Gary Benenson & James L. Neujahr
Project Directors, City Technology
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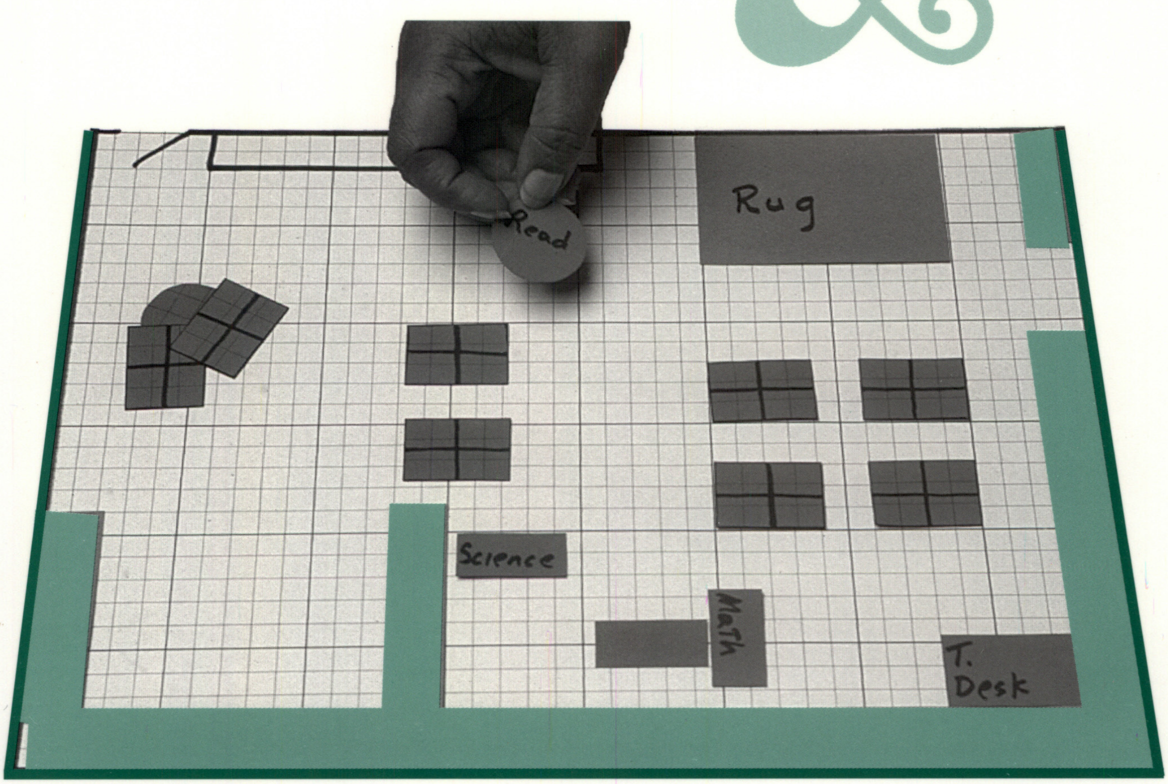
Stuff That Works!
A TECHNOLOGY CURRICULUM FOR THE ELEMENTARY GRADES

# Designed Environments

## Places, Practices & Plans




Foreword by GEORGE D. NELSON

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Gary Benenson and James L. Neujahr
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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*

# INTRODUCTION

## What Is Technology?

***Stuff That Works!** Designed Environments: Places, Practices, and Plans* 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.

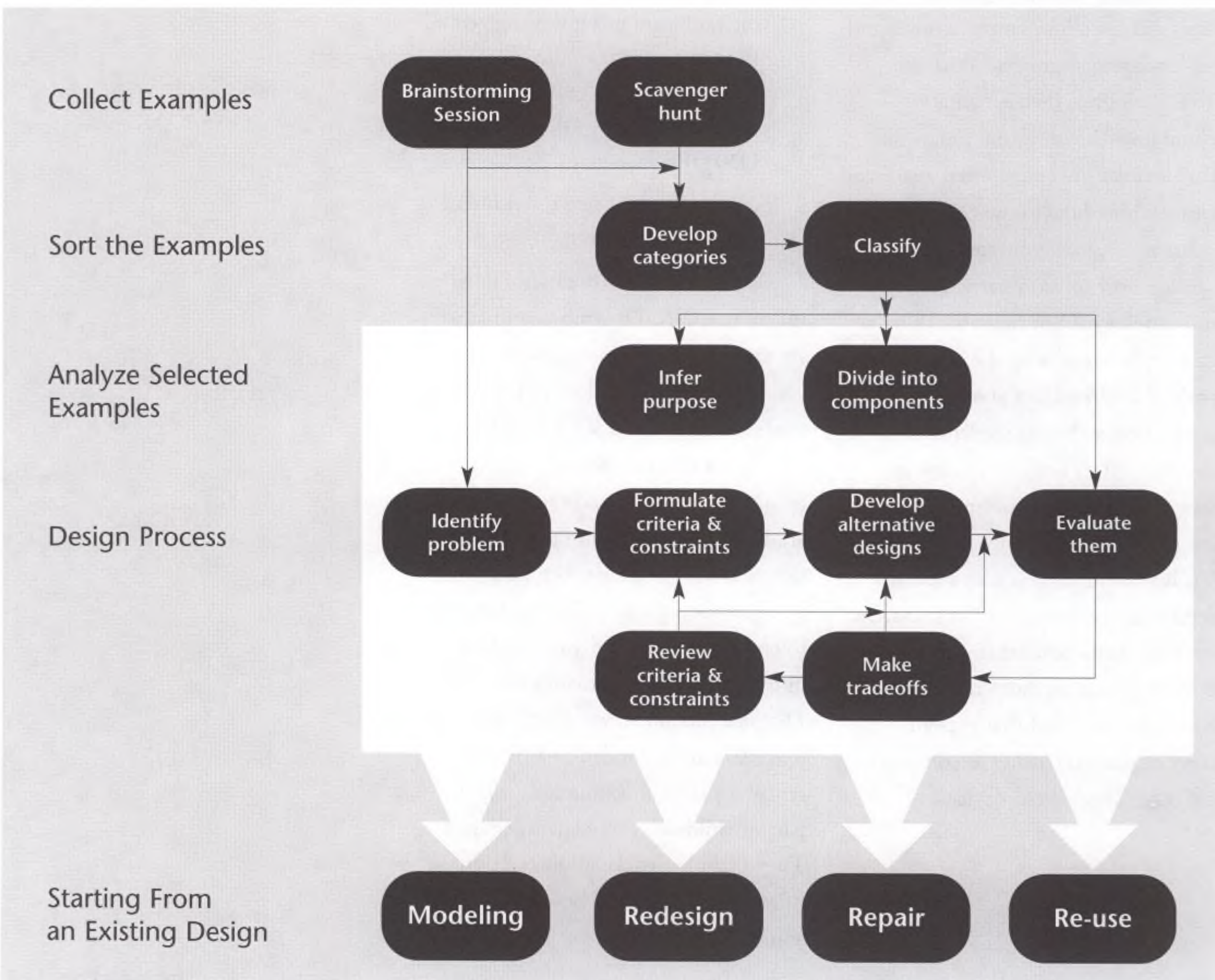
The ***Stuff That Works!*** approach is based on artifacts and systems that are all around us and available for free or at very low cost. You need not be a technical guru or rich in resources to engage yourself and your students in technology. The activities in *Designed Environments: Places, Practices, and Plans* are grounded in a broad range of places and situations that are part of children's everyday experiences. They include the classroom, schedules, rules, other places at school, and animal habitats.

# 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 *Designed Environments: Places, Practices, and Plans*

*Designed Environments: Places, Practices, and Plans* is about using the process of design to make environments work. This book introduces children (and teachers) to the design process by involving them in creating solutions to problems in environments that are very familiar and important to them: the classroom and the school. Through the projects described here, children learn the basic techniques of design technology by applying them first to the familiar school and home environments. The projects engage children in problem-solving grounded in democratic processes that result in real and positive changes. They learn basic approaches to environmental design problems that involve working with others and taking responsibility for improving the shared environment. These are valuable experiences, techniques, and skills in design technology that children can apply to other life situations.

*Designed Environments: Places, Practices, and Plans* looks at the organization of space and time in daily life, and engages students in creating and evaluating their own designs. The content and activities presented here will help you meet these instructional goals:

- Introduce the fundamental theme of environments as complex systems that are designed and evaluated;
- Develop a broad view of technology and its role in everyday life;
- Develop an understanding of technology design;
- Develop process skills in observation, data collection, categorization, problem identification, data organization and presentation, design and evaluation;
- Develop skills in communication and group work.
- Develop awareness of problems in the immediate environment, and responsibility for solving them;
- Foster a sense of control in relation to everyday problems.

# 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. It also reviews what is known from relevant cognitive research.

**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 and concepts; materials, references to standards and teacher tips; and sample worksheets.

**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 *Designed Environments: Places, Practices, and Plans* 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.

*Designed Environments: Places, Practices, and Plans* presents a number of activities, most of which involve students in real design projects. That is, the goal of the project is not to make a drawing or model. Rather the goal is to design a real environment, implement the design, live in the new environment, and then see if it is an improvement over the preceding environment. Thus students work through the full design process illustrated on page 2. The design process is so important to this guide that it is described in considerable detail in Chapter 2.

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.

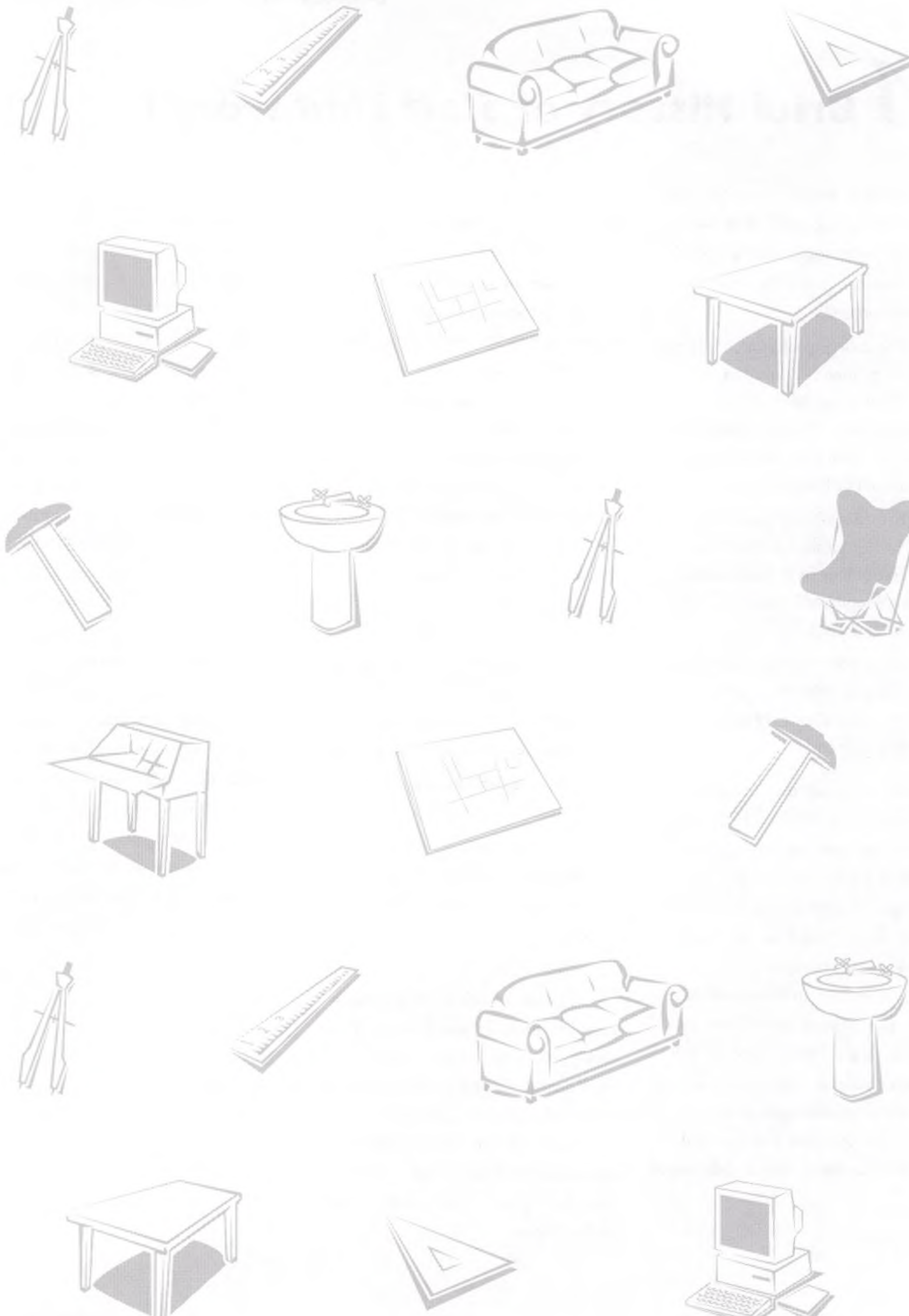
During the 1997-98 and 1998-99 academic years, the teachers participated in workshops that engaged them in sample activities and also provided opportunities for sharing and discussion of classroom experiences. The workshop activities then became the basis for classroom projects. The teachers were encouraged 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

*Designed Environments: Places, Practices, and Plans* is about analyzing and designing environments. This chapter provides an introduction to the meaning of *environment* as it is used in the concepts and activities you'll find in subsequent chapters. We start with a list of environmental design problems generated in a brainstorming session with some teachers. It is a wide-ranging list of activities that suggests a very broad definition of *environments.* We give structure to the concept of environment through three categories: the environment of space—the places of our lives; the environment of our practices, shaped by rules, procedures, rites, laws, conventions, and so forth; and the environment of time, which we structure through our schedules and plans. Following these are four examples of environmental design. The first example is of a redesign project that we encourage you to carry out in your own home or at school. This is followed by examples of *Designed Environments* projects that are based in classroom settings.

## What Is a *Designed Environments* Problem?

Think about some of the minor (and not so minor) annoyances that complicate your daily life. Do you waste time looking for things that are not where they ought to be? There are the keys you can't find in the rush to leave for work. You know a memo is among the papers on the desk, but you have to shuffle through the whole pile several times before you find it. Misplaced keys and lost memos are problems of how things are organized—where they are kept. Is there a pile of papers you don't really have a place for? How will you deal with the overflowing catchall drawer? These too are problems of how things are organized. To solve problems like these you first have to analyze how and why they came about in the first place. Only then can you design new, more effective ways to organize things. Problems resulting from the way things are organized are as common in the classroom as in the home. Teachers and children lose or misplace things. Teachers and children have problems putting things away in such a way that they can easily be found and retrieved when they are needed next time.

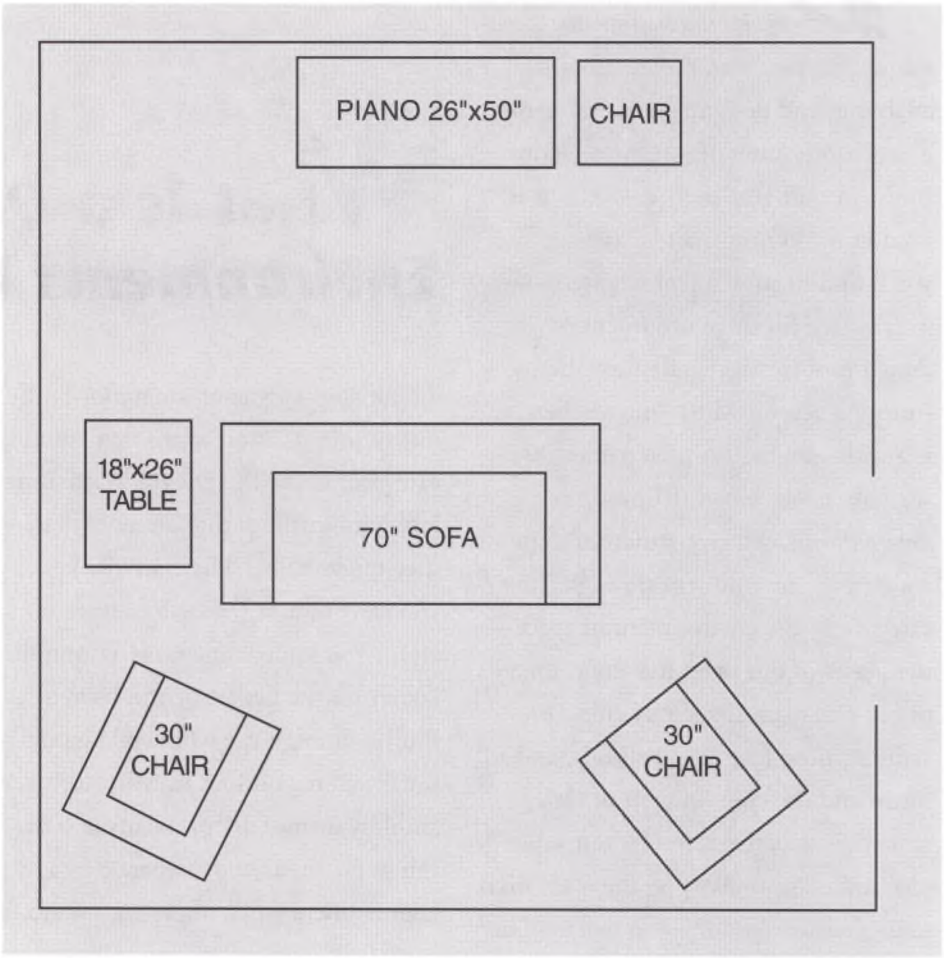
The range of environmental design challenges in the classroom and in the home goes far beyond problems of storage and retrieval. Decisions about the furniture in the room and how to arrange it are design decisions that influence the sort of environment you create. Recurring problems in the classroom can be indicators that something in the design of the environment or the way it is used is not working. Here are some clues that tell you there may be an environmental design problem for you to analyze and solve:

- Conflicts between students frequently arise in a particular area of the room.
- Certain rules are frequently broken.
- There is never enough time to finish certain activities.

When we asked teachers to brainstorm ideas for environmental design projects, they came up with this wide-ranging list:

- Rearrange the living room furniture.
- Develop rules for watching TV.
- Adapt the class schedule to accommodate a two-hour science investigation.
- Plan a shopping trip to several stores.
- Design a closet organizer.
- Invent new ways to display children's work.
- Change the rules of a game to make it easier or faster.
- Add new folders to a filing system and rearrange the contents.
- Set new procedures for using the pencil sharpener.
- Move children's seats to control behavior.
- Change activity centers in the classroom.
- Modify a game to fit a different-sized play area.
- Decide where to place things in kitchen cabinets.
- Develop ways to control classroom temperature.

1-1: **Plan for rearranging the living room**



What do the things on this list have in common? They all involve doing something to improve a situation. They do not involve creating a new product or building something. Environmental design activities involve rearranging the things that are already at hand, or establishing new procedures for how things are to be used or done. The activities in the list above involve different environments, but we live in all of them and to varying degrees they are under our control. In *Designed Environments: Places, Practices, and Plans,* we categorize environments under three headings: space, time, and rules and procedures.

The starting point for spatial design activities like these is usually a problem, a need, or a sense that things can be improved. The trigger for each designed environment activity in this guide is the identification of a problem that the class can solve, a need that can be met, a situation the class can improve. The word *trigger* is appropriate for these spatial design situations because they propel us into action:

- Storage space is hard to get to.
- Drawers are cluttered.
- There are frequent spills in the lunchroom because it's poorly organized.
- The rug is getting dirty because of too much traffic.
- The block area is a mess.
- There is not enough sunlight in the science area.
- There isn't enough storage space.
- There's no place to display projects.
- Where can we hang student work?
- Where can we keep work in progress?
- How can we have block building carry over from day to day?

