (Information) Stephanie: ¿Quién es? (Who is it?)
	Freddy: Agarrando ropa (Taking your clothes) Carlos: Cuarto para enganchar ropa como una chaqueta o abrigo (Room for hanging up clothing such as a jacket or overcoat)

Once I had obtained about five responses for each of the six symbols, I gave out copies of the museum map with the explanations of the symbols. I walked the students through the map, discussing the various parts of the museum.

We began with the first symbol. Marina read the explanation: "phone." I instructed the children to find the symbol on the map. Carlos stated, "The phone is next to the North American Mammals." The next symbol was for "stairs." By looking at the map Jan Carlos was able to tell me that there was a phone next to the stairs. Next they found the boys' and girls' bathrooms. One by one, each symbol was found on the map.

The students seemed to enjoy the activity since it involved a guessing game. The informal discussion helped me to see who was understanding the purposes for a symbol. It also helped me see who was able to read a map, and to follow directions using symbols. For homework, they were asked to find three symbols outdoors or inside their apartment buildings.

I then asked the students to divide into three groups. Each group had the assignment of creating a new symbol for "phone," "restrooms," or "information." The "restroom" group worked especially well and seemed to have agreed on the type of symbol they wanted.

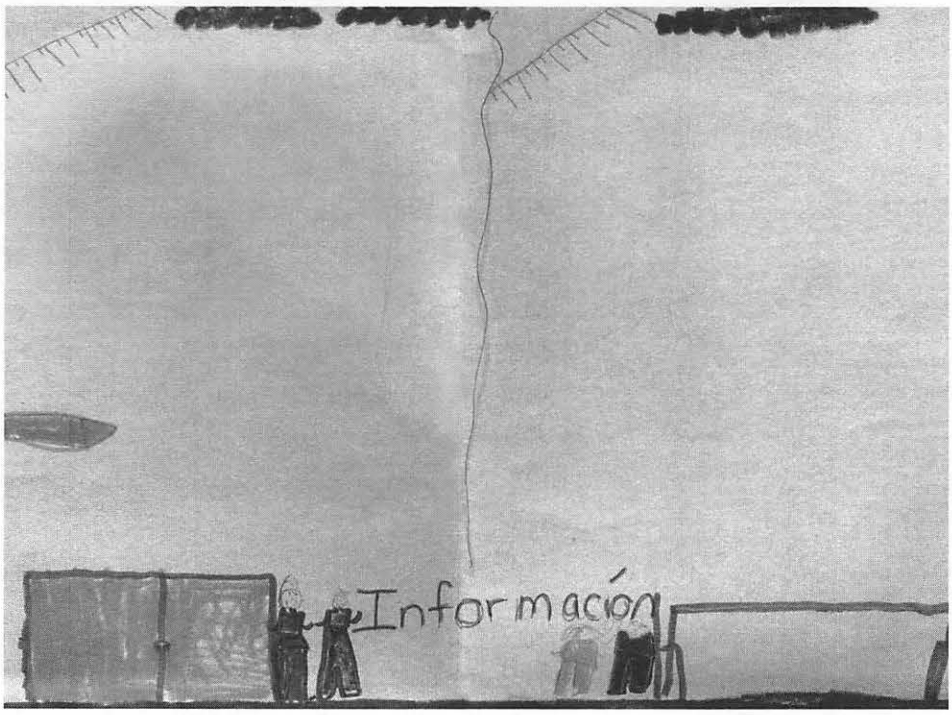
The next group I visited was the "phone" group. Each group member began to draw his or her own symbol. Three students drew conventional pay phones of the kind that would be found in the museum. Natalie drew what looked like a cell phone. The fifth child in the group drew a platano (plantain), because "it has the same shape as a phone."

At this point, it became clear how prior knowledge and experience play a role in learning. José had no idea what Natalie had drawn, because he had never seen that kind of cell phone. As we continued to talk, I asked them about the types of phones they had at home. Out of this discussion, several other types of phone emerged. They finally agreed on two symbols.

No symbol is totally self-explanatory. In order to decode a symbol properly, the reader or receiver must share some of the context of the person who created the symbol. By showing her symbol to José, Natalie was testing it to see if he could decode it. In asking students what kinds of phones they had at home, Kathy was eliciting some of the background knowledge that might be needed for decoding a symbol for a telephone.

The final group had the most difficult task, which was to develop a symbol for "Information." They attempted to create this symbol by drawing a scene showing someone asking for information. (See Figure 4-11.)

4-11: **Coming up with a symbol for "Information"**



Once everyone had finished, each group was asked to show their symbols to the other students, to see if they could understand them. The testers had no problem with the phone symbol. They knew what it was immediately. The bathroom symbol also presented relatively little problem. However, the "Information" group could not get their point across. The conversation went like this:

TEACHER:
What do you think these symbols are trying to say?

NATALIE:
It looks like a school or mall.

ANDREW:
... a store...

CARLOS:
Children are missing from their parents.

JAN:
The picture says that the boy asked where the bathroom is, and the girl said, "It's over here."

Jan actually came quite close to the intent of the symbol, which was to symbolize "Information" by showing someone asking for directions. It is not always easy to represent an abstract concept graphically.

Trips to museums and zoos are excellent opportunities to explore signs and symbols. Some teachers have distributed the floor plan prior to the trip and used it to prepare for a signs-and-symbols scavenger hunt at the museum or zoo.

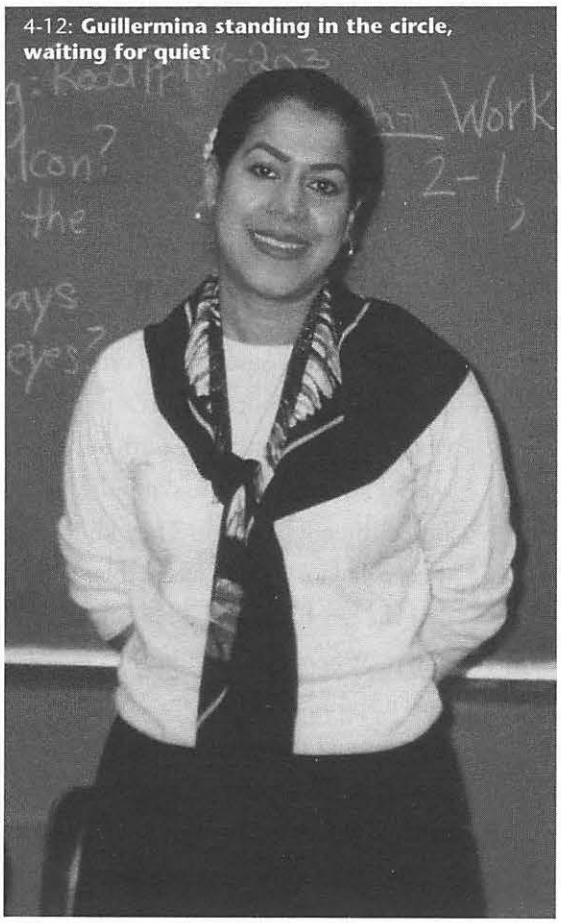
Signs and Symbols as Expressions of School and Classroom Practice

The next two stories have a slightly different focus. While literacy is still important to these teachers, they are also concerned with the potential of signs and symbols to solve problems in the school. Guillermina Montano, a fourth-grade teacher, begins with a symbol she has just invented: standing in white circle to restore order in the classroom. After decoding this symbol, the students look for situations in the school where a sign or symbol might help to implement the rules. Mary Flores, a special education teacher, describes her work with Resource Room students from grades two and five in analyzing signs and symbols in their environment. Mary's narrative features considerable dialogue among the children, and many links with literacy.

What Does It Mean When I Stand in the White Circle? *by Guillermina Montano*

Guillermina began by introducing a new symbol, whose meaning quickly became apparent to the students. Here is her account:

At the beginning of the day, I taped a white circle, about 20 inches in diameter, to the floor in the front of the classroom. As the children entered the room, they asked what the circle was for. I answered that they would find out very shortly. That afternoon, when the prep teacher (relief teacher during a preparation period) relieved me for my prep period, I secretly stayed outside the room. I waited there to see how they would behave with the prep teacher. Of course, they started to "act out." I immediately re-entered the classroom, and stood inside the white circle with my arms behind my back, not saying a word. (See Figure 4-12.) The children immediately quieted down. Then I left the classroom again and did not return until my prep period was over.



4-12: **Guillermina standing in the circle, waiting for quiet**

Guillermina Montano teaches fourth grade at P.S. 115 in the Washington Heights section of Manhattan. She recognized classroom practices as a topic of great importance to her students, and wanted to expand their awareness of how symbols are used to express the rules.

At the end of my prep period, we did another experiment. My prep teacher tried standing in the white circle to see how the children would respond. They immediately told him to step out of the circle, because I was the only one allowed in it! Of course, they failed to become quiet.

Afterwards, we brainstormed about behavior patterns. Some students shared their thoughts about what had just happened. What was the connection between my standing in the circle and their quieting down? Some students went so far as to say that I was trying to control their behavior by doing this.

The next day, I repeated the same behavior without saying anything to the children. Again, they became quiet. No words were spoken, and I did not return to my room until the prep period was over.

The third day, I stood on the circle after the prep teacher had left. I asked the students to write about what had been happening for the past two days, both before and after I stood on the circle. What did the circle represent? Some answers were:

* *I think that it reminds her where to stand when everyone is crazy. She stands there and everyone shuts up.*
* *I see a circle and I also see feet on it and someone is standing straight with their hands behind their back.*
* *When the class is talking and screaming she stands in her spot and everyone chills out.*
* *She's waiting for silence. She's waiting for the kids to be quiet so she can give the lesson.*
* *Her control is that she's just standing there and her message is to be quiet and in some weird way it works.*

Karen listed a variety of possible meanings for the circle on the floor:

* *A happy face*
* *A shape with a figure inside*
* *A symbol*
* *A sign*
* *A sphere for world peace*
* *A clock*
* *A map*
* *A sign to be silent*

Like Kathy Aguiar, Guillermina presented her students with a puzzle: what does this symbol mean? But there was an added twist: the symbol was aimed directly at them. They knew that their behavior was unacceptable, and that the teacher had the job of controlling it. When she stood in the circle, they responded almost immediately. The context provided all of the clues to decoding the symbol. At the same time, as Karen pointed out, a circle could have many different meanings. Symbols are interpreted in context.

This opening activity laid the groundwork for the next one, several days later: identifying symbols used by other teachers for a similar purpose. Guillermina continues:

I explained to the class that the circle was a symbol I had invented to ask them to exhibit a certain behavior pattern—i.e., being quiet and attentive. I told them this was going to be a new classroom rule. A few days later, I organized the children in groups of six and designated a recorder for each group. I asked each group to make a list of methods their other teachers had used to control students' behavior. Some of the methods were:

* *One teacher used to scream at us.*
* *Almost all of them would take our privileges away.*
* *Calling names*
* *They hit the ruler on the desk.*
* *Taking a big ruler and snapping it on the board*
* *Stomping*
* *Screaming at us*
* *Putting us in the corner*
* *By banging the book on the table*
* *They ring a bell.*
* *They call the principal.*
* *They change your seat.*
* *No taking us to gym or the yard*

I noticed that the children only mentioned teachers who had managed their students with difficulty. They did not make any comments about teachers like Ms. Gonzalez, who is very subtle in her management techniques. They don't realize how much it takes to control children in a quiet way.

Generally speaking, teachers resort to raising their voices, threats, or punishments only after other methods have failed. It is far more effective to use symbols, such as standing in the circle. Of course, a symbol is only effective if there is basic agreement about its meaning and a willingness to respond to its message.

Several days later, Guillermina extended this discussion by asking her students how rules and practices operate in different environments. Here are some of their answers:

JOSEPH:
Signals control us because signals tell us what we can do. They tell us whether to walk or stop, whether you can smoke or not, and stuff like that. Rules control us by telling us exactly what and what not to do. They tell us don't run, don't talk, and don't fight. Both bad and good drugs control us by making us sleepy or hyper, drowsy, or attentive.

NATALIE:
I think that symbols are important because they help people with directions and rules. I think that music is important because it relaxes you and calms you down. And you get the rhythm on your mind. I think that jail controls people because the police is...

ALFREDO:
I would make people behave by telling them that they are very nice and by telling them that they are doing good work. Or I would make all of the kids play with him and make him feel like if he was a very good friend to the class, but still I would make him do all of his work.

These comments are very insightful. Natalie points out that music can be a subtle way of sending messages. Alfredo observes that people often respond in kind to the signals they receive from others. A child is more likely to behave if the teacher indicates that she believes he will.

Building on this new awareness, Guillermina next engaged her students in designing and testing their own signs and symbols for implementing school practices. They began by brainstorming areas where the children's behavior could be improved. The list included:

- Clean bathrooms
- No fighting allowed
- No graffiti
- No pushing on stairwells
- No miniskirts

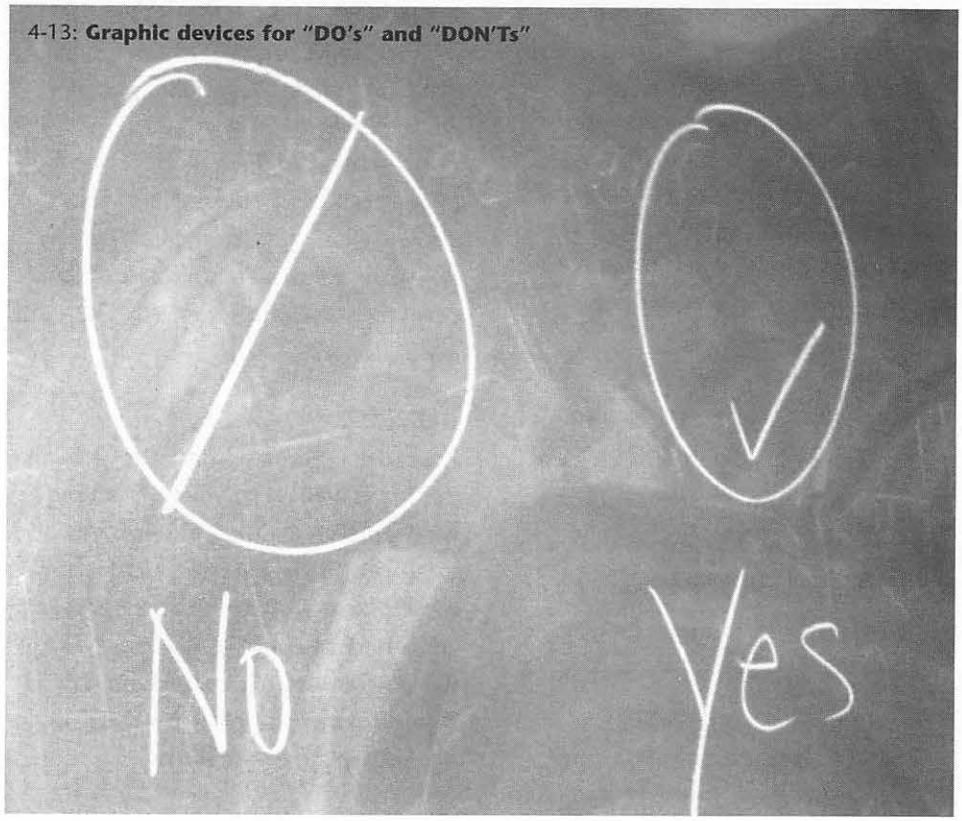
The next task was to collect some data:

Children were sent in groups of four to various places in the school to observe and record where signs were needed. Two issues for which the students decided to make signs were "NO FIGHTING" and "NO LITTERING."

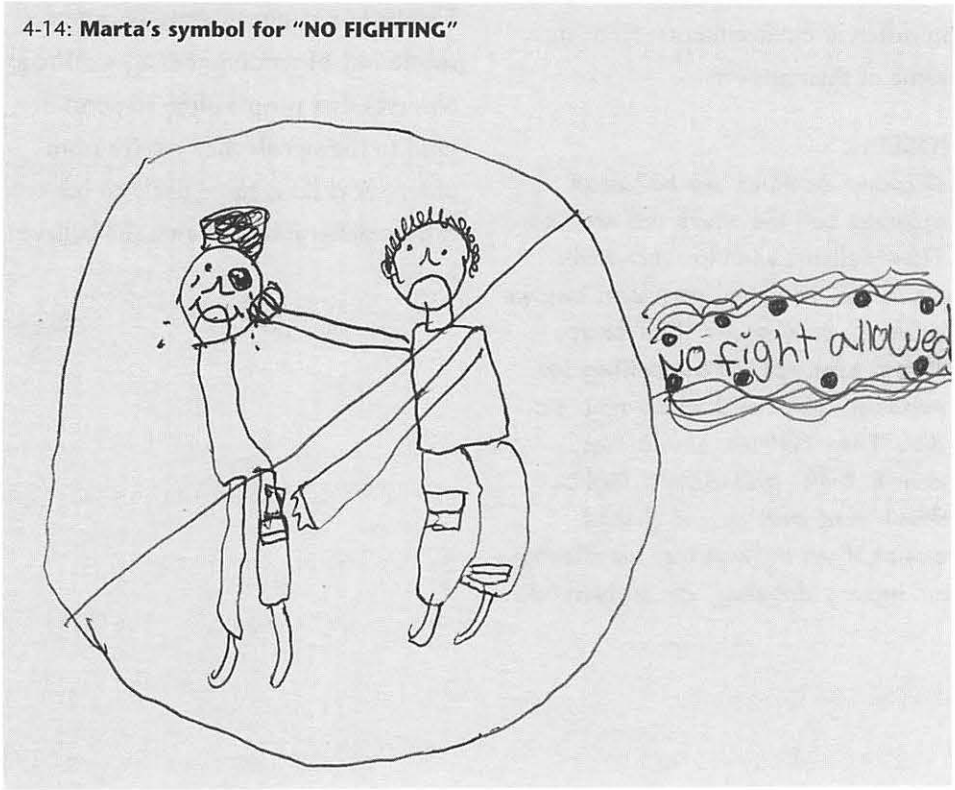
Before the students started making their signs, they discussed graphic symbols that say "Do something" or "Don't do something." These are shown in Figure 4-13.

The students designed their signs and wrote reflections about them. Marta made one sign to say "NO FIGHTING" (Figure 4-14), and another to indicate "NO LITTERING" (Figure 4-15).

4-13: **Graphic devices for "DO's" and "DON'Ts"**



4-14: **Marta's symbol for "NO FIGHTING"**



Marta described the first one this way:

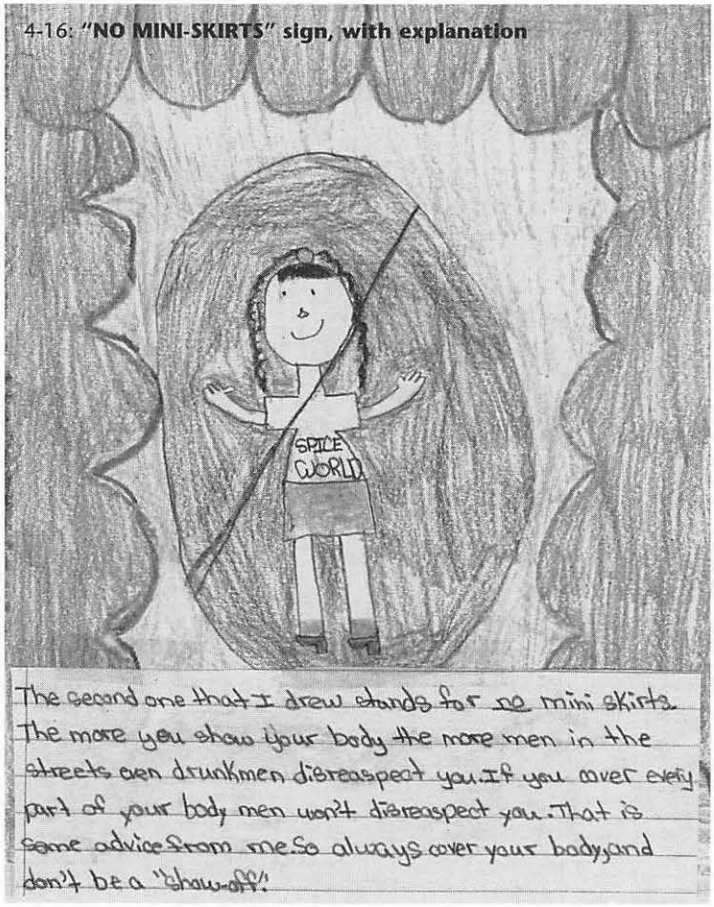
My first symbol represents that fighting is no way to solve your problems. And I think it is important for the school. Because you might get hurt one day and the person who hit you will get in a lot of trouble. So if you get in a fight, you just get out of it, because it might be really bad.

As the students were making and posting their signs, they thought of other issues for which signs might be helpful. Some of the other signs conveyed the messages:

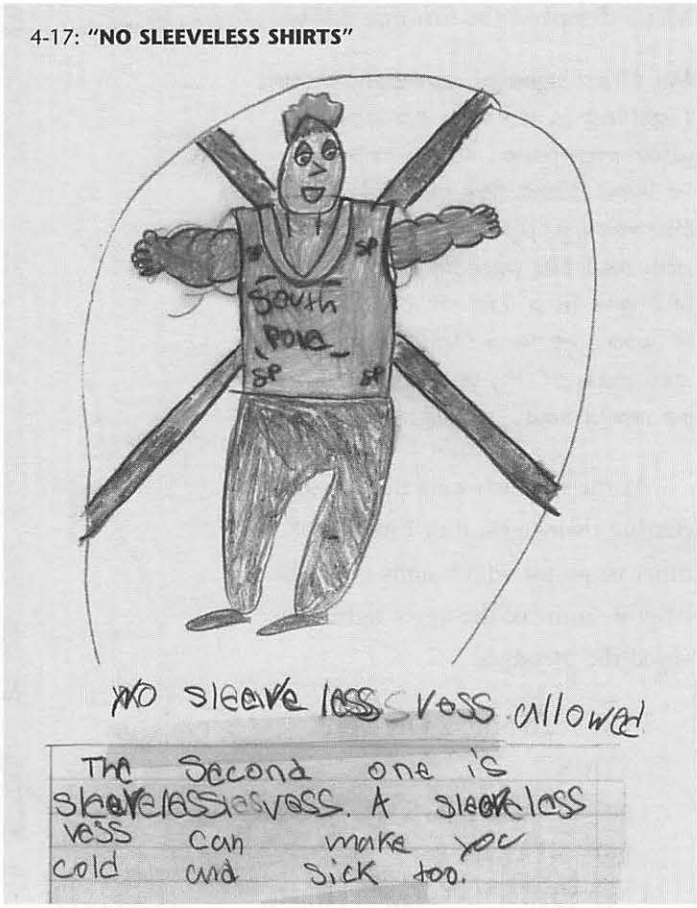
- NO RUNNING ON THE STAIRS!
- NO FLOODING THE WATER FOUNTAIN!
- NO STANDING ON THE TOILETS!

4-15: **Marta's symbol for "NO LITTERING"**

4-16: **"NO MINI-SKIRTS" sign, with explanation**



4-17: **"NO SLEEVELESS SHIRTS"**



The need for a dress code also came up. Guillermina describes how this issue arose, and what her students decided to do about it:

During this investigation, some students decided that the dress of some of the students was inappropriate. What followed as a result were signs and symbols indicating what was and was not acceptable for boys and girls in the school. (See Figures 4-16 and 4-17.)

Would these signs be effective? In their predictions about the signs, several of the students were very optimistic, and even passionate.

MELISSA:
I think it will work because the signs will help the children understand that they have to care for the school. If they don't care for the school, who is?

YANERY:
I feel very good about being in this project. I think people will pay attention to our little posters. Maybe they will stop fighting and all those things. I have faith in God that everything will work out O.K. If everyone stops fighting this school will be the greatest. I just hope that that comes truly true. I think these posters are the best posters I have ever seen in my life.

Of course, there was no way to know how effective the signs would really be except by testing them. Guillermina's class decided to conduct a survey to see how well their signs conveyed their messages and to determine whether other students would follow them. There were three survey questions:

1. **What do you think this picture represents?**
2. **What do you think is the hidden message?**
3. **If they saw this sign around the school, how do you think people would act?**

Here is a typical set of responses to these three questions about one of the "NO LITTERING" signs:

1. *Throwing trash*
2. *"Do not litter."*
3. *They are going to respect it.*

In addition to collecting data, the students wrote about how they felt while they were conducting the surveys. Here is part of what Alfredo wrote:

I felt very thankful for getting attention from all of the teachers and for the kids that paid attention to us and they all agreed with our signs and symbols. I really felt joyful and thankful. The teachers agreed with what we were doing for the school and they felt surprised when we showed (the signs) and asked them the questions in the survey.

Guillermina felt in retrospect that the experience had been a very positive one for her students. It had helped them develop their sense of social responsibility, and had also taught them how to convey a message without words. Here is her final reflection:

Based on my observation during this theme, my students became more conscientious about meeting the needs of the school as a whole. They developed a certain ownership of the school and tried to help maintain order. They are constantly talking about developing new signs and symbols to improve the culture of the school. When they were conducting the surveys, they showed a sense of pride and a sense of belonging. My students were able to recognize that signs and symbols are a form of communication without words. Also, they are more aware of how signs and symbols are all around them, and how much they are a part of their everyday lives.

From Sign-and-Symbol Detectives to "Who Ate Nelson García?" *by Mary Flores*

Mary Flores teaches Resource Room at Community Elementary School 42 in the South Bronx. Each day, she works with five small groups of Special Education students, ranging from second to fifth grade. Some of her students have been with her as long as three years.

Mary describes her situation in the following way:

My Resource Room setting is out of the norm. I have five groups with no more than eight students at a time. If my lesson doesn't work with one group, I have the opportunity to change the activity and do it differently with the next group. By the time I have finished with the fifth group, I have polished the lesson.

There are major differences among her five groups of students. The youngest group, the second-graders, are mostly non-readers and non-writers, and become frustrated easily. At the opposite extreme are her "veterans," mostly fifth-graders who have been with her for several years, and have participated in many *Stuff That Works!* activities. These students feel very secure with Mary, and they are eager to express their ideas and to try new things. In this section, Mary describes her work with her second-grade "neophytes" and her fifth-grade "veterans."

Mary usually begins a unit with a brainstorming session. She asked her students to think of examples of signs and symbols, and to try to come up with a definition of each of these terms. Here is what happened with her fifth-graders:

April 26

I decided to finish off the year with a bang. I suspected that the signs-and-symbols area of technology would be an exciting way to culminate a productive year. This area of technology appeals to me and I anticipate that my students will also become motivated by this topic. I conducted this investigation with my fifth grade veterans. We had the following discussion:

TEACHER:
What are signs and what were they designed to do?

HERIBERTO:
Signs are things in the street. They have "STOP" signs.

MOISES:
... something that makes a command.

CYNTHIA:
They have different kinds of signs, like who you are.

HERIBERTO:
Like what?

CYNTHIA:
... like "Sagittarius."

DERRELL:
They were designed to give people and objects signals about what way they should go, how, and who.

EBONY:
They made signs so nobody would get in an accident.

TEACHER:
What signs are found in the school?

EBONY:
... "UP" and "DOWN," "ONE WAY" ... In the bathroom, "WASH YOUR HANDS BEFORE YOU LEAVE THIS ROOM."

HERIBERTO:
When they are testing, they say, "DO NOT DISTURB."

MOISES:
The pass is a sign.

CYNTHIA:
On the door there is a sign.

Of course they all began to look around the room for anything resembling a sign.

TEACHER:
What are symbols?

CYNTHIA:
Flintstones Vitamins. I was only kidding!

Although she was only kidding, she was looking beyond the printed word. "Flintstones" symbolizes something appealing to children.

DERRELL:
A blueprint is a symbol.

HERIBERTO:
... like in The Indian in the Cupboard (a chapter book they had been reading). Little Bear had symbols on his teepee like bulls, an ax, and a scalp. Symbols are like drawings or designs like diamonds, hearts. You know, like on cards.

CYNTHIA:
Like when you go to Egypt, they have some symbols on the walls.

Moises had gotten out of his seat and was flipping through the pages in the dictionary. He is always curious about the dictionary definition.

TEACHER:
Okay, Moises, read the dictionary definition to us.

MOISES:
"Something that stands for or represents something else. The dove is a symbol of peace. The mark '+' is the symbol for addition."

TEACHER:
Well class, do you accept that as our definition? Do we agree?

ALL:
Yes!

DERRELL:
The Statue of Liberty represents the United States. The Statue of Liberty is a symbol for freedom.

TEACHER:
Do you think signs and symbols are observed in this school?

MOISES:
Some of them, like the "UP" and "DOWN" one (on the staircases) are ignored, because I saw Ms. Flores doing it before (ignoring the signs), and many other teachers too.

TEACHER:
What symbols have you noticed in the school?

DERRELL:
In the yard. They are painted on the concrete. Skelzees (Skelly) board, footprints, that one where it got 10 numbers and you throw a stick on it. That's a symbol.

HERIBERTO:
The death sign (skull-and-cross-bones) is a symbol.

TEACHER:
Why do children follow the signs on a board game, but don't follow the signs or symbols in the school?

MOISES:
If you don't follow the rules in a game, then the game won't be fun at all. Not only that, but you'll lose. If you don't follow the signs in school, nothing happens.

HERIBERTO:
Kids don't follow the signs in the school because they think the rules don't apply to them, so they keep crashing.

HERIBERTO:
In Ms. Roman's room you have symbols. (Ms. Roman is the Art teacher.)

CYNTHIA:
The numbers on the doors.

TEACHER:
Are numbers symbols?

CYNTHIA:
I don't have a clue.

MOISES:
I think they are because...

DERRELL:
...in the Stone Age, they used numbers as symbols.

HERIBERTO:
In Egypt they have these symbols that show you death and when mummies were alive.

It's interesting that besides naming the symbols, this group defined "symbol." There was no question about what it meant to each of them. This group is confident about their responses. I have set an environment for them that is non-threatening. They take risks. They are not afraid that I will criticize them.

The issue of numbers as symbols intrigued me. I was surprised that they could refer to history to validate Cynthia's response that "a number is a symbol." Although Cynthia was not sure whether numbers were symbols, the others in the group confirmed this idea for her.

For Mary's students, a "sign" generally uses words, while a "symbol" expresses an idea without words. As one child put it,

I learned that symbols MEAN words, but they just USE pictures.

In looking for examples of symbols, the children were very inclusive. They included historical symbols, mathematical symbols, cultural symbols, and symbols for abstract concepts, such as "death" and "freedom."

Mary's next activity was a "Symbols Scavenger Hunt:" a search for symbols in the school building.

We went out on a scavenger hunt in search of symbols. I eliminated signs altogether because I felt scavenging for signs would not pose a challenge for this group. After the hunt, I asked the students to share their findings:

TEACHER:
What symbols did you find and what do they represent?

HERIBERTO:
We found masks. In Indian countries they do dances with them.

MOISES:
... Voodoo stuff ...

DERRELL:
We found the drama masks. It stands for "acting."

EBONY:
We found a snail symbol on the staircase. It stands for "slow."

CYNTHIA:
Yeah, like it means to "walk slow." We found animal pictures.

MOISES:
The weirdest thing we found is a dragonfly. It was in the library. It may stand for "speed."

CYNTHIA:
We found pens to write. We found it on the Writing Room door. That means that that is where you will write.

These veterans had exceeded Mary's expectations in their grasp of symbols and their meaning, but this was her most advanced group. How would the second-graders fare with these kinds of activities? It was time to find out:

April 27

Now on to my biggest challenge. I have a second grade group that can be difficult to manage. They are virtually non-readers. I suspect that their disability is what causes the acting-out behavior.

I can't help but remember the way they behaved, back in October, when I attempted to introduce a *Stuff That Works!* project to this group. It was pandemonium. Well, it's now April and time to give it another try. I am going where no man nor woman has gone before. I am going to attempt an inquiry-and-design project with this group.

Why? I guess it's because Annette Purnell (an early childhood teacher and *Stuff That Works!* participant) made me think about how beneficial this project would be to this particular group. This may be a way of reaching them, thereby helping them to overcome their disability. After all, being non-readers, they probably rely on graphic symbols to aid them in negotiating their way around the environment.

I began as I always do, with a sharing of ideas. What understandings did this particular group bring to this topic?

TEACHER:
What are signs?

KEISHA:
A sign is when it has a red light. Like look both ways when you are crossing the street so you don't get hit.

DARIKIS:
Where the things are, like that. Like the staircase. They say "UP" or "DOWN," like that.

CARLOS:
Follow the "EXIT" (to) where you (are) going.

KEISHA:
You can learn from right and wrong like the "BE A GOOD LISTENER" sign. It (is) suppose(d) to show you like if you are going to the bathroom, you ask somebody to help you find the bathroom. You gotta look for the sign. That's why you need to learn how to read.

DARIKIS:
They help you to find the cafeteria.

TEACHER:
Is there a sign in this school that says "CAFETERIA"?

KEISHA:
Yes there is. It's like a picture. It got a picture of food.

TEACHER:
Is that a sign or a symbol?

KEISHA:
It (is) a symbol. A symbol shows you a picture, a sign tells you the word. Once I was going out with my father. He was not paying attention to the sign, but I was paying attention and it said, "DO NOT WALK INSIDE THE RESTAURANT." I was looking at the symbol. It was a picture of the store and people walking in. But this time it had an arrow going beside it and a little box said, "COME BACK AT 5 O'CLOCK."

WOW! That response made me realize that I had hit pay dirt.

Mary's hunch was correct. These children seemed to be highly attentive to graphic symbols in their environment, perhaps even more than children who could read and write. Could these students be introduced to decoding of words through the much less threatening route of decoding graphic symbols?

Next, Mary wanted to take them on a scavenger hunt, but she had to find a way to make it exciting for them. She came up with an analogy that was very effective:

I told them, "Today we are going to pretend we are detectives. We need to find clues. We have to determine where a sign or symbol needs to be posted, so as to help the younger kids that can't read. But first we have to see what signs or symbols are already there."

I don't know why, but these silly little stories always get the students interested. They couldn't line up fast enough. Notice that I did not point out their own reading disabilities.

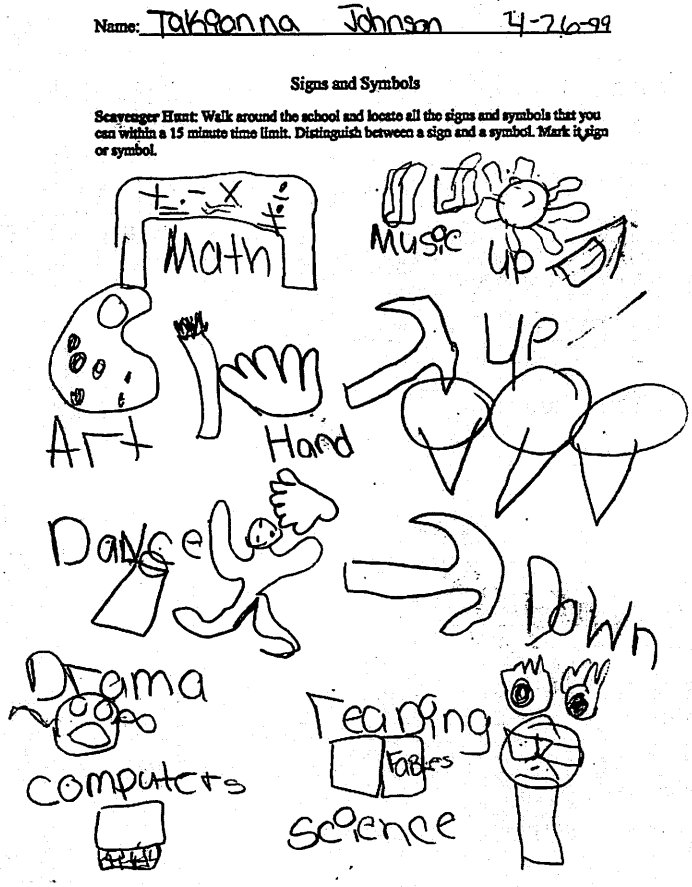
We proceeded on our scavenger hunt. Immediately upon leaving the room, the students found the "DOWN" sign on the staircase.

I asked Darikis, "If we were to design a symbol for this sign, what would it be?" He stated, "A boy walking down the stairs."

We spent the whole time on the first floor. At every turn, they found either a sign or a symbol. They couldn't write them down fast enough.

We found many signs and symbols. Then we got to the quilt on the first floor, which has symbols for all the school subjects. I asked them what the purpose of this quilt was. Takianna commented, "It shows you all the things that this school teaches." (See Figure 4-18.)

4-18: **Takianna shows the school subject symbols**



I then posed the same question that I had posed to other groups:

TEACHER:
If the words were not written below the symbols, would you be able to tell what the pictures represented?

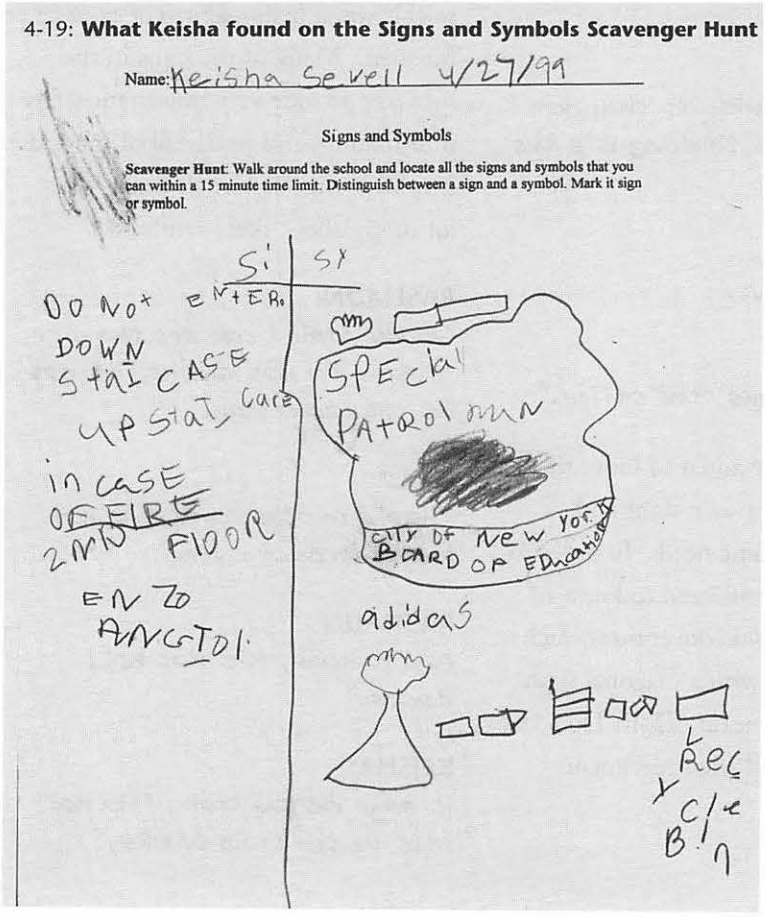
DARIKIS:
You would know the math one because it has the "+" and take-away sign, so I know it means "Math."

Some of the symbols were easy to identify, while others were not so simple. Nevertheless, they were gaining knowledge of what a symbol is. I had accomplished more with THIS topic, on THIS day, than I had with any other in the past seven months!

Keisha forced Ben, our security guard, to stand still while she sketched his badge, as well as its inscription, on her paper. (See Figure 4-19.)

On our way back to the classroom, Keisha detoured us. She stated, "I know where there is a symbol for Earth Day and I can read it." I couldn't let that remark get away, so we all followed her. Keisha immediately led us to a poster that shows the journey that paper takes to be recycled. She could decipher what the symbols on the poster represented. I was impressed.

4-19: **What Keisha found on the Signs and Symbols Scavenger Hunt**



Mary felt that this scavenger hunt had given these students an outstanding opportunity to demonstrate their understanding of signs and symbols. Next, she wanted to find out what they felt they had gained from it.

TEACHER:
What did you learn?

DARIKIS:
A sign tells you a word.

KEISHA:
I found out that teachers and children have symbols on they shirts, they pants, they shoes, they sneakers. A badge is a symbol. A calendar has a whole bunch of symbols like "April."

CARLOS:
I learned that some are words and some are pictures.

DARIKIS:
I learned about following the signs. They help you look for something.

TEACHER:
What questions do you have?

KEISHA:
I want to know, if people can't see, how can people cross the street?

DARIKIS:
Why do signs have pictures?

CARLOS:
Because if you don't know the words the pictures will give you the answers.

DARIKIS:
Why do we need symbols?

CARLOS:
So the picture could help you.

DARIKIS:
We could help the little kids read it.

CARLOS:
By the arrows. It's up or down.

JOEL:
We can help them by talking to them.

KEISHA:
Don't put the word, just put the pictures.

DARIKAS:
If you see a kid looking at the sign and he don't know how to say it, we help them.

This discussion indicates that these students are paying attention to symbols found in their environment. I didn't expect that they would gain such a rapid understanding of signs and symbols. They brought a great deal of prior knowledge with them. Keisha, in particular, seemed to find signs and symbols everywhere, which in turn stimulated the rest of the group. She noticed the security guard's badge, the symbol on my slippers, another on a student's shirt, and yet another on the ring a teacher was wearing. It confirmed my belief that these students rely on the signs and symbols they find in their environment for their understanding.

Having established the importance of signs and symbols, and the reasons for using them, Mary felt ready to take the next step. She wanted her students to think about where new signs and symbols might be needed in the school.

TEACHER:
Where do you think we can use a symbol?

KEISHA:
By the basement, so they don't go down there thinking it's the bathroom.

CARLOS:
By the office...

KEISHA:
...a arrow says "the office."

Next, Mary wanted to move them to designing their own signs and symbols to fill these needs. In order to do this, they would need to know of some basic symbol conventions, such as the red circle with a diagonal slash through it that means "Don't Do This." She did a little experiment:

I wanted to test their prior knowledge. I drew a symbol that says "No Smoking" on a piece of paper. Keisha figured it out:

KEISHA:
It has two circles and two lines going across the cigarette. You want to know how I know? She is a security guard and she be wearing a pink thing that has "NO SMOKING."

This exchange triggered a discussion on symbols the students remembered from another environment: the New York City subway system. Most of the children have spent considerable amounts of time riding subway trains, so this was a major source of experience for them. Many of the signs in the subways provide very important safety information, and nearly all of them use graphic symbols. The students had a lot to say about these symbols:

RASHAUN:
On the train I can see the sign, "Please do not smoke, do not let the radio play."

JOEL:
There's another one, "Do not push the door open."

RASHAUN:
And it says, "Do not hold doors."

KEISHA:
It says on the train, "Do not step by the train tracks,"

because when the train leaves there's a little space so you don't fall inside.

DARIKIS:
One says, "Do not pull the red string" (the cord for the emergency brake).

KEISHA:
Sometimes inside a handicapped train stop, they will have like a little path (ramp) so you can push yourself on it.

RASHAUN:
When I was on the train, I saw what the sign says. It says, "Do not throw cigarettes under the train." (See Figure 4-20.)

Mary wanted to see how her older students would respond to the idea of making signs for the school environment. This group already had experience in a variety of analysis and design experiences, including the following:

- mapping the classroom to scale (see *Stuff That Works!* guide, *Mapping);*
- collection of data about which rules are broken by students in the corridors and bathrooms (see *Stuff That Works!* guide, *Designed Environments: Places, Practices, and Plans);*
- analysis of simple mechanisms, and design of "Rube Goldberg" devices (see *Stuff That Works!* guide, *Mechanisms and Other Systems).*

Mary was eager to see what carryover there might be from these experiences to their latest challenge: design of signs and symbols for the school. Their studies of rule-breaking had made them aware of problems that might be addressed by creating appropriate signs.

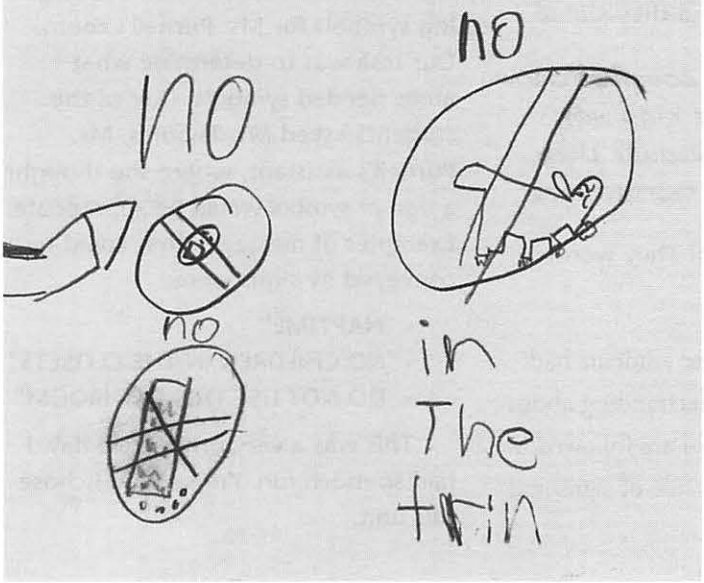
Later that afternoon, I met with my veterans. Of course, they never cease to amaze me. What would today bring? I decided to pose the same question to them that I had asked the second-graders:

TEACHER:
Where do you think we could use a sign or a symbol in this school?

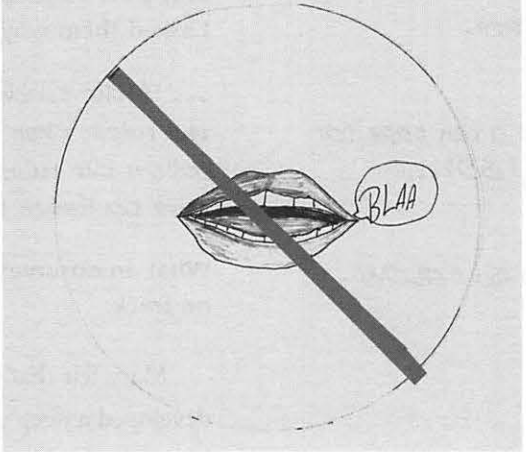
MOISES:
In the bathroom because there are some nasty people in the school. They don't wash their hands when they leave the bathroom.

EBONY:
I say the classroom. "NO TALKING." I'll use a mouth. (See Figure 4-21.)

4-20: **Rashaun's drawings of signs in the subway**



4-21: **Ebony's "NO TALKING" sign**



HERIBERTO:
I say in the Teachers' Lounge because kids just go in and buy soda. A symbol could be a big gigantic hand that says, "STOP, NO KIDS ALLOWED."

EBONY:
... in the garden, because people throw their trash in the garden.

MOISES:
This could be the motto: "STOP THAT TRASH AND SAVE THE GRASS."

HERIBERTO:
Hallways! "NO RUNNING IN THE HALLWAYS. RUNNING IN THE HALLWAY, YOU GET A WEEK'S DETENTION."

MOISES:
"KEEP TO THE RIGHT."

TEACHER:
What could we use to make this sign?

MOISES:
Cardboard, tape.

EBONY:
Red tape and green tape for "STOP" and "GO"...

HERIBERTO:
...and yellow to "SLOW DOWN."

MOISES:
Ooh, ooh! We could put the yellow tape in the hall and tell them "SLOW DOWN," but I doubt it's gonna work.

HERIBERTO:
I got one. We could get somebody's camera and when we see them breaking the rules we can take a picture and we develop them, we can write a note and say "This kid is not following our rules."

TEACHER:
Keep thinking about this investigation. Think about how we should proceed. Heriberto, you talked about collecting data. I think this would be a good starting point for us. This way, we can determine if our signs worked or not.

I allowed Moises and Heriberto to go out and collect data that would answer their question, "Do you follow the signs and symbols in the school?" It was interesting that they only posed this question to teachers. I asked them why, and they stated,

... if the teacher doesn't follow the rules, then the kids won't follow the rules because they have to listen to the teacher.

What an observation! They were on track.

Mary felt that these students had developed a deep understanding about how rules in the school are followed or not followed, and the role of signs and symbols in expressing them. Also, they came up with some good suggestions about signs that could influence behavior, although they were skeptical about the effect that signs alone could have.

As in any good brainstorming session, they had covered a wide range of territory. Mary's next step was to narrow their focus to designs that could be created and tested easily. Once again, Mary's colleague Annette Purnell provided a crucial suggestion:

April 29

I had a discussion with Annette Purnell. She suggested that my students could design symbols for her kindergarten classroom. She recognized that there were problem areas in her room, where symbols could be helpful.

This afternoon, I met with my veterans. We visited Ms. Purnell's room. She and I had coordinated our schedules so that her students would not be in the room when we entered. My students liked the idea of designing symbols for Ms. Purnell's room. Our task was to determine what areas needed symbols. One of the students asked Ms. Thomas, Ms. Purnell's assistant, where she thought a sign or symbol would be appropriate. Examples of messages that could be conveyed by signs were:

- **"NAPTIME"**
- **"NO CHILDREN IN THE CLOSETS"**
- **"DO NOT USE THIS BATHROOM"**

This was a very productive day. I had so much fun. I'm so glad I chose this unit.

The following day, Mary borrowed a set of wooden signs and symbols from the block area of one of the early childhood classrooms in her school. Her purpose was to have her students sort these signs into categories, as a way of exploring the differences and similarities among them. Here is what happened:

April 30

It was almost time for me to meet with my veterans. As usual, Moises was ten minutes early. I was standing by the door talking to a colleague. I never indicated to Moises what I intended to do with the signs and symbols. When I turned to look into the room, Moises had divided all the signs on the table into two groups. He had done this spontaneously, without any suggestion from me. We then had the following exchange:

TEACHER:
What are your two categories?

MOISES:
...things with four sides, and things with more or less than four sides.

TEACHER:
What made you decide to group them?

MOISES:
I was bored.

He rearranged them again, this time into four groups, and asked me to guess what the categories were. Hard as I tried, I couldn't figure them out. Moises explained his categories this way:

1. *(The signs that show) bikes go together because they are both about bikes.*
2. *The "ONE WAY" and the "CROSSING" signs are talking about rules on the street.*
3. *"YIELD," "STOP," and "RAILROAD CROSSING" go together because they are talking about stopping.*
4. *"PHONE" and "HANDICAP" go together because they are blue."*

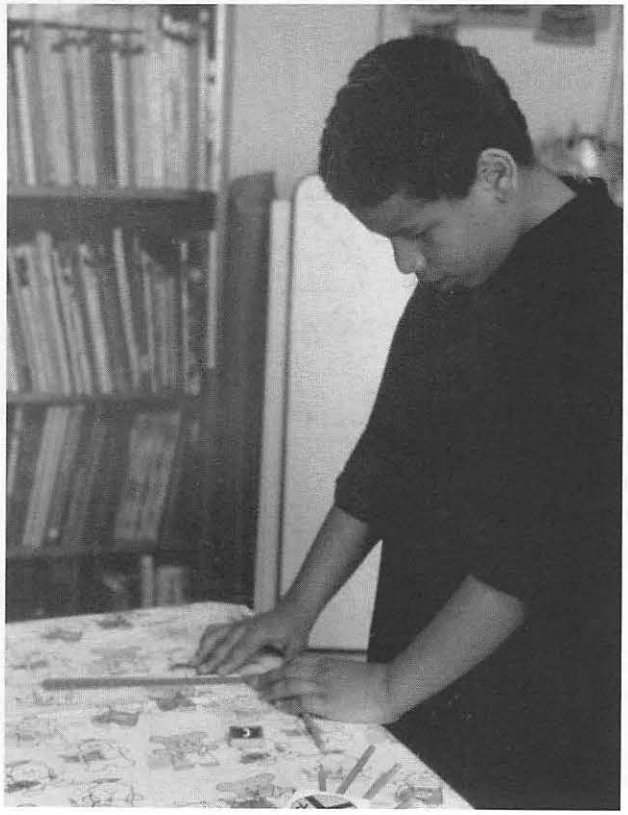
I asked him if he could find another way of categorizing the signs and symbols. His next method was the icing on the cake:

MOISES:
I used the ruler to measure all the signs. If they were above 6 cm., I put them in one pile. If they were below 6 cm., I put them into another (pile). (See Figure 4-22.)

TEACHER:
What does someone think about when designing a sign or symbol?

MOISES:
If something is wrong, you make a sign. Signs have to have specific kinds of shapes, different colors. If you want someone to slow down, you use yellow. If you want somebody to stop, you use red. Ooh! I got a new way to categorize: things you CAN do and things you CAN'T do.

4-22: **Moises measures his signs**



Meanwhile, Mary's second-graders started working on the signs and symbols for the school. They especially liked the idea of making signs for children who couldn't read yet. Although they were barely literate themselves, it made them feel good that they would be helping these younger children out.

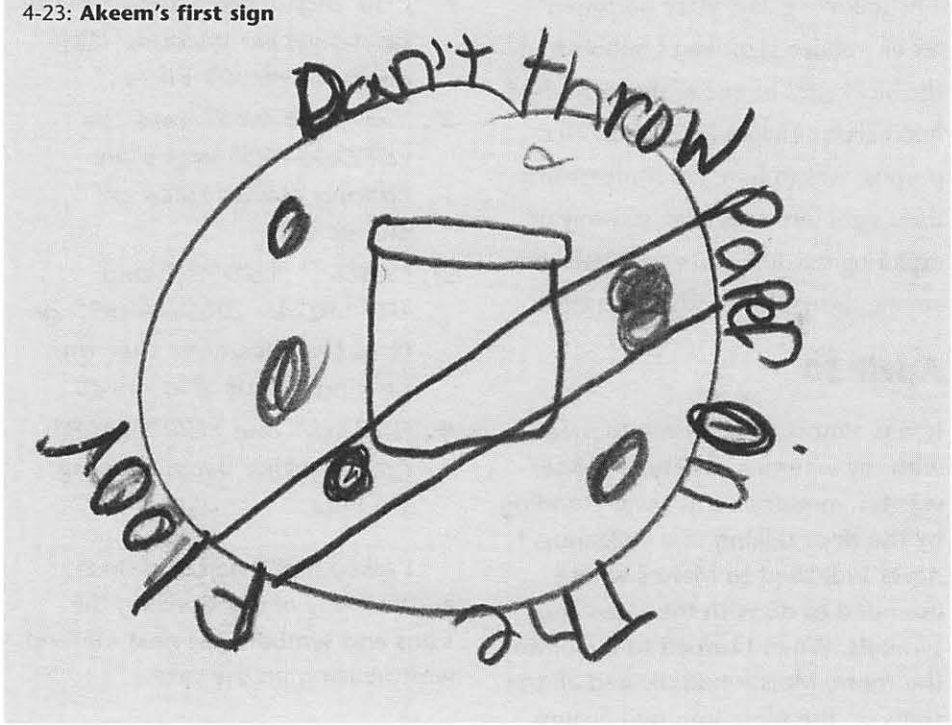
May 7

Akeem entered the classroom and asked if he could work on his sign. He is a student that has difficulty remaining on task. He becomes frustrated because he can't write, but he was motivated by this activity.

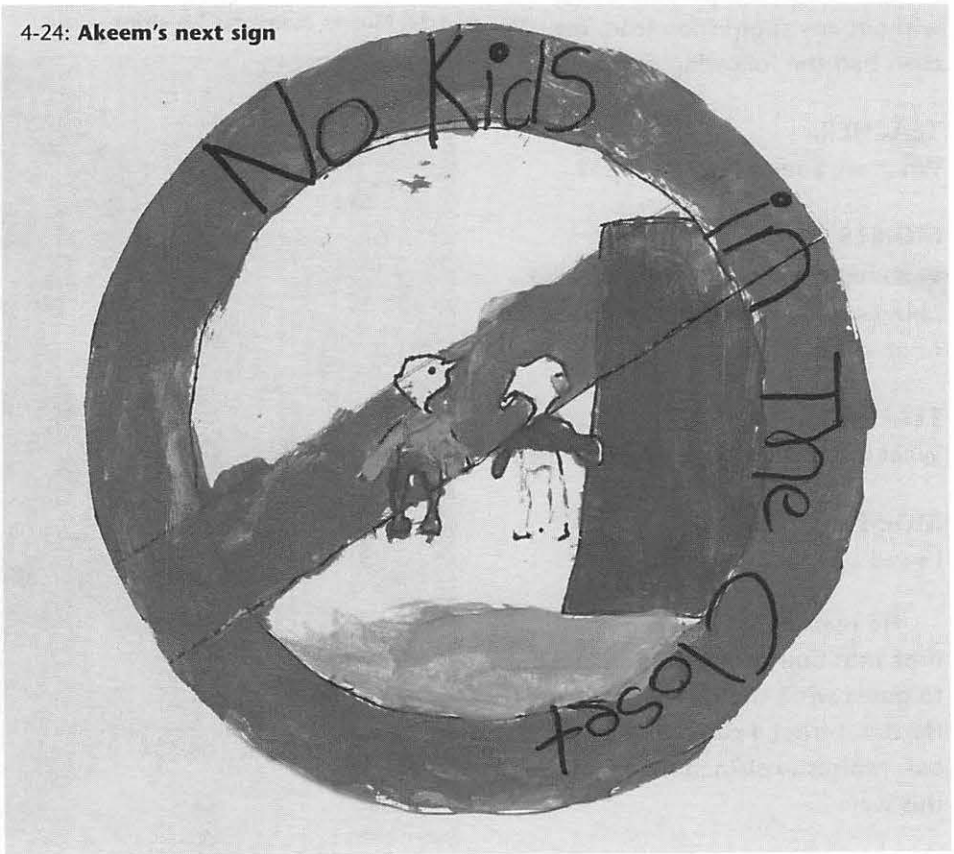
He worked diligently on his sign. It was the longest I have ever seen him remain on task. The sign had just six words: "DON'T THROW PAPER ON THE FLOOR," but this is a good start for him. (See Figure 4-23.) I will attempt to lead him in the direction of a longer piece of writing. I am hoping the symbols will motivate him to write.