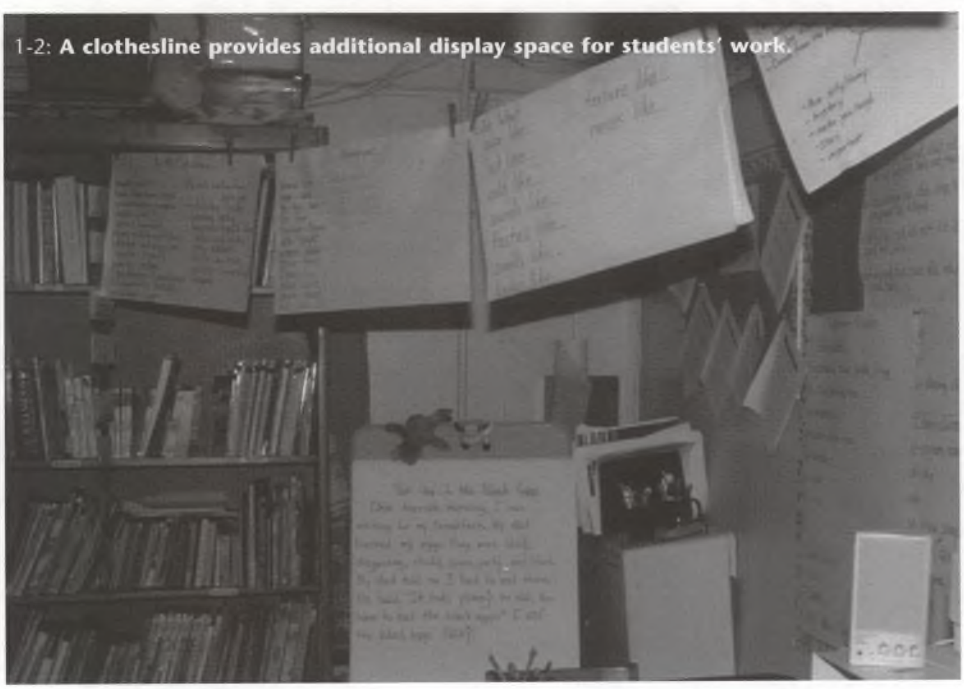
# Space

"Spatial environment" is what we usually mean when we say "environment." It encompasses everything we can see: the natural environment and the built environment.

The spatial environment is the focus of the engineer, architect, and interior designer. It's also frequently the focus of the classroom teacher. For example, you are engaged in designing the spatial environment when you...

- Plan storage spaces for learning materials;
- Rearrange desks and tables;
- Develop display spaces;
- Organize bulletin boards.

1-2: **A clothesline provides additional display space for students' work.**



Any of these could lead to a design project that would engage the best thinking and problem-solving of a class. Design projects promote a variety of important skills:

- identifying problems in the environment;
- deciding what information is needed to understand the problem, and gathering it;
- creating possible solutions, selecting the best, and implementing it;
- evaluating the solution, then redesigning it if necessary.

There are other equally important outcomes of designed environment projects. When children engage in solving real problems, they take responsibility for the solutions. Through them they practice democracy and they develop social responsibility. What's more, some of the nagging problems of the classroom get solved!

## Time

Time shapes our lives as much as space does. We can be as constrained by time schedules as by spatial structures and boundaries. We can't escape the demands of time, but we can do a better job of organizing the way we use it.

Schools vary greatly in the organization of the day, the week, and the year. Some teachers are told the exact times they must teach reading, writing, and arithmetic each day. Others are less rigidly constrained. All teachers use their creativity to adjust class schedules to meet the needs and interests of children. For example, some are able to rearrange the time spent in each curricular area in order to provide a double period for special projects. Others revisit a topic, such as mapping, throughout the year rather than studying it more intensively over a few days. Teachers regularly deal with the problem of too many curricular demands and too little time. Classroom *Designed Environments* projects can also begin with problems relating to time:

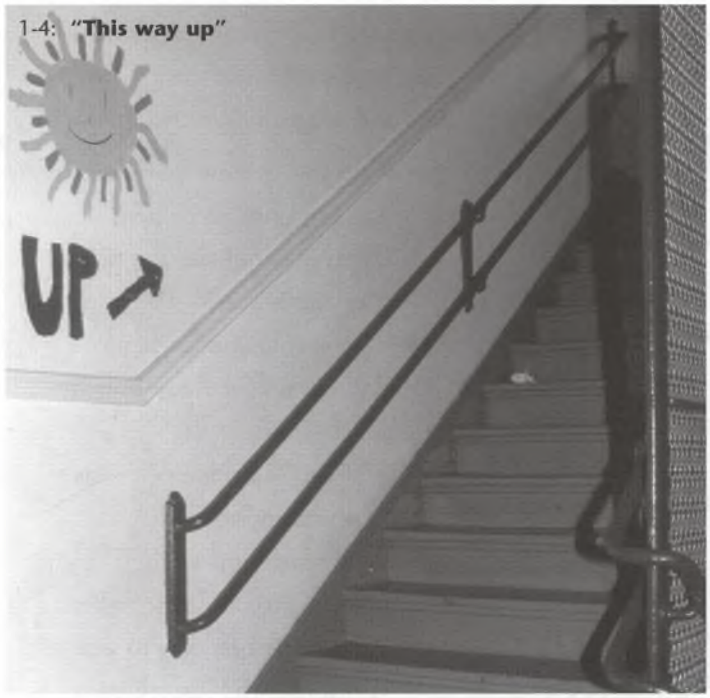
- There's not enough time to finish this project.
- We wasted 10 minutes on the cafeteria line because too many go to lunch at the same time.

1-3: **Time planning**

| Monday | |
|---|---|
| 3:30 | Home from school |
| 4:00 | Play ball |
| 5:30 | Eat |
| 6:00 | Sega |
| 7:00 | Homework |
| 7:30 | TV |
| 9:30 | Bed |

- We lose too much time between reading and math.
- Why don't we ever do social studies in the morning?
- I hate it when the intercom keeps coming on.
- I always have to take work home: there's not enough time to do it in class.

After school, many children are free to decide what they do until dinnertime. Even in the evenings when parents are home, children decide how to divide their time among television, hanging out, talking on the telephone, using the computer, and doing homework. Children's use of time is fertile ground for analysis and planning. An interesting activity is for children to keep track of how they use time. As children collect data on how they use time, they are at the same time making categories: one may record time spent in the broad category of "watching television"; another might have a category for each show watched. Children's time data provides the context for reflection on how they use time. Real-life time data is the starting point for plans of alternate ways to schedule after-school time. Figure 1-3 is one child's plan for how to use time.



1-4: **"This way up"**

## Rules and Procedures

Here is another list of common teacher activities:

- Plan a lesson.
- Modify a game.
- Set rules for use of the pencil sharpener.
- Develop guidelines for Internet use.
- Plan a class trip.

Activities like these, while they have spatial and temporal connections, do not fit neatly under our first two categories. We list them under the heading: environment of rules and procedures.

Rules and procedures make a different sort of environment than space and time. Rules and procedures shape how we live in space and time.

From the time we get up until we go to sleep, we are guided, constrained, freed, and frustrated by rules, laws, customs, regulations, and procedures. Consider the following rules and procedures.

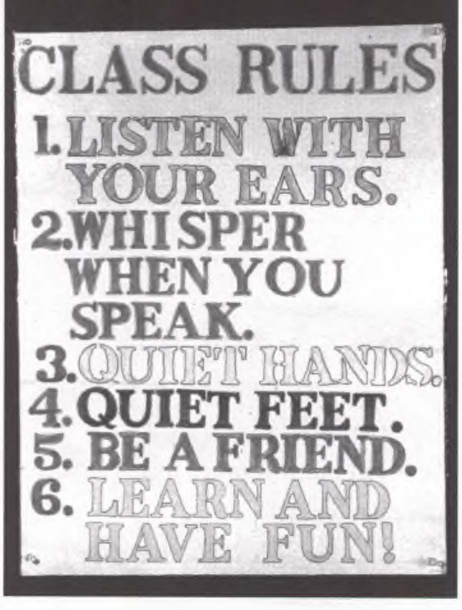
- Drive on the right side of the road.
- Stop at the red octagonal signs.
- Take a number at the deli counter.
- Knock before you enter.
- Raise your hand if you want to say something.
- Go to the end of the line.
- Everybody gets just one piece of cake.
- Fill out insurance forms at the doctor's office.
- Leave the building for the fire drill.
- Stand for the Pledge of Allegiance to the flag.

This list barely does justice to the multitude of customs, laws, regulations, accepted practices, rules, and procedures that shape our lives. We live in environments that guide, encourage, and restrict what we do. Often we are not aware of the rules until they are broken—i.e., when someone cuts into line or takes too much food. Rules and procedures provide the structures that some feel as freedom, others as constraint. Rules and procedures are as much a part of the classroom environment as are the time schedule and the classroom layout. (See Figure 1-5.) More important, classroom rules and procedures are largely under the control of the teacher. They represent an area where students and teachers can analyze their own environment, figure out what works and doesn't, and actually come up with a better design. Here are some questions that can trigger projects to design improved rules and procedures in the classroom:

- Who and/or how many may go to the bathroom and when?
- When may one use the pencil sharpener?
- Who gets to speak when?
- How do we get ready to leave the classroom?
- How do we decide who gets to use the computers?
- Should we allow eating/chewing gum in class, and if so, when?
- What is the best way to deal with those who interrupt?
- What ought we do to those who bother others?
- How should we decide who goes to which activity area?
- What is a quick way to get homework corrected?

The flip side of developing rules and procedures is enforcing them. What happens when a child breaks a classroom rule? A teacher may react by ignoring the behavior, encouraging the child to conform, cajoling, or punishing. The ways that teachers deal with rule breakers is of particular interest to children. During the later elementary years, fairness becomes the criterion children use to judge teacher discipline. How do they feel about the ways their teacher deals with rule-breaking and other misbehavior? Is there a place for their input?

1-5: **Class rules**




# Designed Environments and You

You could now be saying, "This isn't hard. I'm already an expert at rearranging things, making schedules, and deciding how to do things. I do this all the time." That is the point. All of us engage in designing places, practices, and plans, but most of the time without reflection. However sometimes we do ask: "How can I do this better?" or "How can I improve this situation?" Such questions lead from a "making do" approach to environmental design issues to the sort of analysis and design activities that characterize this guide.

# Getting Started: Redesign Your Desk

This is an introduction to designed environments that you can do on your own. By the nature of teaching, almost all of us have messy desks. "Redesign your Desk" takes you through these steps in the process of analysis and design:

- Identify the problem.
- Gather and analyze information about the problem.
- Determine the criteria for a redesign to meet and identify constraints on the design.
- Design possible solutions.
- Select the best solution and implement it.
- Evaluate the new design. Does it meet the criteria?

Try reorganizing your desk in school or at home, but do it with attention to analysis and design by following the steps listed above. You may find that some steps overlap others. You will find that you have to go back and forth between steps. That's because the order represents a linear sort of thinking that doesn't apply to the way you approach problems or that doesn't necessarily work for this particular project. So be creative in your thinking, but try to employ each step at some point as you're working on the problem. The description below goes through the steps in the design process in the order listed above, but it will be clear that the order would not be followed in real life designing.

1-6: **Desk before redesign**

## Identify the Problem

Clutter, lack of space, poor organization: these are a few desk problems. Typically there is one overwhelming problem that triggers the desire to redesign or to fix a situation. For this example, we will redesign to solve the problem of desk clutter. This does not mean that clutter is the only problem addressed in the redesign activity. As we think about how to improve the desk, we will think of other issues. Clutter is simply the problem that triggers redesign in this instance.

## Gather Information and Analyze the Problem

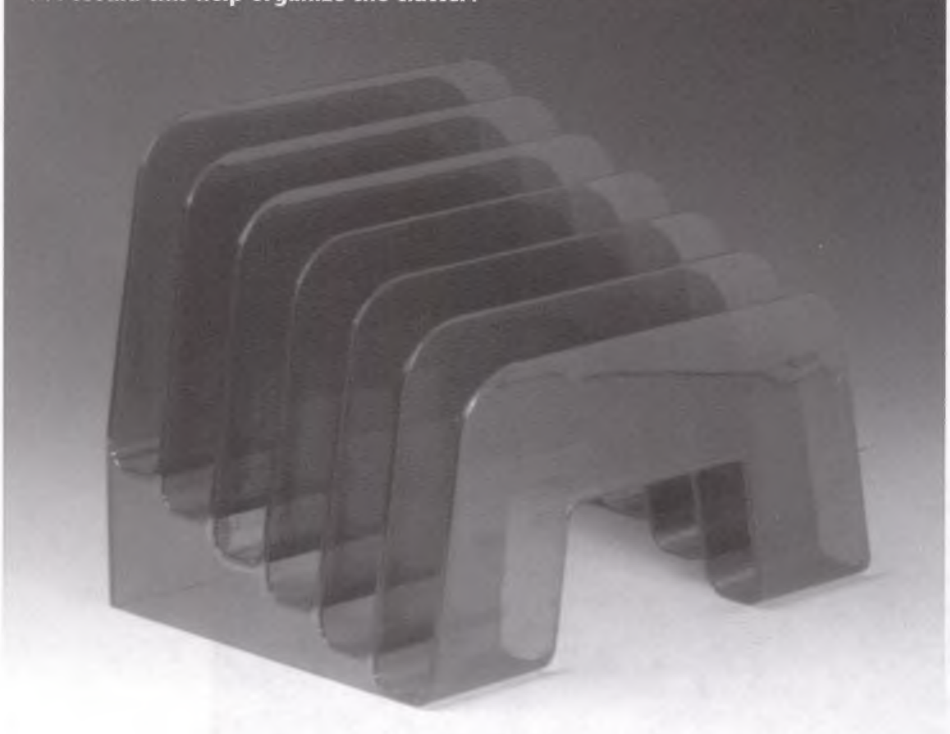
There is a pile of things on your desk: school papers, mail, newspaper clippings, unread journals, and so forth. What does it mean to gather information about this clutter? First, sit down at your desk. Go through the items on the desk to see what you have. Resist the temptation to try to put them away as you go along. If putting things away were easy, you would have already done it. As you look through the clutter to see what you have, the natural thing is to begin to sort it out. So, categorize the clutter. Categorizing is an essential step in analysis.

Now look at the various places you have available for putting things away. As you think about where you would place each item, you think of places at your desk or away from it in terms of how convenient they are, how adequate. For some things there may be no appropriate place. What is needed in order to take care of these? And what about the things that you've kept for a long time but don't use? Why did you keep them? This analysis is necessary before you can identify the limitations within which you must work and figure out what criteria a new design should meet.

Information gathering and analysis goes beyond examining your own experience. You need to go to new sources of information in order to bring new knowledge to solving the problem. There are two ways to do this for the desk redesign. First, gather information on different ways desks are organized. Talk to friends and colleagues about how they organize their home office. What do they have on the desktop? What sort of files do they keep and where?

Second, get information about the kind of products available to make desk organization easier. These include stacking trays, drawer organizers, sorters, pencil holders, portable filing

1-7: **Would this help organize the clutter?**



systems, and so forth. Visit an office supply store. Note the sorts of organizers that are displayed with desks. Check what is available through office supply catalogs. This additional knowledge leads to a broader range of design solutions.

## Select Criteria and Determine Constraints

*Criteria* and *constraints* sound technical and, in fact, they distinguish technology design from everyday design.
Setting criteria for a design means being explicit about what a design is to accomplish. Criteria develop from the needs a design is expected to meet. Criteria specify how well, or to what extent, a need is to be met in order for the design to be considered acceptable or successful.

Constraints are limits on the designing process. They might include:

- Time available to develop and implement a solution;
- Resources such as money, materials, or expertise;
- Existing rules and regulations, including requirements for authorizations.

Constraints are guidelines within which designs are developed.

It makes sense to create a list of criteria and constraints while you are gathering and analyzing information about your desk (the previous step). In fact, it's a good idea to keep a list of the various needs that you become aware of as you sort the desk clutter into piles of bills, papers and the like, and as you try to figure out where to put all these things. A list of needs to be met by a design might look like this:

### Needs

- Create space to spread out work.
- Find a place to organize bills, plans, and records.
- Find space for current files.
- Create a place for the phone at the desk or next to it.
- Keep the pencil sharpener and stapler easily accessible.
- Keep a place for the keyboard, mouse and monitor on the desk, and computer under it.

The criteria are set in terms of these needs:

- How much space do you really need for your work?
- How will you know that you have been successful in designing places to put the things that made up your desk clutter?

The answers to these questions become the criteria to be met by the design. Criteria developed from the above list of needs might look like these:

### Design Criteria

- A clear work area of 12" x 24"
- Easy to decide where new papers go so they don't accumulate
- Use computer and phone without leaving desk
- Have access to what I need while working

As you set design criteria, be aware of features in the current desk design that are working well. You will want to keep these features in a new design. They too should be cast as design criteria. Design criteria are not set once for all time. Don't be surprised if, as you use the desk, you discover another function that the desk should accommodate. Add it to the list of design criteria.

The constraints on redesigning your desk are probably based on the structure of the desk (size, cubby holes, drawers), where it can be placed, and resources available to buy files or desk accessories. There may be additional constraints if other family members use your desk. (If they do, they will be happy to see the clutter gone.) Here is a list of typical constraints.

### Constraints

- Limited desktop space (30" x 42")
- Limited improvement funds: $50
- Computer to be used by others in family
- Total filing space: two drawers – letter size
- No phone jack near the desk
- Desk must stay against the same wall, and within three feet of its current location.

There is another type of constraint. It arises from several needs competing for the same resource. For example, clear space for working competes with the space needs of a monitor, mouse pad, keyboard, pencil sharpener, stapler, and desk organizer. Limited desktop space means one of two things. Either you make tradeoffs among the things you want on the desktop or you find ways to use desktop space more efficiently. A more efficient use of space is to have the keyboard out of the way when not in use. However, using available funds for an accessory to store the keyboard limits money available for other things—so you're back to making tradeoffs.

## Design Possible Solutions, Then Select and Implement One

Now begin the redesign process. Brainstorm different ways to accommodate all the things you want at your desk. Think also about the things or functions that might be moved away from the desk, temporarily or permanently. For example, do you really need to keep bank statements from the past five years at your desk? Is this really the best place to store your maps or photos?

There are several ways to explore alternatives. Sometimes it is easier to play with alternate designs using pencil and paper. Sometimes it is easier to simply move things around on the actual desk, seeing how they fit. Sometimes the final design is the result of a series of trials, each guiding and shaping the next until you reach what you believe to be the best. Whatever the process for generating possible designs, select and implement the one that seems to best meet the criteria you have set out.

## Evaluate Your Redesign

There are two ways to evaluate a redesigned desk. Both are important. The first is unstructured, informal, and done almost automatically: "This seems OK," or "I don't know if I can get used to this," or "I need to change this." Sometimes in the process of implementing the redesign, unforeseen problems arise. If this is the case, modify the redesign or select another of the redesign options. For example, the desk may have been moved to a new location without planning for adequate lighting. Design modifications for this problem may be simple. Other unforeseen problems may require a whole new design. The informal evaluation of the redesigned desk is ongoing. Every new activity at the desk gives its own feedback as to whether the desk accommodates that activity as well as the old design did.

The formal evaluation comes after the redesigned desk has been used for a few weeks. It addresses the question, "Does the new design meet the criteria for a functioning desk that you set out (and perhaps augmented)?"

Here is a restatement of criteria listed above. To the right is a list of the sort of things that might be accepted as evidence that the criteria are met. Sometimes the evidence that a criterion is met is implicit in the design criterion. Nevertheless, as you develop design criteria, think about what it means to fulfill each one. This is the evidence you'll use to evaluate the redesign

The important things to experience in the "Redesign your Desk" activity are the thoughtful aspects of a designed environment activity. You didn't simply sort out the clutter—some to the wastebasket, some to a file, the rest to another stack whose destination you hadn't decided. Rather, you thought about how you use the desk and what the current problems were. You planned how you would change it and how you would know if the changes worked. These design criteria, alternative design options, and evaluation are all processes that raise everyday design experiences to the level of understanding and using technology.

**Table 1-1**

## EVALUATING DESIGN SOLUTIONS

| Design Criteria | Evidence |
|---|---|
| A clear area of 12" x 24" | Whenever I want to spread out my work, space is available without first cleaning up. |
| Easy to decide where new things should go | There are few, if any, unsorted things on the workspace. Little time is needed to put papers in their places. |
| Use computer and phone without leaving desk | It is easy to switch from paperwork to computer work and back again. The phone is within reach. |
| Have access to what I need while working | Ability to complete work without having to leave the desk for office supplies or tools. Ability to find these articles quickly while working. |


1-8: **Desk after redesign**

# Designed Environments in the Classroom

Everyday classroom life surrounds you with opportunities for environmental design. In the preceding pages you have begun to see what the opportunities are. The curricular decision is to select the opportunity to exploit. Preparing to teach designed environments is not the typical task of becoming familiar with a new curriculum or the materials that accompany it. Rather, it is looking at the things you already do in a different ways. To prepare to do designed environments with children, you need first to step back, think about things you automatically do as a teacher, and ask, "What would happen if the children and I did these things together?"


Here are some of the things teachers ordinarily do themselves, without involving children:

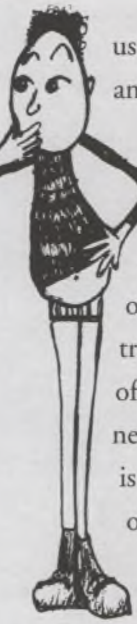
- Prepare the classroom at the beginning of the year;
- Choose the posters to put up and decide where to put them;
- Decide where tables and chairs should go;
- Select activity areas and the things to go in them;
- Arrange for class trips, selecting destinations;
- Set up the procedures to:
  - take attendance;
  - determine lunch preferences;
  - get information to the office;
  - regulate the talking in class;
  - control the use of the pencil sharpener and/or other scarce resources;
  - control access to the bathroom;
  - set the classroom time schedule.