Once he completed his first sign, he begged to make another sign. I offered him some suggestions, but he told me it would be hard for him to draw the ones I'd suggested. He finally agreed to make a sign for Ms. Purnell's kindergarten classroom that read, "NO KIDS IN THE CLOSET." This time he used paint and stencils to make the sign. He remained on task for the full 45 minutes. (See Figure 4-24.)

4-23: **Akeem's first sign**



4-24: **Akeem's next sign**



Mary began to feel that she could engage these second-graders in writing by encouraging them to integrate graphic symbols with words. A few days later, it appeared that this strategy had been successful with Rashaun:

I decided to propose to the students the idea of designing their own game boards. Where will the symbols come from? We will use the ones we have obtained from computer clip art, catalogs of safety signs, packaging signs, etc. My second graders were in the process of beginning to draw plans for their games. Rashaun decided that he didn't want to make a game plan. He chose to write a story. Often, I let him do what pleases him, because it's easier than the challenge of getting him to do what I want him to do.

Of his own accord, he decided to use symbols in his story. As he worked he commented,

I am not going to act silly any more. I am going to listen and be nice to the teacher. I am not going to act crazy either in Ms. Wilson's room (his regular classroom) or Ms. Flores's room.

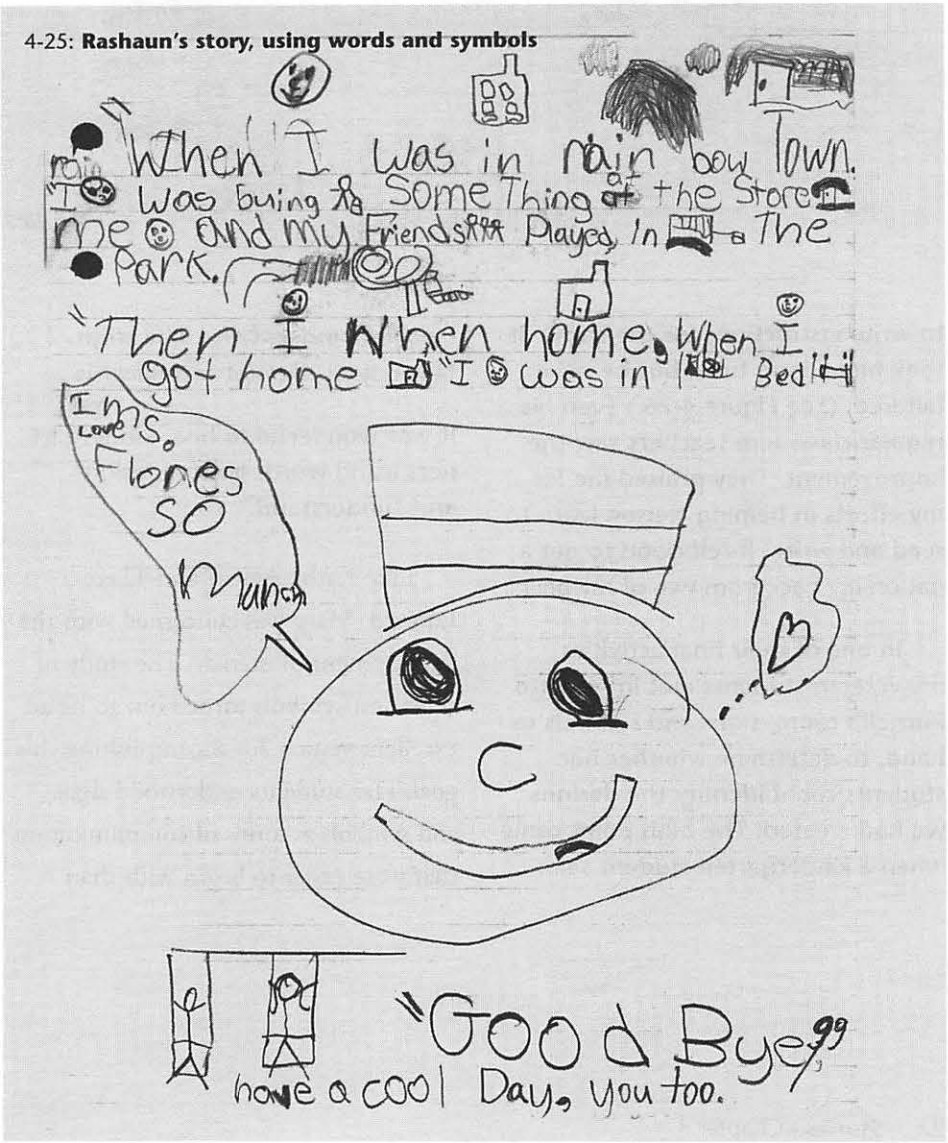
Rashaun is my most difficult child. He has a short attention span, is confrontational and can turn the class upside down. I was pleased with the story he'd created, because it showed me that although he is not always paying attention, something is getting through. I praised his efforts and encouraged him to read his story to the class. (See Figure 4-25.)

Overall, Mary was very pleased with the outcomes of her work on signs and symbols. She felt that this theme had unlocked a great deal of the potential of her special education students, who find traditional reading and writing instruction frustrating. By exposing them to other ways of communicating, they could both use their artistic talents and simultaneously see the value of written language from a different angle.

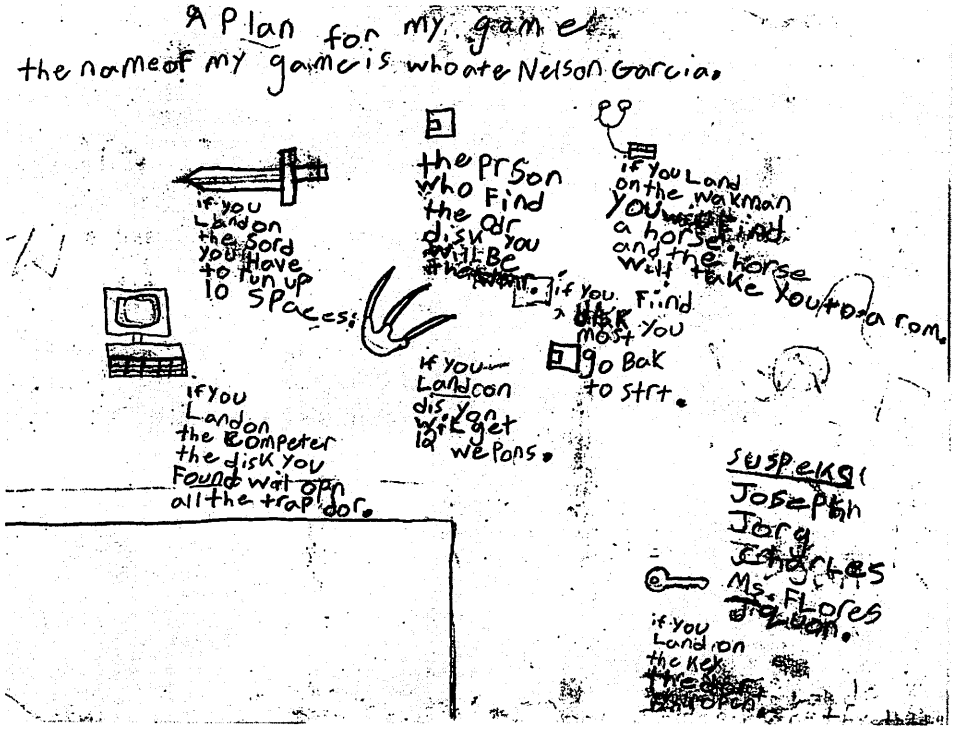
The effects of this unit reached well beyond her Resource Room, as Mary recounts:

My biggest challenge was teaching Luís, a second-grade student who only three months earlier had entered my setting as a virtual non-reader. He was driven by the design of his game, "Who Ate Nelson García?" (Nelson García was another student in his class.) I instructed him

4-25: **Rashaun's story, using words and symbols**



4-26: **Luís's instructions for playing the game "Who Ate Nelson García?"**



to write instructions for the game. It took him a long time, but he never faltered. (See Figure 4-26.) Even his regular classroom teachers saw the improvement. They praised me for my efforts in helping Nelson learn to read and write. It felt good to get a pat on my back from two of my peers.

In one of their final activities, my veteran students met in Annette Purnell's room, signs and symbols in hand, to determine whether her students could identify the designs we had created. The high point came when a kindergarten student said:

I don't understand the sign. I think you should redesign it.

It was wonderful to hear kindergartners using words like "redesign" and "understand."

Like Kathy Aguiar and Theresa Luongo, Mary was concerned with the development of literacy. The study of signs and symbols turned out to be an excellent vehicle for accomplishing this goal. Her students understood signs and symbols as forms of communication that were easier to begin with than written language. Having acquired some experience with signs and symbols, it seemed natural that they would begin to value words as well as graphics. Keisha expressed this point when she said, "You gotta look for the sign. That's why you need to learn how to read." Thus, signs and symbols provided a non-threatening route into the world of written language.

Like Guillermina Montano, Mary wanted her students to understand how signs and symbols can govern behavior. They were able to see that every sign and symbol is created for a purpose, and that it may or may not be effective. When Heriberto said, "Kids don't follow the signs in the school because they think the rules don't apply to them," he was evaluating the signs and finding them wanting. They then went on to create signs that they thought would be effective, particularly with the kindergarten students. These signs provided lessons in literacy for these younger students as well.

Analysis and Design of Signs, Symbols, and Codes

In this section, three upper-elementary-grade teachers describe the units they developed for their students. Felice Piggott, a fourth-grade teacher, and Christine Smith, working with her sixth-grade science class, both engaged their students in designing and testing signs. Felice's students developed signs that signified "DANGER." They then devised innovative ways to test them by posting them around the school and observing people's reactions. Christine gave each group a "secret message," such as "DON'T FALL IN THE HOLE!" or "BE CAREFUL OF THE HOT LIQUID!" They had to design a graphic sign that could convey this message without words. Then they tested these signs by seeing if everyone else could understand them.

This chapter concludes with two signs-and-symbols units Angel Gonzalez developed for two fifth-grade science classes. In the first of these, his students designed hand signals for students to use in the classroom. Angel's second unit begins with the analysis of symbols used in advertisements and product packaging. The students then designed marketing campaigns for snack packages that would be sold for hurricane relief.

How Will We Know If Our "DANGER" Signs Are Effective? *by Felice Piggott*

New York State had just instituted new high-stakes tests for the fourth grade, and Felice had spent most of the year preparing her students for these exams. Once they were over, she wanted to engage them in some activities that would be both educational and fun. She decided to focus on the design of signs and symbols. Felice describes what happened:

I needed to get something going after the sheer drudgery of test preparation. My spirits were low, as were the kids'. So I got them started with signs, and POW!!! The kids were very excited about designing something, and really took the next step independently of me: the notion of testing their designs.

First Session

The warm-up for this activity was a chat about signs:

- **What is the purpose of a sign?**
- **Are all signs the same?**

Here, I elicited the idea that some signs use words and some use symbols.

Next, Felice organized the students into groups and asked each group to come up with an idea for a "DANGER" sign. They had to produce a preliminary sketch and a decision about the sign's shape and colors. Felice writes:

VERY EXCITING! After the kids broke up into groups, the room was buzzing! There was lots of discussion about what the sign should look like:

Felice Piggott teaches fourth grade at P.S. 145 in the Manhattan Valley section of Manhattan. Felice has considerable experience in implementing long-term design projects. For example, her students once redesigned their school cafeteria (see ***Stuff That Works!*** *guide* Designed Environments: Places, Practices, and Plans).

MANDI:
A railroad track with two people and a question mark, like whether they should cross or not...

STEPHANIE:
I'm afraid of dogs, so maybe the sign should be in the shape of a dog. Like, "WATCH OUT!" (for the dog or something).

GABRIEL:
The symbol should be something dangerous, like fire or lightning.

STEPHANIE:
The colors should be blue and black, 'cause that's what will happen to you if you don't watch out!

SHEVAUN:
The symbol should just be a face, like a smiley face, but with the mouth in an "O" shape and the eyes real wide.

MUSTAFA:
The sign should be like an intersection, with a person in the middle, and a car coming.

Second Session

The purpose of this session was for each group to make its sign, with all the group members contributing. The kids got busy. Sign-making went on for an uninterrupted 30 minutes. The kids really didn't ask me to do much except say they were doing the right thing and stay out of their way. As the signs were completed, they were displayed. (See Figure 4-27.) The children IMMEDIATELY began to view each other's work critically:

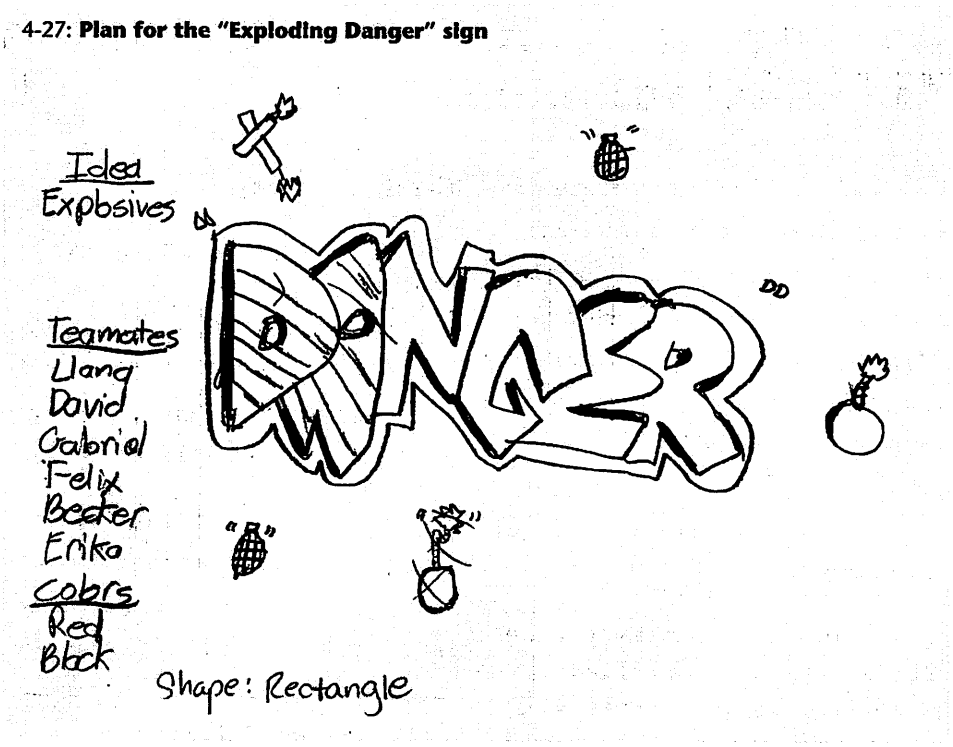
What is THAT? Oh, it's a TRAIN? No, no, it's GOOD, but it takes a while to see that...

As they looked at the signs, this became a natural opportunity to discuss:

- How will we know if our signs are effective?
- How can we test the signs?
- What is an effective test?

Here are some of their ideas:

4-27: **Plan for the "Exploding Danger" sign**



TROY:
Test it on the bathroom door. See if it keeps people out.

ERIKA:
What if someone has to go, really bad?

TROY:
Well, then they'll have to go to another floor, and then we'll know if it is good or not!

GEORGIE:
We could go around and ask some kids what they think it means.

MANDI:
We could take a field trip outside to see if people know what it means. ... strangers, you know?

TROY:
I think we should put it on our classroom door to cut down on all the interruptions. You know, all those kids who ask you to read things, or sign stuff. Maybe it'll keep people out.

TRACEY:
I think you should try it on the teacher bathroom to see if it works on the teachers!

The kids were really into the idea of testing their signs. So, guess what we did next!

Felice did not need to convince the students of the importance of testing their signs, but there was a further step she wanted them to take. They would have to find a way to record the test data. In presenting this challenge, Felice was underlining a key component of a valid test: there has to be a method of presenting the data so others can examine it. Felice introduced this requirement by posing a logistical problem.

Third Session

I explained to the groups that MY dilemma was that I couldn't watch all the teams do their tests. Therefore, I would need a way to know what the groups had done and how people had reacted to their signs. I asked each group to devise a test for their sign and a way to record the data from the test. Each team began to brainstorm ideas for testing and for collecting data. Generally, each group came up with a site for their test and a tally sheet or check-off list to record people's reactions. (See Figure 4-28.)

The "Skull Danger" group originally wanted to test in the teachers' bathrooms, but Tracey objected:

I think the teachers would start to wonder why we were sitting there and would probably scream at us to go back to our room!

After careful consideration, they decided to test it in the boys' and girls' bathrooms. They placed their sign on a closed stall door and stood nearby to observe reactions. This team was the most specific in their test criterion:

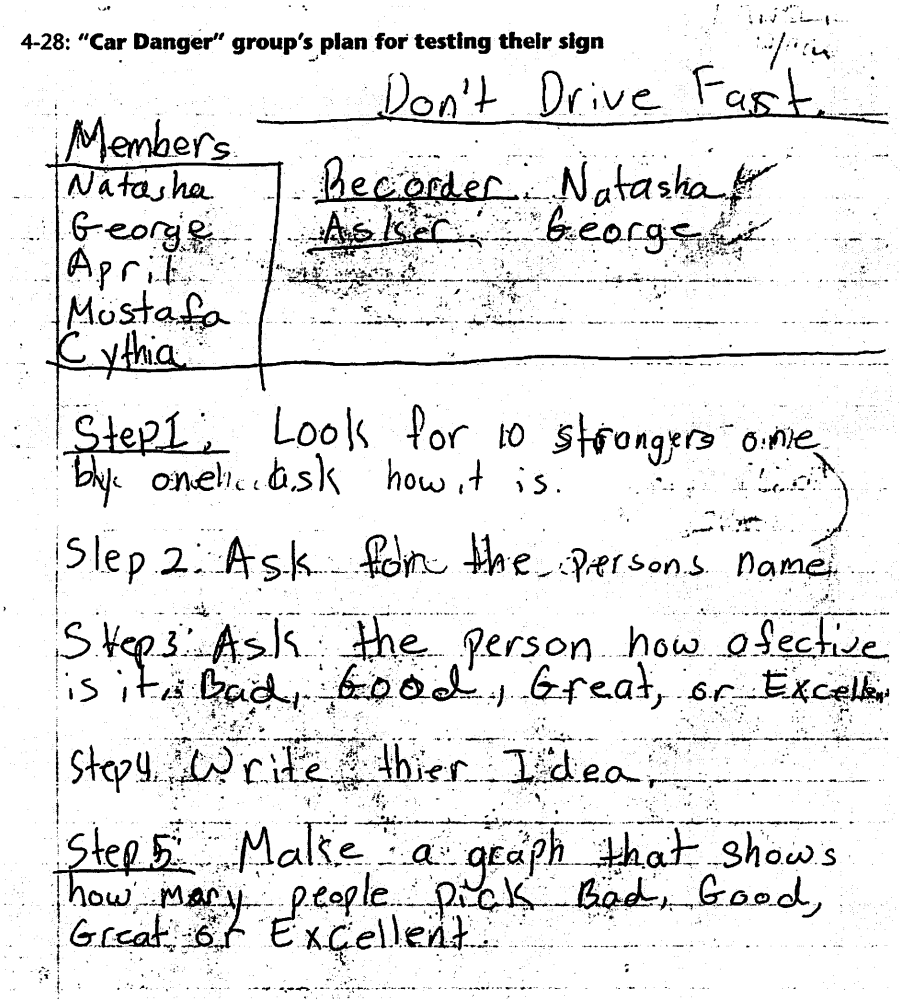
If the sign is effective, then kids won't go in the stall. If it's not, then kids will crawl under the door, and use the stall anyway. That's what they sometimes do when they KNOW they're NOT supposed to go in.

The students were able to plan the tests in considerable detail, before actually performing them. The tests included:

- Asking people what they thought the sign meant;
- Asking people how effective the sign was; and
- Observing whether people actually paid attention to the signs.

In the next session, they actually conducted their tests:

4-28: **"Car Danger" group's plan for testing their sign**



Fourth Session

I received many phone calls from other teachers, who were wondering why my kids were:

- **hiding behind bathroom doors;**
- **scaring children in the halls; or**
- **asking to sit in other classrooms, e.g., to observe across a hall.**

Figure 4-29 shows the data from the "Car Danger" group's survey. In Figure 4-30, the "Skull Danger" group presents the results of its covert observations of whether students "fall for" their sign by not using the toilet. In the final session, Felice's students discussed what had happened during the tests and drew some conclusions. They had a lot to say about other people in the school, about their signs, and even about themselves:

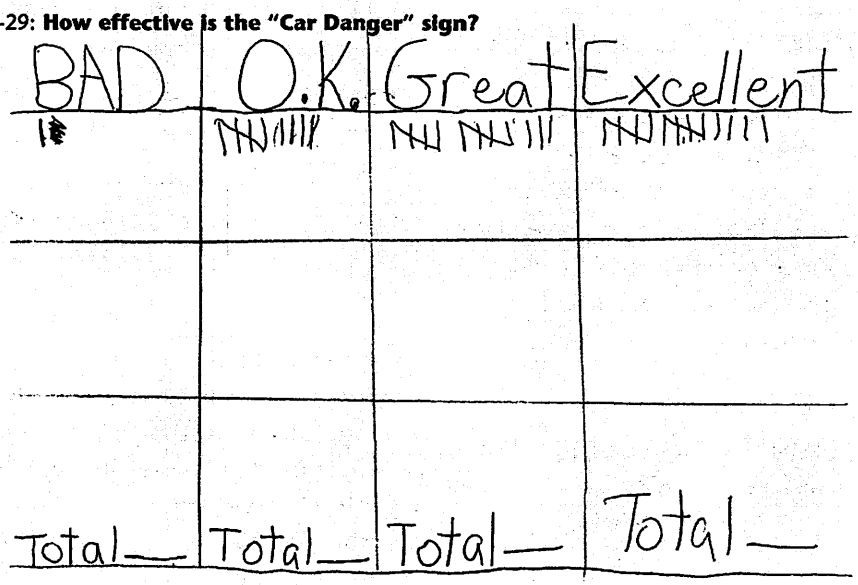
Fifth Session

TEACHER:
What did you learn from the tests?

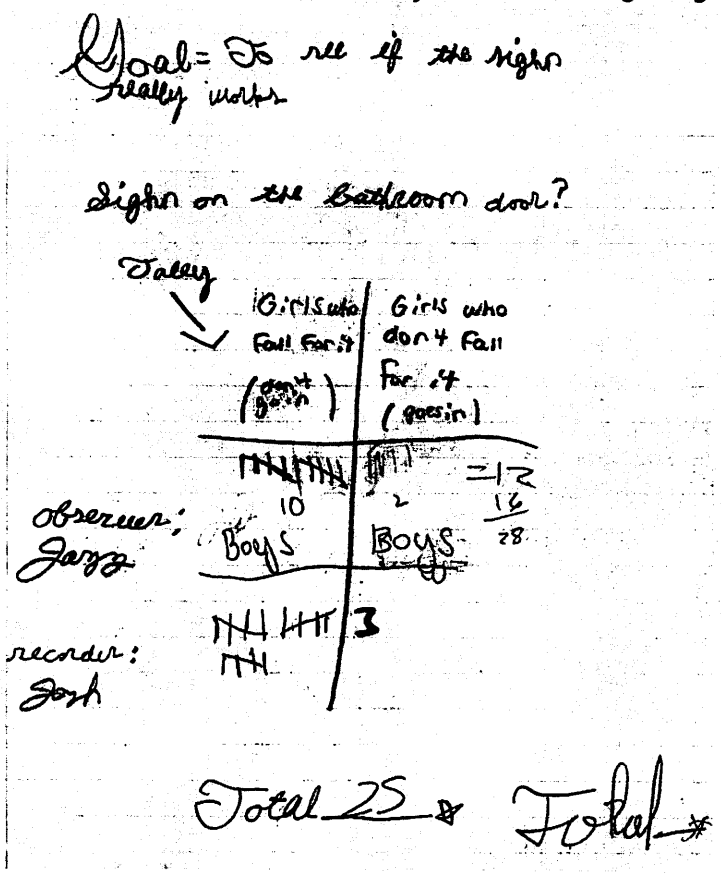
TROY:
... that we probably should have used different colors, because green means "GO," not "DANGER," and our design wasn't good.

GEORGIE:
... that only one team should do the testing, or that we should have discussed it more.

4-29: How effective is the "Car Danger" sign?



4-30: Data from the observation study of the "Skull Danger" sign



GABRIEL:
I think we did a good job, and that our sign was good. It's just that we didn't ask the same people, or that we DID ask the same people. Otherwise, we did good. (Some team members had asked school staff only, while others had asked both staff members and children.)

NATASHA:
I was afraid to ask people, but they were mostly nice about it, helpful. That surprised me.

GEORGIE:
We needed to be more organized with our notes and stuff. (Tally sheets had gotten lost.)

VINCENT:
Most people don't notice things. A lot of people didn't see the sign, even when it was RIGHT THERE!

SHEVAUN:
EVERYBODY on the team needs to contribute. I mean, after the whole test thing, some people on my team were saying, "Well, my idea was better," though they had NO ideas to contribute when we designed the thing!

GEORGIE:
I guess this is what the guy who invented the "STOP" sign went through!

This last comment is very insightful. Georgie realized that every sign is a product of some sort of design-and-test procedure similar to the one they had just done. Felice was very pleased by the outcomes of this activity, although she had some critical reflections of her own:

It's great that kids can devise their own tests, but how can I observe them as they are doing the testing? Obviously, they can work in their groups and record the data, but I wanted to be there too!

How do I get the idea across that testing must be uniform—that all the data should be collected under the same conditions?

How do I stop the testing from degenerating into "tricking someone" or "trying to scare someone"? These things happened with some teams.

If we had more time, I would envision this leading to the next step of redesigning their signs based on the tests.

You Need to Warn People That There Is a Hole in the Ground! *by Christine Smith*

Christine developed a unit on symbols for her most difficult class, a sixth-grade science class. She met with this group for three single periods and one double period per week. With some exceptions, the students in this class were poorly motivated to do work, either in class or at home. A steady influx of new students during the year made matters even worse. She began her work on signs and symbols with a brainstorming session:

Day 1: Brainstorming Signs

I gathered the class together for a brainstorming session on signs. Some of my questions were:

- **What is a sign?**
- **Why do we have signs?**
- **What are some examples of signs?**

The results of the brainstorm really surprised me. The class had great ways of describing signs, and came up with a lot of ideas that I hadn't thought of. Some of their responses were:

EDWIN:
A sign tells you something.

NIORKA:

... tells you what to do.

JOSHUA:
... tells you what you CAN'T do.

LUISA:
... tells you where to go.

HAROLD:
Signs are for communicating.

NIORKA:
A sign is a command someone gives you when they are trying to communicate.

They gave lots of examples of signs, such as "STOP" signs, "NO PARKING" signs, and traffic lights.

I wasn't sure how to classify traffic lights initially, so I asked the class how they are different from "STOP" signs. Someone suggested they are signs that are constantly changing. This was a new category I hadn't thought of. Also, the idea of sign language came up. The class decided that it didn't quite fit in the same category as traffic lights, but we never determined how to categorize hand signals.

Christine Smith was in her second year of teaching science at I.S. 164, a large middle school in the Washington Heights section of Manhattan. There were many behavior problems in her classes, and she saw signs and symbols as a topic that would engage her students.

Christine's students quickly moved from a narrow conception of "sign"—a posted notice using graphic symbols and/or words—to a more general view. Both traffic lights and sign language use visual symbols, just as "STOP" signs and "NO PARKING" signs do. The difference, as one of the students pointed out, is that traffic lights (and sign language) are dynamic rather than static. They generate a sequence of symbols that change over time, while printed or painted signs always show the same thing. This distinction is also one of the major differences between written language, which is usually static, and spoken language, which is dynamic. Christine finished this session with a little game:

The brainstorms and discussion can get tiresome for the students, so I often try to incorporate a game toward the end of class. I asked the students to list as many signs as they could in four minutes. This was fun, because then we went through the answers and students had to cross signs off their lists that other students had too. The person who had the most non-duplicated signs would win the game. We didn't actually finish, but the students really liked it.