These are some of the ways that teachers structure the learning environment and keep order in the room as part of their jobs. Each decision shapes the environment the children will experience and each presents an opportunity for involving children in an environmental analysis and design activity.

You cannot engage children in every one of these decisions, or even a significant percentage of them, and still have time to do other things in the classroom. Depending on the students' maturity, you may feel that some areas should be off-limits. You can begin by involving children in the redesign of only one procedure or rule, time schedule or cluttered area. Children can learn to analyze what is wrong with the current procedure, set criteria for what a new procedure should accomplish, then design, implement, and evaluate a new procedure. They learn by doing it. As they gain experience, they become more proficient in all of these processes. Later, when another issue comes up that could benefit from student thinking, they will be more skillful in addressing the new problem.

### Is This Really Technology?

Is redesigning how you use your desk really an application of technology? Remember first that technology goes far beyond computers. Technology is even broader than science, although technology may use the results of science as well as make new science possible. Technology is all around us and includes all the artifacts and most of the environments and systems of our daily lives. It includes all the efforts from prehistory to the present to improve the conditions of human life. The results of technology range from improved transportation systems to doorknobs that are easier to use, from signs that direct us more clearly through an airport to designs for more efficient use of space. The constant aim of technology is to improve some aspect of life, mindful of tradeoffs in other areas of life. The success of the new product of technology is measured by a weighing of the improvements made against the costs of the improvement. Although the redesign of a desk has a limited impact, it nevertheless addresses a goal of any technology: to improve a particular aspect of life with reasonable tradeoffs.



# Design of Space in the Classroom

Monda's third grade classroom had a problem. The rug was getting dirty because people kept walking across the rug with shoes on. Of course there was a rule: "Don't walk on the rug with your shoes on!" But those who knew the rule usually didn't remember it until they were halfway across the rug and visitors to the room didn't know the rule. The fact that people kept crossing the rug was a clue that it was in a place where paths naturally crossed. The problem seemed more a spatial problem than one of rules and procedures inadequately enforced. Since the children were involved in the problem, it was a good one for them to solve. Simply stated the problem was this: How can we reduce or eliminate shoe traffic across the rug?

# Gathering Information: Analysis of the Problem

Initially the children and teacher brainstormed about what information might be useful and how they might get it. To get the brainstorming started, Monda asked, "Where are people going when they walk on the rug?" She asked questions that further narrowed the focus of the children's ideas:

"Where are they going if they are in stocking feet?"

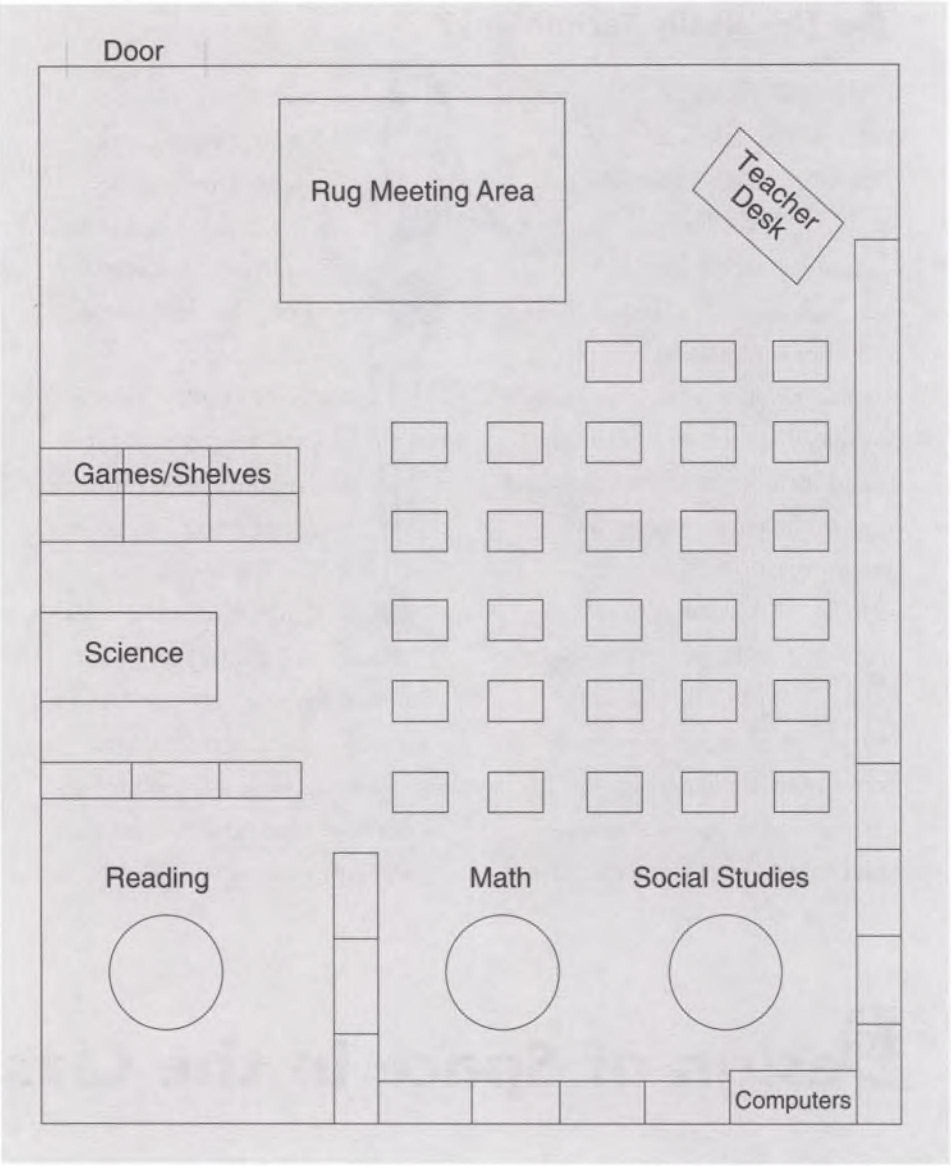
Class meeting
Circle time
Play games

"Where are they going when they have shoes on?"

To Ms. Monda
Out of the room
To the math area

The teacher wanted the children to see that when the rug area itself was the destination, there was seldom a problem. The problems arose when people were trying to get somewhere else. She wanted them to really see the nature of the problem, so she introduced the idea of recording the paths people were taking when they crossed the rug with shoes on. Drawing each pathway was a way to collect data on their problem. She gave them a data collection aid: an 8 1/2" x 11" classroom map (Figure 1-9). Each time someone crossed the rug with shoes on, the rug monitor for that day drew a line showing where the person had walked. The teacher also taped a large-scale copy of the map on the board in front of the rug. The class collected all the daily data on this large map and discussed the growing body of information during class meetings. After the first day the data appeared as in Figure 1-10.

1-9: **Data collection aid: a map of the classroom**

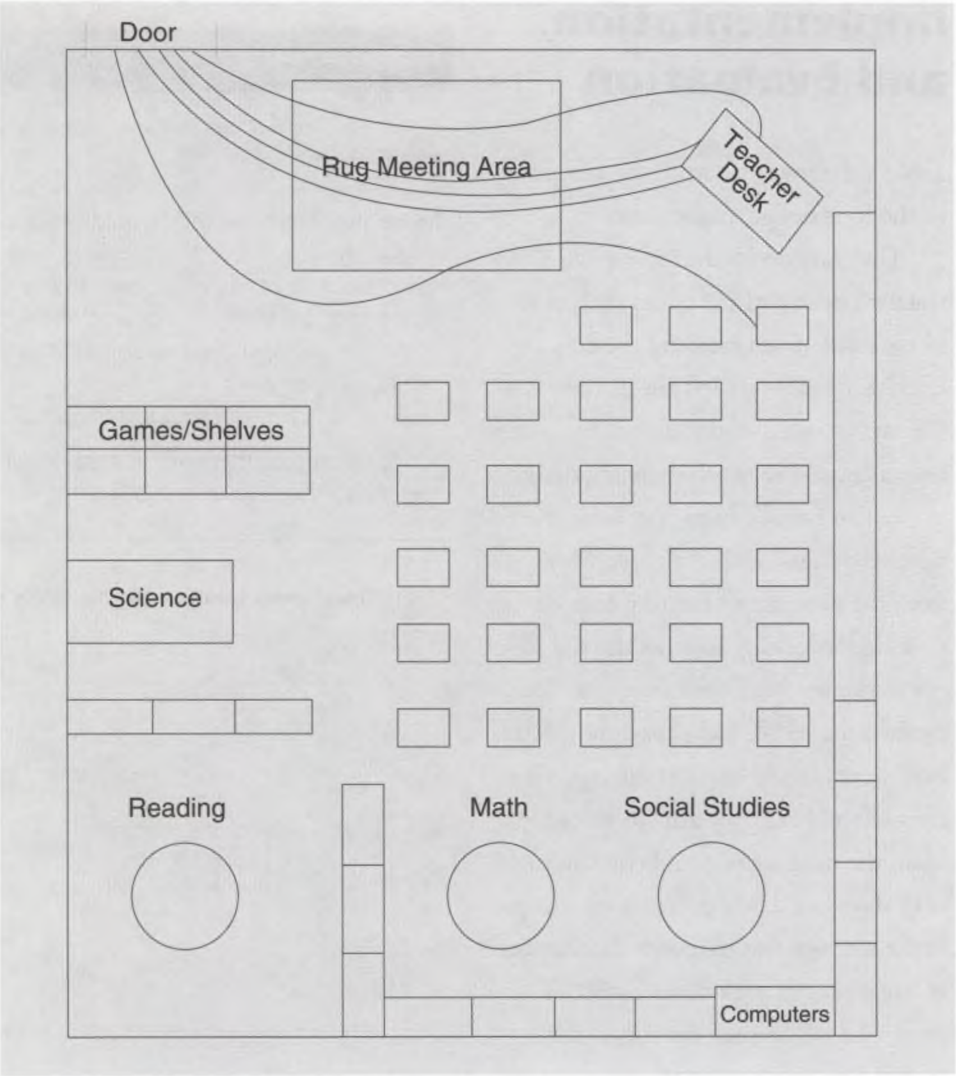



After a week had passed, the class discussed their data. They agreed on these general results.

- When visitors come to the room and cross the rug, it's to get to the teacher, not to a special area.
- People cross the rug to get from the desks to the door.
- People cross the rug to get from the science area to the sinks.
- More kids have been detouring around the rug since we started data collection.

In order to think about possible solutions, the children needed broader background knowledge. Their teacher provided some of this by taking small groups to other classrooms, which were organized in different ways. These visits provided images of different classroom arrangements.

1-10: **Classroom map showing traffic across the rug**




## Design Criteria and Constraints

The class met for pre-design brainstorming to stimulate thinking about many different design options. Then they broke into groups of four to begin to design solutions to the problem. They were told to think quickly of at least three different plans, but not to choose any of them. Then they reassembled as a class and the teacher helped them think about the things they could and couldn't change in the room. These became the design constraints.

- They could move the desks, tables, and shelving that served as dividers.
- They could not move anything attached to the floors or walls.
- No additional furniture was available.
- The rug could not be placed where it might get wet from art or science activities.

The teacher also led them to think about the functions the rug was to serve. These became the design criteria.

- The rug was to be used for class meetings. This meant a chalk board or marker board had to be available where the rug was.
- The rug should be easily used for lounging while reading, or for board games.
- The design should make it difficult for people to cross the rug without thinking about it.

## Design Solutions

The children proposed a variety of solutions to the rug problem. These included:

- Put a rope barrier around area, leaving all else the same.
- Move the shelves so they would block one side of the rug.
- Move the rug to the reading area, leave the group meeting by the board, and have kids bring mats to sit on during group meetings.
- Move the rug and the group meetings to the reading area, using a portable easel in place of the wall mounted chalkboard for class lessons.

## Selection, Implementation, and Evaluation

Table 1-2 shows the students' reactions to the four design suggestions:

The class decided to move the teacher's desk and the game shelves to block traffic from crossing the rug. Everything else was left the same. This was a status quo solution, involving only a "tweaking" of the existing design.

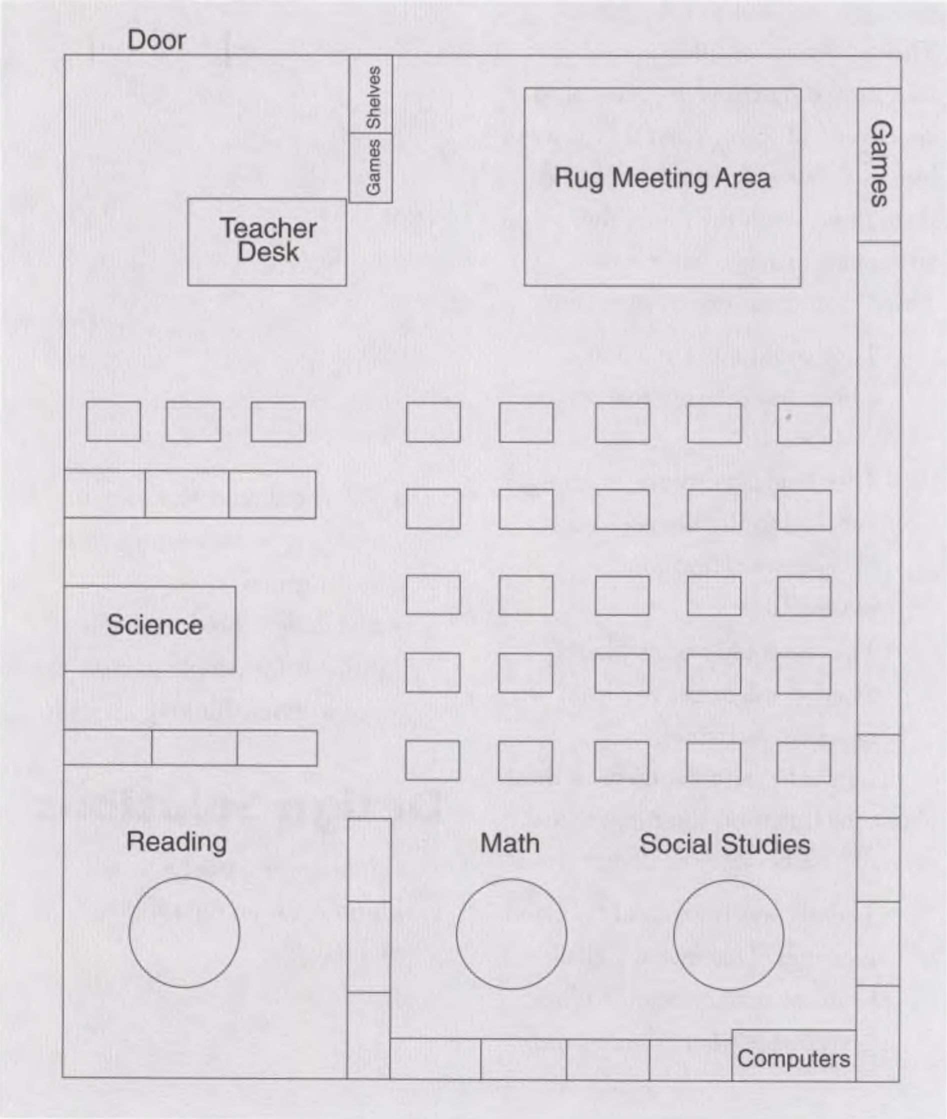
As can be seen in Figure 1-11, the selected design blocked the pathway from the door across the rug, and it was no longer necessary to cross the rug to get to the teacher's desk from the door. By the time people had passed the shelves, they were already beyond the rug. The class selected rug monitors to record again the number of people on the rug with shoes on. Their criterion for success in the redesign was to reduce the number of rug crossings with shoes by 80%. After two weeks they examined the data. They had seen no one at all cross the rug with shoes on!

**Table 1-2**

REACTIONS TO PROPOSED DESIGN SOLUTIONS

| Suggested Design | Reaction to Design |
|---|---|
| Put a rope barrier around area, leaving all else the same | Would look "tacky"; nothing stable to fasten it to that wouldn't fall down |
| Move the shelves so they would block one side of the rug; move the teacher's desk to the other side of the rug, closer to the door | Best solution |
| Move the rug and the group meetings to the reading area | Prefer to keep class and group meetings in current place |
| Move the rug to the reading area, leaving the group meeting by the board | Don't have individual mats, and they would not be as good as the rug if we did |

1-11: **The chosen solution to the "dirty rug" problem**



# Redesign of Time in the Cafeteria

The children were complaining as they returned from lunch: "We had to wait a really long time again." Fiona, their teacher, had heard the complaint before—and it was justified. The lunch periods were poorly planned and not everyone followed the schedule. This could be a good problem to analyze, perhaps even one the children could help to solve. She decided to open the topic for brainstorming. Her intent was to have the children further define the problem so she could gauge their interest in studying it. If it seemed appropriate at that stage, perhaps they would lay the groundwork for further information gathering. She led a class discussion to get started:

**FIONA (TEACHER):**
**Josh said you had to wait a long time again today.**

**SAM:**
*Yeah, it took forever.*

**MEG:**
*We were stuck on the stairs for an hour.*

**FIONA:**
**Did all of you have to wait on the stairs?**

**PAT:**
*No, the ones in front were O.K.*

**TOM:**
*But even the ones in front had to wait a long time.*

**FIONA:**
**Why do you think it was so long?**

**TOM:**
*Mrs. D's class is supposed to be behind us, but they sneaked in front of us.*

**SAM:**
*The lunch ladies are really slow.*

**FIONA:**
**Is it usually this bad?**

**MARY:**
*Monday it didn't take so long.*

**TOM:**
*Who decides when classes have lunch?*

**FIONA:**
**That's something we can find out. How many of you would like to study this, to see if we can make it better? ... Good. Let's begin by thinking about the information we need to really understand the problem.**

When a system is not working well, it is easier to see the various components of the system. The lunch schedule, a system with several interacting components, was not working well. Thus the poorly functioning schedule provided an opportunity to see what was necessary for a schedule to run smoothly. Fiona guided the discussion and data collection decisions so children would understand what things were important to the schedule not working. In the discussion the children decided that they needed information in these areas:

1. How long do we wait? Is it the same each day?
2. How fast do they serve food? Is it the same for every meal?
3. When do other classes arrive for lunch? How many are in each class?
4. Who plans the schedule? What is the schedule?

# Gathering Information and Analyzing the Problem

Fiona set up eight groups to gather information, two groups for each of the four sets of questions. First, a group had to define its problem further. For instance, a group addressing the first question, "How long did they wait on line?", decided they would measure the time from when they joined the lunch line until they got to their tables. Similarly, the children in each group had to decide how their group would collect the information they needed.

Fiona had to help a group addressing question 2 figure out how to collect their data on speed of service. They finally decided to see how many kids came out from the serving area during two-minute periods. They collected data over two-minute periods each day for a week and then compared the results for each day. The data showed that the number of kids served on average in a two-minute period was different each day.

**Table 1-3**

## AVERAGE NUMBER OF CHILDREN SERVED IN TWO MINUTES

| | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| **Number served** | 12 | 10 | 11 | 8 | 10 |

Data on question 1, how long children had to wait in line, also showed a variation from day to day.

**Table 1-4**

## HOW LONG CHILDREN WAITED TO BE SERVED

| | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| **Wait time** | 4 min. 40 sec. | 7 min. 10 sec. | 10 min. 0 sec. | 8 min. 10 sec. | 7 min. 15 sec. |

Fiona wanted the class to see the relationship between how many children were served in two minutes and how long children had to wait in line. She had the class compare the findings on questions 1 and 2. The shortest waiting time was on Monday. This corresponded to the day when the most children were served every two minutes. Similarly, long waits went along with the fewest children being served in two minutes. The children started to see how these variables were related.

Not surprisingly data on question 3, when classes arrived for lunch, also varied from day to day.

**Table 1-5**
WHEN CLASSES ARRIVED FOR LUNCH

| | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| **Mrs. F's class** | 12:05 | 12:05 | 12:05 | 12:05 | 12:05 |
| **Mrs. D's class** | 12:08 | 12:10 | 12:00 | 12:06 | 12:10 |

The children discovered that the day when they had to wait the longest was not the day when the service was slowest, but the day when Ms. D's class got in ahead of them.

# Design Criteria and Constraints

Children working on question 4 did more than just get a lunch schedule. They talked with the principal to find out how the lunch schedule had been designed. They found that all the lunches were scheduled between 11:00 and 1:15, that the lower grades had to go first, and that each class had 45 minutes for lunch. When children reported to the class on question 4, these parameters set by the principal seemed like reasonable constraints for any redesign. The class discussed how long it was acceptable to wait on line for lunch. They decided that five minutes was the upper limit. A successful redesign of lunch scheduling would result in children waiting no more than five minutes from the time they arrived until they began to be served. This became their design criterion.

# Design Solutions

The next step was to figure out what changes could be made to reduce the waiting time. Working in groups of four, the children were asked to design possible solutions. Fiona decided to change the groups in order to maximize the number of ideas considered by each group. She assigned one student from each of the four question areas to each new group. The groups brainstormed possible solutions in class. Then for homework, each child designed a possible way to reduce the time spent waiting for lunch. The next day the children shared their ideas with their groups. The groups did what amounted to mental experiments to see how well they thought each of the plans would work. They then chose what they thought was the best solution and presented it to the rest of the class.

## Selection, Implementation, and Evaluation

The plans presented by the groups were:

- Adjust the time when each class goes to lunch according to the menu. On slow food days, there would be more time between the arrival times of classes.
- Get more help in the kitchen on slow food days.
- Schedule more time between the times classes arrive.
- Make the teachers follow the schedule.

On the day when each group shared its solution, the assistant principal joined the class to ask questions of each group and to help them work through the implications of each plan. The assistant principal convinced the class that the schedule could not be changed according to the kind of food being served. She didn't think there was room to add an extra worker in the cafeteria line, and there might not be money to hire another person. She agreed that the schedule could be more staggered and suggested that the children make a proposal for new cafeteria arrival times. She also invited the children to think of ways that teachers could be encouraged to follow the schedule.

It was a major project to design a new schedule. First the children determined how much time they had in all. If the last group had to be done by 1:15 and lunch periods were 45 minutes, then the last class had to start lunch by 12:30. That meant all the classes had to go to lunch between 11:00 and 12:30, a 90-minute period. A total of 14 classes went to lunch: three each at the first and second grade levels, two classes each for grades three through six. The first schedule was designed by dividing the 90 minutes by the 14 classes. This yielded lunch periods that began at six- or seven-minute intervals. Table 1-6 shows the original schedule and two proposed modifications.

**Table 1-6**
**TIMES FOR CLASSES TO GO TO LUNCH**

| Class | Original Schedule | First Proposal | Second Proposal |
|---|---|---|---|
| 1a | 11:00 | 11:00 | 11:00 |
| 1b | 11:10 | 11:06 | 11:07 |
| 1c | 11:20 | 11:13 | 11:14 |
| 2a | 11:30 | 11:19 | 11:21 |
| 2b | 11:37 | 11:26 | 11:28 |
| 2c | 11:45 | 11:32 | 11:35 |
| 3a | 11:53 | 11:39 | 11:42 |
| 3b | 12:00 | 11:45 | 11:49 |
| 4a | 12:05 | 11:52 | 11:56 |
| 4b | 12:10 | 11:58 | 12:03 |
| 5a | 12:15 | 12:05 | 12:10 |
| 5b | 12:20 | 12:11 | 12:17 |
| 6a | 12:25 | 12:18 | 12:24 |
| 6b | 12:30 | 12:24 | 12:30 |

Children developed the first proposal by alternating six- and seven-minute intervals between lunch times. At first they couldn't figure out why that only took them to 12:24 rather than 12:30. Then they discovered that while there were 14 classes, there were only 13 intervals, not 14. When they divided the 90-minute period by 13, they found they could have 7 minutes between classes for all but the last class. This then was their proposal.

They presented the proposal to the assistant principal. Her first reaction was that younger classes needed more time, and the original schedule provided this. The children responded that the younger classes had fewer children so they didn't need more time. Finally all admitted that they didn't know how much time each class was actually using. They chose a group to gather data on how much time each class used to get their lunch. They based the final schedule proposal on this added information. In the presentation of the proposed schedule (Table 1-7), the children included the time the classes actually took to be served as well as class size. The combination of class size and grade level helped make sense of the variations in the time it took to serve a class.

After reviewing the final proposal, the assistant principal asked the class to present the results of their study to the school and to explain their recommendation for a new lunch schedule. The schedule was implemented at the beginning of the next quarter. The children evaluated it by again collecting data on how long classes waited from the time they arrived for lunch until they were all served. They found that some teachers still did not follow the schedule, but in general the waiting times were shorter.

**Table 1-7**

## FINAL SCHEDULE PROPOSAL: BASED ON TIME CLASSES TOOK TO BE SERVED

| Class | Number of Children | Time to Serve Class | Final Proposed Schedule |
|---|---|---|---|
| 1a | 20 | 8 | 11:00 |
| 1b | 18 | 7 | 11:08 |
| 1c | 19 | 8 | 11:16 |
| 2a | 19 | 5 | 11:24 |
| 2b | 21 | 5 | 11:30 |
| 2c | 21 | 6 | 11:36 |
| 3a | 32 | 8 | 11:42 |
| 3b | 30 | 7 | 11:48 |
| 4a | 29 | 6 | 11:56 |
| 4b | 31 | 7 | 12:03 |
| 5a | 31 | 6 | 12:10 |
| 5b | 30 | 7 | 12:17 |
| 6a | 29 | 6 | 12:24 |
| 6b | 28 | 6 | 12:30 |

# Rules and Procedures in the Classroom

The telephone in Bret's room was frequently interrupting his teaching. He had fallen into the practice of always answering it himself. Now he wanted to involve the class in finding a better solution. Bret also wanted the class to experience math in real-world contexts. This could be a good opportunity for working with data. One problem was that the class had little experience collecting and sorting data on everyday things. So he developed an initial procedure that both produced baseline data and gave the children experience in recording data.

1-12: **Who called and why**

| Who Called? | Why? |
|---|---|
| Ms. Abrams | Go to office |

## Gathering Information: Initial Analysis of the Problem

Bret began the project the next day, immediately following the first phone interruption. After the call he said:

> "That was Miss Abrams from the office. She wants someone to take the attendance sheets down right now. We're going to keep track of who calls on the telephone and why. Draw a line down a new sheet of paper. Label one side 'Who called' and the other side 'Why.' On the first line, write 'Miss Abrams' in the first column and 'take something to the office' in the second. Every time someone calls today, I will tell you who called and why they called. At the end of the day we are going to look at all this data and begin to figure a way to deal with these interruptions."

Toward the end of the day, the class came together to review the data they had gathered. They listed reasons for the calls and classified them into groups based on similarities. They listed callers and tallied how many times each one had called. Bret asked everyone to spend some time that night thinking of a way to deal with phone calls so that the class would not be interrupted.

## A Preliminary Design and Design Criteria

The next morning the children shared their solutions.

- Tell the principal to take the phone out.
- Tell the secretary she can't call during the class.
- Don't answer, just let it ring.
- Have a phone monitor answer the phone instead of the teacher.

Bret helped the kids think about the different solutions. The phone had been installed as a safety device, and it couldn't just be removed. If they just let it ring, the phone would still be disturbing the class—and besides, there might be an emergency. As the class considered the solutions, they were also beginning to see some constraints on the designs. They finally decided to try a phone monitor. Then they came up with preliminary instructions for the monitor, and a procedure for deciding who would be the monitor each day.

## More Information-Gathering, Problem Analysis, and Solution Shaping

The monitor for the day was responsible for recording who called and why. The class would look at this new data after one week. By the second day, Bret decided it was time for the children to consider how the phone should be answered. The class decided on "Hello, this is Mr. Lenk's class." When the caller asked for Mr. Lenk, the reply was "I'm sorry, Mr. Lenk is busy teaching. May I take a message?" If a child had to report to the office, the monitor quietly told the child. When the monitor was uncertain how to respond, she or he interrupted Mr. Lenk for assistance. Whenever a monitor was presented with a new situation and didn't know how to respond, the class talked about it later and decided how to deal with the new request. They made up a booklet of requests that came by phone and the response for each type of request. This was the phone answering protocol.

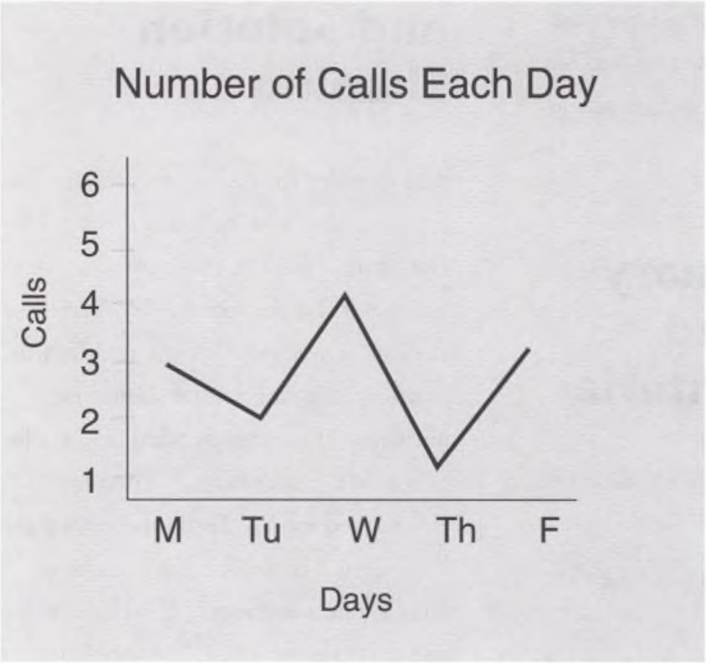
# Design Evaluation and Redesign

At the end of a week, the class held an evaluation session. The main issue was: Did the phone interrupt the class as much as it used to? Did Mr. Lenk have to stop teaching as often? They looked at their data. They saw that there were many more reasons for calls than they had realized. They saw that most of the calls were from the school secretary. They also saw that the actual number of calls seemed to be decreasing. They didn't, however, have data on how many times Mr. Lenk had to be interrupted.

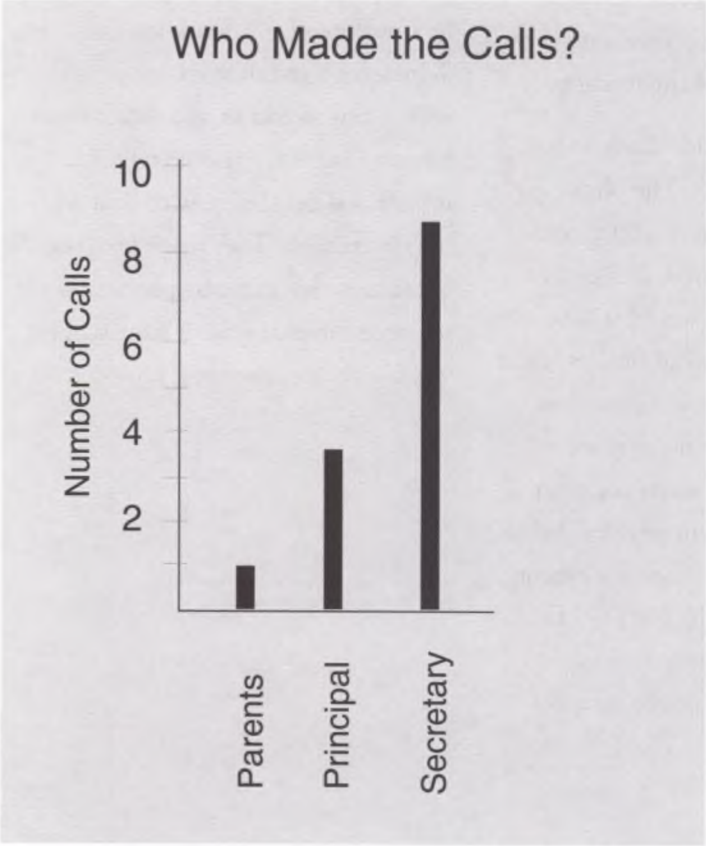
The design solution had been subject to continued evaluation and redesign during that first week as the class developed a telephone answering protocol. They decided to continue with the same system for the following week, but with a change in data collection. In addition to collecting data about the caller and the reason for calling, the monitor would also indicate whom the call was for and if that person had to be interrupted.

After the second week Bret worked with the class to think about how they might represent their data. They made line graphs to show the number of calls each day and bar graphs to show who made the calls.

1-13: **Number of calls each day**




1-14: **Who made the calls**



The class also made bar graphs to show the reasons for the calls.

Bret also asked students to whom they would like to show the data, and what the reaction to the data might be. Since most of the calls were from the secretary, they decided to discuss their results with her. They weren't sure what the results would be. Since many of the calls were for administrative information such as the lunch list and attendance list, the secretary helped the class think of how they could get the information to the office before it was needed. The secretary probably also became more sensitive to her calling, because the number of calls decreased.

The telephone-answering project differs from the other design projects we looked at in this chapter. The class did not gather all the information they could on telephone calls, analyze it, develop a protocol, try it out, and then evaluate it. Instead, they implemented an initial way of responding to phone calls that they continually revised. The adequacy of the protocol was evaluated with each phone call. When the monitor could respond to the call, the protocol was successful. When the monitor had to interrupt Mr. Lenk, the protocol was inadequate. Then the class had to change the protocol to address every new type of phone request. Each time the protocol was amended, it provided responses to more requests. The design processes used in the first three examples of this chapter are frequently referred to as constituting a design cycle. The development of a phone answering protocol is an example of design by repeated, short-term, design cycles. It is characterized by immediate evaluation and redesign of each new phone answering protocol. This represents a technology design project just as much as do the first three examples of design projects.

# Designed Environments Projects and Life in the Classroom

Children and teachers in these three classroom vignettes see problems in the classroom and school as being their problems and they see themselves as able to address the problems together. These are real problems of telephone interruptions, excessive waiting for lunch, and a rug that is being worn too quickly. These are classrooms where teachers encourage children to think about real situations, and to work collaboratively to gather information and figure out ways to improve school and classroom environments.

Many teachers worry about control issues, especially when children are invited to share real responsibility in the classroom. In the above examples, however, none of the teachers relinquished control. Control was shifted to the analysis and design process. That process requires criteria to define what is meant for a procedure, schedule, or furniture layout to be functioning well. The design process also requires that there be an evaluation to see if the criteria have been met. By inviting their students' participation, these teachers shared the responsibility with their students, while teaching children how to design and how to evaluate a solution democratically. By helping children establish reasonable criteria for evaluation, the teachers guaranteed that the new design met their needs as well as those of the students.

Chapter 2

# CONCEPTS

## Content: Design Process, Learning, and Child Development

The central goal of *Designed Environments: Places, Practices, and Plans* is for children to apply technology design processes to situations in their daily lives. This chapter contains content background for *Designed Environments* activities and relates children's learning and development to those activities. Understanding technology design processes is central to the activities, and so a major portion of this chapter is devoted to a detailed description of them.

## Where's the Technology?

How does technology relate to designing environments? As presented in *Stuff That Works!*, 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.

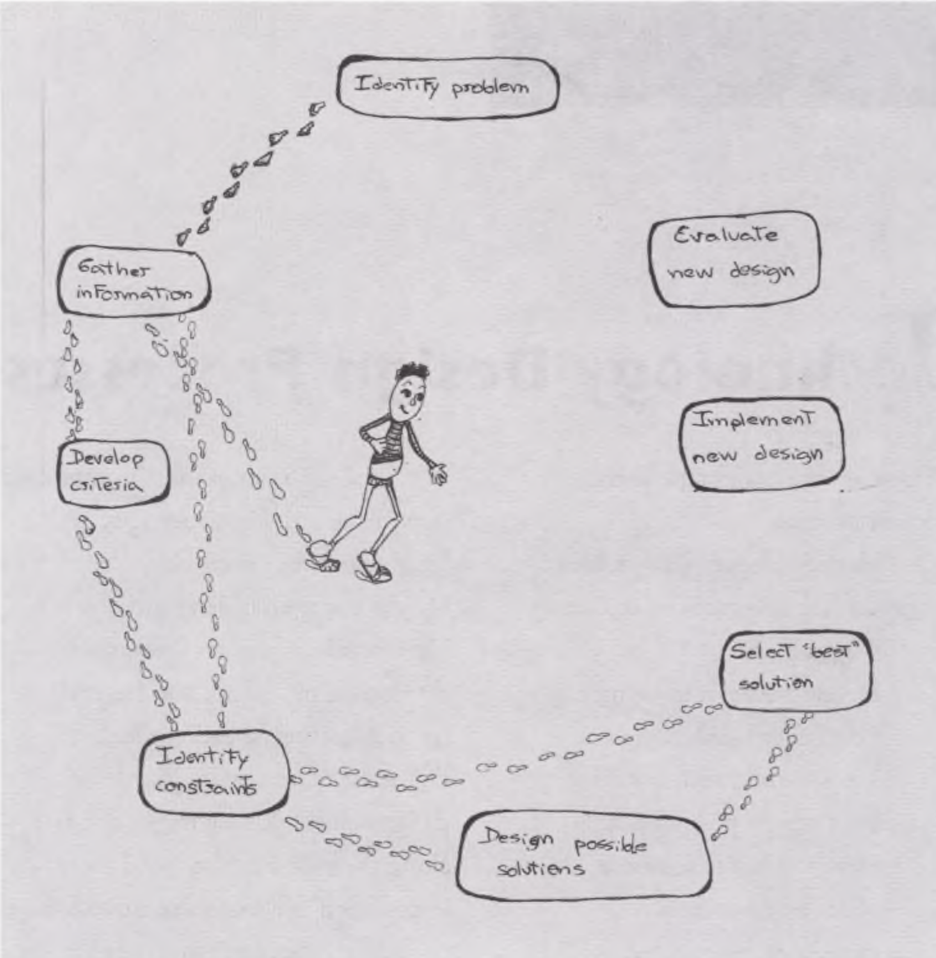
## Technology Design Processes

These are the basic steps in the design process:

- Identify an everyday problem.
- Gather information: analyze the problem.
- Develop criteria to be met by a design solution.
- Identify the constraints that limit design possibilities.
- Design possible solutions.
- Select a best solution.
- mplement the selected design solution.
- Evaluate the new design.
- Develop a new design solution, if indicated by the evaluation.

What follows is an examination of each step in the order in which they are listed above, but don't be misled. Design is not an orderly process. It is like writing: as you go forward in developing new ideas, you have to go back and revise earlier ideas. For example, as children work on design solutions, they might discover along the way that they need more information and that there are additional constraints affecting what they can do.

2-1: **Design is not an orderly process.**




The need to go back can also occur at what the designer thinks is the end of the process, when the design is being evaluated. Even bad designs usually meet all the initial design criteria, but a design solution will fail at the evaluation stage if relevant criteria were omitted at the beginning. Before redesign begins, the design criteria need to be changed.

These experiences are common to the experience of all designers, not just children. This non-linear messiness is part of the process and is reflected in the approach to environmental design presented in *Designed Environments: Places, Practices, and Plans.*

## Planning for the Unexpected

*Designed Environments* activities are not static pieces of curriculum that fit neatly into a particular time slot in the school year. Rather, they are triggered when children identify a problem or need in the classroom or school environment that can be solved by changing the way the environment is designed. Thus, as you do your curriculum planning, try to build in some flexibility. This will let you take advantage of the opportunity for an environmental design project when it arises rather than slotting your *Designed Environments* work into an arbitrary period, such as the tenth week of the school year.

# Identify a Problem or Need

In the normal course of living, children, like all people, experience challenges and difficulties. They encounter situations where changes in the physical space or the way it is used—which includes such things as schedules and rules—would make life easier, more fun, and more interesting for themselves and others. But children often don't recognize the problems, and even if they do, it probably doesn't occur to them that they could have a role in coming up with solutions. A major goal of *Designed Environments: Places, Practices, and Plans* is to sensitize kids to design problems in their environments, and then to help them see themselves as capable of using design to change things for the better.

The best way to introduce a *Designed Environments* project is to use a problem that children are already aware of. Chapter 1 described how Fiona guided her children from their upset into a *Designed Environments* project. The children's complaints had identified a problem: wasting time waiting for the school lunch. Although it was their problem, the children had not begun to see it as one they could solve. Fiona legitimized the problem by discussing it with them. As she elicited different observations from the children, a more complete understanding of the problem emerged. This process helped the children see the problem as one they might address.

Fiona's children had already verbalized the problem. But what do you do when children are bothered by something but don't express it directly? This is where a scavenger hunt and brainstorming come in. In this case, the object of the scavenger hunt is to find problems in environments—"environments" being physical spaces and how they are used as determined by habit or by rules, regulations, and schedules. Brainstorming is a tool for generating ideas about a problem itself—what additional information is known or needed and preliminary notions about possible solutions.

2-2: **What's the problem here?**

## Getting the Most from Brainstorming

Brainstorming is a technique for getting a lot of ideas on the table fast. It can help children see and think broadly about a particular topic. The technique is simple. Present a question or problem to the class and record all contributions. This is not a time to judge the quality of a contribution, but rather to elicit as many ideas as possible. Ideas that appear silly are recorded alongside those that seem better. Brainstorming is productive because each student begins to form a larger concept of the topic, and get new ideas about it, by hearing the ideas of others. Categorizing the items on the brainstorm list is a common way to follow-up the brainstorming. Brainstorming is also a good awareness-raising activity to precede a scavenger hunt.