Next, Christine wanted her students to make their own sense of the concepts of a "sign" and a "symbol." She introduced this discussion with a fanciful tale about a distant planet:

Day 2 (double period): Definitions and Symbols Game

I told my students: "Pretend I am a visitor from another planet where we do not have signs. Write a definition of 'sign' that will help me understand what it is."

This warm-up activity worked great! Every student understood "sign" well enough to create a definition. Some of them were almost a page in length. As a class, we selected the most important ideas that needed to be incorporated in the definition. One resourceful student took a peek in the dictionary, and that helped too. We settled on the definition of a "sign" as "a piece of metal, wood, or paper, or a gesture, that gives information."

In their written assignments, some students expanded this definition. For example, Gina wrote:

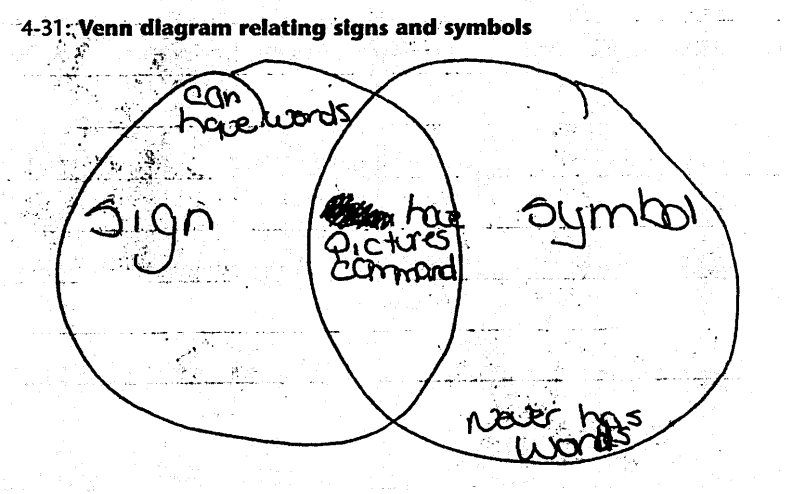
To me, I think a sign is like a warning. It tells you not to bring a pet or it is a red light for cars to stop or it is a green light for cars to go. It says to be quiet in a library.

Christine then had her class consider the meaning of "symbol." Again, she led a brainstorming session. These are some of the characteristics of a "symbol" that they came up with:

* *Drawing words*
* *Symbols never have words*
* *A short way to say something*
* *A picture or drawing that tells a command*

The brainstorms always provide good opportunities for students to share their ideas and participate in class discussions. I've noticed that by writing students' names next to their ideas, I get an overwhelming number of comments, even from students who might otherwise not participate. One student created a Venn diagram showing the relationship between symbols and signs. (See Figure 4-31.) Our definition for "symbol" ended up being: "A picture that stands for or represents something."

4-31: Venn diagram relating signs and symbols



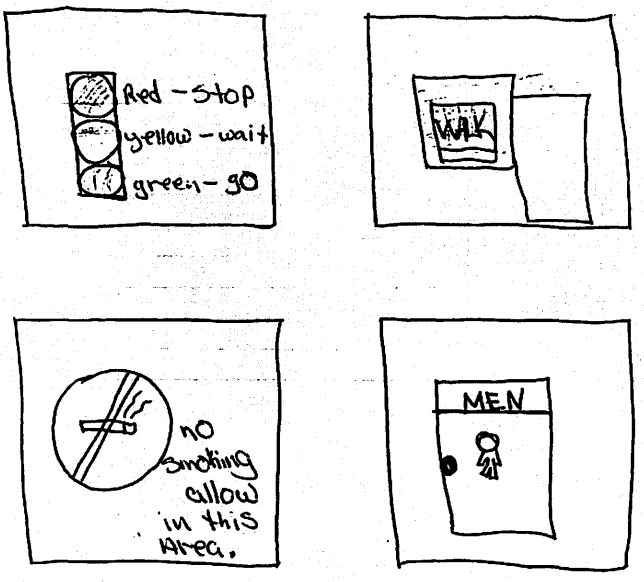
By this point, they were in the middle of a double-period class of about 80 minutes. The students were beginning to get restless, so Christine introduced another symbols game. Her classroom had six rows of six seats each, divided in the middle by a wide aisle. She made all the students on each side of the aisle into a team and challenged each of the two teams to be the first to come up with the meaning of each "mystery symbol." Christine writes:

We made up a symbol guessing game where each team could get a point for being the first to guess the correct message behind a symbol. At first, I drew the symbols on the board, but after the first few, I started having students come up to draw them. The class really seemed to like this activity. I think a large part of it was the excitement of writing on the board. I was surprised at how many symbols they were familiar with!

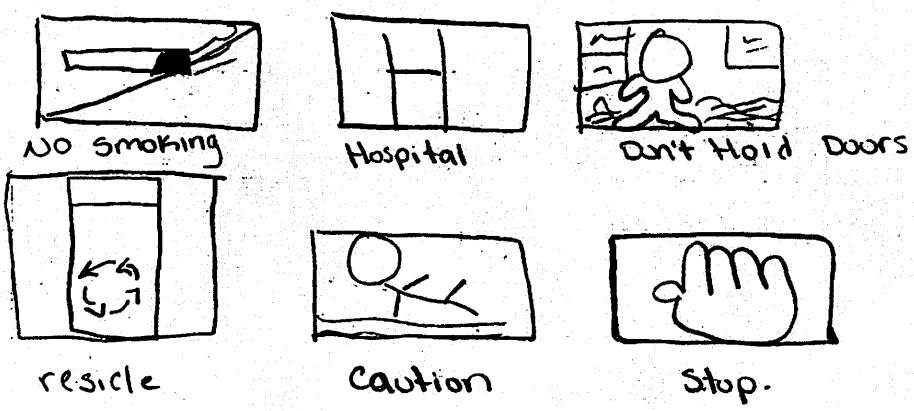
For homework, I asked them to find signs with just words, signs with only symbols, and signs with both words and symbols. (See Figure 4-32.)

Christine had now engaged her students in thinking about what signs and symbols are, how they work and what they mean. The next step was to have them design some. As a warm-up activity, Christine asked them to think of and draw some signs that used no words. An example is shown in Figure 4-33.

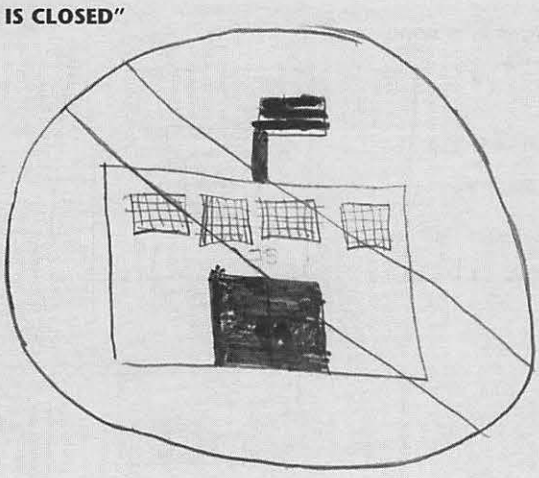
4-32: **Examples of signs and symbols**



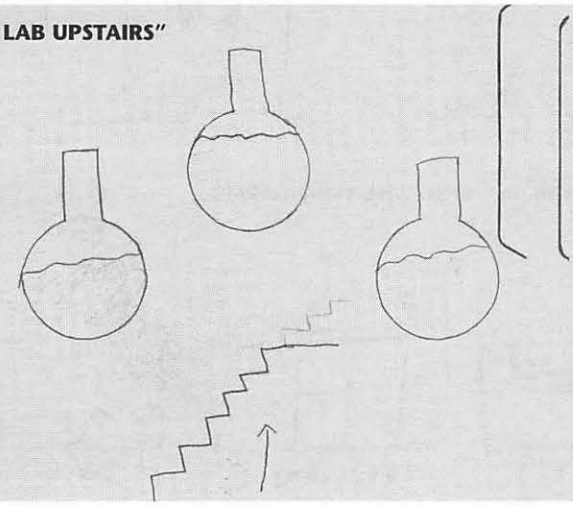
4-33: **Signs that use no words, with explanations**



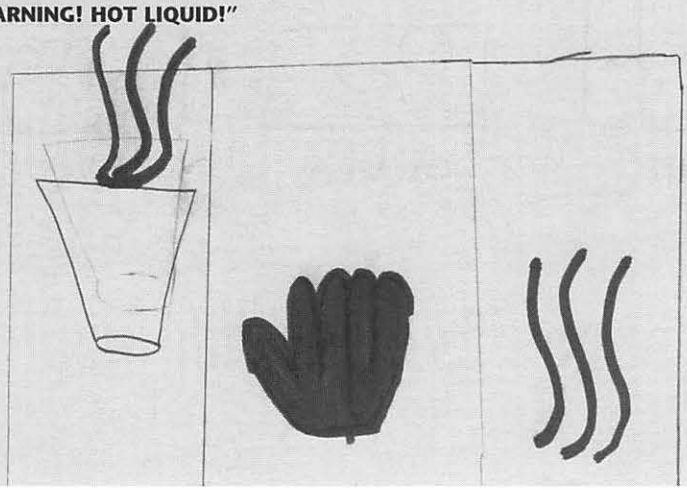
4-34: **"SCHOOL IS CLOSED"**



4-35: **"SCIENCE LAB UPSTAIRS"**



4-36: **"WARNING! HOT LIQUID!"**



Day 3: Creating Signs Without Words

After the warm-up activity, I gave each group an index card with a message on it and told them not to show anyone else their card. They needed to create a sign to tell people this message without using any words. Some of the messages were:

- You want to tell people that school is closed.
- You need to warn people that there is a hole in the ground, so they won't fall in.
- You want to tell people not to shut the shades.
- You want to tell people that the sun is so bright, they should buy sunglasses.
- You want to tell people that the Science Lab is upstairs.
- You want to tell people that they can get the subway downstairs.
- You want to warn people to be careful of a hot liquid, such as cocoa or coffee.

Some samples of the students' work are shown in Figures 4-34, 4-35, and 4-36.

The class really liked this activity, which came off much better than I had expected. Most of the class worked in pairs, but there were a few students who preferred to work on their own. I was surprised by the number of common symbols the students already knew about and incorporated into their signs.

Giancarlo and Joshua had the problem of symbolizing a hole in the road and of warning pedestrians not to fall in. They drew road barriers set up in a square. I was surprised that they thought of that, and even more shocked when the class later translated the sign to mean "DANGER!" Another group drew a price tag with a "$" on it to represent "FOR SALE."

To finish this unit, Christine wanted to do something that would both be fun and provide some closure. Her plan was to have the students try to identify what each sign meant. Like Felice, she also wanted her students to look at the signs critically and to think about how they could be improved. Here is her account:

Day 4: Sign Quiz/Game

Initially, I designed this game as a quiz. Although they had been doing well so far with signs and symbols, they tend to need a lot of structure to get anything accomplished.

I had them number a paper from 1 to 9, the number of signs. I then held up each of their signs from the previous day, one by one, and asked everyone to write down the message they thought the sign was supposed to give. They loved trying to figure out the signs.

Once everyone had written down their answers, we went through them again, and they began to guess out loud. I had been certain that most of the signs would be too confusing for them, but I was wrong. I guess that sixth-grade minds must all be on the same wavelength!

They recognized the flask as representing the Science Lab, sawhorses as symbols for "DANGER," and interpreted the circle on top of a pole as "SUBWAY ENTRANCE."

As we discussed each sign, I raised several questions with them:

- **What is confusing about this sign?**
- **Which symbols make the meaning clear?**
- **What could we do to make the sign easier to understand?**

Everyone was really nice about giving and receiving suggestions for how the signs could be improved. We spent a lot of time talking about the warning sign for hot liquids (Figure 4-36). One of the issues was color. The steam was drawn in blue, and no one figured out what it was. Edwin suggested using red around the cup, to indicate heat. It became clear that color is important in some signs, in helping people to understand the message.

We also had some different ways of representing "NO" or "DON'T DO THIS" in signs. The class picked up on this. Also, they wanted to know:

Are there times when we must use words on a sign to get the message across?

The discussion after the quiz/game was the best opportunity the students had for sharing. When the students' work was presented to the class for critique, they were able to explain the ideas behind the various symbols they had included.

Like Felice Piggott, Christine enabled her students to look at their own and one another's designs critically, and to analyze what parts did and didn't work. However, Christine's class had little experience in doing this kind of evaluation, which made their achievement all the more impressive. One of the most important goals of a design activity should be to foster children's willingness to subject their own work to some sort of objective evaluation. Developing respect for evidence is a major goal in both science and technology education.

In reflecting on this unit, Christine felt that it had been more successful than she had anticipated. Her students had worked together as a group, and many students took their ideas and questions home with them. At the same time, there were some pieces that she felt were lacking. Here is Christine's overall evaluation:

Looking back, the class did a really good job with these activities. They thought a lot, and participated in class discussions more than usual. There were definitely some complaints, along the lines of "What does this have to do with science?" On the whole, though, the students were finally thinking about our class outside of the building. They would come in with stories about interesting or misleading signs, or show me signs they had created themselves. Unfortunately, they sometimes created these signs during a class discussion or other unrelated activity.

I saw positive sides of students who previously had contributed very little. The Quiz/Game Day was the first really fun day we had had as a class in a long time.

The next time I do this activity, I will incorporate graphing as a way of representing how well people understand the signs. I would have liked to have them figure out a way to gather, categorize, and represent the data on the effectiveness of their signs.

Hand Signals for Student Needs

by Angel Gonzalez

Angel Gonzalez is a science specialist at the Family Academy, a public elementary school in Central Harlem, New York City. Angel meets with one class at a time, while their regular teacher has a "prep" period. Often, he tries to collaborate with the regular classroom teachers, so that his lessons will carry over into the rest of the curriculum.

September 9 (the first day of school)

The class had just completed a few hours with their regular teacher, Mr. Johnson, and had begun to review rules and routines. I introduced the topic by asking the class how order, respect, and organization are maintained in a classroom. The students listed various rules. I pointed out that in any situation, people will devise ways of working, living, or playing with each other to prevent chaos and have a happy and productive time together. These methods could be called "social practices."

Eric added that social practices are like demands on people. I agreed, and asked the class to think of organizational problems that they faced in class, and that they could work together to solve. Here is the brainstorming list:

1. Seating arrangements;
2. Students asking to go to the toilet, and thereby disrupting the flow of a story or class discussion;
3. Students talking out of turn;
4. Chaotic class line-ups;
5. Need for more time for fun activities such as gym, recess, and games.

Angel has wisely chosen to begin this unit on the very first day of school, a time when new rules and procedures are being established. He used this occasion to involve the students in a discussion of how rules and procedures are used to govern their behavior. The brainstorming session on social practices set the stage for the signs-and-symbols design project that followed:

September 16

We reviewed the definition of "social practices" and went over the examples we had listed. As a class, we could come up with ways to lessen the disruptions caused by students needing to go to the bathroom. What other needs could lead to disruptions, if students had to ask each time? The class made the following list of issues, which could result in a student disrupting the class:

* *Wanting water to drink;*
* *Needing to sharpen one's pencil;*
* *Having to go to the Office;*
* *Needing to use the bathroom.*

I asked each individual to write down their ideas for solving these problems. I then divided the students into groups of three or four, and had the students share their ideas within each group. Each group then had to present its best solution to the class.

The overwhelming consensus was that we should devise signals to communicate these needs without speaking. We discussed how the signals could be made by the hands, by any other part of the body, or in any other way. I asked for other uses of signals made with the hands or body. They came up with examples from baseball:

* *The catcher signals the pitcher;*
* *The umpire makes a signal that means, "You're out!"*
* *The umpire has another signal that says, "Safe!"*

In looking for solutions to the classroom interruption problem, Angel's students recognized that they would have to come up with a means of silent communication. What techniques could they use? Drawings and graphic images can communicate without sound, but these would have to be drawn each time or kept handy for use when needed. A simpler solution is to use one's own body to make the signals.

The teams met again to devise their codes. As an assignment, I asked them to refine their ideas, and to come back ready to write them down. We would have to figure out how to select the best ideas.

September 23 & 24

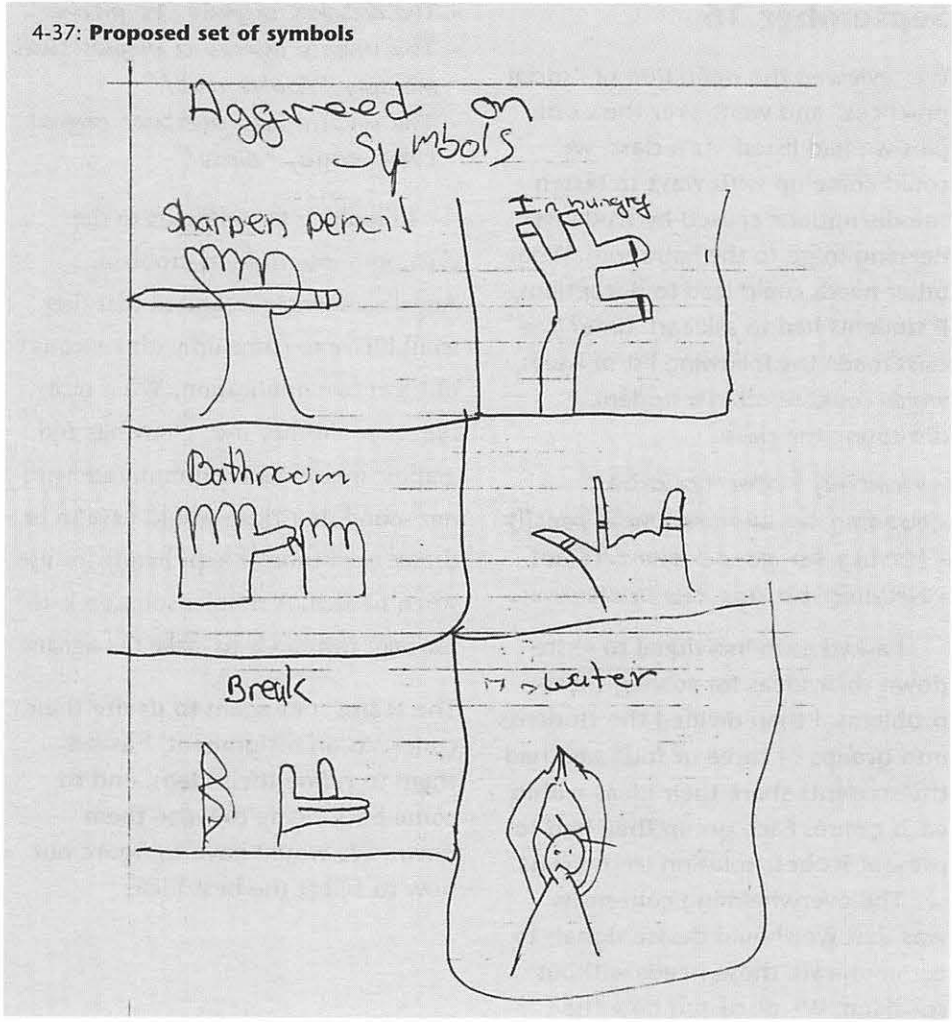
Each team proposed signals to be used for six different messages. (See Figure 4-37.) Only one set of symbols could be tested. We decided that we would vote on all of the groups' proposals for each symbol by a show of hands. The process of voting was tedious but productive. We decided in a fair way, and everyone's ideas were considered and respected.

After we had decided exactly which hand signals would be tested, I asked each team to take one of the signals and make a few drawings of it. (See Figure 4-38.)

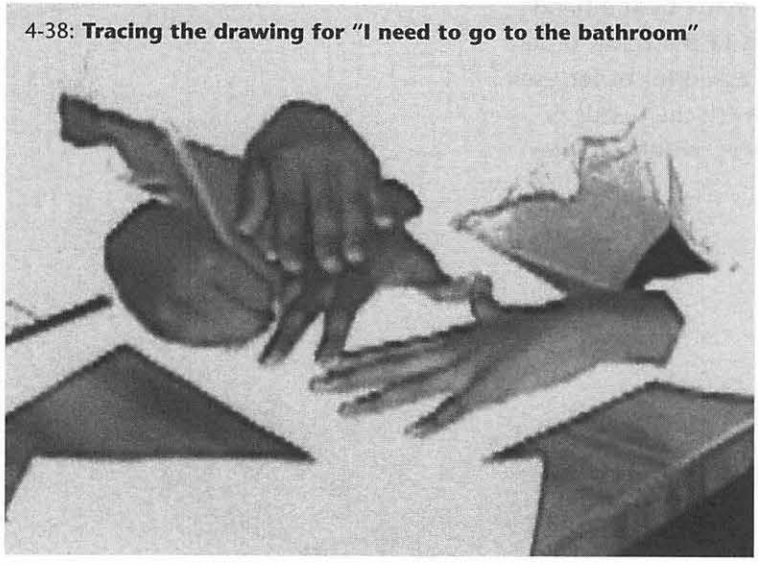
The students had an important stake in selecting the designs to be tested. Not only would they be using these signals themselves, but also the signals would eventually be introduced throughout the school. It was essential that everyone's voice be heard and that the decisions be made in the fairest possible way.

Once the decisions had been made, the students faced another design problem: How would they inform everyone about the new hand signals? They decided to have each group make its own drawings of the six hand signals and to empower a committee to select the best ones.

4-37: **Proposed set of symbols**



4-38: **Tracing the drawing for "I need to go to the bathroom"**



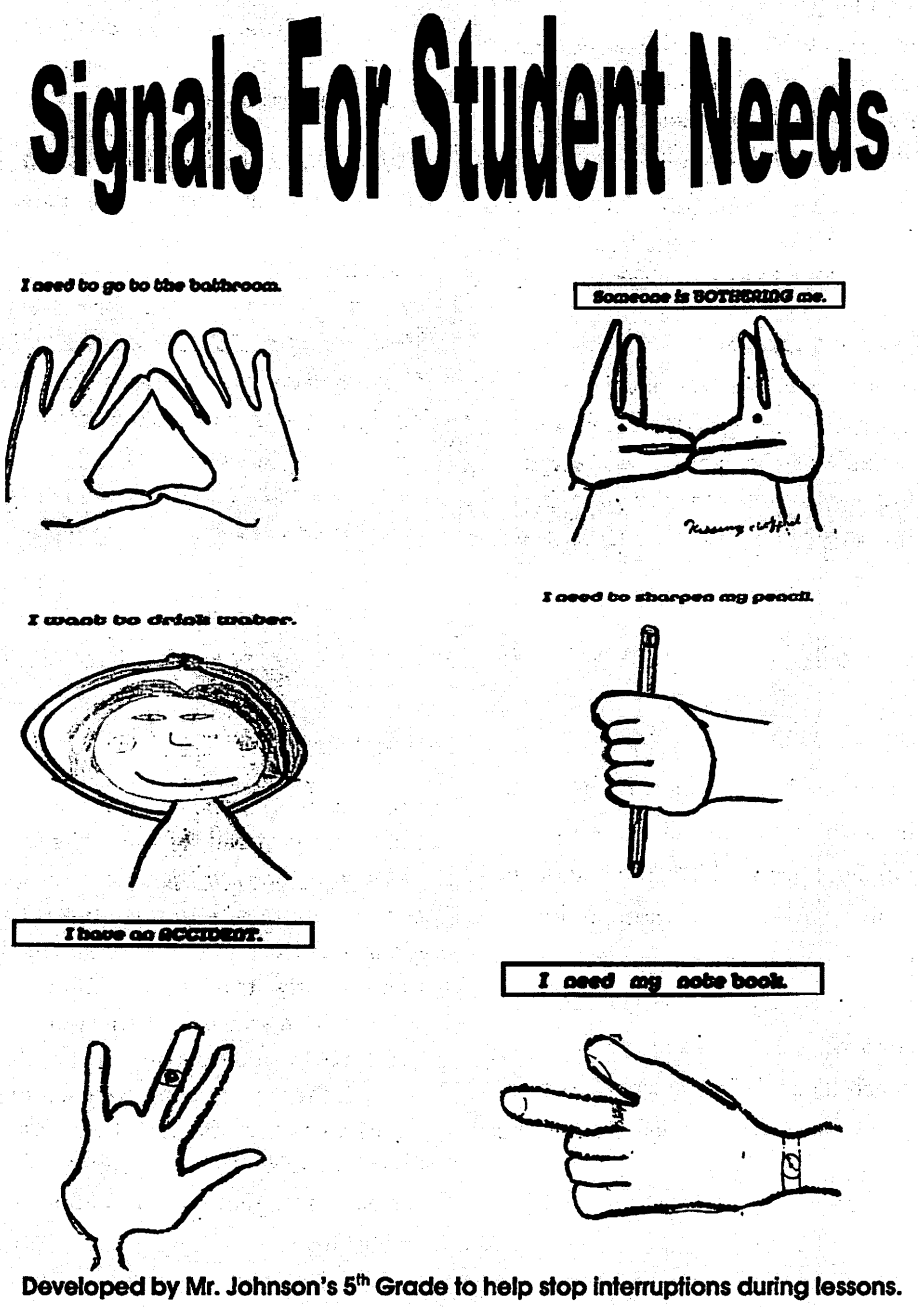
October 1

Today, the teams finished their drawings. We had an adequate number of drawings of each hand signal. During lunch period, a committee of seven students met and made the final selection for each one. I suggested that they pick the one that demonstrated how to make the signal most clearly.

After the selections had been made, I had the students trace the drawings with a marker, to improve their legibility when photocopied. Some had to be reduced, while others had to be enlarged. I typed the meaning of each symbol, and let them choose the font. (See Figure 4-39.) Then the committee photocopied the key and gave them to Mr. Johnson to begin using them. His class would pilot-test them. He agreed to introduce them one at a time until they were all learned.

For homework, Angel asked the students to discuss the evaluation of the symbols and reflect on the process of designing them:

4-39: **Key to hand signals**



1. How will we know if the signals are successful?

SOPHIE:
Because if we could make new signals, then all kids in the Family Academy and all people would love it.

* Students will (use the) signals.
* There'll be less interruptions.
* Adults will know what they mean.

CHRISTOPHER:
First we will know by trying it on the first grade. Then we come back a couple of days later and we see how the signals are working. If the signals work then we go to every other class, and see if it works there. If it doesn't work then we come back to Science. The committee would pick some more signs. Then we do that all over again.

2. What are your feelings and reflections about our work with signals?

SOPHIE:
We had fun and I felt good when just us the 5th grade made the first grade try to learn how to make signals when they grow up. They already are starting to learn how to do it. ...When Mr. Angel told us that they were learning how to do it, I was so excited because (of) all the hard work to make them.

STEPHANIE:
I think it (is) fun when you do that and it (is) fun when you vote... Some of the signals are not right, and I think we should have a vote on the signals again so we can know which one is good. We should try the signals first before putting it around the room.... If interruptions are what we talk about, maybe other people in the world can learn signals.

Design Your Own Brand! *by Angel Gonzalez*

Working with another fifth-grade class, Angel developed an activity that explores how symbols often work covertly to influence people. He had his students analyze advertisements and product packaging for symbols and hidden messages. They then designed their own advertising campaigns for snack packages, which they sold in the school to raise funds for hurricane relief. Here is Angel's account:

September 28

I provided Ms. Harris's class with a bulk supply of snack foods. These were to be sold to the rest of the school community to raise funds for victims of Hurricane Georges, which had recently struck the Caribbean.

The idea was to put the snack products in small plastic bags and market them as though they came in a variety of brands. Each team would have to design its own brand and develop a marketing campaign for selling it.

I divided the class into teams of four to six each and explained that the mission of each team would be to sell the largest quantity of a particular type of snack. They would have to compete with the other teams by creating advertising messages that would influence students to buy their brand.

After I presented this idea of marketing snacks, the students asked if they could actually taste the snacks that they would be trying to sell. Of course, I agreed wholeheartedly, saying that one could not market something without trying it first.

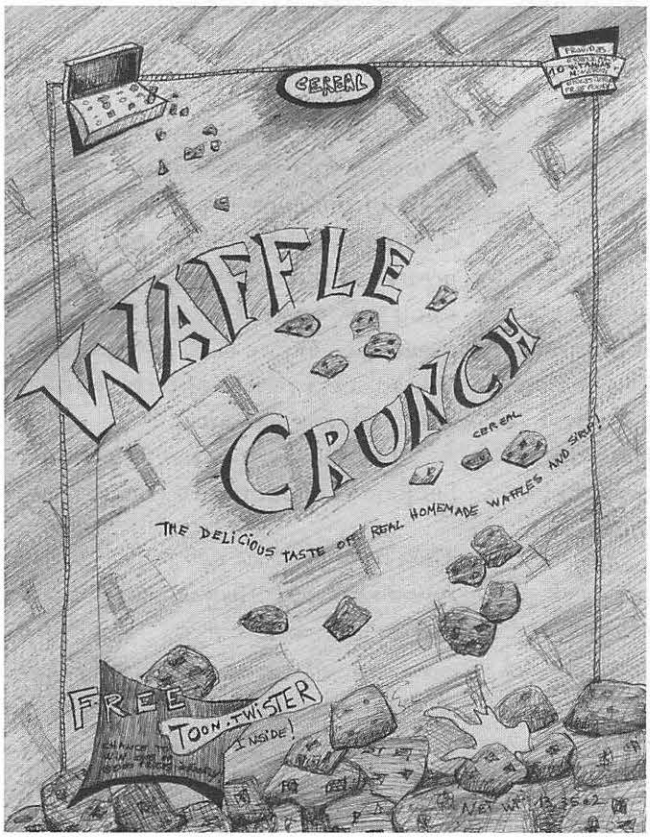
In order to create their own ads, they would first have to study how advertising gimmicks work to convince children to buy one brand of a product instead of another. I presented them with copies of the front of a cereal box (Figure 4-40) and the "Analyze an Ad" worksheet (Figure 4-41).

After our initial meeting, I showed each of the teams the original box cover so they could scrutinize it up close. After the teams wrote their individual and group analyses in their journals, the team representatives shared the following observations:

- The ad targets children.
- The basic colors were yellow, brown, red, black, white and silver. Some people found them to be attractive, while others thought they were ugly.
- Gregory noticed that all of the elements of the ad were placed against the background of a giant waffle.
- The box cover creates an illusion of motion by the use of curves in the wording, and the little waffles emerging from a waffle maker at the top. These waffles become larger and larger until they plop into the bowl at the bottom.

I told them that we would be analyzing more ads and TV commercials to give us more ideas for symbols we might use to design the various brands of snacks. I explained that about half the teams would have "cheese curls" to sell and the other half would have "animal crackers."

4-40: **Cereal box cover**



4-41: **"Analyze an Ad" worksheet**

Analyze An Ad

Take an ad. Study the ad. First alone and then as a team, answer the following questions:

- What is the name of the product?
- What is being sold?
- Who are they trying to get to buy the product?
- How are colors, shapes, or words used?
- What makes this ad appealing?
- How are people, places, or things used in the ad?
- Do you like the name of the product? Why or why not?
- What ideas would you use for your ad?
- How is the background used?

For homework, I asked them to look at the covers of any food packages to get ideas for marketing their own brands. The session ended with lots of interest and enthusiasm.

September 29

I presented the class with a few videotaped TV commercials from Saturday morning cartoon programming. The ads featured dolls, action figures, toy weapons, and candy. I asked the students to analyze these commercials in the same way they had examined the cereal box cover. They pointed out the following:

* *The TV ads depicted happy children and exciting action to obtain the viewers' interest.*
* *They made fake things (such as dolls and toys) look real.*
* *They showed dolls doing things that only real people can do.*
* *The candy ads used animation to make the candy seem to come alive.*

Unfortunately, student disruptions caused an early end to this discussion.

October 5

Today the class behaved a lot better. We were able to analyze magazine ads for clothing, cosmetics, and cars, as well as more cereal boxes. I used some of these items to decorate a classroom bulletin board. Each group presented their analysis of one ad using the "Analyze an Ad" worksheet. (See Figure 4-41.) They were able to see a variety of techniques and intended audiences.

Charmaine wrote the following in her journal about the TV commercials:

They're trying to sell a doll called Amazing Amy. They want us to buy it 'cause it talks. They show oatmeal with dinosaurs and eggs so you would buy (the oatmeal). ...They show Betty Spaghetti come apart and stuff but sometimes it doesn't really do that.

Angel felt that the time had come for them to create their own ads. By looking at TV and magazine ads and cereal boxes, they had gathered many ideas, which they could now incorporate into their own designs. Creating their own marketing campaigns would make them even more aware of how advertisers use hidden symbols for persuasion.

October 6

I explained that each team would have about 20 zip-lock bags of snacks to sell. They will use their ads as labels for these packages. They can also make larger versions to post around the school. I limited the colors of these ads to black, white, and gray, which are the only colors that could be photocopied. It would have been too time-consuming to color each of 20 or more copies by hand.

To start with, I asked the class to make a list of items that would be essential to include in their ads. They came up with the following ideas:

1. *Graphics, which could include cartoons, pictures, etc.*
2. *Brand name*
3. *Company name*
4. *Talk about the product, possibly including jingles, in clear-cut language*
5. *Action*
6. *Logo*
7. *Offering "freebies"*

I assigned three groups to promote "animal crackers" and the other three groups to design campaigns for "cheese curls." The groups worked well and became excited about the task, especially after receiving samples of their products for tasting. The three "animal crackers" teams made up the following brand names:

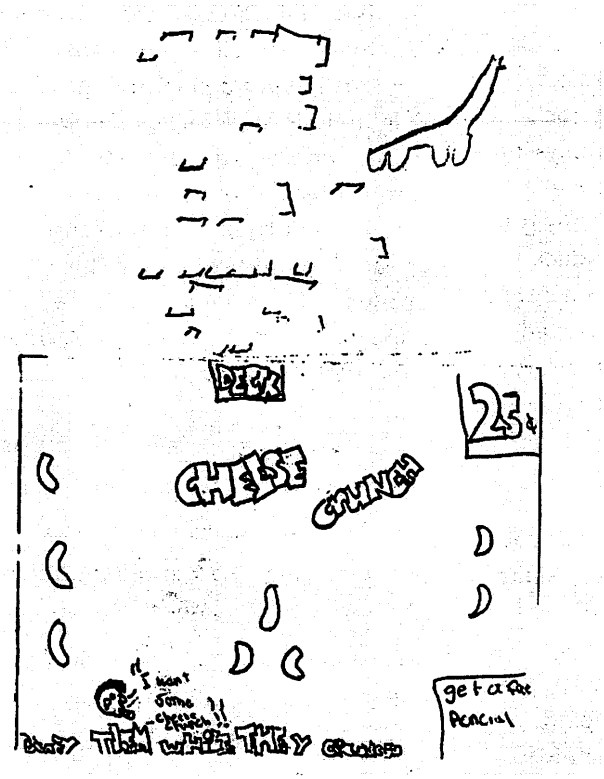
1. NTZD Chocolate Factory
2. KGLD Harlem World Crackers
3. McCoy's Bakery

The teams selling "cheese curls" selected these names:

1. DECK Cheese Crunch (see Figure 4-42)
2. Pirate Girls Cheese Logs (see Figure 4-43)
3. Wolf Pack

As I rotated among the teams, I suggested that they darken their sketches and lettering so they would stand out better when photocopied. At the end of the class, I collected their drafts and agreed to photocopy them, so they could see what the copies would look like, before making them final. At lunchtime, a committee helped to copy the ads, finalize the brand labels, cut them out, and organize them for packaging.

4-42: **DECK Cheese Crunch**



4-43: **The Pirate Girls Brand**

October 15

Another committee volunteered to pack snacks of equal amounts, plus the proper labels, in the zip-lock bags. It was a tedious assembly-line process, but the children really enjoyed it, especially since they got to keep broken or leftover snack pieces. The idea of having lunchtime committees has worked very well, because these tasks are difficult to manage with the whole class.

October 19

We now have about 20 bags of each brand of cheese curls and the same amount of each brand of animal crackers. All the bags have equal amounts of snack food. Each bag has a 4 1/4" by 5 1/2" photocopied brand label in it. This size allowed four labels to be copied on one sheet of standard-sized paper. The bags will be sold for 25 cents each.

The class brainstormed and defined the tasks that needed to be done to prepare for the sale. Many students were preoccupied with their brand labels and wanted to continue working on them. As Didi said, "What can you do to make people buy your brand? How can we change people's minds?" Some students wanted to improve on their ads by putting in prizes, fixing up their graphics, or adding coupons.

I expressed sympathy with their concerns, but stressed that our goal was to see what influences kids towards buying a particular product. Our analysis and conclusions would help us improve our advertising campaigns in the future. I was pleased that they were thinking critically about how to sell their products. These ideas would be important in our evaluation of what worked well and what did not.

Some students saw the activity as a competition whose purpose was to see who could sell the most snack packages. Angel had to remind them that the goal of the project was to learn about how symbols work in selling a product. A competitive atmosphere can easily obscure the educational goals of an activity.

We developed some questions to guide us in developing a plan for the sale and for collecting data:

* How can we find out why someone bought one brand instead of another?
* How will we be fair to all brands?
* How will the snacks be displayed on the table for sale?
* What records will we keep?
* What information do we need from the buyer? What should we ask them?
* Who will do the selling?
* Who will question the buyers?

Each of the teams discussed these questions among themselves, and then shared their ideas with the class.

We made the following decisions:

1. Only 3 or 4 of Ms. Harris's students will be selling at any one time.
2. Only one package of each brand will be displayed at any one time.
3. The brand names will be placed in alphabetical order.
4. Only one type of snack (animal crackers or cheese curls) will be sold at any one time, to make it easier to collect data.
5. Only one student will be allowed to go shopping at any one time.
6. After each sale, the buyer will be asked, "Why did you choose that brand over the others?" All data will be recorded.
7. One person will collect money and keep a record of the amount collected.
8. We will keep a tally of the number of packages sold of each brand.
9. Buyers will not know the purpose of the study. They will be told only that the proceeds will go to victims of Hurricane Georges.

On October 21, the snack sales took place. All of the students who bought the snacks came from the fourth-grade classes. As one of Ms. Harris's fifth-graders was making the sale, another was taking data. On the data form, the recorder wrote down the name and grade of the buyer, the brand they selected, and the reason they gave for their choice. (See Figure 4-44.) The recorder also kept a tally sheet showing the number of bags sold of each brand. (See Figure 4-45.)

4-44: **Data form**

Science Study Snack Sale

Interviewer's Name _____
Date Oct 21st Teacher Ms. Fox

Name of Buyer/ grade	Brand Bought	Why Picked This Brand?
Garry Ba... 4th	DECK 1	He don't know.
Eric ... 4th	Wolf Pack 1	Wanted to try it out.
Steven ... 4th	Wolf Pack 2	He likes the Wrestling team.
Janet ... 4th	Wolf Pack 3	just Picked it
Keisha 4th	DECK 2	Because it's Crunchie!
Davon 4th	Wolf Pack 4	Likes Advertisement
Richelle 4th	Wolf Pack 5	Because she likes the name
Roger 4th	Deck 3	He likes it.
Justina 4th	Deck 4	Because it her favorite
Octavia 4th	Wolf Pack 6	She can eat it for lunch.

4-45: **Tally sheet**

Ms. Harris' Class Snack Sale & Study

Tally of Cheese Curls Bags Sold

Pirate Girls Logs	Wolf Pack	Deck Cheese Crunch
𝍸 𝍸 ||||	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||	𝍸 𝍸 |||
Total 9	Total 27	Total 7

October 26

I guided them through the analysis of the data. They produced a lot of work and then shared their findings. To assist them in interpreting the information gathered from the sale, I distributed a worksheet. (See Figure 4-46.)

Questions #1 through #5 on the worksheet asked students to summarize the data from the survey forms and tally sheets, which they were generally able to do correctly. Questions #6 and #7, and #9 through #11 were not well understood by the students. Evidently, considerably more discussion would have been needed to clarify the meaning and intent of these questions. With this particular class, Angel felt that he had gone about as far as he could, because the work was already "too abstract for many."

Question #8 was the most interesting. This question separated potential audiences according to their age groups. Kendra explained how she thought each group would respond to the brands her class had created:

4-46: **Data analysis worksheet**

Different Brands Snack Sale

Data Analysis Guide

a. Study the tally and interview sheets.
b. Answer these questions as best as you can.
c. Graph your data. Can you graph tallies for each gender?
d. What questions do you have and what are your answers, if any?

Questions:

1. What were the total sales for each brand?
2. Which brand sold the most? ... the least?
3. How many children in total bought that type of snack (e.g., cheese curls)?
4. Did the boys prefer one brand over the others?
5. Did the girls prefer one brand over the others?
6. What other information would be helpful in analyzing your data?
7. Do you think we needed to sell to more students to get a better picture of what influences them to buy a brand?
8. Do you think grown-ups would buy the same pattern as the fourth-graders did? How about teenagers? How about first-graders?
9. What conclusions can you make about your data?
10. What would you do differently in the future?
11. If you were trying to sell more snacks to fourth-graders, how would you advertise to them in the future? What about the other age groups? Gender groups?

Grown-ups: Yes, because they like the name brands.

Teenagers: Definitely they will buy it, because it's between the Wolf Pack (a popular wrestling team) and the Pirate Girls.

First-graders: (They) may not know because they don't pay attention to see what brand they'll pick.

Angel's students saw how characters from popular culture can be used to sell products. By selling exactly the same product under different brand names, they became aware of how advertisers manipulate consumers. Ads and commercials use symbols and personalities that are familiar to the public to trick them into thinking that one brand is better than another, when in fact they are identical. Angel's students also saw that these symbols are more effective with some audiences than with others. "Wolf Pack," for example, would not have the same appeal to adults or first-graders as it did for fourth-graders and teenagers. This is an example of how the context affects the usefulness of a symbol.

Angel's students did their own summary and evaluation of the project:

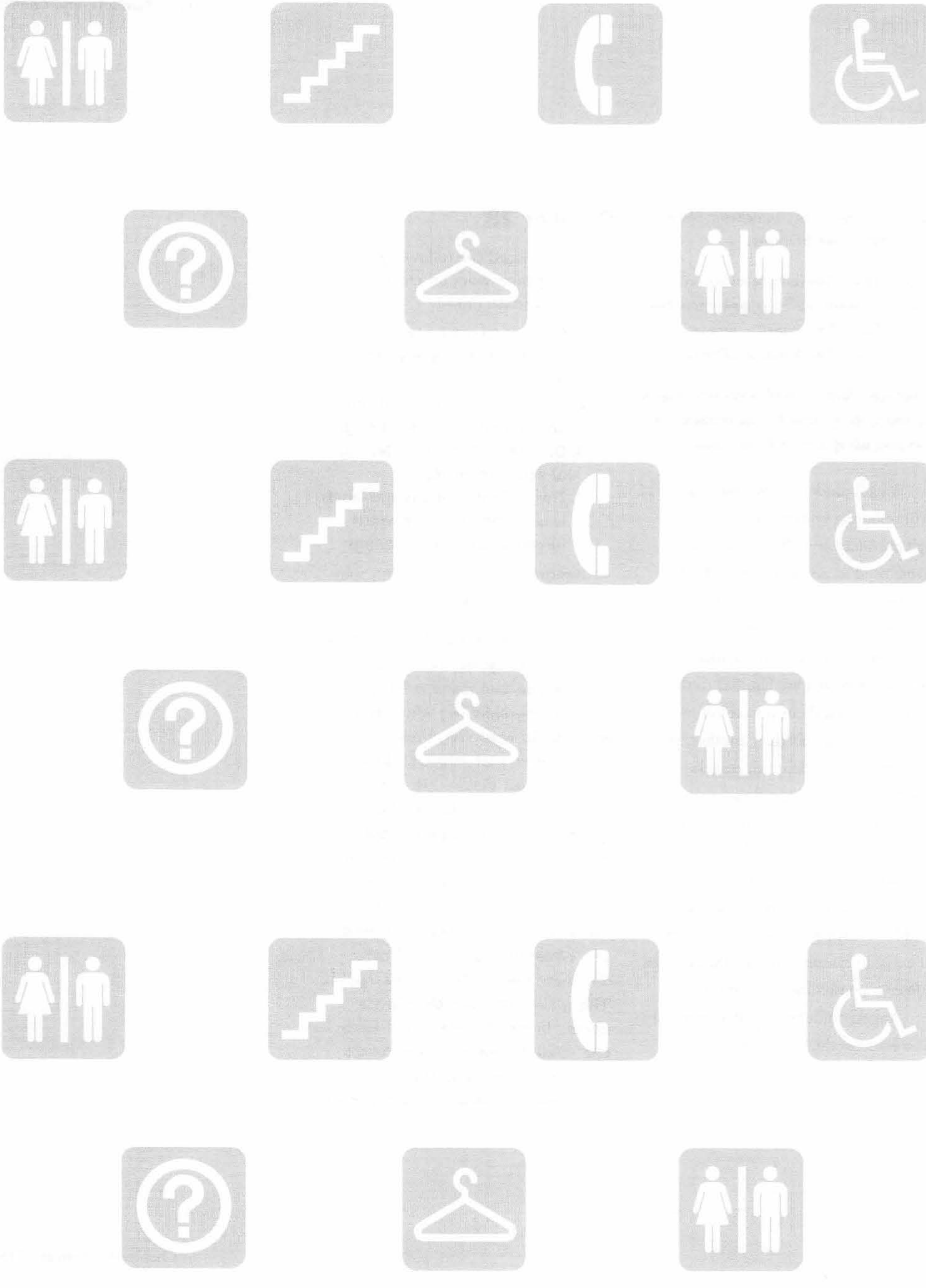
October 28

The class shared the following ideas regarding their work on creating and marketing snack brands:

1. **One has to put oneself in the minds of the people you are selling to.**
2. **One needs to use lots of color and animation in advertising.**
3. **One needs to create a feeling of action in an ad.**
4. **The designing of ads and labels was a brain-stretcher which forced us to think of sayings.**

Kendra wrote the following summary of the project:

The class analyzed the products that we are going to sell. My team made the name of the product by thinking what name will fit. It was fun, because we could make pictures of the name that we had picked. It was hard, because you had to analyze the graphing of how many people picked which ones they like. Also you can use tally marks to help you. The total sales are forty-three in all. The boys preferred the Wrestling over the Pirate Girls or the DECK cheese curls. The girls preferred the Pirate Girls. In the future, I will keep the name brand of my product, so when I grow up, the people will know my product is famous.



Chapter 5

RESOURCES

Help for Teachers

Making Connections with Literature

Using literature as a supplement and enhancement for instruction is good teaching practice because:

- Children learn from everything they experience.
- Children learn more effectively when instruction is associated with positive emotions, such as those evoked by a good book.
- Literacy is key to children's success as learners.
- There are many different learning styles.

We encourage you to incorporate books of all kinds into your work with *Signs, Symbols, and Codes.* We've included an annotated list of quality books on the following pages. They include storybooks that demonstrate the benefits of understanding and using signs and symbols; and nonfiction books on how signs and symbols play multiple roles in our daily lives.

But don't stop with these. You know your students and you know better than anyone else how they learn. When you see a book that might further your instructional goals, interest or challenge a particular student, or evoke feelings that make learning more fun, add it to the books that are available to your students.

Alvin's Secret Code, by Clifford B. Hicks. Penguin Putnam Books for Young Readers: New York 1998.
(Recommended grades: 3-6)

Twelve-year-old Alvin and his best friend Shoie use their knowledge of codes and ciphers to solve a dangerous mystery.

Angela's Top-Secret Computer Club, by Holly Keller. Greenwillow Books: New York, 1998.
(Recommended grades: 2-6)

Angela and her friends in the top-secret Computer Club use their knowledge of computers, codes, and e-mail, to discover who is causing all the problems with the school computer.

A Caribou Alphabet, by Mary Beth Owens. Farrar, Straus & Giroux: Brunswick, ME, 1990.
(Recommended grades: K-3)

This innovative alphabet book, inspired by the Maine Caribou Transport Project, captures the beautiful world of the caribou, from "A" for antlers to "Z" for below-zero weather.

The Case of the Backyard Treasure, by Joanne Rocklin. Scholastic, Inc.: New York, 1998.
(Recommended grades: 2-5)

Liz the Whiz and her younger brother use codes, a chart, and a map of the backyard, to solve Zack's mystery.

The Case of the Mysterious Codes, by John F. Warner and Peggy Nicholson. The Lerner Publishing Group: Minneapolis, MN, 1994. (Recommended grades: 3-6)

"The Casecrackers," an ethnically diverse group of children, solve mysteries in and around Newport, Rhode Island. These sharp young detectives use logical deductions and powers of observation to get to the bottom of things.

Diadem – Book of Signs, by John Peel. Scholastic, Inc.: New York, 1997.
(Recommended grades: 4-6)

This is the incredible story of the adventures of Score, Renald, and Pixel on the planet Rawn. There are codes, mysterious symbols, and suspense, as the trio track down a magician who can change both shape and form.

Garrett Morgan, Inventor, by Garnet N. Jackson. Modern Curriculum: Cleveland, 1992.
(Recommended grades: K-4)

A brief biography of the African American inventor. It describes in rhyming text how his lifelong interest in machines led to the invention of the traffic signal.

Handtalk School, by Mary B. Miller. Simon & Schuster Children's Books: New York, 1991.
(Recommended grades: K-5)

Words and sign language depict a group of students involved in putting on a Thanksgiving play at a school for hearing impaired children.

The House of Dies Drear, by Virginia Hamilton. Macmillan Publishing: New York, 1984.
(Recommended grades: 6 and up)

A black family tries to unravel the secrets of their new home, which was once a stop on the Underground Railroad. The signs, symbols, and codes, and the figurative language, make this an exciting book to read.

I Have a Sister—My Sister Is Deaf, by Jeanne Whitehouse. HarperCollins Children's Books: New York, 1984.
(Recommend grades K-3)

Using only her face and shoulders, she says things that many people cannot say with words. She reads people's expressions to learn things she cannot hear.

Indian Signals and Sign Language, by George Fronval. Random House Publishing: New York, 1985.
(Recommended grades: All)

Full-color photographs and text describe nonverbal symbols used by the Native Americans of the Great Plains. The book includes more than 800 signs, smoke signals, picture writing, and the language of feathers and body paint.

I Read Signs, by Tana Hoban. William Morrow & Co.: New York, 1987.
(Recommended grades: PreK-2)

Uses photos to introduce signs and symbols frequently seen along the street. Young children recognize these words long before they are taught to read.

I Read Symbols, by Tana Hoban. Greenwillow Books: New York, 1996.
(Recommended grades: PreK-2)

Symbols are everywhere, and children don't need to read to understand this universal language. This book depicts many signs and symbols frequently seen along the highway.

I See a Sign, by Lars Klove. Simon & Schuster Children's Books: New York, 1996.
(Recommended grades: K-4)

WALK. STOP. ONE WAY. These are often the first words that children learn to read on their own. This book features full-color photos of the signs, and simply written text.

Jessi's Secret Language (The Baby-Sitters Club Series #16), by Ann M. Martin. Scholastic, Inc.: New York, 1996.
(Recommended grades: 4-6)

As the only African American in her sixth grade class, Jessi gains a sense of belonging by participating in the Baby-Sitters Club. She learns sign language in order to communicate with a hearing impaired child.

Maps and Symbols, by Angela Royston. Raintree Steck Vaughn Publishers: Austin, TX, 1999.
(Recommended grades: 2-6 and teacher reference)

This book tells all about maps and explains how mapmakers use symbols to pack in all kinds of information.

Marshal Matt and the Case of the Secret Code, by Nancy I. Sanders. Concordia Publishing House, 1997.
(Recommended grades: K-3)

Janie loses her new gloves while sleigh riding with her friends. Marshall Matt and Janie then go on an all-out search for Janie's new gloves. Together they find plenty of secret code messages, clues, and confusion!

Me on the Map, by Joan Sweeney. Crown Publishing: New York, 1998.
(Recommended grades: K-3)

A child introduces the world of cartography. Based on the idea that simple drawings can be maps, the book begins with crayon drawings of the floor plans of a girl's room and house. She describes how her room, her house, her town, her state, and her country appear on a map of her world.

Money, Money, Money: The Meaning of the Art and Symbols on United States Paper Currency, by Nancy Winslow Parker. HarperCollins Publishers, Inc.: New York, 1995. (Recommended grades: 1-6)

A short course in American history, focusing on the signs and symbols you can find in your wallet. The author explains the symbols that appear on U.S. paper currency, from $1 to $100,000.

More Simple Signs, by Cindy Wheeler. Viking Penguin: New York, 1998.
(Recommended grades: PreK-2)

Children usually have a lot to say, through gestures, movements, pictures, and/or words. This book shows how American Sign Language utilizes all of these natural skills. It uses helpful hints and picture clues to make the signs accessible to young children.

Our National Symbols, by Linda Carlson Johnson. Millbrook Press: Brookfield, CT, 1994.
(Recommended grades: 2-5)

Describes how national symbols evolved after the American Revolution. These include the flag, the Pledge of Allegiance, the Liberty Bell, the eagle, Uncle Sam, and the Statue of Liberty.

Out of Darkness: The Story of Louis Braille, by Russell Freedman. Houghton Mifflin: Boston, 1999.
(Recommended grades: 4-8)

Braille was a nineteenth-century Frenchman. Blinded at the age of three, he went on to develop a system of raised dots that enable visually impaired people to read and write.

Pass It On!: All About Notes from Secret Codes and Special Inks to Fancy Folds and Dead Man's Drops, by Sharon Bailly. Millbrook Press: Brookfield, CT, 1995. (Recommended grades: 3-6)

This book explores the history of writing. It offers instructions for making special inks, using various alphabets and codes, and creating personal seals and private letter drops.

A Picture Book of Louis Braille, by David A. Adler. Holiday House, Inc.: New York, 1998.
(Recommended grades: K-3)

This picture biography presents the life of the nineteenth-century Frenchman, accidentally blinded as a child, who invented the raised-dot code now used around the world by the visually impaired.

Red, Yellow, Green: What Do Signs Mean? Scholastic, Inc.: New York, 1998.
(Recommended grade: PreK-3)

A sticker activity book that teaches children about common signs including STOP, DON'T WALK, DETOUR, SCHOOL CROSSING, and many more. It uses clever rhymes to remind readers of the meaning of these signs.

The Rockslide Rescue (The Shoebox Kids, Bk. 8), by Sandra L. Zaugg. Pacific Press Publishing Association, 1998.
(Recommended grades: 2-6)

Willie, who uses a wheelchair, is caught in a landslide along with his grandfather. Some of the other Shoebox kids use Morse code to find them and bring them to safety. The book includes transcriptions of Morse code and instructions for making a "butter-tub" transmitter.

Samuel F.B. Morse, by Jean Lee Latham. Chelsea House: New York, 1991.
(Recommended grades: 2-6)

A brief biography of the inventor of the telegraph and Morse code.

The Secret Birthday Message, by Eric Carle. HarperCollins Children's Books: New York, 1986.
(Recommended grades: K-3)

On the night before his birthday, Tim finds a rebus note, a secret message directing him to his gift.

The Secret Code, by Dana Meachen Rau. Grolier Publishing: New York, 1998.
(Recommended grades: K-3)

Oscar, who is visually impaired, teaches Lucy how to read his Braille book. Intrigued by Oscar's "Secret Code," the other class members are eager to learn it too. Readers are also invited to learn Braille, and to use it to decipher a note from Oscar.

Secret Codes and Hidden Messages, by Jeffrey A. O'Hare, Boyds Mills Press, 1997
(Recommended grades: 3-6)

This little book is full of great codes. Along with Morse code, sign language, semaphore, and Braille, it also includes chart codes, ice cream codes, hidden picture codes, and musical codes.

The Sign Painter's Secret: The Story of a Revolutionary Girl, by Dorothy and Thomas Hoobler. Silver Burdett Press: Englewood Cliffs, NJ, 1994. (Recommended grades: 4-6)

When British troops occupy her house during the Revolutionary war, young Annie MacDougal must find a way to help General Washington's troops by keeping the sign painter's secret.

Signs and Symbols Around the World, by Elizabeth S. Helfman. Lothrop, Lee & Shepard Co.: New York, 1967. (Recommended grades: 5-8)

Describes graphic signs and symbols and their importance in communication through history. Examples includes picture writing by cavemen, numbers, musical notes, religious signs, trademarks, signs in science and industry, trail markers, and traffic signals.

Taking a Walk/Caminando, by Rebecca Emberley. Little, Brown & Company: Boston, 1991. (Recommended grades: K-3)

Labeled illustrations and Spanish and English text introduce signs, symbols, and other things a child sees while on a walk.