Begin by conducting your own scavenger hunt and brainstorming for *Designed Environments* problems in your school—minor inconveniences, snafus, poor practices, and so forth. Think about categorizing what you come up with. Categories for school problems could be based on the level in the educational system at which problems originate or the physical places in which they occur.

Disorderly transitions is an example of a problem that begins at the classroom level. Examples of problems that are created at the school level might include the way the school day is structured or how children are assigned to classes. Problems created at the school district level typically stem from policies. New curriculum and testing demands mandated at the state level create a different set of problems.

A whole new set of issues emerges when you brainstorm problems according to the places they occur—on the playground, in the bathroom, or in the hall. What about particular areas of the classroom such as coat closets, storage areas for student work, the teacher's desk? There are other types of categories, each one of which provides a different lens for brainstorming about school problems—the people involved, for example (principal, teachers, aides, children, custodians, parents), or troublesome behaviors. List all of the problems you find. This is a consciousness-raising process to prepare you for helping your students become aware of *Designed Environments* problems.

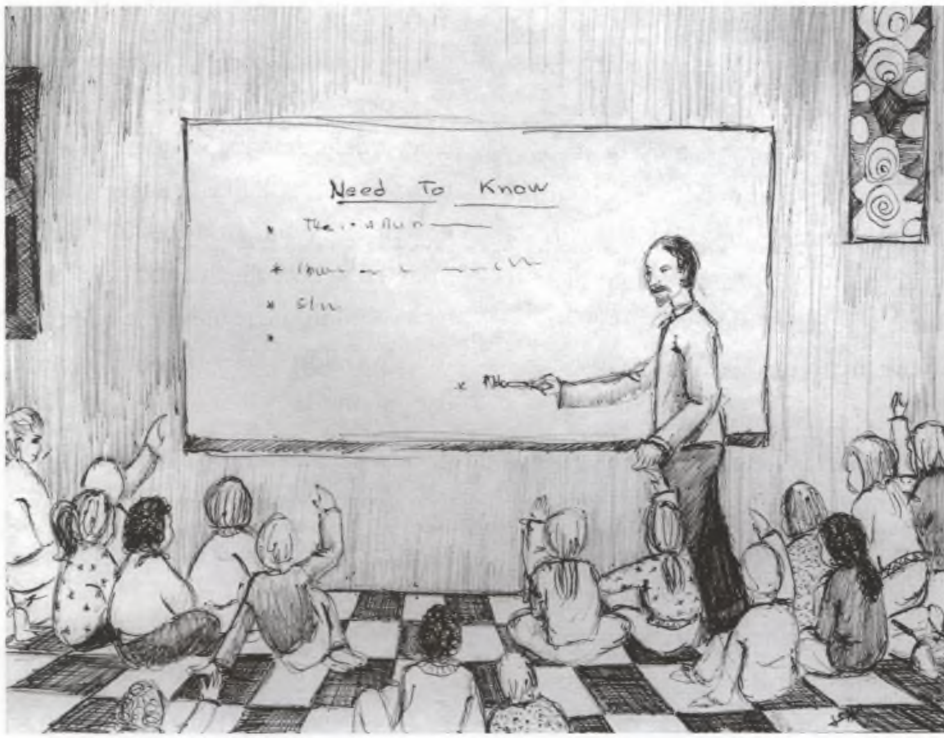
Next, go through the same process from the point of view of your students. What kinds of problems, annoyances, and disruptions do they contend with at school? When you identify a condition that impacts a lot of students and that is amenable to improvement, bring it up for class discussion. Encourage children to talk about the situation and about their experience with it. Such a discussion lets children know you are interested in the things that make their life at school more difficult and also in their ideas about how to make things better.

# Gather Information and Analyze the Problem

Chapter 1 describes how Fiona's class began brainstorming about time wasted in the cafeteria. She led the brainstorming into a discussion of the additional information they needed to understand the problem better. Without this kind of guidance, a discussion about a problem may jump prematurely into possible solutions before the full nature of the problem is known. The teacher's job is to help children think about the kind of information they will need, and how they might go about getting it, before beginning to design solutions.

A good brainstorming session leads to more information-gathering. One purpose of brainstorming is to identify areas where more information is needed. These should be sufficiently clear so that groups of students can sign up for areas at the end of the brainstorming session.

2-3: **Brainstorming can get a lot of ideas on the table fast.**




These questions will help focus the brainstorming and identify areas where additional information about a problem is needed:

- Why is it a problem? What is it about the situation that we don't like?
- What information can we collect to see how severe or widespread the problem is?

Qualitative information:

- Does it happen at a particular time?
- Who is involved?
- Does it happen every day or just some days?
- Does it always happen in a particular place?
- Are the same people or groups always involved? If so, which ones?

Quantitative information or data

- How long does it last?
- How many incidents are there?
- How many people are affected?

Divide students into small groups and assign one question to each group. The groups should figure out how to get their information and then gather it. As groups share what they find out, allow time for the class to analyze this new information. The purpose of sharing isn't to make a report, although this is an important experience (and addresses an English Language Arts standard). Rather, the purpose is to achieve deeper understanding by using critical listening and thinking skills to analyze each report. Questions like these will help children develop and apply these critical skills:

- Does the information in the report agree with what you know of the situation?
- Does the information (data) in one part of the report agree with information in another part? In other words, do the numbers and number patterns make sense?

Next, have children compare reports, using questions like these:

- Does the information in Group A's report seem to match the information from Group C?
- How are these facts (give examples of facts reported by two different groups) related? Do they support each other or contradict each other?

(In the cafeteria schedule problem described in Chapter 1, one group reported the official lunch schedule and another group reported class arrival times at the cafeteria that were different from those scheduled.)

Analysis of the information gathered at this stage leads directly to the next steps in the design process.

## Develop Criteria to Be Met by a Design Solution

When children first begin to develop design criteria, their thinking tends to be generalized as well as personalized. They might describe what an improvement would look like or suggest a goal or end result, and they are likely to describe how they would be affected by a solution. Here are some questions to help children start thinking about design criteria:

- What should the environment (space, way of doing things) look like once we have solved the problem?
- What should a new design allow or help us to do that the current one doesn't?
- What are the good points about our current way of doing things? How can we maintain them in a new design?

Now you need to help them move beyond these initial ideas. Your task is to help them see the solution in terms of its parts—a systems approach—and to broaden their perspective beyond their own point of view. Everyone who has contact with the space or practice or plan where the problem exists will be affected by the design solution. Questions like these will help children take that fact into account as they go about working on the problem:

- Think about my job as the teacher. What do you think I would like the new design to do?
- What do you think is important to the principal regarding this problem? Is it the same as what is important to you and me? Why or why not?
- What would a kid in kindergarten (or the third grade, and so on) think about this problem?

An environment is a complex system with many interrelated parts that function together. The classroom environment includes students, the teacher, visitors, people who use the room outside of class hours, objects such as supplies and materials, rules and regulations that affect what happens in the room, and so on. A change in the way the classroom is arranged might result in the need to change a classroom rule.

Like the classroom, the school is a complex environment. Thus, changes planned by children may affect other classes as well. When they do, the system of interrelated parts affected by the new design may stretch to the whole school. These questions will help children think in terms of the school as a system:

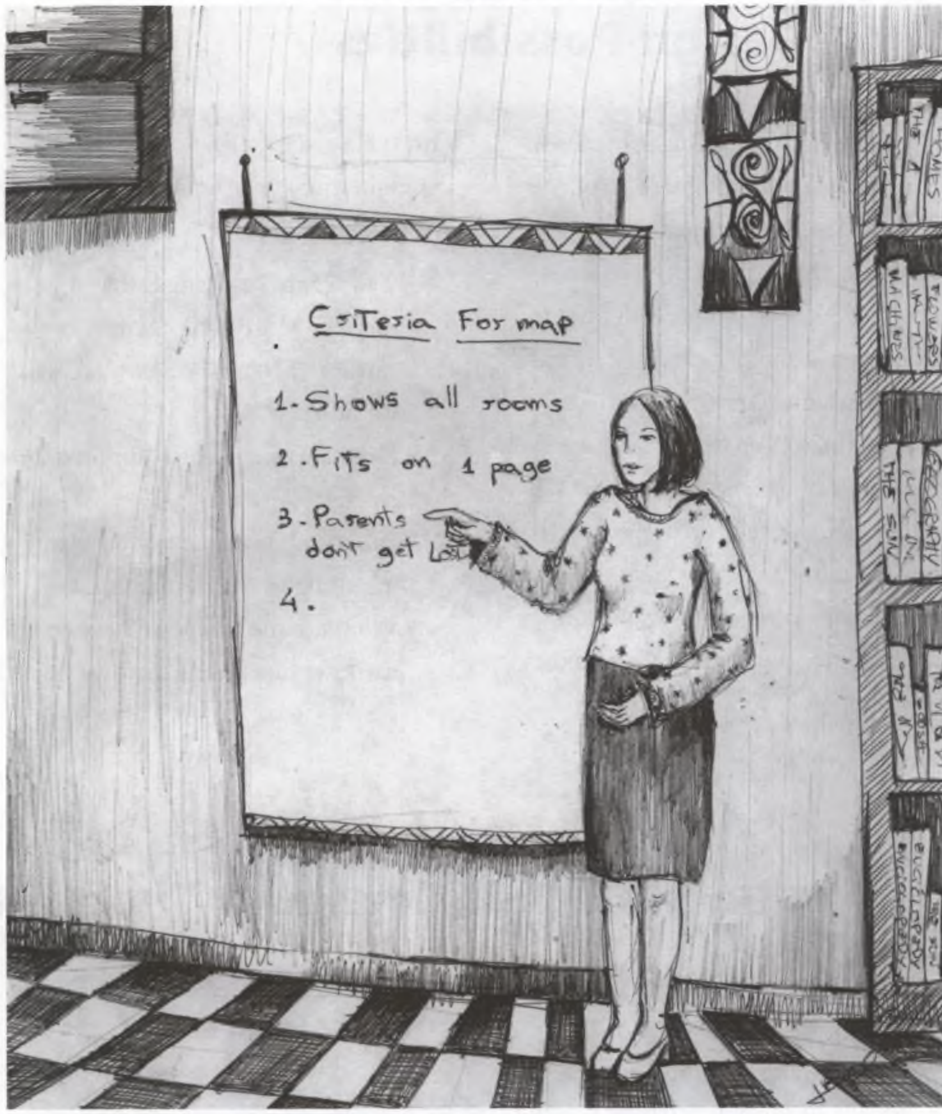
- Who else could be affected by our design solution?
- Could the new design affect anyone in another (specify) class? How?

The cafeteria schedule planned by Fiona's class would affect other teachers, other classes, and cafeteria workers. Their points of view should have been considered in planning the new design. When children figure out all the people affected by a change, they are developing the notion of a system. When children consider the desires of these other people as they develop design criteria, they are developing the values and attitudes of good citizenship.

Design criteria are the conditions that a design solution must meet in order to solve the problem that has been identified. They are used at two key points in the design process—when the design is being formulated and when it is being evaluated.

At the design stage, children use the criteria as a framework on which to build their design solution. They project what a design would be like when implemented, and test that projection against the criteria, using everything they know about people, materials, and whatever else is involved in the design.

At the evaluation stage, the criteria are used to measure the success of the design by comparing the solution with the criteria to see if they have been met. If the design doesn't meet all the criteria, the designer has more work to do. Evaluation also measures the adequacy of the original design criteria.




2-4: **How will we know if our design solves the problem?**

Because environments are such complex systems, designers often find that a design doesn't work because it has unintended consequences, even though it meets all the criteria initially set. In such a case, additional criteria are needed, as well as a redesign.

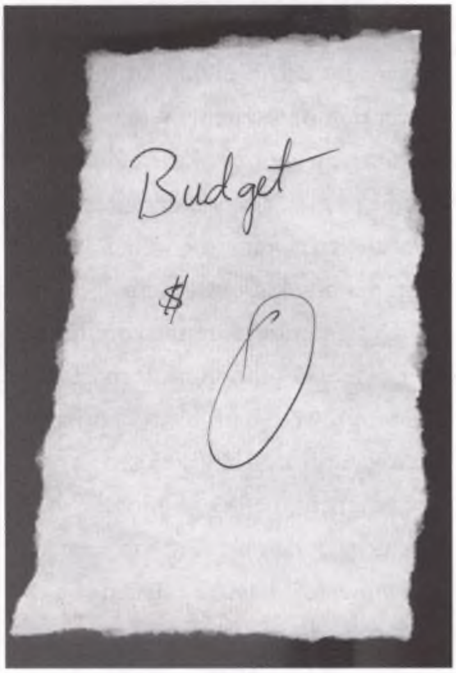
# Identify Constraints That Limit Design Possibilities

All design is done within constraints. Constraints include limited resources such as time, money, space, and materials. Lack of authority to carry out the design or the need to obtain permission is another kind of constraint.

Constraints come to light in several ways as a natural part of the design process, as designers gather and analyze information, develop criteria, and share their ideas and criteria with others who have a stake in the design solution. This happened in Fiona's class as they shared designs with each other and with the assistant principal. Here are some questions that help identify design constraints:

- Can we make changes that require money? More equipment? New furniture? Where will we get what we need?
- Does anyone need to approve the changes we want?
- What stands in the way of changing things in this environment?
- What are the limits we have to work within? What can't we do?

2-5: **What limits what we can do?**




# Design Possible Solutions and Choose the Best One

Fiona's class worked through four stages of the design process:

1. The class brainstormed possible designs to shorten cafeteria waiting time, then individual children developed their own proposals.
2. Individual proposals were shared within groups, becoming the basis for a single proposal from each group.
3. Group proposals were shared with the class and the assistant principal.
4. After feedback on the group proposals, the class developed a final design, in this case a new lunch schedule.

As children see that they can solve real problems and thereby improve the class and school for themselves and others, their school lives are affected in positive ways. The outcome in the form of an implemented solution is important, but precisely because this is such powerful work, the process leading to the solution is even more important. Each child needs to see his or her contribution to the solution. Thus the process leading to a "best" solution should be collaborative, so that everyone feels a sense of ownership, rather than competitive, which gives one group credit for the "best" design and the rest are left with a sense of failure.

Use these ideas to guide discussions that lead up to selecting the design solution that will be implemented:

- There is no one best design.
- A design may be most effective in meeting one or more criteria but might (and often does) fall short in addressing others.
- Any real-life design context is complex: there are many desirable outcomes, many constraints.
- Different criteria will compete with one another. Not all desirable outcomes can be achieved by one design.

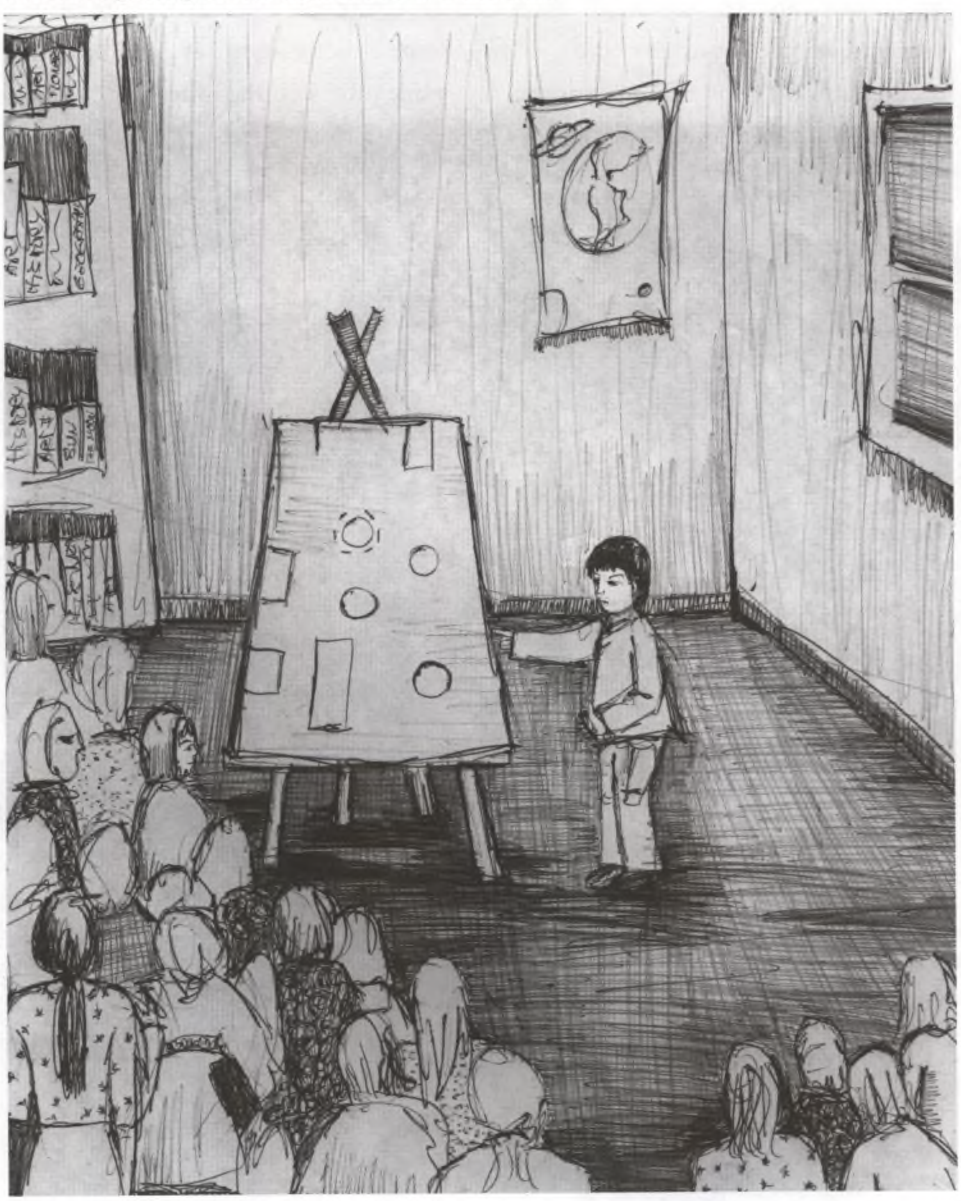
- Children will not agree on which outcomes are most or least important.
- Each design developed by a child or by a group can reveal valuable ideas about the problem and about what makes a solution desirable. Each design represents a unique point of view and contributes to the overall process.
- Each proposed design (even the most off-the-wall one) can stimulate new design ideas.
- Each reaction to a proposed design contains implicit criteria, constraints, and ideas of how something will work. These are worth exploring further.
- Trade-offs begin to be made and understood as the class moves toward an acceptable common design.

When children present their designs, use the following to help them make their thinking as clear as possible for the benefit of all:

- Did anything present a problem for you as you thought about your design? How did you deal with it?
- What other designs did you consider? Why did you reject them?
- Describe how you imagine your design working.
- How does your design meet the criteria?
- Describe how your design stays within the constraints.

Take each design effort seriously, even when the child pretends not to do so. There is something in each child's work that can contribute to the thinking of others. In the act of presenting it, a child will often get new ideas or see problems in his or her design. Watch for and encourage this on-the-spot thinking. As you guide the class toward choosing a design that can be implemented, take every opportunity to acknowledge the collective thinking and collaboration that have helped to shape the design.

2-6: **Sharing design ideas with the rest of the class**



# Plan How to Implement the Solution, Then Implement It

The ways to implement a design are as varied as environmental designs are. Designs that change the physical space of a classroom and designs that affect other parts of the school usually take more planning to implement than designs that affect only a few children or are limited to classroom procedures.