Tomorrow's Alphabet, by George Shannon. Greenwillow Books: New York, 1996. (Recommended grades: PreK-3)

For children already familiar with the sounds of the alphabet, this is a lively book about creative design. Why does "A" stand for seed? Because this seed is tomorrow's Apple.

26 Letters and 99 Cents, by Tana Hoban. William Morrow & Co.: New York, 1995. (Recommended grades: PreK-3)

This innovative book is really two books in one—an alphabet book and a counting book. On the alphabet side, each upper and lower case letter is matched to a photo of an object. Turn the book around and the numbers are illustrated in sequential order from 1 to 30, by 5's to 50, and by 10's to 90.

Uncle Sam and Old Glory: The Symbols of America, by Delno C. West and Jean M. West. Simon & Schuster Children's Books: New York, 1999. (Recommended grades: 3-6)

This book shows how the American buffalo, the Statue of Liberty, the Mayflower and Uncle Sam have all been used to symbolize the United States and its political system.

You Don't Need Words! A Book About Ways People Talk Without Words, by Ruth Belov Gross. Scholastic, Inc.: New York, 1991. (Recommended grades: 2-5)

Describes sign language and other ways that people communicate without words. Among the topics discussed are Native American picture writing, hobo signs, international signage, code flags, body language, and hand signs.

Assessment

Nearly everyone agrees about the importance of assessment, but what exactly is it, and why is it so significant in education? In a very broad sense, education is like a very large design problem and assessment is the method of evaluating the design. However, education has many objectives, not just one, so assessment also includes a complex process of deciding what to assess and how. Another major complication is that many different kinds of people have a stake in the outcome of the educational process. Parents want to know how much their children are learning and how they can best help them. Politicians worry about the backlash from voters if the educational system appears to be "failing," however that term is defined. Administrators fear that they will be held accountable for low test scores in their schools.

Teachers, who have the most sustained and direct involvement of any adults in the educational process, are constantly looking for ways of knowing how well and how much their students are learning. This data can come from both formal and informal assessment methods, and may be either qualitative or quantitative. At the same time, teachers are often held accountable to conflicting requirements that are difficult or impossible to meet. For example, the goal of providing a supportive and welcoming learning environment may be in conflict with the regimentation imposed by administrative requirements. Another common concern of teachers is that high-stakes testing will require them to "teach to the test" rather than to support student learning.

Regardless of demands from outside the classroom, a teacher's primary responsibility is to engage students in exploring and understanding the subject matter. Assessment includes any method of finding out how much of this exploring and understanding actually happens. Information gained through assessment is the only factual basis for knowing what students are learning, how to motivate learning more effectively, how and whether to redesign the curriculum, how to tailor it to the needs of individual students, and how and when to involve parents in the process. Assessment is far too extensive and important to be narrowly defined by standardized test results or to be determined by people outside the classroom.

Here are some basic conclusions that follow from this view of assessment:

- Assessment should be based on clear educational goals.
- Many different kinds of information should be collected as part of assessment. Some of the most important assessment data is totally unexpected.
- Assessment should not be divorced from curriculum; every learning activity should also provide information for assessment.
- Whenever possible, students should become involved in assessing their own learning—for example, by evaluating their own designs or predictions.
- Assessment should examine not only what students have learned, but also the opportunities provided by the curriculum and the learning environment.

We will illustrate each of these points using examples from the teacher stories in Chapter 4.

Educational Goals

To assess students' accomplishments, it is important to begin with clear-cut goals, against which the outcomes can be measured. Often, new goals will present themselves as a unit unfolds, and these should be included too. In the example cited below, Mary Flores began with a simple goal—to move her second grade special education students towards literacy, and was able to pursue this one goal consistently throughout the project.

Mary had a hunch that her non-reading second-graders had learned to interpret their environment by decoding graphic symbols. Because many of these children had serious behavior problems, Mary was reluctant to take them on a signs-and-symbols scavenger hunt in the school, but she decided to take the risk. If her intuition was correct, she felt, she could use the study of signs and symbols as a way of motivating them to read and write. Mary believed she could move her students seamlessly from the graphic symbols they already knew to the more intimidating realm of language literacy.

It turned out that Mary was right. Her students were already able to read many of the graphic symbols in their environment. Furthermore, they were aware that these symbols have word equivalents, and that both a word and a graphic symbol sometimes appear together on the same sign. As one child put it, "If you don't know the words, the pictures will give you the answers." Mary had succeeded in stimulating these non-readers to see reading as an outgrowth of interpreting graphic symbols.

Later, Mary also found several ways to make the transition from making graphic symbols to writing words and sentences. First, she engaged her students in creating signs and symbols for kindergarten students. To help the kindergartners learn to read too, these signs would have to have words as well as pictures. Another strategy was to have her students create their own games. The game boards consisted mostly of symbols, but the instructions for playing the game would have to be written in sentences. In retrospect, Mary felt that some of these youngsters had made tremendous progress through these activities.

Information from a Variety of Sources

If educational goals are complex and multifaceted, so are the means of assessing to what extent these goals are met. The narrowest view of assessment, most popular in political circles, confines it to standardized tests. A somewhat broader view expands assessment to include all kinds of paper-and-pencil instruments designed specifically for assessment, such as worksheets, homework assignments, tests, and quizzes. Our view of assessment is broader still. In the course of an activity, nearly anything students do generates information that is valuable for assessment.

Felice Piggott's work with "DANGER" signs illustrates how a complex set of educational goals requires equally complex assessment methods. Felice began her fourth grade signs-and-symbols unit after a difficult period of high-stakes testing, so a major goal was simply to engage them in something exciting and fun. Of course, she had educational goals as well. She wanted them to reflect on signs and symbols in the environment, and to be aware of how they are used. In designing their own symbols, she hoped that they would think about alternative ways of representing a simple message.

Felice had another goal, which was considerably more of a challenge. She saw the unit as an excellent opportunity for her students to learn basic ideas about design. An essential ingredient of any design project is the evaluation of the design, and Felice wanted her students to come up with their own methods for testing their designs, including the collection and analysis of quantitative data.

In assessing this work, Felice looked at a wide variety of outcomes. She looked not only at the signs the students created, but more importantly, at the methods they designed to test these signs. Felice evaluated their plans for the tests, their follow-through in implementing what they had planned, and their recording and interpretation of the data. In their comments, students recognized that their objectives included both the design of signs, and also the design of evaluation methods. They also reflected on how well the groups had functioned. Clearly, Felice had conveyed a rich set of educational goals to her students.

Part of the attraction of teaching is that much of what happens in the classroom is unpredictable, and some of the surprises are pleasant and even

thrilling. Consequently, it is impossible to decide in advance what all of the methods of assessment will be. Often, serendipity provides ways of assessing students' learning that nobody could have anticipated.

Chapter 4 contains some striking examples of serendipity. When Theresa Luongo's student used a "NO U-TURN" sign to indicate "DON'T GO UNDER THE ARCH!" he was demonstrating his understanding of the power of a symbol to convey a message, even though it was not the same message intended by the sign maker. Mary Flores was impressed by the kindergarten student who said, "I don't understand the sign. I think you should redesign it." This child had obviously developed a comprehensive grasp of the design process. Along the same lines, one of Felice's students made a remarkable connection between the design process he had gone through and that of professional designers when he said, "I guess this is what the guy who invented the STOP sign went through."

Curriculum as a Source of Assessment Data

In order to maximize the amount of information available, the curriculum itself should be seen as a rich source of assessment data. Nearly all of the teachers whose stories appear in Chapter 4 used a brainstorming activity or scavenger hunt to introduce their signs-and-symbols units. In either activity, students provide data about what they already know, while also beginning to explore a topic. For example, Guillermina Montano solicited her third graders' ideas about what the white circle in front of her classroom might mean. A few days later, she asked them for examples of how symbols and signals are used to guide children's behavior. Subsequently, they brainstormed areas in which children's behavior could be improved. Each of these sessions was both a learning activity, and an assessment opportunity for Guillermina.

Working with a sixth grade class with many behavior problems, Christine Smith found a variety of creative ways to assess her students' work in the context of her signs-and-symbols curriculum. In-class assessments took the form of brainstorming sessions and games, which required the students to figure out the meaning of "mystery" symbols. Christine invented the term "quiz/game" to suggest that these enjoyable events also served as assessments. After the students had designed their own signs to convey secret messages, Christine held each one up to the class and asked them to determine its meaning. In doing so, the students were developing their own ability to decode symbols and evaluating one another's signs. At the same time, they were also providing Christine with assessment data both about their decoding abilities, and also about the signs they had designed.

Students Assess Their Own Learning

Should the audience for assessment data include students themselves? Obviously, students need to know how well they are doing, so they can gauge their own efforts and develop realistic goals for their own learning. However, traditional assessment is usually presented to students in an adversarial manner, in the form of test grades and report cards that frequently undermine rather than enhance their motivation for learning. In traditional forms of assessment, students are always evaluated by adults rather than by themselves or each other, and the outcomes of assessment often have high stakes. These factors contribute to the view of assessment as an antagonistic process. How can students assess their own and one another's learning without all of the baggage of traditional assessment?

Signs and symbols offer natural opportunities for peer assessment. An obvious test of any symbol is whether the audience can figure out the message the symbol is supposed to convey. This sort of assessment is a feature of each of the design projects described in Chapter 4. Guillermina Montano's students posted signs by water fountains and stairways and asked other students what they thought they meant; Felice Piggott's students observed how others responded to their "DANGER" signs;

Mary Flores's second and fourth graders tried their signs out on kindergarten students; and Christine Smith conducted a quiz/game to test each group's signs with the whole class. In each case, the signs were being evaluated not by the teacher, but by other students. Often the outcomes of these peer assessments led to self-assessments such as this comment by one of Christine's students: "We should have used a different color."

In Angel Gonzalez's class, peer assessment took on an added dimension. His students were attempting to solve a problem of real significance to them: classroom interruptions caused by students asking to go to the bathroom, sharpen a pencil, etc. The solution would be to create a silent signaling system to convey messages to the teacher during class. The test of the system was to try it out in a classroom, and see if it really did reduce the number interruptions. Because the design project arose from a real problem, the designs could be evaluated by seeing how well they actually solved the problem. More than two years later, some of these hand signals are still in use in Angel's school!

Assessing Teaching, Curriculum, and Learning Environment

Like anybody else who designs or plans anything, most teachers engage in informal assessment of their work on an ongoing basis. They ask themselves, "Is it working?" This question is really one of self-assessment: "What is the quality of the learning opportunities I have provided for my students?" Some of this self-assessment by teachers is based on student learning outcomes of the kinds described above. At the same time, teachers also assess learning opportunities on the basis of their own perceptions and experiences.

Several examples of these self-assessments by teachers appear in the teachers' stories in Chapter 4. Felice Piggott, for example, felt that she should have introduced the concept of a fair test, and that the evaluation of the designs should have led to redesign activities. Christine Smith, in her reflections, suggested that next time she would require her students to collect quantitative evaluation data and would incorporate graphing as a way of representing the data. At the conclusion of his "Sell Your Brand" activity, Angel Gonzalez presented his class with a "Data Analysis Worksheet" that included such questions as, "What other information would be helpful in analyzing your data?" In retrospect, Angel felt that this and other some questions went well above the heads of his fifth graders.

The Institutional Context

Every school is different. Each one offers both resources that can be helpful in implementing a new curriculum, and barriers that can make it difficult. It is useful to analyze both carefully, with an eye to mobilizing and extending the resources and overcoming the barriers. In this section, we will look at how some teachers have gained crucial support from school staff, parents, other teachers, and administrators as they developed new programs in science and technology.

The Custodian

The custodian is a key person in the success of any project, particularly one that may take students outside of the classroom and into the rest of the building. The custodian is probably more familiar with the physical layout of the building than anyone else. He or she also has the best access to discarded materials, such as cardboard, waste paper, or wood, that can be very useful. A cooperative custodian can also offer suggestions about additional storage space, and can insure that projects in process will not be thrown out.

The custodian's involvement can also lead to exciting surprises, as the following story illustrates. A second-grade teacher and her class were studying the water supply system of a school in the South Bronx, New York City. They began with the water fountain just outside their classroom. The children were convinced that the water for the fountain was stored in the wall just behind it. Then somebody noticed that there were pipes leading to the fountain. They followed the pipes along the ceiling and realized that they came from someplace else in the building. At this point they went to another floor and noticed a similar pattern of pipes. Eventually, their investigation led them to the basement. There they met the custodian, who gave them copies of the blueprints (maps) of the building, and showed them how the water came into the building. The following day, he gave them an opportunity to turn on the boiler, so they could see how the hot water was heated! The outcome of this investigation was a working 3D model of the building's water supply in which the pipes were represented by straws and the reservoir by a basin held above the highest floor.

Parents

Parents can also be critical to the success of a curriculum project. A number of teachers have involved parents in investigations of the community around the school. One ESL teacher in East Harlem, New York City, whose students were recent immigrants from various parts of Latin America, engaged her students in a study of the casitas in the community. A *casita* (literally, "little house") is a small building constructed by community residents on a vacant lot, which may serve as a clubhouse or a religious shrine, or which may be used to house livestock. Several parents who were very familiar with the community accompanied the class on their field visits and facilitated their discussions with the users of the casitas.

How does a teacher get parents involved in the first place? Some teachers have organized parent/child workshops, after school or on Saturdays, as a way to inform parents of what their children are doing and to solicit their support. One strategy that has worked is to have a parent/child workshop a few weeks after children have begun a project. In the workshop, parents and their children are encouraged to pursue a hands-on project that is similar to what the

children have already been doing in school. Because the children have already started the project, they will often take the lead in explaining the material and offer their parents advice on how to proceed. At the same time, parents will provide their own experiences and expertise, and some may become excited enough to volunteer additional support. Parent volunteers can provide the additional adult presence needed for taking the class outside the building.

Other Teachers

Just as children often require peer interaction to pursue a project, so peer support can be essential for teachers too. Another teacher can be a springboard for ideas, a source of advice on overcoming difficulties, and a friend to turn to when everything seems to go wrong. There are many models for teacher/teacher collaboration, each of which can work in some circumstances. Ultimately, the collaborators have to figure out for themselves what works best for them. Here are some examples of ways in which teachers in the same school have worked together:

- An experienced teacher gave workshops in the school, in which she engaged other teachers in some of the same activities she had been doing in her classroom. Several of the other teachers became interested and sought advice on pursuing these activities in their own classrooms.
- An experienced special education teacher mentored a less experienced special education teacher, offering her assistance in some of the same projects she had done in her own classroom.
- A science cluster teacher met with a classroom group during a "prep" period twice a week. She enlisted the students' classroom teacher in pursuing some of the same projects as part of their regular classroom work.
- A fifth grade teacher and a kindergarten teacher decided to work together. After the fifth-graders had pursued some of their own investigations, several of them became the facilitators in helping the kindergarten children do similar studies. The work involved cataloging and mapping what they found in nearby empty lots. Besides being a collaboration among teachers, this project was also a collaboration between older and younger children.

Collaboration among teachers may be actively discouraged by the culture of the school. Even in the best circumstances, collaborations can be difficult to sustain. Just as every school is different, so is every classroom. Ideas and strategies that work in one classroom may or may not be directly transferable to another, and it is important to remain sensitive to differences in chemistry and culture from one room to the next. The most important ingredient in a collaboration among teachers is the commitment to work and learn together, regardless of the outcome of any particular project or idea.

School Administration

A major component of a teacher's setting is the culture of the school administration. A principal, assistant principal, or other supervisor can make or break an innovative curriculum project. Some teachers are fortunate enough to find themselves in environments that nurture innovation; others are not so lucky. For better or worse, the tone set by the administration is a major factor that every teacher has to deal with. Even without initial support, however, there are a number of strategies for bringing a skeptical (or even a hostile) administrator on board.

One teacher, who was a participant in an in-service inquiry science program, had a roomful of upper-elementary students engaged in long-term science investigations, largely of their own design. She decided to encourage them to enter their projects in the school science fair. She immediately ran into the opposition of her principal, who insisted that all of the material on the display boards be "professionally done." The teacher knew that her students were invested in their projects, and perfectly capable of creating their own displays, but unable to type the material or produce fancy graphics. To make the displays for them would be to undermine all of their efforts and enthusiasm. So she presented the situation to her children, without any suggestion about what they ought to do about it.

The next time the principal visited their classroom, the students let him know that they wanted to enter the science fair, and they believed they could make display boards which would be perfectly readable. In any case, they would be around to explain anything the judges didn't understand. With the teacher standing by silently, the principal reluctantly gave in. At the fair, it became clear that these were the students who had the best grasp of their own projects, although there were others that had nicer-looking boards. Neither the children nor the teacher were surprised when they won first, second, and third prizes, and went on to the District fair! Equally important, the teacher felt that this was a turning point in her relationship with the principal. Afterwards, he interfered much less with her efforts at innovation.

It is far more effective to mobilize children, parents, other teachers, and staff than to confront an administrator directly. He or she will have a much harder time saying no to children, parents, or a group of teachers than to an individual. Also, successful programs speak for themselves. Outside authorities, such as science fair judges, funding sources, or important visitors, can make even the most reluctant principal sit up and take notice. Most important, innovation succeeds best when innovators lay the seeds quietly over time, and exploit opportunities to overcome resistance.

Resist the temptation to take on every adversary, every time. Focus instead on the resources that are available to you, and learn how to mobilize them effectively. Wait for opportunities to let your efforts speak for themselves.

INTRODUCTION

What Is Technology?

Stuff That Works! Signs, Symbols, and Codes will introduce you to a novel and very engaging approach to the study of technology at the elementary school level. In education today, the word *technology* is most often associated with learning how to use computers, and that is certainly important. But learning how to use a particular kind of technology is not the same thing as learning how and why the technology works. Children learn about computers as users rather than as students of how computers work or of how to design them. In fact, computer analysis and design require technical knowledge that is beyond most adults, let alone elementary-aged children. Fortunately, there are many other examples of technology that are much more accessible than computers and that present many of the same issues as computers and other "high-tech" devices.

The purpose of technology is to solve practical problems by means of devices, systems, procedures, and environments that improve people's lives in one way or another. Understood this way, a computer is no more an example of technology than...

- the cardboard box it was shipped in,
- the arrangement of the computer and its peripherals on the table,
- the symbol next to the printer's ON/OFF switch,
- or the ballpoint pen the printer replaces as a writing device.

A box, a plan for the use of table space, an ON/OFF symbol, and a pen are examples of technologies you and your students will explore in this and the other *Stuff That Works!* guides.

The *Stuff That Works!* approach is based on artifacts and systems that are all around us and available for free or at very low cost. You need not be a technical guru or rich in resources to engage yourself and your students in technology. The activities in *Signs, Symbols, and Codes* are grounded in a broad range of places and situations that are part of children's everyday experiences. They include symbols used on maps, signs, packages, and consumer products, as well as gestures used by teachers and children to get one another's attention and convey messages.

Chapter 6

ABOUT STANDARDS

Overview

In Chapter 3, "Activities," we have listed standards references for each activity. This type of listing is now found in most curriculum materials, in order to demonstrate that the activities "meet standards." In a way, these standards references miss the point, because the national standards are not meant to be read in this way. Meeting standards is not really about checking off items from a list. Each of the major standards documents is a coherent, comprehensive call for systematic change in education.

This chapter shows how the material in this book is consistent with national standards at a very fundamental level. We will look in detail at the following documents:

- *Standards for Technological Literacy: Content for the Study of Technology* (International Technology Education Association, 2000);
- *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993);
- *National Science Education Standards* (National Research Council, 1996);
- *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000);
- *Standards for the English Language Arts* (National Council of Teachers of English & International Reading Association, 1996); and
- *Expectations of Excellence: Curriculum Standards for the Social Studies* (National Council for the Social Studies, 1994).

Most of these standards are now widely accepted as the basis for state and local curriculum frameworks. The first document on the list is included because it is the only national standard focused primarily on technology. The *New Standards Performance Standards* (National Center on Education and the Economy, 1997) is not included because it is based almost entirely on the *Benchmarks, National Science Education Standards,* the original *NCTM Math Standards* (1989), and the *Standards for the English Language Arts.*

Although they deal with very different disciplines, these major national standards documents have many remarkable similarities:

- They are aimed at all students, not only those who are college-bound.
- Using terms like "literacy" and "informed citizen," they argue that education should prepare students to understand current issues and participate in contemporary society.
- They recommend that school knowledge be developed for its use in solving real problems rather than as material "needed" for passing a test. They strongly endorse curriculum projects that arise from students' own ideas, experiences, and interests.
- They focus on the "big ideas" of their disciplines as opposed to memorization of isolated facts or training in narrowly defined skills. In other words, fewer concepts should be dealt with in greater depth. As the National Science Education Standards express it, "Coverage of great amounts of trivial, unconnected information must be eliminated from the curriculum." (NRC, 1996, p. 213)

- The standards reject standardized tests as the sole or even the major form of assessment. Traditional exams measure only what is easy to measure rather than what is most important. "While many teachers wish to gauge their students' learning using performance-based assessment, they find that preparing students for machine-scored tests—which often focus on isolated skills rather than contextualized learning—diverts valuable classroom time away from actual performance." (NCTE/IRA, 1996, p. 7) The standards promote authentic assessment measures, which require students to apply knowledge and reasoning "to situations similar to those they will encounter outside the classroom." (NRC, 1996, p. 78) Furthermore, assessment should become "a routine part of the ongoing classroom activity rather than an interruption" and it should consist of "a convergence of evidence from different sources." (NCTM, 2000, p. 23)
- They highlight the roles of quantitative thinking, as well as oral and written communication, in learning any subject, and they emphasize the interdisciplinary character of knowledge.
- They view learning as an active process requiring student engagement with the material and subject to frequent reflection and evaluation by both teacher and learner.
- They urge teachers to "display and demand respect for the diverse ideas, skills and experiences of all students," and to "enable students to have a significant voice in decisions about the content and context of their work." (NRC, 1996, p. 46)

The *Stuff That Works!* materials are based on these ideas and provide extensive guidance on how to implement them in the classroom. We begin our study of technology with students' own ideas and experiences, address problems that are of importance to them, develop "big ideas" through active engagement in analysis and design, and draw connections among the disciplines. While the standards are clear about the principles, they do not provide many practical classroom examples. *Stuff That Works!* fills this gap.

Where the Standards Came From

Historically speaking, the current tilt towards national curriculum standards is a dramatic departure from a long tradition of local control of education. How did national standards manage to become the order of the day? In the late 1970s, the country was in a serious recession, driven partly by economic competition from Europe and Japan. In 1983, the National Commission on Educational Excellence (NCEE) published an influential report, *A Nation at Risk,* which painted a depressing picture of low achievement among the country's students. The report warned of further economic consequences should these problems continue to be ignored, and advocated national curriculum standards for all students. Adding to these arguments were pressures from textbook publishers, who felt that national standards would make state and local adoption processes more predictable.

Around the same time, several of the major professional organizations decided to provide leadership in setting standards. The pioneering organizations were the National Council of Teachers of Mathematics (NCTM) and the American Association for the Advancement of Science (AAAS), whose efforts culminated in the publication of major documents in 1989. In the same year, the National Governors' Association and the first Bush

Administration both endorsed the concept of establishing national educational goals. The NCTM was deeply concerned about the issues raised by *A Nation at Risk* and was convinced that professional educators needed to take the initiative in setting a new educational agenda. Otherwise, the reform of curriculum would rest in the hands of textbook and test publishers, legislatures, and local districts.

Both the NCTM and the AAAS standards projects began with a similar basic position about pedagogy. Influenced by research about what children actually know, they recognized the disturbing fact that "learning is not necessarily an outcome of teaching." (AAAS, 1989, p. 145) In contrast with traditional approaches to education, which emphasize memorization and drill, the new national standards promote strategies for active learning. A related theme of the early standards efforts was that the schools should teach fewer topics in order that "students end up with richer insights and deeper understandings than they could hope to gain from a superficial exposure to more topics..." (p. 20)

Meeting standards requires a major investment of time and resources. Some of the necessary ingredients include new curriculum ideas and materials, professional development opportunities, new assessment methods, and smaller class sizes. The *National Science Education Standards* are the most explicit in identifying the conditions necessary—at the classroom, school, district, and larger political levels—for standards to be meaningful. The authors state, "Students could not achieve standards in most of today's schools." (NRC, 1996, p. 13) More money might not even be the hardest part. Standards-based reforms also require understanding and commitment from everyone connected with the educational system, starting at the top.

The history of standards may contain clues about their future. Standards imply neither textbook-based instruction nor standardized tests. Standards arose because traditional text- and test-based education had failed to result in the learning of basic concepts by the vast majority of students. Ironically, there are many textbook and test purveyors who market their products under the slogan "standards-based." Standards could easily become discredited if those who claim their imprimatur ignore their basic message.

What the Standards Actually Mean

Standards are commonly read as lists of goals to be achieved through an activity or a curriculum. This approach is reflected in the lists of standards references and cross-references that appear in most curriculum materials, as evidence that an activity or curriculum "meets standards."

Presenting lists of outcomes reflects a narrow reading of standards, which can be very misleading. These lists suggest that "meeting standards" is simply a matter of getting students to repeat something like the statements found in the standards documents.

In fact, the standards are much richer and more complex than these lists imply. Many of the standards do not even specify the knowledge that students should acquire, but deal rather with ways of using that knowledge. Here is an example from *Benchmarks for Science Literacy:*

> "By the end of fifth grade, students should be able to write instructions that students can follow in carrying out a procedure." (p. 296)

This standard talks about something students should be able to do,

rather than what they should know. The newly released NCTM document, *Principles and Standards for School Mathematics* (2000), unlike the earlier one (NCTM, 1989), explicitly separates "Content Standards" from "Process Standards." The Content Standards outline what students should learn, while the Process Standards cite ways of acquiring and expressing the content knowledge. The Process Standards include problem solving, communication, and representation. The Benchmarks example just cited is another example of a process standard. Similarly, in the English Language Arts (ELA) document (NCTE/IRA, 1996), all twelve standards use verbs to express what students should do, as opposed to what they should know. Any reading of standards that focuses only on content knowledge is missing a central theme of all of the major documents.

There is also material in the standards that qualifies neither as content nor as process. Here is an example from the *Benchmarks* chapter called "Values and Attitudes":

> "By the end of fifth grade, students should raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out." (p. 285)

This standard asks for more than a specific piece of knowledge, ability, or skill. It calls for a way of looking at the world, a general conceptual framework that transcends the boundaries of disciplines. Similarly, the "Connections" standard in the new NCTM document underscores the need for students to...

> "... Recognize and apply mathematics in contexts outside of mathematics." (NCTM, 2000, p. 65)

These are examples of broad curriculum principles that cut across the more specific content and process standards. These standards are not met by implementing a particular activity or by teaching one or another lesson. They require an imaginative search for opportunities based on a reshaping of goals for the entire curriculum.

In general, the standards documents are at least as much about general principles as about particular skills and knowledge bases. The *Standards for Technological Literacy*, the *Benchmarks*, and the *National Science Education Standards* each identifies some big ideas that recur frequently and provide explanatory power throughout science and technology. "Systems" and "modeling" are concepts that appear in all three documents. The presence of such unifying ideas suggests that the individual standards references should not be isolated from one another. They should rather be seen as parts of a whole, reflecting a few basic common themes.

What Use Are Standards?

Increasingly, teachers are being held accountable for "teaching to standards." These demands are added to such other burdens as paperwork, test schedules, classroom interruptions, inadequate space and budgets, arbitrary changes in class roster, etc. In the view of many teachers, children and their education are routinely placed dead last on the priority list of school officials.

Understandably, teachers may resent or even resist calls to "meet standards" or demonstrate that their curricula are "standards-bearing." It is not surprising that many teachers cynically view the standards movement as "another new thing that will eventually blow over."

The push to "meet standards" is often based on a misreading of standards as lists of topics to be "covered" or new tests to be administered. It is not hard to imagine where this misinterpretation might lead. If the proof of standards is that students will pass tests,

and students fail them nevertheless, then the standards themselves may eventually be discarded. Paradoxically, the prediction that "this, too, shall pass" would then come true, not because the standards failed, but because they were never understood nor followed.

Standards are intended to demolish timeworn practices in education. Some of these practices place the teacher at the center of the classroom but reduce her or him to a cog in the machinery of the school and the district, with the primary responsibility of preparing students for tests. The standards documents recognize the need to regard teachers as professionals, students as active, independent learners, and tests as inadequate methods of assessing the full range of learning.

Within broad frameworks, the standards urge teachers to use their judgment in tailoring the curriculum to students' needs and interests. The *NRC Science Standards,* for example, call for "teachers [to be] empowered to make the decisions essential for effective learning." (1996, p. 2) Neither teachers nor administrators should interpret standards as mechanisms for tightening control over what teachers and students do. While they are very clear about the goals of education, the standards are less specific about how to meet them. Innovative curriculum efforts such as ***Stuff That Works!*** fit very well within the overall scheme of standards.