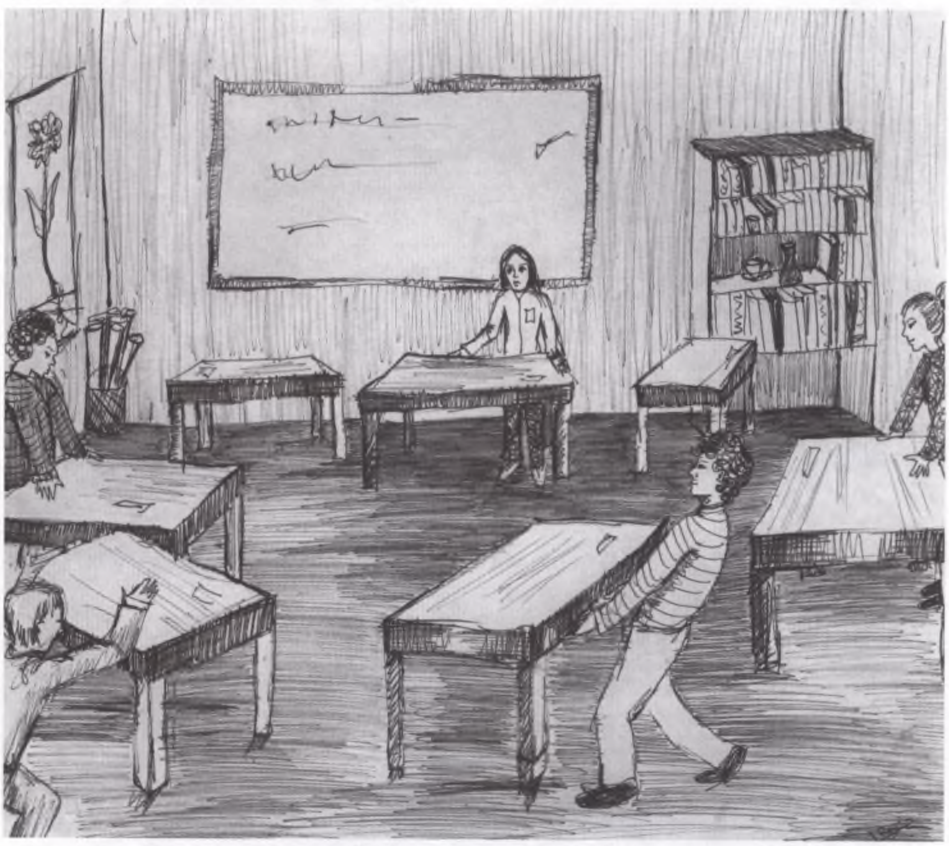
Encourage children to plan how they will implement a change, even when it is a simple one. When implementation is allowed just to happen, carried by the enthusiasm of the children, problems usually emerge—e.g., disagreements about who does what, what goes where, or what the design actually means. Planning how to implement a design avoids these problems or makes them easier to resolve. Fiona's children had to plan carefully because their schedule redesign affected the whole school. Their implementation plan included a "communications campaign" to persuade others of the merits of a new lunch schedule and to win their cooperation.

The implementation phase of a complex design project is itself a design project. Children need to analyze what needs to be done, the number of children needed to do each thing, and the sequence of actions, and then they need to determine who will do what. Some designs require significant planning to implement because the implementation itself takes place within constraints. In Chapter 4, you will read about Angel's children who could only rearrange the classroom furniture during their lunch hour.

Other projects require much less planning to implement, but are subject to revision as feedback during implementation reveals new criteria and constraints. An example of this is seen in Chapter 1, as Bret's class worked toward a solution to constant interruptions from the telephone in the classroom. Their initial plan underwent a series of modifications as new situations arose and had to be accommodated. Each new development served as an evaluation of the protocol they had developed, and thus led immediately to a redesign.

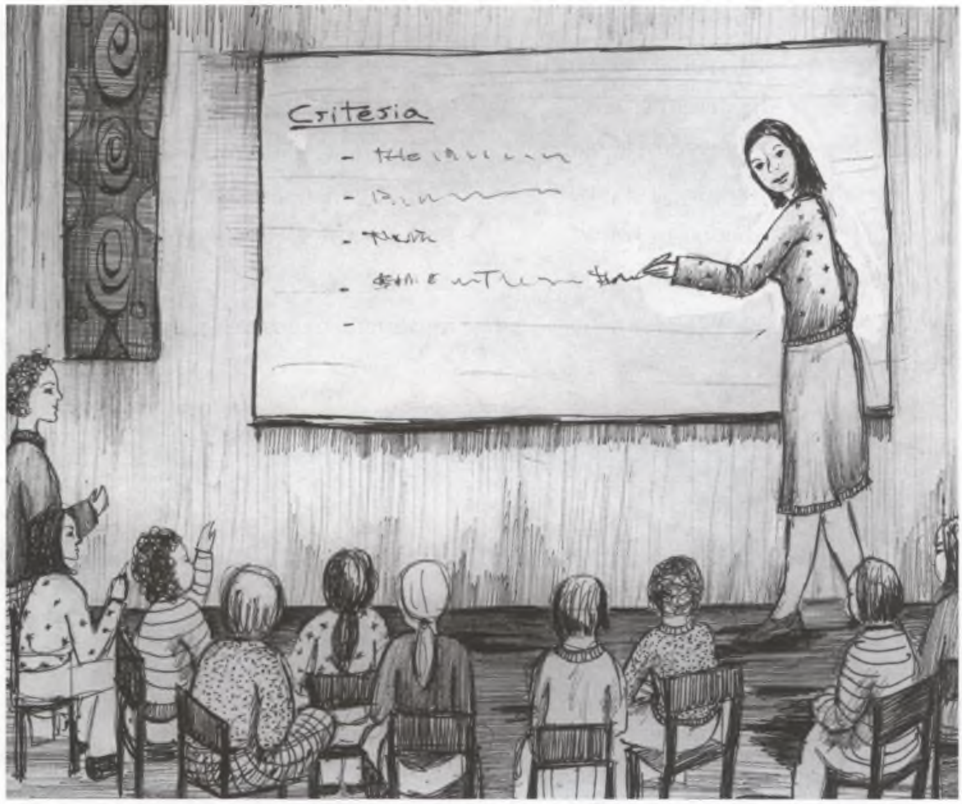
One final word on implementation: Involve as many children as possible in the implementation, not just the group whose idea it was. If evaluation can take place while the design is being implemented, you may want to involve some children in the evaluation effort while others do the implementation.

2-7: **Implementing a design solution**



# Evaluate the Solution After a Trial Period

2-8: **Elicit general impressions about whether the design worked or not.**




In our experience, evaluation is the most difficult step in the design process. If a design works well once it is implemented, a formal evaluation plan may seem unnecessary. If the new design is not working, children and teacher may simply go back to the old way of doing things rather than investing more time in a project that seems to have failed to achieve its goal. In either case, valuable learning opportunities are lost.

Regardless of the apparent success or failure of the design solution, we encourage you to conduct a formal evaluation of the design. This is a unique time to develop children's intellectual skills and to model a good life-long habit. The groundwork for evaluation has already been laid. By this point, you will have seen children develop and practice analytic and problem-solving skills, social skills, and communication skills. These same skills are exercised in evaluation, but with more emphasis on analysis.

Start by eliciting students' general impressions about whether a design solution is working or not working. Whichever answer they give, follow-up immediately by asking, "Why?" List all the "whys" on the board. This list will lead in two directions: some of the "whys" will be related to the design criteria set earlier in the project; others will suggest criteria that were omitted.

Reproduce the list of design criteria that your class developed earlier. Ask the children to analyze the list of reasons the design works or doesn't work and decide which reasons are related to the criteria. The next step is for them to develop a way to demonstrate how each criterion is or is not met. This is usually an issue of measurement: What can you count that will show that a criterion is or is not met, and how will you count it? The criterion Fiona's children had set for the redesign of the lunch schedule was that nobody would have to wait more than five minutes to be served lunch. Here the measurement is simple. The only decision to make is when to begin timing the wait and when to end.

Some criteria are qualitative rather than quantitative—e.g., "I like it better," "It's more comfortable," and so forth. Systematically gathering opinions from all the people affected is one way of dealing with qualitative data.

The reasons designs don't work are often linked to important criteria that were not included in the design criteria established at the beginning of the process. Review the list of reasons why designs work or don't work and identify those that are not related to the original design criteria. Ask the children to develop, from this list, additional criteria that should be included in the design criteria. When these have been developed, discuss what techniques you might use to measure whether or not a particular criterion was met. This is where redesign begins.

## Redesign

The idea of going back to redesign the solution should carry a positive message: Rather than settling for a solution that doesn't achieve your goals, you can always make it better. Even if constraints on time or other resources prevent the class from carrying out a redesign at present, it's important to get this positive notion across. The children will already have ideas about how they would improve a design. This is something for them to value, even if they can't do the redesign right now. The ideal scenario, of course, is for children to use everything they have already learned in the project to do it even better the next time.

# What Children Need to Know for *Designed Environments* Projects

Children need to know very little traditional subject-matter content in order to carry out *Designed Environments* activities. This is not to say there is no content, however. Rather than being conceptual or fact-based, the content of *Designed Environments* is based on using critical thinking skills, analysis, and perceptual awareness, and on putting everyday experience and practical knowledge to work in order to solve problems. More than anything else, when children are engaged in *Designed Environments* projects, they are learning by doing.

When children—even 5- and 6-year-olds—think about how to redesign a room, they bring to the problem a wealth of experience that comes from living and working in rooms their entire lives (however short!). The wider the experience, the more varied the possible solutions they can consider. Some children will come with ideas about how to do specific things. They will have experience in making plans and arranging things, though they may not know to call it that. Your job is to provide opportunities for them to heighten their awareness of and ability to use what they already know and to expand this everyday knowledge.

# Children Learning from Children

Children can help each other become more aware of what is around them and able to describe what they think. The most observant and verbal children will often bring lots of ideas to a group discussion. Encourage and honor all children's ideas as a way to broaden everyone's background knowledge and to give all children confidence to share what they think. This doesn't mean you should accept inaccurate information, however. But rather than labeling an answer as wrong, you can use guided discussion and questioning to help children evaluate their own ideas and revise them when necessary. This can happen during the course of a discussion by encouraging further reflection and analysis within the group, or it can happen when a child takes on a question as a research project.

# Directed Observation

By directed observation we mean focusing children's attention on a specific aspect of the environment. This is typically done by asking children to:

- Describe/record the details of a place or object, often through drawing.
- Compare a new place, object, or arrangement with one that is already familiar.
- Look for cause-and-effect relationships.
- Analyze the way the parts of a complex object (or environment) interact with each other.
- Count or measure things within the environment.
- Look for order within the environment—a sequential order of events or a predictable change in some aspect of the physical environment, such as light, temperature, or noise.

# Expanded Opportunities for Observations

Field trips, used in conjunction with focusing activities like those above, are among the best ways to broaden children's background knowledge of the environment. Field trips can be within the school as well as outside. When the project involves redesigning something in the classroom, field trips to other parts of the school are invaluable. Take the class on trips to other classrooms to see how desks and other furniture are arranged, how supplies and other materials are stored, what centers there are and how they are set up, and any other aspect of classroom design. On any field trip, draw the children's attention to how people arrange things, where the signs are located, where traffic bottlenecks occur and why. Through such experiences, you expand the reservoir of everyday knowledge children draw upon in designing solutions to new problems. This is the knowledge that underpins *Designed Environments* activities.

## Lots of Talk

Talking about what was observed on a field trip is as important as the trip itself. It is critical that children have opportunities to discuss similarities and differences, to compare one experience to another, to specify the details of a situation with clarity and accuracy, and to share other such analyses. Through these conversations children help themselves and each other form a coherent understanding of a new situation and connect this to their understandings of other similar situations. Hearing others talk about how things are done in the everyday world, they form connections with current factual knowledge, conceptual understanding, previous experience, and partially remembered ideas and images. Through this process they revise and build on what they already know as they acquire new knowledge and insights.

## What a Teacher Knows

There is another sort of content that teachers bring to activities in *Designed Environments: Places, Practices, and Plans.* This is related to specialized knowledge that trained professionals use when they design environments—knowledge about lighting and visibility, how much space people need to feel comfortable, how to control variables such as noise, heat, and traffic. What a teacher knows is that some light levels make reading easier; some noises are distracting, and crowding often leads to behavior problems. You can help your children think about how these variables affect people's behavior and sense of well-being by asking them to think about the answers to questions like these:

- How much space do you need to be comfortable?
- How does what you can see change when light goes from dim to bright?
- What happens when you are trying to work and people nearby are making a lot of noise?

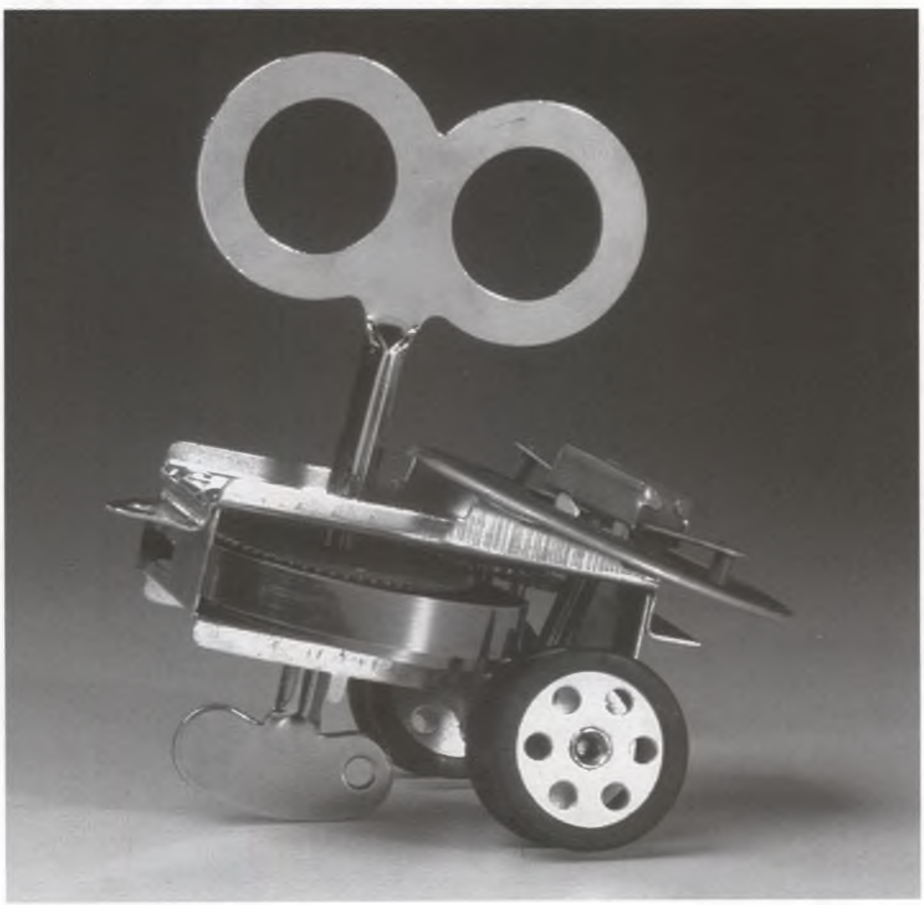
# Systems Thinking and Environments

*Systems* is one of the common themes in the AAAS *Benchmarks*. It is also a unifying concept of the *National Science Education Standards*, and systems thinking is a goal of various other educational standards. These are the basic characteristics of a system:

- A system is a group of interrelated parts that together form a whole.
- The functions of a system are greater than the functions of its parts.

These statements define a system in terms of structure and function. A system is easily understood when applied to a mechanical device. For example, a wind-up toy car is a group of interrelated parts: wheels, axles, springs, gears, keys, toggles, and the like. Placed in the right relationship to one another, the parts form a toy that is able to do more than any of the parts can do separately, namely move itself.

2-10 **A wind-up toy is a system and contains sub-systems**



The wind-up car is a system in and of itself. It also contains subsystems—groups of parts which themselves form systems. The wind-up motor, apart from the wheels and chassis, is such a subsystem. The wind-up car itself can be a subsystem when placed in a larger system. This can be seen when a child places the car on a network of roads and buildings that she has constructed in the block corner.

Identifying the interrelated parts of a system is more complex when people are involved. A child needs help to see that he is a part in a classroom system, along with all the other people in the room. When he is sad, others are sad too. Even for adults it is difficult to identify everything that is important in a system. It is almost impossible for the beginner to specify ahead of time everything a design should be and do.

The experience of planning and evaluating environmental designs develops the ability to identify the parts and functions of a system. Conversely, the ability to identify the parts and functions of a system helps one to define that system. Environments are systems, so environmental analysis is systems analysis and should be guided by the same kinds of questions that guide systems analysis—for example:

- What are the components of the system?
- How do these components interact?
- How does a change in one component affect another?
- What are the properties of the system as a whole?
- How does the system as a whole function?

These are the same questions children are answering when they gather and analyze information about an environmental design problem, identify design criteria, design and implement a solution, and evaluate the effectiveness of the design.

# Learning and Child Development in *Designed Environments* Activities

Roger Hart is an environmental psychologist whose specialty is children in their environments. He describes children as designers of their own spaces from a very early age. Initially this "designing" is finding spaces that feel comfortable, that fit. Children crawl beneath tables, especially with tablecloths hanging down. They burrow beneath sheets and curl up in large cardboard boxes.

As children grow, they begin to combine elements as they design their environments. They drape the sheet over the card table to enclose the space completely. They arrange several boxes together. They begin to "furnish" the environments they design, bringing in their favorite things. They create their own spaces and exert control over them.

Hart's initial focus is on structures that children build themselves. He then expands his focus to include children participating with adults in designing real spaces. He identifies several benefits to children that accrue from this kind of design work. They...

- discover principles of spatial relationships;
- establish one's place in the world by giving shape to it;
- gain a sense of control over the world;
- work with others to develop shared goals;
- develop confidence in the use of the environment to carry out one's goals;
- cooperate with others to shape a shared environment;
- develop a sense of involvement in and responsibility for the "real" world.

In Hart's view, a goal of childhood is preparation for democratic responsibility and effective citizenship, and that requires the development throughout childhood of the capacities listed above.

A major goal of public education in a democracy is to develop an effective citizenry. That job is entrusted primarily to the social studies curriculum. Benenson (2001) has analyzed design technology contributions to the major curricular areas. He points to one general success of the social studies curriculum: the socialization of children to accept the cultural and political norms of the society. Such socialization is one part of producing good citizens. There is a second, more active part to good citizenship—to be alert to shortcomings in the status quo and committed to transforming social situations for the better. The social studies curriculum is far less successful in this task, since it is more apt to focus on learning content rather than on analyzing and transforming social situations. *Designed Environments* projects situated in the child's own environment provide balance to the traditional social studies program in this regard.

Carol Gilligan studies social and moral development from a feminist perspective. Although her starting point is quite different from Hart's, she too is very concerned with the sort of people we become. Much developmental theory, based primarily on the study of males, has emphasized the development of independence and of concepts of individual rights and justice. Gilligan's study (1982) of women's development has resulted in a different set of equally important characteristics that are the goal of development through childhood:

- caring for self and others;
- taking active responsibility for conditions in one's world;
- having a sense of responsibility to see real troubles in one's world;
- having a sense of responsibility to alleviate real troubles in one's world.

Gilligan suggests that full development for both sexes entails both strands of development—an integration of rights and responsibilities. *Designed Environments* projects provide a rich context for this kind of development. They help children recognize problems in their school environment and then motivate them to work together and implement solutions.

Chapter 3

# ACTIVITIES

This chapter offers a series of projects designed to give students direct experience with designing and evaluating environments of various kinds. 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 1-4 deal with the ways that practices and procedures are an aspect of the environments we inhabit, ranging from classrooms to the world of games. Activities 5-7 deal with the designed environments of places, large and small. The activities are designed to give students experience with many of the concepts discussed in Chapter 2, "Content."

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

## ACTIVITIES AT A GLANCE

| Activity Title | Page | What Students Learn About Designing Environments | | | |
|---|---|---|---|---|---|
| | | Analysis | Design | Implementation | Evaluation |
| 1. Interruptions | 54 | × | × | × | |
| 2. Examining Classroom Procedures | 57 | × | × | × | × |
| 3. The Broken Rules Project | 60 | × | × | × | × |
| 4. The Games Project | 67 | × | × | × | × |
| 5. Classroom Environmental Design | 72 | × | × | × | × |
| 6. Environmental Redesign of Larger Spaces | 77 | × | × | × | × |
| 7. Critter Habitats | 83 | × | × | × | × |

# Let Us Count the Ways:

## An Introduction to Data Collection

**"A good scientist is a person in whom the childhood quality of perennial curiosity lingers on. Once [s]he gets an answer, [s]he has other questions."**

Frederick Seitz, *President*
Rockefeller University

Children are natural data collectors. School-age children are actively engaged in acutely observing, negotiating, and interpreting data about their family members and peers, the popular culture (through music and media), and the academic setting—curriculum, schoolmates, and teachers. They collect, interpret, and prioritize this information about the worlds in which they live for personal growth, social purposes, and academic advancement (not necessarily in that order!).

Data collection is an essential piece of most of the classroom projects that follow, and it takes several forms:

- Counting and recording the number of students engaged in a particular activity;
- Using a checklist to record observations;
- Taking a survey by asking questions of students and school staff.

The daily procedures, routines and communal behaviors of school culture are all fodder for data collection and observation. In the projects that follow, data collection is often the preliminary step to focus student attention on a relevant real-world problem of procedure and routine or an aspect of classroom or school design that is ponderous or unmanageable. Having students collect data on a student-identified classroom or school-wide procedural or design "problem" often has the dual benefit of correcting that problem and empowering students. Additionally, for educators, data collection is a means of integrating many curriculum areas simultaneously and intuitively: math, social studies, language arts, and science.