Teachers who have tried to implement ***Stuff That Works!*** activities in their classrooms have often come away with positive feelings about them. The following comments are typical:

- *The strengths of this unit are the opportunity to group students, work on communication skills, problem solve ... and plan real life tests. I have watched my students go from asking simple yes/no questions to thinking and planning careful, thoughtful active questions. The students began to see each other as people with answers... I was no longer the expert with all the answers.*
- *I must begin by telling you that I found this particular guide to be so much fun and the students demonstrated so much energy and interest in this area... I was able to engage them in the activities easily... The activities were very educational and provided so much vital information that helped students connect what is being taught to them in math to real life situations, e.g., graphing behavior and using tallies to record information. For my [special education] students, I found this gave them self confidence...*
- *I read the entire guide from front to back... Although the main idea of the unit is not specifically a large focus of instruction in our fourth grade curriculum, I recognized the power behind the ideas and activities and knew that this unit would promote collaboration, problem solving and communication... Overall, I think my students loved this unit and felt enormously successful after we finished...*
- *My most important goal for students is that they feel good about themselves and realize what they can do. I liked these activities, because they had these results.*

The standards are intended to promote just these sorts of outcomes. When a teacher has a "gut feeling" that something is working well, there is usually some basis to this feeling. As the *NRC Science Standards* state, "outstanding things happen in science classrooms today... because extraordinary teachers do what needs to be done *despite conventional practice* [emphasis added]." (1996, p. 12) Unfortunately, even an extraordinary teacher may not find support from traditional administrators, who complain that the classroom is too noisy or messy, or that somebody's guidelines are not being followed. Under these circumstances, standards can be very useful. It is usually easy to see how valuable innovations fit into a national framework of education reform that is also endorsed by state- and district-level authorities. Standards can be used to justify and enhance innovative educational programs whose value is already self-evident to teachers and students.

What the Standards Really Say

In order to justify work as meeting standards, it is necessary to know what the standards really say. In the remainde of this chapter, we summarize each of the six major standards documents listed at the beginning of the chapter, and show how the *Stuff That Works!* ideas are consistent with these standards. We provide some historical background for each of the standards, and look at the overall intent and structure before relating them to the *Stuff That Works!* materials. These sections should be used only as they are needed. For example, if you would like to use some of the ideas from this Guide and are also required to meet the *National Science Education Standards,* then that section could be useful to you in helping you justify your work.

Standards for Technological Literacy: Content for the Study of Technology

In April 2000, the International Technology Education Association (ITEA) unveiled the *Standards for Technological Literacy,* commonly known as the *Technology Content Standards,* after extensive reviews and revisions by the National Research Council (NRC) and the National Academy of Engineering (NAE). In its general outlines, the new standards are based on a previous position paper, *Technology for All Americans* (ITEA, 1996). The latter document defined the notion of "technological literacy" and promoted its development as the goal of technology education.

A technologically literate person is one who understands "what technology is, how it is created, and how it shapes society, and in turn is shaped by society." (ITEA, 2000, p. 9) According to the *Standards,* familiarity with these principles is important not only for those who would pursue technical careers, but for all other students as well. They will need to know about technology in order to be thoughtful practitioners in most fields, such as medicine, journalism, business, agriculture, and education. On a more general level, technological literacy is a requirement for participation in society as an intelligent consumer and an informed citizen.

Given the importance of being technologically literate, it is ironic that technology barely exists as a school subject in the U.S., and is particularly hard to find at the elementary level. In a curriculum overwhelmingly focused on standardized tests, there seems to be little room for a new subject such as technology. To make matters worse, there is considerable confusion over what the term "technology" even means. Many in education still equate it with "computers." The Standards advocate for technology education based on a broad definition of "technology," which is "how humans modify the world around them to meet their needs and wants, or to solve practical problems." (p. 22)

The *Technology Content Standards* describe three aspects of developing technological literacy: learning about technology, learning to do technology, and technology as a theme for curriculum integration (pp. 4-9). To learn about technology, students need to develop knowledge not only about specific technologies (Standards 14-20), but also about the nature of technology in general (Standards 1-3), including its core concepts: **systems, resources, requirements, trade-offs, processes,** and **controls.** Resources include **materials, information,** and **energy,** while **modeling** and **design** are fundamental examples of processes (p. 33). Students learn to "do" technology by engaging in a variety of technological processes, such as **troubleshooting, research, invention, problem solving, use** and **maintenance, assessment** of technological impact, and, of course, **design** (Standards 8-13). Technology has obvious and natural connections with other areas of the curriculum,

including not only math and science, but also language arts, social studies, and the visual arts.

According to the *Technology Content Standards,* design is "the core problem-solving process [of technology]. It is as fundamental to technology as inquiry is to science and reading is to language arts." (p. 91) The importance of design is underlined by the statement, a little further on, that "students in grades K-2 should learn that everyone can design solutions to a problem." (p. 93) Several pages later, the Standards suggest that young children's experiences in design should focus on "problems that relate to their individual lives, including their interactions with family and school environments." (p.100) However, the *Technology Content Standards* offer little if any guidance on how to identify such problems. The vignette provided on the following page, "Can You Help Mike Mulligan?" is based on a literature connection rather than children's environments.

Signs, symbols, and codes are technologies for representing and communicating information. Sign-and-symbol design activities offer easy access to the processes of design, because the design cycle is relatively short, and evaluation methods are obvious. The basic test of a symbol design is: *Can the intended audience figure out what it means?* As Theresa Luongo's work in Chapter 4 demonstrates, even very young children can engage in the design and redesign of symbols. Mary Flores's story shows how non-reading second-graders created graphic signs for kindergarten students and tested them by seeing how well the younger children could interpret them. Through this activity, both groups were developing key insights about design, as one of the kindergarten students indicated when he said, "I don't understand the sign. I think you should redesign it."

Where does technology education "fit" in the existing curriculum? The Technology Standards address this problem by claiming that technology can enhance other disciplines: "Perhaps the most surprising message of the *Technology Content Standards* ... is the role technological studies can play in students' learning of other subjects." (p. 6) We support this claim in the following sections, which draw the connections between the material in this book and national standards in science, math, English language arts, and social studies.

Benchmarks for Science Literacy

There are two primary standards documents for science education: The American Association for the Advancement of Science (AAAS) *Benchmarks for Science Literacy* (1993) and the National Research Council (NRC) *National Science Education Standards* (1996). Unlike the *National Science Education Standards,* the *Benchmarks* provide explicit guidance for math, technology, and social science education, as well as for science. *Benchmarks* draws heavily on a previous AAAS report, *Science for All Americans* (1989), which is a statement of goals and general principles rather than a set of standards. The newer document recasts the general principles of *Science for All Americans* (SFAA) as minimum performance objectives at each grade level.

The performance standards in *Benchmarks* are divided among 12 chapters. These include three generic chapters regarding the goals and methods of science, math, and technology; six chapters providing major content objectives for the physical, life, and social sciences; technology and mathematics; and three generic chapters dealing with the history of science, "common themes," and "habits of mind." The last four chapters of *Benchmarks* provide supporting material, such as a glossary of terms and references to relevant research.

Recognizing that standards are necessary but not sufficient for education reform, the AAAS has also developed some supplementary documents to support the process of curriculum change. These include *Resources for Science Literacy: Professional Development* (1997), which suggests reading materials for teachers, presents outlines of relevant teacher education courses, and provides comparisons

between the *Benchmarks,* the *Math Standards,* the *Science Standards,* and the *Social Studies Standards.* A subsequent publication, *Blueprints for Science Reform* (1998) offers guidance for changing the education infrastructure to support science, math, and technology education reform. The recommendations in *Blueprints* are directed towards administrators, policy makers, parent and community groups, researchers, teacher educators, and industry groups. A subsequent AAAS document, *Designs for Science Literacy* (2001), provides examples of curriculum initiatives that are based on standards.

The *Benchmarks* document offers a compelling argument for technology education. The authors present the current situation in stark terms: "In the United States, unlike in most developed countries in the world, technology as a subject has largely been ignored in the schools." (p. 41) Then they point out the importance of technology in children's lives, its omission from the curriculum notwithstanding: "Young children are veteran technology users by the time they enter school.... [They] are also natural explorers and inventors, and they like to make things." (p. 44) To resolve this contradiction, "School should give students many opportunities to examine the properties of materials, to use tools, and to design and build things." (p. 44)

Like the *Technology Standards,* the *Benchmarks* identify design as a key process of technology and advocate strongly for first-hand experience in this area. "Perhaps the best way to become familiar with the nature of engineering and design is to do some." (p. 48) As children become engaged in design, they "begin to enjoy challenges that require them to clarify a problem, generate criteria for an acceptable solution, try one out, and then make adjustments or start over again with a newly proposed solution." (p. 49) These statements strongly support the basic approach of ***Stuff That Works!,*** which is to engage children in analysis and design activities based on the technologies already familiar to them. Like ***Stuff That Works!,*** the *Benchmarks* also recognize the back-and- forth nature of design processes, which rarely proceed in a linear, predictable sequence from beginning to end.

The uses of symbols, graphics and models for communication are a recurring theme of *Benchmarks.* "Communication" appears as a major category under "The Designed World"; it reappears as "Symbolic Relationships" under "The Mathematical World," as one of the "Common Themes," and as one of the "Habits of Mind." *Signs, Symbols, and Codes* focuses on the most basic devices used to communicate information. The activities engage children in recognizing and interpreting signs and symbols in their own environments, and then in designing and testing new ones. The *Benchmarks* section on "Communication" in "The Designed World" recommends just these sorts of activities:

> "Even before children master the alphabet, they know that various shapes, symbols, and colors have special meanings in society (for example, red means danger, a red octagon means stop, green means go, arrows show direction, a circle with a slash means no). Young children are fascinated by the various forms of giving messages, including sign language, road signs, recycling symbols, and company logos, and they should have opportunities to invent forms of their own. Their symbols can be used in classroom routines, illustrating the need to have common meanings for signs, symbols and gestures. They should learn that writing things down and drawing pictures could help them tell their ideas to others accurately.... Students can discuss what the best ways are to convey different kinds of messages—not to decide the right answers, of course, but to start thinking about advantages and disadvantages." (p. 197)

The section on "Communication Skills" specifies symbol design activities in a different context: "By the end of fifth grade, students should be able to write instructions that others can follow in carrying out a procedure [and] make sketches to aid in explaining procedures or ideas." (p. 296) Elsewhere

in *Benchmarks,* the chapter on "The Mathematical World" advocates what we would call "a scavenger hunt for symbols":

> "Symbols are just things that stand for other things or sets of other things or kinds of other things. They can be objects or marks, even sounds. Perhaps it is not too early to engage students in collecting or identifying symbols ... and making up symbols to represent relationships... In this activity, students should be helped to realize that the idea of symbols is not the sole property of mathematics, and letters are not the only kind of symbols used. They should gather and compare the uses of as many different kinds of symbols as they can find in mathematics and elsewhere—hieroglyphics, numbers, icons, musical notation, etc." (p. 217)

The National Science Education Standards

In 1991, the National Science Teachers Association asked the National Research Council to develop a set of national science education standards. These standards were intended to complement the *Benchmarks,* which include math, technology, and social studies as well as natural science. The National Research Council (NRC) includes the National Academy of Sciences, which is composed of the most highly regarded scientists in the country. Over the course of the next five years, the NRC involved thousands of scientists, educators, and engineers in an extensive process of creating and reviewing drafts of the new science standards. The results were published in 1996 as the *National Science Education Standards* (NSES).

Who is the audience for standards? The conventional view is that standards outline what students should know and be able to do, and that teachers are accountable for assuring that their students meet these guidelines. The NSES take a much broader approach, looking at the whole range of systemic changes needed to reform science education. The document is organized into six sets of standards. Only one of the six, the "Science Content Standards," talks directly about what children should learn through science education. The other five address other components of the education infrastructure, including classroom environments, teaching methods, assessment, professional development, administrative support at the school and district levels, and policy at the local, state, and national levels.

Collectively, these standards outline the roles of a large group of people on whom science education depends: teachers, teacher educators, staff developers, curriculum developers, designers of assessments, administrators, superintendents, school board members, politicians, informed citizens, and leaders of professional associations. If an administrator or school board member were to ask a teacher, "What are you doing to address the *National Science Education Standards?"* the teacher would be fully justified in responding, "What are *you* doing to meet them?"

One message that recurs frequently in the NSES is that teachers must be regarded as professionals, with a vital stake in the improvement of science education and an active role "in the ongoing planning and development of the school science program." (p. 50) More specifically, they should "participate in decisions concerning the allocation of time and other resources to the science program." (p. 51) The *Standards* explicitly reject the reduction of teachers to technicians or functionaries who carry out somebody else's directives. "Teachers must be acknowledged and treated as professionals whose work requires understanding and ability." The organization of schools must change too: "School leaders must structure and sustain suitable support systems for the work that teachers do." (p. 223)

Teachers should also play a major role in deciding and/or designing the science curriculum. The *Standards* call for teachers to "select science content and adapt and design curricula to meet the needs, interests, abilities and experiences of students." Although teachers set the curriculum initially, they should remain flexible: "Teaching for understanding requires responsiveness to students, so activities and strategies are continuously adapted and refined

to address topics arising from student inquiries and experiences, as well as school, community and national events." (p. 30) Not only teachers, but also students, should play a major role in curriculum planning. The Teaching Standards make this point explicit: "Teachers [should] give students the opportunity to participate in setting goals, planning activities, assessing work and designing the environment." (p. 50)

The Science Standards do not make the distinction between design and inquiry as sharply as do the Technology Standards: "Children in grades K-4 understand and can carry out design activities earlier than they can inquiry activities, but they cannot easily tell the difference between the two, nor is it important whether they can." (p. 135) Thus, many of the abilities and concepts needed to meet the standard "Science as Inquiry" are also developed through design. These include: "Ask a question about objects... in the environment"; "plan and conduct a simple investigation"; "employ simple equipment and tools to gather data"; and "communicate investigations or explanations." (p. 122)

Signs-and-symbols design activities offer a rich context for developing these inquiry abilities at an early age. Not only are signs and symbols of interest to even the youngest children, but the process of design and evaluation is relatively rapid and free of complications, such as the need for special equipment. All of the stories in Chapter 4 feature children asking questions about signs and symbols they find in their environment, and communicating their interpretations and explanations. In several of the stories, notably those of Angel Gonzalez and Felice Piggott, we also see students planning and conducting investigations of how well their signs and symbols work.

An important aspect of signs and symbols is their role in managing the classroom environment. This role is evident, for example, when Theresa' Luongo's pre-K/K students design symbols for protecting classroom pets; when Guillermina's fourth graders develop ways to manage behavior in the hallways and classroom, when Mary Flores's special education students design graphic symbols for a kindergarten classroom, and when Angel Gonzalez's students develop a signaling system for conveying student needs. The "Teaching Standards" section of the NSES calls for just this sort of involvement of students in designing improvements to their schools and classrooms:

> "As part of challenging students to take responsibility for their learning, teachers [should] involve them in the design and management of the learning environment. Even the youngest students can and should participate in discussions and decisions about using time and space for work." (p. 45)

Principles and Standards for School Mathematics

The first of the major standards documents, *Curriculum and Evaluation Standards for School Mathematics,* was published in 1989 by the National Council of Teachers of Mathematics (NCTM). Additional standards for teaching and assessment were published in 1991 and 1995, respectively. In 2000, the NCTM released a new document, *Principles and Standards for School Mathematics,* intended to update and consolidate the classroom-related portions of the three previous documents. Some of the major features of the new volume, different from the prior version, are the addition of the Principles, the division of the standards into the categories "Content" and "Process," and the inclusion of a new process standard called "Representation."

The new NCTM document acknowledges the limitations of educational standards: "Sometimes the changes made in the name of standards have been superficial or incomplete... Efforts to move in the direction of the original NCTM Standards are by no means fully developed or firmly in place." (pp. 5-6) In spite of this candid assessment, the authors remain optimistic about the future impact of

standards. Their goal is to provide a common framework for curriculum developers and teachers nationwide. If all schools follow the same standards, then teachers will be able to assume that "students will reach certain levels of conceptual understanding and procedural fluency by certain points in the curriculum." (p. 7)

The NCTM *Principles and Standards* begin by presenting the six sets of principles that are the underlying assumptions for the standards. Some of these principles are common to the other standards documents: that there should be high expectations of all students, that the goal of learning is deep understanding, and that assessment should be integrated with curriculum. Other principles underscore the need to learn from cognitive research. More than in any other field, there has been extensive research into how students learn mathematics, and this research base is reflected in the Principles. For example, the "Curriculum Principle" calls for coherent sets of lessons, focused collectively on one "big idea." Similarly, the "Teaching Principle" specifies that teachers must be aware of students' cognitive development. The "Learning Principle" cites research on how learning can be most effective.

The standards themselves are organized into two categories: Content Standards and Process Standards. The former describe what students should learn, in the areas of Number and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability. The Process Standards discuss how students should acquire and make use of the content knowledge. The subcategories are Problem Solving, Reasoning and Proof, Communication, Connections, and Representation. Unlike the earlier NCTM document, the new version uses all the same standards across all of the grade levels, from K through 12. In this way, the NCTM is advocating for a carefully structured curriculum, which builds upon and extends a few fundamental ideas systematically across the grades. Readers may be surprised to find an Algebra Standard for grades K-2, or a Number and Operations Standard for grades 9-12.

Stuff That Works! units and activities offer rich opportunities for fulfilling a key ingredient of the NCTM standards: learning and using mathematics in context. The Process Standard called "Connections" makes it clear that mathematics should be learned by using it to solve problems arising from "other subject areas and disciplines" as well as from students' daily lives" (p. 66). ***Stuff That Works!*** fulfills this standard in two fundamental respects: it provides mathematics connections with another subject area, technology, and it uses artifacts and issues from everyday life as the source of material for study. The mathematics students learn is drawn from all of the Content Standards, as well as all of the Process Standards except for Reasoning and Proof.

The units and activities in this book offer powerful opportunities for developing the basic themes of the Representation Standard, which reject the memorization of symbols and their use as "ends in themselves." Instead,

> "Representations should be treated as essential elements in supporting students' understanding of mathematical concepts and relationships; in communicating mathematical approaches, arguments and understandings to one's self and others; in recognizing connections among related mathematical concepts; and in applying mathematics to realistic problem situations through modeling." (p. 67)

Through signs-and-symbols activities, students recognize a wide variety of symbols from their everyday experiences. In addition, they explore how symbols operate to represent ideas in compact ways, and how they are used to communicate information. Ultimately, they design their own symbols, and test them with others, which leads to an understanding of how the communication process can fail. These experiences provide the background for the use of symbols, including graphic representations, in mathematics.

Standards for the English Language Arts

By 1991, it had become clear that standards would be produced for all of the major school subjects. Fearful that English language standards might be produced without a firm basis in research and practice, two major professional organizations requested Federal funding for their own standards effort. The following year, the Department of Education awarded a grant for this purpose to the Center for the Study of Reading at the University of Illinois, which agreed to work closely with the two organizations, the National Council of Teachers of English (NCTE) and the International Reading Association (IRA). This effort culminated in the 1996 publication of the *Standards for the English Language Arts* by the NCTE and IRA. These *ELA Standards* are now widely accepted for their clear, concise outline of English language education.

The *ELA Standards* adopt an unusually comprehensive view of "literacy," much broader in its scope than the traditional definition of "knowing how to read and write." (p. 4) Literacy also includes the ability to think critically, and encompasses oral and visual, as well as written communication. Recognizing that these forms of language "are often given limited attention in the curriculum," the *Standards* outline the variety of means used to convey messages in contemporary society:

> "Being literate in contemporary society means being active, critical, and creative users not only of print and spoken language, but also of the visual language of film and television, commercial and political advertising, photography, and more. Teaching students how to interpret and create visual texts such as illustrations, charts, graphs, electronic displays, photographs, film and video is another essential component of the English language arts curriculum." (pp. 5-6)

According to the *ELA Standards,* there are three major aspects to language learning: **content, purpose,** and **development.** Content standards address only what students should learn, but not why or how: "knowledge alone is of little value if one has no need to—or cannot—apply it." The *Standards* identify four purposes for learning and using language: "for obtaining and communicating information, for literary response and expression, for learning and reflection, and for problem solving and application." (p. 16) Purpose also figures prominently in the third dimension of language learning, development, which describes how students acquire this facility. "We learn language not simply for the sake of learning language; we learn it to make sense of the world around us and to communicate our understanding with others." (p. 19)

Of course, purpose and motivation vary from one situation to another. The authors of the *Standards* make this point, too, in their discussion of **context.** "Perhaps the most obvious way in which language is social is that it almost always relates to others, either directly or indirectly: we speak to others, listen to others, write to others, read what others have written, make visual representations to others and interpret their visual representations." Language development proceeds through the practice of these communication skills with others:

> "We become participants in an increasing number of language groups that necessarily influence the ways in which we speak, write and represent." While language development is primarily social, there is an individual dimension as well: "All of us draw on our own sets of experiences and strategies as we use language to construct meaning from what we read, write, hear, say, observe, and represent." (p. 22)

How does this broad conception of literacy and its development relate to daily classroom practice? The authors recognize that the *ELA Standards* may be in conflict with the day-to-day demands placed on teachers. "They may be told they should respond to the need for reforms and innovations while at the same time being discouraged from making their instructional practices look too different from those of the

past." Among those traditional practices are the use of standardized tests, "which often focus on isolated skills rather than contextualized learning." Prescribed texts and rigid lesson plans are further barriers to reform, because they tend to preclude "using materials that take advantage of students' interests and needs" and replace "authentic, open-ended learning experiences." (p. 7) Another problem is "the widespread practice of dividing the class day into separate periods [which] precludes integration among the English language arts and other subject areas." (p. 8) Taken seriously, these standards would lead to wholesale reorganization of most school experiences.

This introductory material sets the stage for the twelve content standards, which define "what students should know and be able to do in the English language arts." (p. 24) Although these are labeled "content" standards, "content cannot be separated from the purpose, development and context of language learning" (p. 24). In a variety of ways, the twelve standards emphasize the need to engage students in using language clearly, critically and creatively, as participants in "literacy communities." Within these communities, students sometimes participate as **receivers** of language—by interpreting graphics, reading and listening and—and sometimes as **creators**—by making visual symbols, writing, and speaking.

Some teachers have used the *Stuff That Works!* activities and units primarily to promote language literacy, rather than for their connections with math or science. Technology activities offer compelling reasons for children to communicate their ideas in written, spoken, and visual form. In early childhood and special education classrooms, teachers have used *Stuff That Works!* to help children overcome difficulties in reading and writing, because it provides natural and non-threatening entry points for written expression. In the upper elementary grades, *Stuff That Works!* activities offer rich opportunities for students to want to use language for social purposes. Several characteristics of *Stuff That Works!* contribute to its enormous potential for language learning and use:

- Nearly every unit begins with an extensive group discussion of what terms mean, how they apply to particular examples, how to categorize things, and/or what problems are most important.
- The activities focus on artifacts and problems that engage children's imaginations, making it easy to communicate about them. Teachers who use *Stuff That Works!* usually require students to record their activities and reflections in journals.
- This guide, along with *Mapping,* focuses on the problem of communication, and offers numerous experiences in visual thinking and visual communication.
- In the early childhood classroom, and in work with learning-disabled children, signs-and-symbols activities offer a natural and non-threatening route to language literacy.

For each of the *Stuff That Works!* topics, the opening activity is a scavenger hunt or brainstorming session. In a scavenger hunt, students develop an understanding of the topic by collecting and examining physical examples and discussing them. Often there are discussions about what the words mean, and how well some of the examples fit a category. For example, Mary Flores's second graders were grappling with the concepts of "sign" and "symbol," and the differences between them. One student said, "A symbol shows you a picture, a sign tells you the word." Mary's students were beginning to "participate as knowledgeable, reflective, creative and critical members" of a literacy community. (ELA Standard #11, p. 44)

Many special education students have very low self-esteem and are deeply frustrated by the difficulties they experience in learning to read and write. Working with a group of non-readers, Mary decided to explore their awareness of signs and symbols in the environment. It turned out that these children were keen interpreters of signs, which they often used to compensate for their difficulties in reading. Mary exploited their ability to understand

graphic symbols to help them make the transition to language literacy. In the process, they were learning "to adjust their use of spoken, written and visual language to communicate effectively." (ELA Standard #4, p. 33)

Students who engage in signs-and-symbols activities learn to interpret and evaluate examples of graphic communication created by others, and also to create and test their own designs. These kinds of experiences in visual communication are rarely encountered in most school curricula, although mandated by the *ELA Standards*. The design of signs, symbols, and codes engages children very directly in considering basic issues of language and communication.

For example, in designing a sign to convey the message, "WARNING, HOT LIQUID!", Christine Smith's students had to decide what kinds of symbols would convey the meaning "HOT." For a symbol to be effective, both the designer and the audience have to agree about what the symbol means. This is an example of learning "sensitivity to the purpose, nature and audience of a text." (p. 20)

Curriculum Standards for Social Studies

The social studies encompass a variety of disciplines, all concerned with the complex and changing relationships between the individual and society. Some of these fields have traditionally been taught as separate subjects. By the early 1990s major standards-setting efforts were underway for civics, economics, geography and history. In an effort to provide a framework for these separate disciplinary standards, in 1994 the National Council for the Social Studies (NCSS) issued *Expectations of Excellence: Curriculum Standards for Social Studies*. This document is not intended to replace the individual disciplinary standards, but rather to serve as a guide for integrating them under broad interdisciplinary themes.

> "Teachers and curriculum designers are encouraged first to establish their program frameworks using the social studies standards as a guide, then to use individual sets of standards from history, geography, civics, economics, or other disciplines to guide the development of strands and courses within their programs." (p. 17)

According to the NCSS, a primary purpose of social studies is to prepare students for their roles as citizens in a democratic society.

> "NCSS has recognized the importance of educating students ... who are able to use knowledge about their community, nation, and world, along with skills of data collection and analysis, collaboration, decision-making, and problem-solving [for] shaping our future and sustaining and improving our democracy." (p. 3)

This statement covers a lot of ground, and supports both sides of a major political controversy over the role of social studies in the schools. Should students learn what their society wants them to know, or should they develop as critical thinkers who can improve the way the society works? The NCSS *Standards* say "yes" on both counts: they should not only become "committed to the ideas and values" of our society, but also learn "decision-making and problem-solving." A companion NCSS document, *National Standards for Teaching Social Studies* (2000) is even more explicit: "Social studies teachers should ... encourage student development of critical thinking." (p. 35)

What sorts of educational strategies will accomplish these goals? The *Social Studies Curriculum Standards* outline five basic "Principles of Teaching and Learning." To begin with, the experiences should be "meaningful": "Students learn connected networks of knowledge, skills, beliefs and attitudes that they will find useful both in and out of school." Learning should "integrate across the curriculum," using "authentic activities that call for real-life applications." In applying what they have learned, students should "make value-based decisions" and develop a "commitment to social responsibility." (pp. 11-12) The *Teaching Standards* set the context for such education, in calling for "learning environments that encourage social interaction, active engagement in

learning and self-motivation." (p. 35)

Angel Gonzalez's "Signals for Student Needs" activity is an example of an extended curriculum unit that provides "for the study of the ideals, principles, and practices of citizenship in a democratic republic." (p. 30) The project not only involved students in solving a problem of importance to them, but also challenged the assumption that only adults can have a voice in how a school is run. At the beginning of the project, the students generated a brainstorming list of problems that lead to disruptions of the flow of classroom activities. Several of the problems on the list had to do with students disrupting a lesson by making requests of the teacher.

The next phase of the project was to make a more detailed list of the kinds of things that lead to these disruptions. Then Angel divided the class into groups, and asked each group to come up with a solution for the disruption problem. The consensus was that a system of hand signals would help to solve the problem by giving students way to indicate their needs unobtrusively. These signals would have to meet a set of criteria, which the class developed. They also agreed upon a list of six different messages, which were the most common sources of disruption. Then each group met again to design its own set of six signals, one for each of the messages. Meanwhile, Angel had arranged with a first grade teacher to run a test of the hand signals in her class.

The next step was to negotiate a common set of hand signals from among the proposals of the groups. For each of the messages, each group presented its idea, and the entire class voted on these ideas. Eventually, they selected one best hand signal for each message. Then they had to represent these ideas on paper, so they could be taught to the first grade class. Again, each group met separately to make its own drawing of each of the six selected hand signals. These were again voted upon, this time by a committee, before creating a master set of drawings to present to the first graders.

These activities, and to a lesser extent those of Guillermina Montano, Mary Flores, and Theresa Luongo, address two of the ten strands of the Social Studies *Standards:* Power, Authority and Governance (VI) and Civic Ideals and Practice (X). The latter of these strands advocates for direct participation of students in "identifying social needs, setting directions for public policies, and working to support both individual dignity and the common good." (p. 30) While the *Standards* propose that these activities take place at the high school level, it is clear that Angel's elementary school children had already begun to accomplish these objectives.

The Governance Strand is concerned with the ways in which decisions are made in contemporary society. By selecting the hand signals democratically, Angel's students were exploring "how groups and nations attempt to resolve conflicts and seek to establish order and security." This process helped them to "become more effective problem-solvers and decision-makers when addressing the persistent issues and social problems encountered in public life." (p. 26) When students design signs and symbols to solve real problems in their lives, they are learning powerful lessons about socially responsible, democratic decision-making.

Appendix A

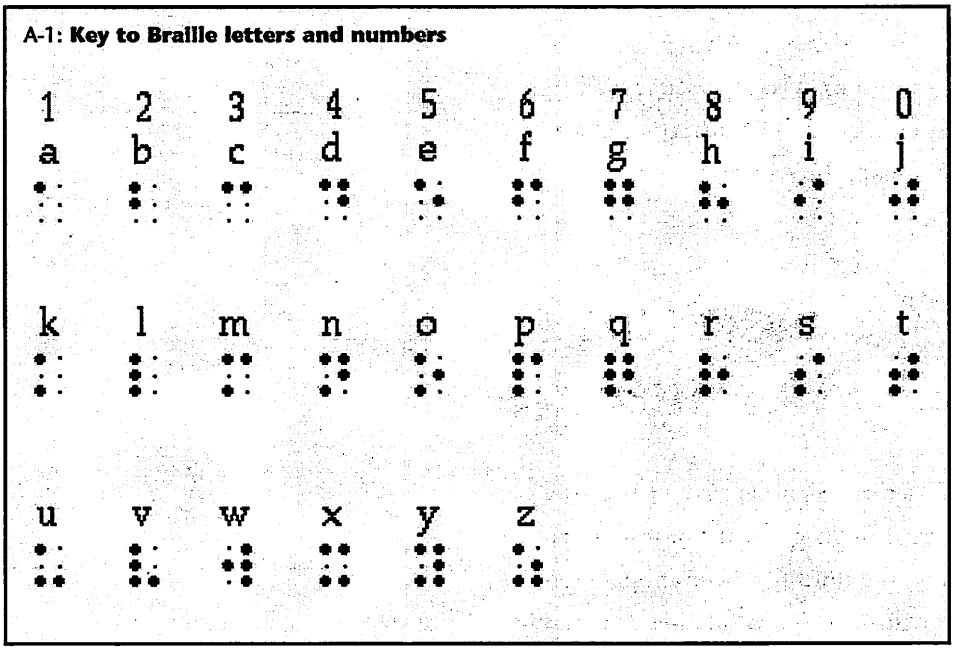
A Gallery of Codes

A code is a system of symbols that work together as a unit. The symbols used in a code are often arbitrary, so a key is needed to unlock the code. The key provides synonyms in a language that is already familiar. For example, a map key translates the graphic symbols used on the map into words. In this appendix, we will examine and decipher codes from six very different fields, ranging from Braille to refund coupons.

Braille

Braille is an arbitrary system that uses only two basic symbols, the dot and the absence of a dot. The dots are raised, so that a visually impaired person can feel them. The dots are clustered in little 2 x 3 grids called cells. Figure A-1 shows a key for interpreting the number and letter symbols of Braille. Note that the Braille language reuses the symbols for the letters "A" through "J" to encode the digits "1" through "0."

A-1: **Key to Braille letters and numbers**



Because each of the six positions in a cell has two possibilities—"dot" or "no-dot"—there are 64 (2 x 2 x 2 x 2 x 2 x 2) possible cells. A cell that has no dots at all represents a space between words, leaving 63 other combinations. The key in Figure A-1 shows only 26 of these. The others are used to encode punctuation marks, dozens of common letter combinations, and many common words. A complete guide to Braille is available on the web at the following address:

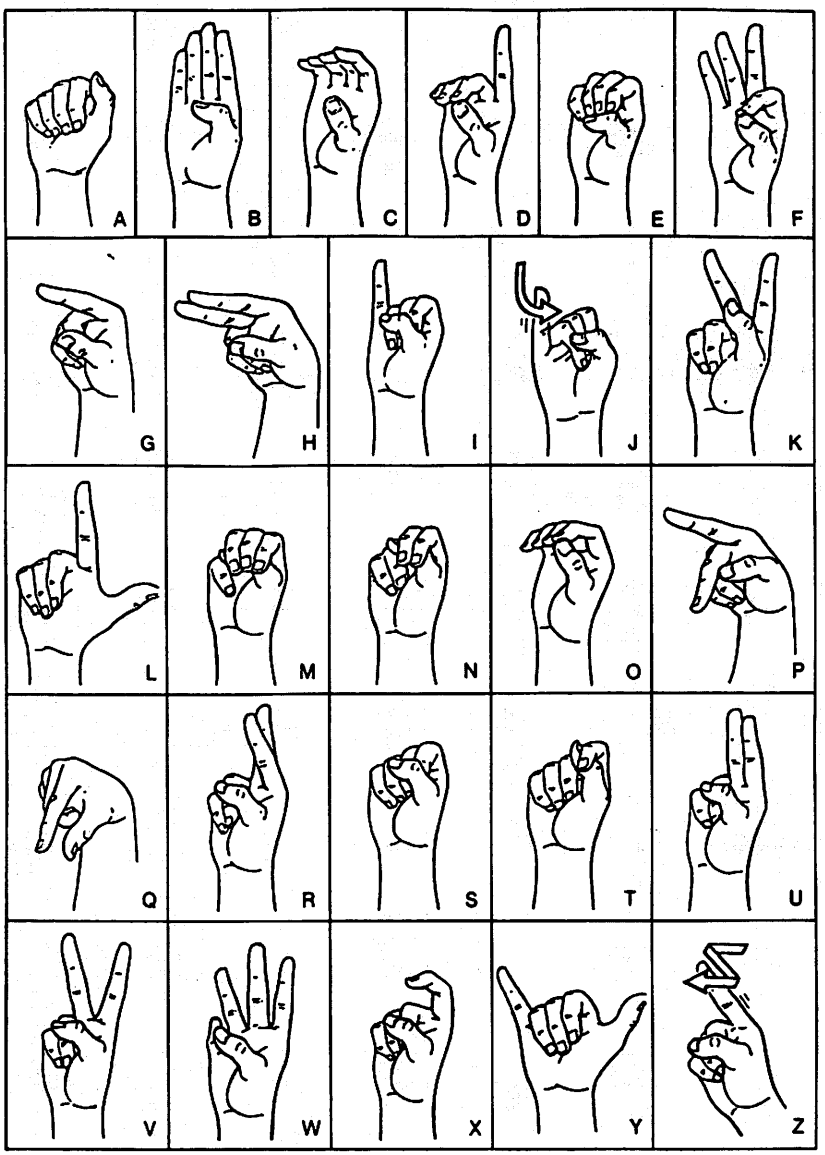
http://www.brailleauthority.org/def.html

The site also provides information about other Braille codes, such as those used to represent math and science symbols, musical notation, and computer information.

American Sign Language

American Sign Language (ASL) is a visual language for the hearing-impaired. It is the third most commonly used language in the U.S., after English and Spanish. ASL includes a largely arbitrary set of "lettersigns" that form a code for representing the letters of the alphabet. (See Figure A-2.) A few of these signs look similar to the letters they represent. The lettersigns are actually only a small part of the language, which also has thousands of signs for words and concepts, and takes considerable effort to learn. Many of these signs are very expressive. For example, to make the sign for "car," you put both hands in front of you and pretend to be turning a steering wheel back and forth.

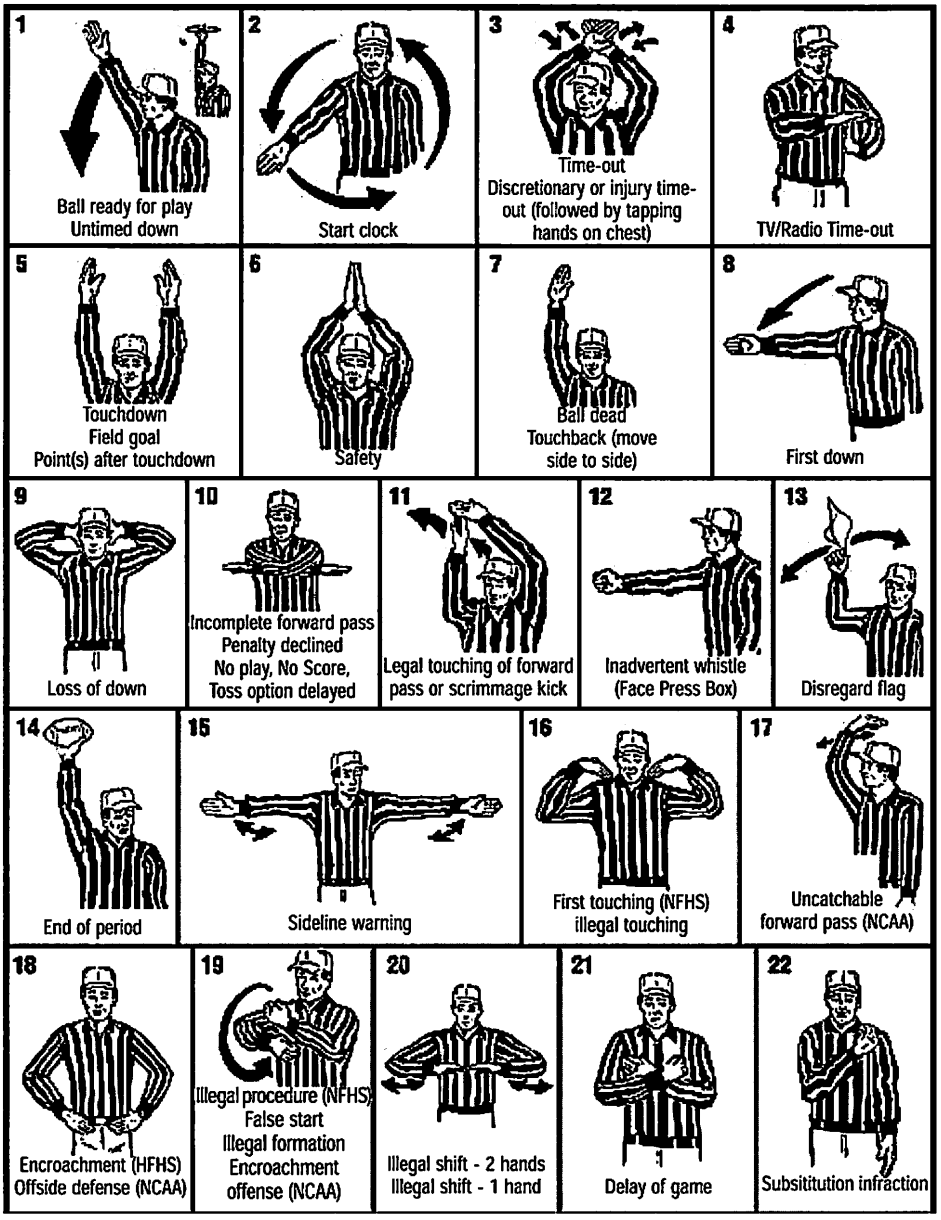
A-2: **Key to the ASL lettersigns**



Football Referee's Signals

A system of signs and symbols can be found in nearly any team sport. In a relatively quiet sport like tennis it may be possible to hear the scorekeeper, but in a sport such as football, it is nearly impossible to hear anything. Thus, football requires a visual code for transmitting information. Figure A-3 shows a key to some of the official referee's signals for football.

A-3: **Some of the referee's hand signals used in football**



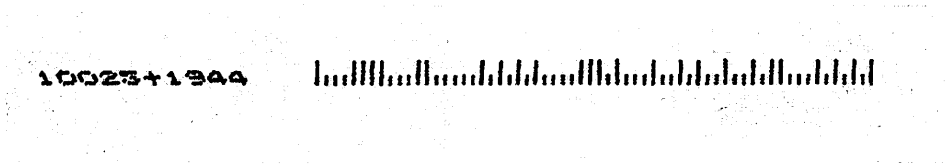
Postal ZIP Codes

There are some codes that everyone needs to know a little about because they are used in ordinary communication. An example of this type is the postal ZIP code. Originally, "ZIP" stood for "Zoning Improvement Plan." Before ZIP codes were introduced in 1963, major cities had already been divided into numbered zones. These numbers were incorporated into the new ZIP codes as the last two digits. For example, "New York 25, NY" became "New York, NY 10025."

The use of ZIP codes became nearly universal by the late 1970s. In 1983, four more digits were added, resulting in the nine-digit code currently used. This system was originally known as "ZIP + 4."

ZIP codes are the basis for automated sorting of the mail. A typical piece of mail is fed into a large scanning machine that reads the entire address and looks up the nine-digit ZIP code in a database. The machine then prints the nine-digit ZIP code on the bottom of the envelope, along with its bar code representation. The bar code is later used to sort the mail for delivery to its final destination. Figure A-4 shows the nine-digit ZIP code 10025-1944 and corresponding bar code, which were printed on an envelope by a scanning machine.

A-4: **Numerical ZIP code and bar code printed on an envelope by scanning machine**



What exactly does the nine-digit code represent? The first digit represents a group of states. "1" means either New York or Pennsylvania; "9" could be California, Oregon, Washington, Hawaii, or Alaska, etc. The first three digits, in this case "100," signify a Mail Processing Facility (MPF), a large postal center where mail to or from a region is scanned and sorted. The nine-digit ZIP and bar codes in Figure A-4 were printed on the envelope by a scanner at the MPF from the region where the letter was mailed. After the letter arrived at the "100" MPF, the bar code was read by a scanning/sorting machine, which put it into a bin for "10025-1944." Of this code, the "10025" stands for a local post office from which mail is delivered. The full nine-digit code represents a route that a letter carrier follows when delivering a single bundle of mail.

Telephone Signals and Phone Numbers

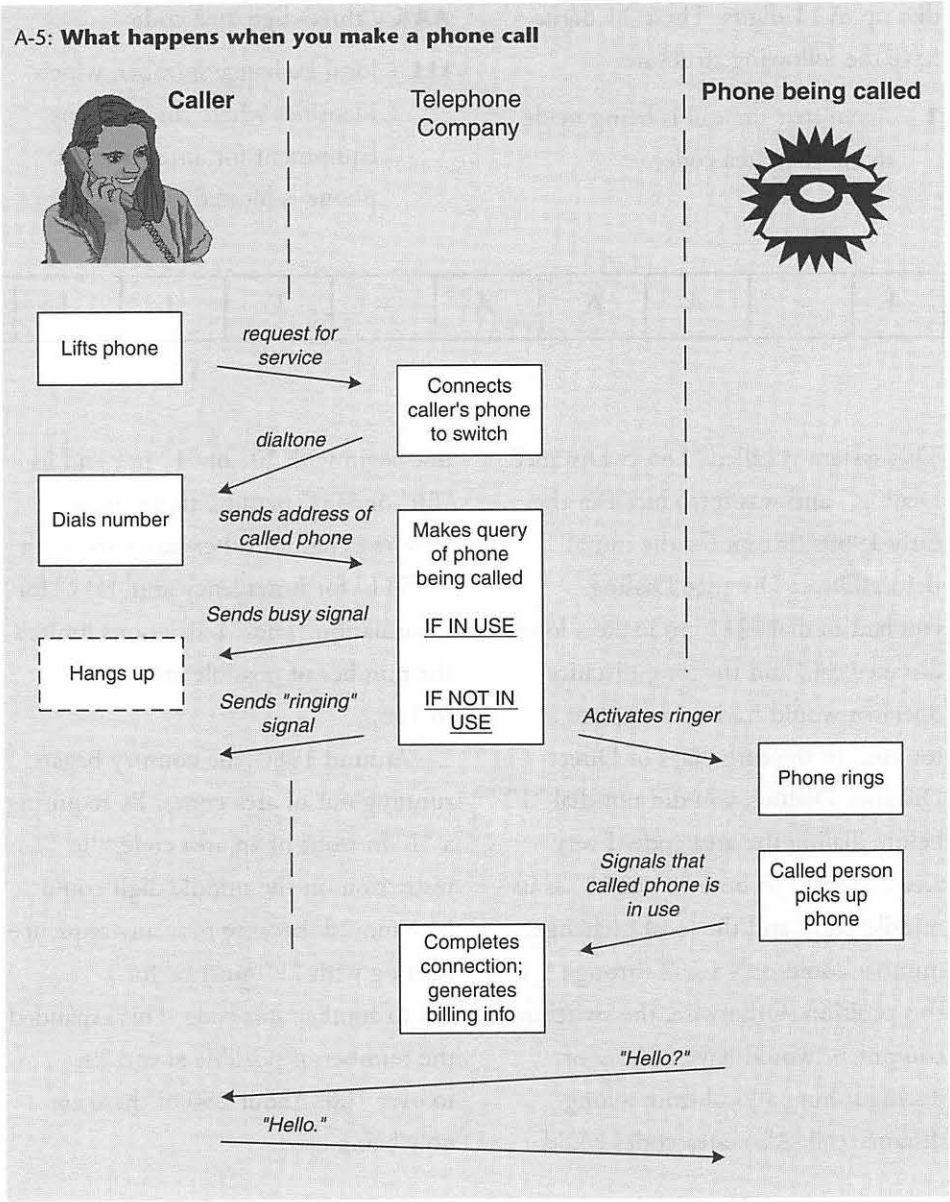
An ordinary phone call involves extensive use of symbols and signals, most of them hidden from the user. As with ZIP codes, however, there are some parts of the telephone signaling code that every telephone user needs to know something about. For example, everyone knows that you have to wait for the dial tone before you can dial a phone number.

Some of the signals involved in a typical phone call are shown in Figure A-5. Lifting a telephone from its cradle sends a signal to the central station requesting service. The telephone company responds, sometimes after a short delay, with a signal called a dial tone, which means, "Your telephone is now connected to a machine that can interpret a phone number." You then dial the number, which is a code for another person's telephone. The telephone company now determines whether that phone is already in use. If so, it sends you back a busy signal. If not, the phone company does two things:

1. It sends you a ringing signal.
2. It sends a signal to the called phone to activate the ringer.

These are not the same! You cannot actually hear the other person's phone ringing. The person you called picks up the phone, which is a signal to the phone company to complete the connection between the two phones. Finally, the verbal messages begin: "Hello?" "Hello."

A-5: **What happens when you make a phone call**



A telephone number is a very powerful code that can select a unique phone from among the billion or so hooked up around the world. How do telephone numbers manage this feat? To make a call from any phone in the U.S., Canada, and parts of the Caribbean to any other, you have to

dial up to 11 digits. These 11 digits have the following structure:

1 = signal that the call is being made to another area code;

AAA = three-digit area code;

LLL = local exchange number, which identifies where the signaling equipment for an individual phone is located;

PPPP = individual phone number, one of nearly 10,000 available in each exchange.

1	–	A	A	A	–	L	L	L	–	P	P	P	P

This system is called "Direct Distance Dialing," and was introduced in the early 1960s (except for the initial "1"). Before Direct Distance Dialing, you had to dial "211" to make a long-distance call, and the long-distance operator would have to complete it for you. In the early days of Direct Distance Dialing, you did not dial "1" before dialing the area code. Every area code had to have "0" or "1" as its middle digit, and the local exchange number could only use 2 through 9 in this position. Otherwise, the switching equipment would have no way of distinguishing a local from a long-distance call. Also, area codes could not begin with "0" or "1" nor end in "00" or "11," because these codes were reserved for other purposes, such as "911" for Emergency and "411" for Information. These restrictions limited the number of possible area codes to 136.

Around 1980, the country began running out of area codes. By requiring a "1" in front of an area code, the restriction on the middle digit could be removed, because now any sequence starting with "1" must be for a call to another area code. This expanded the number of possible area codes to over 700. About 250 of these are now being used.

Three-digit local exchange numbers have to follow roughly the same rules as area codes. The total number of possible phone numbers in an area code is about seven million. In many large cities and suburban areas, the telephone company frequently finds it necessary to introduce new area codes. Why? Apparently, the seven million or so numbers per area code can easily become exhausted, due to the proliferation of cell phones, fax machines, modems, beepers, and pagers, as well as ordinary phone lines.

Bar Codes

ZIP codes and telephone numbers are numeric codes designed to be sent by people, even though they are interpreted largely by machines. They are not too difficult to remember or use. There is another category of code that most people never become concerned with, because they are designed for machine-to-machine communication. These include the electronic codes used to communicate within or between computers; the electromagnetic codes used in radio and TV transmissions; the magnetic codes used on credit cards, audio tape, and video tape; and the optical codes used on CDs and DVDs. The examples just mentioned do not use visible symbols, and the codes are therefore impossible to see without special equipment.

There is, however, one large category of codes that use visible symbols for machine-to-machine communication. These are the ever-present bar codes found on mail (see Figure A-4), airport luggage tags, books, consumer products, coupons, library cards, property tags, standardized forms, and much, much more. It is interesting to explore what these bar codes actually represent. You don't have to crack the bar code itself because the corresponding number is usually written just below or to the left of the bar code. We will not focus at all on the bar patterns, but only on the numbers they represent. Palmer (1995) provides detailed information about the actual bar patterns.

A-6: **Refund coupons for pasta (left) and pasta sauce (right) of the same brand**

A-7: **50-cent refund coupons for two cereal products**

Bar codes are found on manufacturer's refund coupons, such as those in Figures A-6 through A-9. These bar patterns use the Universal Product Code (UPC) system. UPC bar codes are also found on most non-durable consumer products, particularly those sold in supermarkets and pharmacies. By looking at a few coupons carefully, it is not too hard to figure out what these numbers mean.

A-8: **One-dollar refund coupons for ice cream**

A-9: **Cereal coupon offering "$1.00 on any 2"**

Look at the numeric codes circled in Figures A-6 through A-9. Each of the bar codes has a small number "5" in the leftmost position. As you might guess, a "5" in this position simply means "refund coupon." On most packages sold in supermarkets, the first digit is "0," which means "nationally branded item, non-health-related." Most drugstore items use "3" in the first position; and items packaged in the store, such as meat and cheese, have a "2." You will also notice a small number at the extreme right end of the 12-digit code. This is a check digit, which is the result of an arithmetic computation on all of the other numbers. By doing the same calculation and comparing it with the check digit, the bar code scanner verifies that it has read the code correctly.

Next, let's figure out what the other ten digits mean. Consider the two coupons in Figure A-6. These coupons are for different products and different refund amounts. The only thing they have in common is they are both products sold under the same brand name. The bar codes on the two coupons both have "24842" on the left side, and then differ in some of the five digits on the right side. The "24842" must represent the brand name, which is owned by the Nestlé's conglomerate. But this raises another question: Does "24842" represent Nestlé's or the particular brand? A quick check at the supermarket reveals that "NesQuik," one of Nestlé's other brand-name products, has the code "28000" and "Carnation," another Nestlé's brand, uses "50000." So "24842" probably represents only one of the Nestlé's brands.

To find out what the last five digits mean, let's look at the coupons in Figure A-7. Both are issued by the same cereal company, which is represented by the manufacturer's code "38000." Both are for 50 cents, and both show "50" in the last two digits. However, the other three digits are different, to correspond to the different cereal products, represented by "590" and "543," respectively. We notice that in Figure A-6, the last two digits also correspond to the amount of refund in each case, 55 and 75 cents, respectively.

Now, let's test our hypotheses on the ice cream coupons in Figure A-8. All three are for $1 refunds, but the amount codes are not the same, and neither corresponds directly to $1.00. They couldn't put "100" as the value code, because only two digits are available, but why are both "76" and "42" used to represent $1 refunds?

This mystery is resolved when we look at the cereal coupon in Figure A-9, which promises "$1 on any 2," and has an entirely different number, "33," in the refund value position. "$1 on ANY," "$1 on ANY 2," and "$1 on ANY 4" are not the same value, so they are represented by three different codes: "76," "33" and "42," respectively.

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Holmes describes how he designed some famous graphics for *Time* magazine, showing how each symbol or logo evolved from its initial conception to its final form.

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Horton describes how to analyze and design icons for computer software. It contains hundreds of examples and is very easy to follow. One chapter deals with the testing of icon designs.

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This is a collection of creative projects done by the authors' college-level graphic design students. The problems included redesigning the back of a truck to show graphically which side to pass on. One student showed a tomato on the left side and a bottle of ketchup on the right.

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GLOSSARY

Arbitrary symbol: A symbol whose meaning needs to be learned because it does not suggest its own meaning.

Channel: The medium, such as light or sound, through which a message is sent.

Code: A set of symbols or signals that work together as a unit.

Decoding: The process of extracting meaning from a message.

Design: The creation of something new in order to solve a problem, and its evaluation to see how well it works.

Encoding: The process of converting a concept into a message so it can be transmitted.

Expressive symbol: A symbol that expresses its own meaning by depicting some aspect of the concept it represents; also called an icon.

Graphic symbol: An image that serves as a symbol.

Homonym: A word or other symbol that has more than one meaning; for example, "just" could mean "only" or "fair."

Icon: An expressive graphic symbol or image that represents an object, an idea, or an action.

Ideogram: A single symbol used to represent an object, an idea, or an action; for example, a Chinese character or an Arabic numeral.

Key: A table showing the translation of a set of graphic symbols into words.

Phonogram: A symbol that represents a sound; for example, an English letter.

Pictogram: A picture or an icon used to represent an object, an action, or an idea; for example, a NO SMOKING symbol.

Semantics: The study of the relationships between signs and symbols and the meanings they represent.

Semiotics: The study of signs and symbols.

Sign: A figure or device that stands for a word, phrase, or operation; an action or gesture used to convey an idea; a board, placard, or other material displayed in order to advertise or convey information.

Signal: A gesture or other mechanical or electrical action that serves as a symbol for an object, an action, or an idea; for example, the index finger across the lips as a signal for "Quiet!"

Symbol: Something—such as an image, action, or sound—used to represent an idea, object, or action.

Synonym: A word or other symbol that means the same thing as a different word or other symbol; for example, "also" and "too."

Syntax: The set of rules for organizing and manipulating symbols; the way in which words are put together to form phrases and sentences.

Technology: The artifacts, systems, and environments designed by people to improve their lives.

Translation: The process of converting symbols or words from one symbol system or language to another; in other words, a way of expressing the correspondences between synonyms.

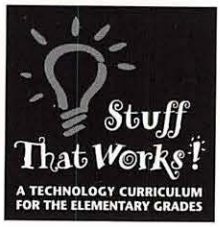
Signs, Symbols & Codes

Gary Benenson and **James L. Neujahr**, *Project Directors, City Technology, City College of New York*
Foreword by **George D. Nelson**, *Director, Project 2061, American Association for the Advancement of Science*

Now elementary teachers can combine the best of science and technology education in a comprehensive curriculum based on everyday materials and artifacts.

Signs, Symbols & Codes uses a novel, engaging approach to teaching different methods for representing information. Signs and symbols can take the form of words and numbers; graphic devices used on maps, signage systems, packages, and consumer products; and even gestures used by teachers and children to get one another's attention and convey messages. A set of symbols organized into a coherent system is called a code. The contexts and activities in this book involve signs, symbols, or codes of some sort and all draw on a broad range of places and situations that are part of everyday experience. Let your students learn how to decipher and use this information both in and out of school. At the same time, meet these broader instructional goals:

- introduce fundamental themes of information, representation, sign, symbol, and communication
- promote literacy by developing a variety of techniques for sending and receiving information
- promote numeracy by increasing awareness of symbols as a means to represent quantitative information
- demystify common artifacts and, by extension, technology in general
- develop process skills in observation, classification, generalization, communication, and design
- foster an appreciation of the immediate environment
- provide rich opportunities for group work.



Signs, Symbols & Codes is one of a five-volume series, *Stuff That Works! A Technology Curriculum for the Elementary Grades*. Developed by City Technology of City College of New York, each volume helps teachers plan and implement classroom activities and units organized around a single topic—how and why a basic technology works. The guides include an introduction to concepts, classroom stories, resources, and information about standards, as well as suggestions for teachers new to the subject. Use a single volume independently or all five to form a powerful vehicle for integrating science, math, social studies, language arts, and everyday technology. The complete series includes:

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