NCTM Standards/Grades K-4 state that "[p]roblem-solving is not a distinct topic but a process that should permeate the entire program and provide the context in which concepts and skills can be learned." NCTM further states that when "problem-solving becomes an integral part of classroom instruction and children experience success in solving problems, they gain confidence ... and develop persevering and inquiring minds." (p. 23)

Here are some simple observation exercises you can use to introduce your students to data collection.

- Assign a small group of students the task of discreetly observing the other students in the class. How many children in the class are out of their seat (getting a drink at the water fountain, using the pencil sharpener, etc.) or out of the room (using the restroom, at a "pull-out program," acting as a monitor, etc.) during one classroom period? The morning? The afternoon? During one day, two days, or one week? Collect data.

OR,

- Assign all students in the class the task of observing (one day, two days, one week) and recording (tally, checklist, etc.) "traffic patterns" within a communal space in the school—the lunchroom, the library, the stairs. How many children are on line for lunch? Waiting to check out books? On the stairs between classes? Collect data.

THEN,

- After the initial data is collected, display the data and discuss the results with the class. What do we notice about the data? Is there a pattern? What might the reasons be for any patterns you observe? And so on. Record student responses on chart paper. Allow students ample time to discuss their observations and formulate conclusions.

This exercise may serve as a warm-up for students to any of the projects that follow. Or, depending on your grade level, the next step could be to ask the students if they are able to identify any problems of procedure or routine inherent in the data. Give a few examples. For instance, if students observed traffic patterns in the school cafeteria, the example could be given that a long line at the cafeteria may indicate that class arrival times should be staggered. If students collected data on how many of their classmates left the room or were out of their seats, a large number not in their seats during instructional time might indicate that procedures for sharpening pencils, getting a drink of water, etc. need to be redesigned. Or maybe it indicates that instructional time needs to be redesigned. There are many opportunities inherent in this kind of work for students and educators.

Students are most engaged and empowered when they are able to directly impact their environment. Educators are empowered when their students are actively and enjoyably engaged and progressing academically. Both are possible when you and your students are engaged in the investigations that follow. Enjoy!

# Activity No 1

# Interruptions

## Grade Level
3 and up

## Overview
Most classes are interrupted by intrusions from the outside—an intercom, a telephone, a person at the door—that interfere with classroom activities. This unit involves children in the analysis of classroom interruptions with the goal of devising a way to decrease unnecessary interruptions.

## Prerequisites
Facility with mathematics and language arts at a third-grade level

## Concepts/Skills
- Identifying environmental problems
- Designing data collection procedures
- Collecting data
- Organizing data
- Analyzing data
- Communicating results

## Standards
- Benchmarks for Science Literacy: 1A1, 1B1, 1B2, 7C1, 7C2, 7D2, 12A1, 12A2, 12A3
- Principles and Standards for School Mathematics: PS2, PS3, Com1, Com2, C3, R1, M1, M2, DA&P1
- Standards for Technology Literacy: 8A, 8B, 8C 11D
- Standards for the English Language Arts: 7, 11, 12
- Curriculum Standards for Social Studies: 3, 5, 6, 10

## Time Frame
6-8 class periods

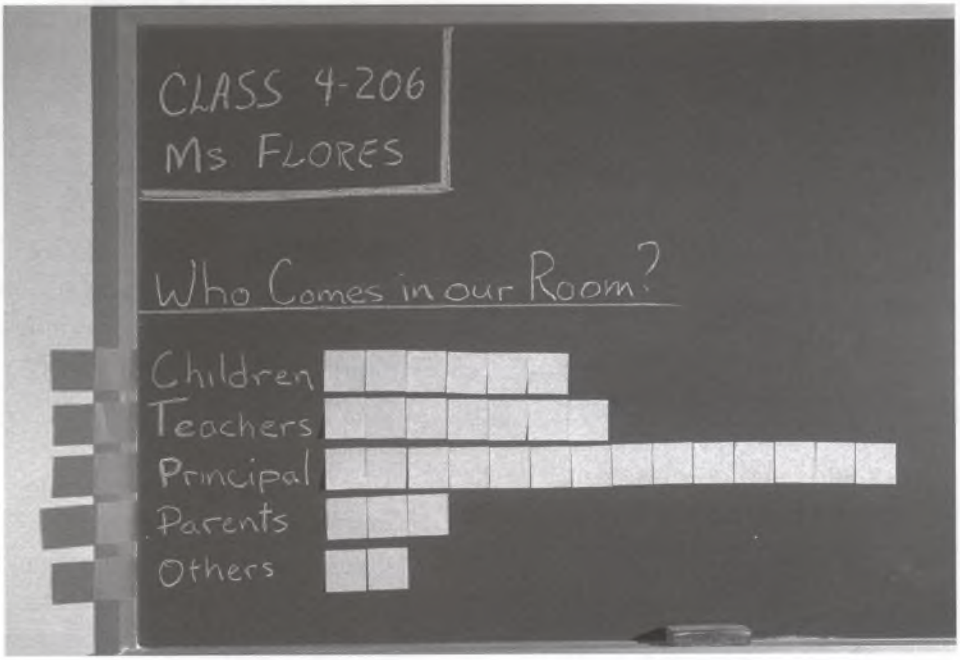
## Materials
- Chart paper
- Markers
- Pencils
- Graph paper, construction paper, oak tag (for presentations)

## Procedure
1. Following a particularly bothersome interruption, call the children's attention to the way interruptions interfere with the class activity. Tell them that later you will take some time to talk about interruptions—how they affect the class and what can be done about them.
2. Bring the class together for a discussion. Remind students of the interruption that occurred earlier. Explain that they are going to work on developing a plan to reduce the number of times the class is interrupted. The first step is to analyze the problem. Ask, "Who interrupts our class?" Record students' answers on chart paper.
3. Explain that for the next three days each student is going to collect data on interruptions. After the three days they will share their information and begin to make a plan.

   *Note: This is a non-structured data collection. The expectation is that children will report quite different results. You will use these different results as an opportunity to help children see the need for systematic data collection.*

4. After three days, bring the class together to share the information they have collected on interruptions. Record everyone's information on the board or chart paper. Draw attention to the differences in the ways children report their findings and the differences in the number of interruptions counted. Have individuals describe how they decided that something was an interruption. Help them see that it's difficult to make a plan to solve a problem when people have different ideas about exactly what the problem is. Then explain that for this project, they will be focusing on who is interrupting the class. Then they'll be able to make a plan for reducing the number of interruptions.
5. Ask students to look at the data they've already collected and identify who interrupted the class. Record all the answers on chart paper. Then ask students to suggest ways to group these interrupters into categories. A typical list might include:
   - Students from other classes
   - Teachers from other classes
   - The principal
   - Someone (other than the principal) on the intercom
   - Parents
   - Visitors
6. Brainstorm ways to collect information about who is interrupting the class. One possibility is to list the categories on the board. Students share the job of "interruption monitor" whose job it is to go to the board and record an interruption in the appropriate category when it occurs. After several days you'll have a tally of interruptions by each category.
7. Assign "interruption monitors" for each of the next several days.

3-1: **A graph of interruptions**



8. Each day for the next five days spend a few minutes with the class discussing the process of data collection and the results. Check with the monitors to see if they had any problems deciding whether to record something as an interruption, or deciding which category to credit as interrupter. Ask the rest of the class to comment on the data collection. Does anyone disagree with the data collected that day? If so, discuss the problem and figure out whether the data collection method or the results need to be changed. If the need for a new category of interrupter emerges, for example, you might decide to add it to the list on the board.
9. After five days of collecting data, set aside a class period to discuss the results. Use questions like these to get the discussion started:
   - Can you see any patterns in the data we've collected?
   - Which category has the most interruptions?
   - Why do you think that category has the most?
   - Which category has the fewest interruptions?
   - Do you think these people mean to interrupt our work?
   - Do you think they know they are interrupting our work?
   - How do you think these interrupters would feel if we told them how we feel about interruptions and showed them our data? Would they want to change their behavior?
10. Divide the class into small groups. Ask each group to discuss the data and decide on a good way to share the information collected with the people who interrupt the class. Groups should then create a graph or chart to show the data on interruptions.
11. Set aside class time to have groups present their data to the class. Have the whole class discuss and agree on the best way to present the data to those who interrupt the class most frequently.
12. Invite the interrupter(s) to the class to talk with students about their findings and to discuss a better way of doing things so that the number of interruptions is reduced.

    *Note: This can be a sensitive area. You may wish to inform the "most frequent interrupter(s)" of the results before inviting them to class. That way they will have a chance to reflect on the problem and come up with some ideas for solutions.*

# Activity № 2

# Examining Classroom Procedures

## Grade Level

1-6

## Overview

Two stories in Chapter 4 tell of a class solving problems involving chairs not being put up at the end of the day, and coats on the floor of the coat closet. "Examining Classroom Procedures" is a general way to guide children in solving everyday classroom procedural problems.

## Concepts/Skills

- Identifying classroom problems
- Designing data collection procedures
- Collecting data
- Organizing data
- Analyzing data
- Communicating results
- Formulating design criteria
- Developing designs
- Evaluating competing designs
- Implementing a design
- Evaluating implementation

## Standards

- Benchmarks for Science Literacy: 1A1, 1B1, 1B2, 7C1, 7C2, 7D2, 11A2, 12A1, 12A2, 12D3
- Principles and Standards for School Mathematics PS2, PS3, Com1, Com2, C3, R1, DA&P1
- Standards for Technology Literacy: 8A, 8B,11A, 11D, 11E, 11F, 11G
- Standards for the English Language Arts: 7, 11, 12
- National Council of Social Studies Curriculum Standards for Social Studies: 3, 6, 10

## Time Frame

4-6 class periods, plus time for preliminary data collection

## Prerequisites

Knowledge of charting, graphing, tallying, and data recording

## Materials

- Chart paper
- Construction paper, graph paper (for data presentations)
- Student journals and/or folders to record and store investigation data

## A. Problem Identification Phase

### Procedure

A small group of children does the initial part of this project. The teacher either presents them with a classroom procedural problem to analyze or guides them as they identify a problem. If the children are to identify a problem, it is essential to keep the group focused on classroom procedures rather than rules. Help students stay on track by giving examples of classroom procedures such as distributing or returning materials, lining up, putting coats away, going to the bathroom, etc. Then brainstorm a list of procedures that do not seem to work well in the classroom.

## B. Analysis Phase

### Procedure

The small group or team analyzes the environmental "problem" through preliminary data collection.

1. Give this group the task of "spying" on their peers to gather initial data on the selected problem. Discuss a plan for recording data discreetly:

- How will we keep track?
- How many days should we record data?

Also explain that overt recording will skew the particular behavior being recorded and "blow their cover."

2. After the preliminary data has been collected, help the group to organize their findings to present to the whole class group.

## C. Design and Implementation Phase

**Procedure**
The whole class or small groups discuss possible design solutions to the environmental/ procedural problem based on data presented by the preliminary team.

1. Have the preliminary working group present its data to the whole class. Then have the whole class brainstorm possible solutions. If any ideas seem impractical or impossible to implement, discuss those with the class so that everyone understands why they won't work. Record all other ideas on large chart paper and post the list in the classroom.
2. Divide class into teams of four students or less. Each team chooses a solution from the brainstormed list, and then designs the best procedure for implementing that solution to solve the problem.
3. Each team then presents its solution to the problem and the suggested procedure for implementing the solution.
4. Choose one of these options for implementing the solutions: one of the presented solutions is chosen by the class to be implemented, with individual groups collecting data for evaluation; or the groups take turns implementing their proposed solutions, with individual groups collecting data for evaluation. Whether one solution is implemented or several, be sure to allow sufficient time for groups to collect data for evaluation.

## D. Evaluation Phase

**Procedure**
Each group presents its evaluation data on the implemented solution(s) to the whole class. The class discusses the results and decides whether design, implementation, or evaluation modifications are necessary.

1. Before groups present their evaluation data, have a class discussion about what a successful solution is and what a solution requiring redesign is. Record these definition on chart paper, including the criteria for each, and post the chart so that it is visible during the following presentations.
2. Each group presents its implementation and evaluation data to whole class. During the presentations and the following discussion, students should refer to the posted chart with its criteria for successful and not-so-successful solutions. Each group's solution should be categorized as "Successful" or "Requiring Redesign, based on those criteria.
3. If time permits, allow time for the redesign, implementation, and evaluation of "solutions requiring redesign. Students may also pursue redesign solutions as independent projects.

## E. Assessment/ Extensions

**Procedure**
Here are some examples of assessment activities through which students might demonstrate understanding and mastery of the concepts and skills listed above for this activity:

- Student journals or logs (done in-class or as homework) that record each session's activities and include student reflections
- A narrative procedure documenting the process or steps towards a successful solution
- The creation of a redesign plan—analysis, implementation and evaluation—for their own (or another group's) solution

- The design of a new procedure for using the class library, sharpening pencils, collecting/checking homework, preparing for dismissal, etc.
- Designing a rubric or rubrics for critiquing "successful solutions" or "solutions requiring redesign"

## Strategies and Tips

- During the preliminary data collection/analysis phase, the preliminary group may be comprised of reluctant students who would benefit from being on the "inside track," as well as more able students adept at recording data.
- During the design/implementation phase, keep groups focused on implementation of one solution at a time. Stress that evaluative data is the only evidence groups will have to show the success of their solution. Therefore, it's very important for them to ask and answer this question for themselves: How will we keep track of what's going on in order to know whether the new procedure is working?
- If investigation time is limited, choose in advance a classroom procedure that you feel is not effective. Students may brainstorm solutions in work teams, vote on the "best" solution, and then track evaluative data as a group.
- Discourage any group's solution that directly involves you, the teacher (e.g., detaining students at lunch or after school, etc.), but encourage systematic and logical implementation of plans of possible solutions whose success you view as doubtful. It is important for students to reflect on plans that didn't work.
- During the evaluation phase, the investigation may be concluded after discussion of the solutions presented, or the notion of redesign may be introduced and the investigation extended.
- Assessment/extension activities may be done independently and/or cooperatively, or assigned as homework or extra credit, portfolio, or "exit" projects.

# Activity № 3

# The Broken Rules Project

## Grade Level
4-6

## Overview
The students develop analytical and problem-solving skills as they carry out an integrated project investigating rules that are broken in school.

## Concepts/Skills
- Brainstorming
- Identifying problems
- Designing data collection procedures
- Collecting data
- Organizing data
- Analyzing data
- Communicating results

## Materials
- Chart paper
- Worksheet #3A: "Rules to Live By"
- Worksheet #3B: "Rules, Rules, Rules"
- Worksheet #3C: "Rule Patrol"
- Graph paper, construction paper, markers, and other materials for making charts and graphs

## National Standards
- Benchmarks for Science Literacy: 1B1, 1B2, 7C1, 7C2, 12A1, 12A2
- Principles and Standards for School Mathematics: PS2, PS3, Com1, Com2, C3, R1, DA&P1
- Standards for the English Language Arts: 7, 11, 12
- National Council of Social Studies Curriculum Standards for Social Studies: 3, 5, 6, 10

## Time needed
6 class periods

## A: Identifying the Rules

**Time:** about 30 minutes

**Materials**

- Worksheet #3A: "Rules to Live By"
- Chart paper

**Procedure**

1. Bring the class together to brainstorm about school rules. Begin by talking about rules in general and having the children give examples of rules. Tell the class that they will be carrying out an investigation of rules.
2. Hand out the "Rules To Live By" worksheet. Give students 5-10 minutes to list as many of the rules they are required to follow in the classroom and in school as they can think of.
3. Bring the class together and have students share the rules they wrote down. Record their rules on chart paper under the headings "Classroom Rules" and "School Rules."

## B: Identifying Who Makes the Rules, Who Enforces the Rules, and Why the Rules Are Broken

**Time:** About 40 minutes

**Materials**

- Worksheet #3B: "Rules, Rules, Rules"

**Procedure**

1. Hand out the "Rules, Rules, Rules" worksheet. Ask a student to read the first two questions: "Who makes the rules in the classroom?" and "Who makes the rules in the school?" Allow time to clarify the questions if needed. Refer children to the "Rules To Live By" chart to help

them think about whether different rules are made by different people. Encourage students to answer the worksheet questions in complete sentences.

2. Ask a student to read the next question, "Who enforces the rules in the classroom?" Again, clarify the question if needed.
3. Let the children work alone or in pairs to fill in their responses to the first three questions on their worksheets, and then go on to the remaining questions.
4. Bring the class together and have students share their responses. Encourage children to ask questions about one another's answers. If students disagree about the answers, help them discuss the reasons for the disagreement and come to consensus. Tell the students they will be doing a study on the rules that children break. They should begin thinking about which rules are most often broken, and where the rules are broken.

## C. Planning the Study

**Time:** 30 minutes plus homework

**Materials**

- Worksheet #3C: "Rule Patrol"

**Procedure**

1. Hand out copies of Worksheet #3C: "Rule Patrol." Describe and discuss the study the children will be planning. Encourage them to ask questions about the worksheet and what's expected of them. To help with questions 1 and 2, ask students for examples of rules that are frequently broken and where they are broken. Pick two quite different examples of rule-breaking (e.g., shouting in the cafeteria and interrupting during math period), and go through how they might be dealt with in question 3.
2. Explain to students that they will be selecting a frequently broken rule to study, then doing research on how often this rule is broken in a particular time and place. They will follow these steps:
   - Think about the particular rule they want to study, and when.
   - Fill out the "Rule Patrol" worksheet as homework.
   - Share these preliminary plans with the class.
   - Work in small groups to design the final study.
   - Carry out the study.

## D. Clarifying the Research Question and Plan

**Time:** One-two 30-minute class periods

**Materials**

- Students' completed "Rule Patrol" worksheets
- Chart paper

**Procedure**

1. Bring the class together and ask students to share their responses to and questions about the "Rule Patrol" worksheet they have filled out.
2. Emphasize that this is a brainstorming session about types of studies and how they might be done. Explain that in a few minutes students will divide into groups to design their own studies.
3. Discuss ways to collect the data in order for the children to clarify for themselves what they might do. Sketch a sample data sheet to give an image of what might be done.

**Name:** Keesha B

**Rule broken:** no running in hall

**Day & Time:** Tuesday on way to lunch

Boys running in hall: ///// /////

Girls running in hall: ///

**Sample Data Sheet**

4. Most students will need help stating a specific question that will focus on the kind of behavior to observe. Help them out with specific suggestions such as:
   - How many times do students call out during a math class? How many times do girls call out? How many times do boys call out?
   - How many students talk when the teacher is giving directions?
   - How many shout in the hallways on the way to lunch?

5. Divide the class into groups of two or three to develop a research question for their group and a plan for collecting the information needed to answer the question.
6. Tell students that, on the following day, they will collect data that will answer their question.
7. Let students find their own way as much as possible as they work together to develop their questions and plans. If a group seems to be stuck, ask questions to help them get back on track.

## E. Collecting Data

**Time:** Students working on their own outside of class time

**Procedure**

Over the next several days, students collect data on how many times their rule is being broken. Make sure this work is proceeding by asking informal questions about how the study is going. When you sense that groups are confused or floundering, ask them to describe what they are doing to help them clarify their procedures.

## F. Reports

**Time:** One period for report preparation, one period for reporting

**Materials**

- Graph paper, construction paper, other materials for making charts and graphs
- Drawing paper
- Pencils, markers

**Procedure**

1. Set aside class time for students to organize their "Rule Patrol" data—e.g., creating a tally sheet to sort out the different kinds of data they've collected. Each group then creates a chart, bar graph, pie chart, or some other graphic representation of their data for presentation to the rest of the class.
2. Allow students to present their data in any manner they choose. Discuss the presentations in terms of the content presented as well as the form of the presentation.
3. Encourage others to ask questions of the presenting group. When all groups have presented their findings, discuss the findings as well as the ways students used to present their data.

## G. Evaluation

**Time:** One or more class periods

**Materials**

- Paper and pencils

**Procedure**

1. Conduct a directed writing activity as an evaluation tool for this project. Pose questions to the students or write them on the board. Students answer in writing. Here are sample questions, or create your own based on your observations of students through all phases of the project:
   - What was the hardest part of planning your study?
   - What was the most fun in doing the study?
   - What did you learn by conducting this study? Explain.
   - Based on your observations, which rule is broken the most?
   - If you were going to do this project again, what would you do differently?
   - What would you do to help students not to break the rules?
   - Did you enjoy this study? Why or why not?

2. Additional assessment activities through which students can demonstrate understanding of learning outcomes are:
   - Journals or logs (done in class or as homework) that record each session's activities and include student "reflections."
   - A narrative procedure documenting the process or steps taken towards the procedural redesign or behavior modification.
   - Designing a rubric of criteria for a "successful" procedural redesign.
   - Designing a data collection plan for an uninvestigated or alternate classroom interruption.

**Extension**

Children may want to consider what they can do about the rule-breaking they have studied, which can be the basis for a new design project.

**Strategies and Tips**

- This sort of inquiry requires close supervision so you can be an effective facilitator when students encounter problems or lose their focus.
- If necessary, start with lessons on compiling data. See "Let Us Count the Ways: An Introduction to Data Collection" (p. 52) for some suggestions.
- If the project doesn't work, don't give up. Try to figure out what went wrong and find another way.
- It's important that an inquiry-based project like this be based on something the students are interested in investigating.
- You can customize this project to make it a short- or long-term one, and you can adjust the amount of time spent on each phase to your schedule and curriculum demands.

**Worksheet #3A**

# "Rules to Live By"

Name Date

**List the rules you are required to follow in the classroom and in the school.**

**Classroom rules**

**School rules**

**Worksheet #3B**

# "Rules, Rules, Rules"

Name ______________________ Date ______________

1. Who makes the rules in the classroom?

2. Who makes the rules in the school?

3. Who enforces the rules in the classroom?

4. Who enforces the rules in the school?

5. Name two rules that are broken on a daily basis.

1).

2).

6. Why do you think these rules are broken?

1).

2).

7. What would help stop people from breaking these rules?

## Worksheet #3C

# "Rule Patrol"

Name/Group ______________________________ Date ______________

Every day rules are broken in the classroom, the halls, the stairways, the cafeteria, the playground, and other areas of the school. Think about a rule that is often broken, and where you most frequently see it broken. You are going to plan a study in which you will observe other students and keep track of each time they break the rule. You may collect your data in any of the places where you normally spend time during the school day.

**Pay attention to rule-breaking in your class and school. Then complete this preliminary plan.**

1. I expect this rule to be frequently broken:

2. I plan to investigate each time this rule is broken during the following class/period/or activity:

3. Here is my plan to determine how many times the rule listed above is being broken:

   Where will I observe?

   When will I observe?

   How long will I observe each class / period / or activity?

   How many classes / periods / or activities will I observe?

4. Show how you will collect and record the data. Make a data collection sheet on which you will
   - Indicate the rule being broken
   - Indicate the day and time you are observing.
   - Indicate the place you are observing.
   - Record each time the rule is being broken

**Things to think about:** Should you include information about who breaks the rules more often? For example, in your class should you keep data on whether boys or girls are the more frequent rule breakers? If you are recording rule breaking in the cafeteria, should you also record whether older or younger children are doing it?

# Activity № 4

# The Games Project

## Grade Level
3-8

## Overview
This project uses the familiar game "Connect Four" to model a series of activities in which students engage in the design process by changing the way a game is played. Students analyze the rules and materials of "Connect Four," change one or more aspects of the game, and play the redesigned game. They analyze and evaluate the new game and make recommendations for further redesign.

Note: If you and your students are not familiar with "Connect Four," you can adapt these activities to a game that you do know.

## Concepts/Skills
- Identifying an aspect of game to change
- Redesigning a game
- Formulating design criteria
- Developing a new design
- Implementing a design
- Communicating/describing the new game and rules
- Evaluating the design's implementation

## Standards
- Benchmarks for Science Literacy: 1B1, 1B2, 3B1, 11A2, 12A3, 12D1, 12D2
- Principles and Standards for School Mathematics: PS2, PS3, Com2, C3
- Standards for Technology Literacy: 8A, 8B, 11C, 11F, 11G
- Standards for the English Language Arts: 7, 11, 12
- Curriculum Standards for Social Studies: 10

## Time needed
5 class periods

## Games Project Sequence
- Part A: Children play "Connect Four" using the official rules. (30 minutes)
- Part B: Children select an aspect of the game to change, change it, and play the game using the new rule/board/move. They evaluate the change. (45 minutes)
- Part C: Children share the changes and evaluations, then discuss criteria to be met by a change. (30 minutes)
- Part D: Children redesign "Connect Four" with a specific objective—so that it takes more or less time to play or to make it easier or harder to play. They select the version they like best and write the rules for this "new" game. (45 minutes)
- Part E: New games exchanged, played, and evaluated by others in the class. (45 minutes)

## A. Introduction to "Connect Four"

Students use homemade materials to learn how to play or practice playing "Connect Four" as it was designed to be played.

#### Materials
- One "Connect Four" game for demonstration purposes
- One set of the following for each pair in the class:
- 1″ square graph paper cut to a 7″ x 6″ rectangle
- Two different sets of 21 playing pieces (blue cubes, yellow disks, etc.)

#### Procedures
1. Introduce the class to this unit in which they will learn how to invent a new game, then to test it to see if others like it. Show the "Connect Four" game and ask if anyone knows how to play it. Invite two students to come up and

demonstrate. Make sure everyone understands how to play, especially that the four in a row can be horizontal, vertical, or diagonal.

2. Have a whole-class discussion of "Connect Four," using these questions to get the discussion started:
    - How do you win "Connect Four"?
    - How do you decide what to do when it's your turn?
    - Do you have special tricks or strategies that help you win?
    - What makes playing "Connect Four" fun?
    - What's hard about playing "Connect Four"?
    - What's easy about playing "Connect Four"?
    - Do you think you could change "Connect Four" to make it more fun, harder, or easier?

    Tell students that today they will get used to playing the game with homemade materials using the rules that come with the game. The next day they will invent new ways of playing "Connect Four."
3. Have the children pair up. Distribute a graph paper playing board and sets of playing pieces to each pair.
4. Ask in what ways play on the 7" x 6" graph paper is different from play on the real "Connect Four" frame with its six rows and seven columns. Help students recognize that the basic difference is that "Connect Four" uses gravity to make all pieces go down. In order to model "Connect Four," students will need to identify one of the 7" sides as the side to which all pieces are pulled.
5. Let pairs of children think about the basic difference between this paper version of "Connect Four" and the game they're used to. Challenge them to figure out ways to play "Connect Four," following the rules, with this paper game board—in other words, challenge them to design one or more ways to "impose" gravity on their game. This is an important preparation for the next session. Allow at least 10 minutes or so for them to play the game with these materials.

## B. Changing "Connect Four"

Children make one change in the way "Connect Four" is played and evaluate the change that they made.

**Materials**
- One set of the following for each pair of students:
- 1" square graph paper cut in a 10" x 10" square
- Two different sets of 21 playing pieces (blue cubes, yellow disks, etc.)
- Additional materials to accommodate redesigns that require larger playing areas or more pieces

**Procedure**
1. Have children work in pairs. Distribute one set of playing materials to each pair.
2. Tell students that they are to make one change in the way the game is played and play the game four times with that change.
3. After pairs have made one change and played the revised game four times, tell them to make a different change and play the game at least four times with this new change.
4. Have each student answer these questions in writing:
    - What changes did you make to "Connect Four"? Describe the changes or write the new rules.
    - Which change did you like the most? Why?

## C. Discussing Changes in "Connect Four"

Students discuss their game changes in order to discover the importance of design criteria in the design process.

**Procedure**

1. Have each pair of students share the changes they made in "Connect Four." Ask questions and let students ask questions to make sure everyone understands the changes. Have each group describe how the change affected the game—whether it was easier, harder, more fun, and so on.
2. Introduce the idea of design criteria by asking students to think about why they made a particular change in the way "Connect Four" is played. For example, did they want to make the game go faster, make it easier, make it harder, make it more fun?
3. With the whole class, brainstorm a list of reasons for changing the way a game is played. Write students' ideas on chart paper under the heading "Design Criteria."
4. Ask children to look at the list and explain what they think "design criteria" means. Guide the discussion so that children discover that "design criteria" refers to the reasons for changing a game—what a designer wants to achieve by changing the way the game is played.
5. Have children once again describe their game changes and try to identify the design criteria that were met by their games.

## D. Redesigning "Connect Four"

Students redesign "Connect Four" to meet specific design criteria. They write up the new rules and procedures for others to play.

**Materials**

- A set of the following for each pair of students:
- 1" square graph paper cut in a 10" x 10" square
- Two different sets of 21 pieces (blue cubes, yellow disks, etc.)
- Envelope to hold game "board," pieces, and instructions
- Additional materials to accommodate redesigns that require larger playing areas or more pieces
- "Design Criteria" chart from previous session.

**Procedure**

1. Post the chart of design criteria where students can easily see it. Remind students of their previous work and the concept of designing to meet specific criteria. Explain that today they will invent and try out several games, then select the best to share with others.
2. Have students work with their partners to design and try at least three variations of "Connect Four," playing each at least four times.
3. When students have had enough time to test out each variation, ask them to write down the instructions and rules for the version they think is the best one. They should also list the criteria that these changes are meant to achieve.
4. Have students put the materials for the game, the instructions, the rules, and the list of design criteria in an envelope.
5. As student teams turn in their game envelopes, assign each envelope a number. On a separate list, record the names of the students responsible for each number. (You'll need this information for the next phase of the project.)

## E: Evaluating Redesigned "Connect Four"

Students exchange, play, and evaluate one another's new versions of "Connect Four."

**Materials**
- Envelopes with redesigned "Connect Four" games
- Worksheet #4E: "Redesigned 'Connect Four' Evaluation Form"
- Pencils

**Procedure**
1. Give one game envelope to each pair of students, being sure that a team doesn't get its own redesigned game. Also give each team a copy of Worksheet #4E.
2. Have student teams read the rules and instructions, then play the game at least four times. If the players aren't sure about rules or game play, they should write down what they don't understand and then ask the teacher for assistance. If you can't figure out what the game designers intended, consult your list to find out who they are and ask them for clarification.
3. Student teams use Worksheet #4E to evaluate the redesigned game.
4. Bring the class together for a discussion of the redesigned games and the design criteria.
5. Have designers make refinements and corrections to their written rules and instructions and make the redesigned games available for students to use during free time.

## Assessment/Extensions
- Have students write reflections of their experience as game designers in their journals.
- Have students write a narrative procedure for designing or redesigning a game.
- Have students write reviews/ critiques of popular games.
- Have students design and conduct a school-wide survey to determine the most popular game by grade, by age, by sex, etc.

## Strategies and Tips
The suggested number of class periods may be extended to include several redesign phases.

Worksheet #4E

# Evaluation of Redesigned Connect Four

Name/Team Date

**Materials**

Were all the materials (board, pieces, instructions and rules, design criteria) present in the envelope?

If not, what was missing?

**Instructions and Rules**

| | Clear: We understood it easily | Confusing, but we figured it out anyway | Not Clear: We needed help to play the game |
|---|---|---|---|
| The object of the game | | | |
| How to start the game | | | |
| Where the pieces can be placed | | | |
| How play proceeds | | | |
| How game ends | | | |
| How game is scored | | | |

Was it fun?

Did the game meet the criteria stated by the designers?

Additional comments on the game you played

# Activity № 5

# Classroom Environmental Design

## Grade Level
3-6

## Overview
Students analyze the design of their classroom. They develop design criteria that are important in designing a classroom, propose designs appropriate to the criteria, and are given the opportunity to implement a successful design plan chosen by the whole class.

## Prerequisites
Knowledge of mapping/creating floor plans required for first procedures, not for modified procedures.

## Concepts/Skills
- Identifying problems
- Designing data collection procedures
- Collecting data
- Organizing data
- Analyzing data
- Communicating results
- Formulating design criteria
- Developing designs
- Presenting designs using maps/models
- Evaluating competing designs
- Implementing designs
- Evaluating implementation

## Standards
- Benchmarks for Science Literacy: 1B1, 1B2, 1B3, 3B1, 7D1, 7D3, 11A1, 11A2, 12A1, 12A2, 12A3, 12D2
- Principles and Standards for School Mathematics: PS2, PS3, Com1, Com2, C3, R1, M2, DA&P1, G1, G2
- Standards for Technology Literacy: 2A, 2B, 2E, 2L, 8A, 8B, 8C, 8D, 11A, 11B, 11C, 11E, 11F, 11G
- Standards for the English Language Arts: 7, 11, 12
- Curriculum Standards for Social Studies: 3, 10

## Time Needed
A minimum of 6 classroom periods, 45–50 min. each (preferably within a 10-day period for continuity purposes)

## Materials
- Large chart
- Grid paper
- Drawing paper
- Journals
- Rulers
- Pencils, markers, crayons

*Note: This sequence of activities is for those with mapping experience. The modified sequence provides scaffolding for those with less mapping experience and requires less time.*

## A. Introduction: Developing Design Criteria

**Time:** 1-2 class periods

**Procedure**

1. Have a discussion with the whole class about the design of the classroom environment. Use questions like these to get the discussion started:
   - How would you describe the way our classroom environment is designed?
   - What things do we have in our classroom that can be moved?
   - How is the furniture arranged?
   - What do you like about the way our classroom environment is designed—the way things are arranged in the room?
   - What don't you like about the design of our room?
2. Explain to students that they will work in teams to discuss specific aspects of the room design that are acceptable or unacceptable based on the following categories of design criteria:

- visual access
- traffic flow
- preventing interruptions
- group seating and/or collaborative work
- individual work areas
- accommodating for heating and/or ventilation access

Teams will report the results of their discussions to the whole class.

3. Divide students into small groups. Allow teams ample time to meet and discuss design criteria.
4. Bring the groups together to share their findings with the entire class.
5. After all work teams have reported, lead a whole class discussion to develop a common set of design criteria for the arrangement of the classroom furniture in order to have the best possible classroom environment. For example, the new design must make it easy for students to get to the teacher's desk, the pencil sharpener, and the door. Point out that if something works well, it should not be changed. The goal is to improve the design, not just to change things for the sake of change. List all criteria agreed upon by whole class on chart paper for future reference.

## B. A New Design: The Design Team Convenes

**Time:** 1-2 class periods

**Materials** Design Criteria list from previous session

**Procedure**

1. With the whole class, review the design criteria list formulated in the last session. Explain to students that they are now going to work with their teams to create a new design for the classroom furniture arrangement based on as many of the design criteria as possible. The team members must reach consensus on the design elements included in the new design.
2. Give teams time to meet and discuss their ideas and come to consensus about what they could do with the furniture to improve the classroom environment. Remind students to use their journals to keep track of the ideas they agree on.

## C. A New Design: The Floor Plan

**Time:** 1-2 class periods

**Materials**

- Design criteria list
- Grid paper and/or drawing paper
- Rulers, measuring tapes, meter sticks, yard sticks
- Markers, pens, pencils

**Procedure**

1. Explain to students that they will work in their teams to create floor plans that represent their ideas for improving the classroom's designed environment by rearranging the furniture. The new arrangement should meet as many of the agreed-upon design criteria as possible. In a future class session teams will present their floor plans to the rest of the class. Their floor plans must:
   - show all of the classroom furniture;
   - show all fixed features in the classroom;
   - represent items proportionately.

2. Display the chart with the list of design criteria so all groups can see it.
3. Distribute supplies to the work teams. Allow ample time for the teams to work together and complete their floor plans.

## D. A New Design: Presentation of the Design

**Time:** 1 class period

**Materials**

- Work teams' floor plans
- Design criteria list

**Procedure**

1. Bring the class together for the presentation of the work teams' floor plans. Start by reviewing the list of design criteria. Explain that after all designs have been presented, the class will choose one to implement.
2. Allow time for each team to present its floor plan, take questions, and discuss related issues that arise.
3. Discuss and then carry out a process for choosing one design to be implemented.
4. Have a discussion and brainstorm ideas about how the design will be implemented—logistics. Questions to answer might include:
   - What's our plan for moving the furniture? Where do we start?
   - Who does what?
   - How can we be sure we are following the floor plan?
   - What do we do if things won't fit?

## E. Implementing the New Design

**Time:** 1 class period

**Materials**

- Selected floor plan
- Tape measure, meter sticks, yardsticks, rulers

**Procedure**

1. Bring the class together and explain that in this class period, students will work together to implement the floor plan. Before anything gets moved, review the selected design plan and the logistical issues previously discussed.
2. To make sure everyone understands how the floor plan relates to the actual room, point to a desk on the floor plan and ask a student to show where that desk would be in the room. Ask the student to describe how he/she decided where the right place was. Choose another desk or other furniture item and repeat this process. Continue until you are sure everyone understands the relationship between the floor plan and the actual classroom.
3. Allow students ample time to arrange the classroom furniture according to the design plan.

## F. Evaluating the New Design

**Time:** Later after implementation: 1 or more class periods

**Materials:**

- New floor plan
- List of design criteria

**Procedure**

1. Bring the whole class together and review the list of classroom design criteria. Have a general discussion about whether students think the new furniture arrangement works and reflects the design criteria.
2. Students then work in their teams to develop a checklist/rubric, based on the list of design criteria, that could be used to evaluate the new design. Explain that students may add new criteria to the list, if they seem necessary.
3. Once each team has developed its checklist, have them use the checklist to evaluate the new classroom design.
4. Bring the class together again. Ask each team to report its evaluation results. Discuss the results and seek a consensus on the acceptable and unacceptable elements of the new design.
5. Have a whole-class discussion regarding what should be the next step based on the groups' evaluations. This discussion is an essential element for bringing closure to this project or to launch a new design and implementation project.
   - Are there parts of the new floor plan that could be changed to improve the classroom environment?
   - Is it "back to the drawing board" for a redesign because the overall design doesn't work?
   - Are there problems—design constraints—that now can be seen to limit the possibilities for redesign?
   - What's the best way to know whether this new design is better than the old one?

## Assessment/Extensions

- Have students write a narrative procedure documenting the process or steps taken towards the new design.
- Have students use their journals or logs to record each session's activities along with their own reflections.
- Encourage students to take on their own redesign projects independently.

## Strategies and Tips

- The design and implementation phases of the investigation may be repeated as time permits. If the plan is to move on to the next project, "Redesigning Larger Spaces," then the notion of redesign should be practiced on a small scale first.
- This investigation may be completed in two weeks, or extended to a month or more depending on you and your students' tolerance for temporary disorder.

MODIFICATIONS TO

Activity № 5

# Procedures for Children Inexperienced in Mapping

## Preparation

Prepare these materials before beginning the unit:

- A classroom map (chart paper size), drawn to scale and showing all fixed features of the room (i.e., location of door, windows, closets, radiators, support columns, sink, built-in cabinets), but not moveable furniture
- A similar map on 8-1/2″ x 11″ paper for children's use (3 or 4 copies per child)
- Cut-outs of classroom furniture made to the same scale as the large map
- A sheet of classroom furniture cut-outs made to the same scale as the 8-1/2″ x 11″ map for children to use as they experiment with different furniture lay-outs (1 for each child)

## A. Introduction: Developing Design Criteria

**Time:** 1 or 2 class periods

Use your classroom map with furniture cut-outs placed as they are in the current classroom configuration. As children list things they like and don't like about the room, point to these on your map, thereby developing their sense of correspondence between the room and its representation on the map. On the map show what is meant by design criteria—i.e., being able to see different parts of the room from your desk, managing traffic flow, etc.

## B. A New Design: The Design Team Convenes

**Time:** 1 class period

Give children the 8-1/2″ x 11″ map of the classroom and its fixed features to help them sketch possible redesigns. (They can place it under a notebook sheet and trace the outlines and sketch in different possible designs.) Emphasize that these are not finished products, but very rough drafts—a sort of visual brainstorming. These rough ideas are shared with the team and discussed in terms of the design criteria.

You may wish to give the children the sheet with furniture cut-outs and the homework assignment of developing their best classroom design.

## C. A New Design: The Floor Plan

**Time:** 1 class period

Provide the sheet with furniture cut-outs and the 8-1/2″ x 11″ map of the classroom (if not done for homework). Working with their design teams, students select the design that best meets the design criteria. If they think of other important benefits of their design, they should add these as additional criteria for a design to meet.

## D. A New Design: Presentation of the Design

**Time:** 1 class period

Children may wish to use the large map of the classroom and furniture as they make presentations. When the new design is chosen, represent it on the large map.

## E. Implementing The New Design

**Time:** 1 class period

(No additional modifications. Follow the suggestions for implementation and evaluation on pages 74 and 75.)

# Activity № 6

# Environmental Redesign of Larger Spaces

## Grade Level
4-6

## Overview
This is a long-term redesign project. The project is intended to engage students in the examination, analysis, and redesign of an unsatisfactory or problematic environmental design of a large communal site within the school facility. In this example the school cafeteria is used as the long-term project. However, any large space that is used by the school community such as the library, a lab, or a community room is appropriate. The intended result of the project is a relevant redesign that empowers the students and impacts the life and/or procedures of the larger school community.

*Note: For one teacher's experience with this project, see Chapter 4 ("Stories"), page 108.*

## Prerequisites
- Understanding of mapping, mapping to scale, area, perimeter
- Prior design experience

## Concepts/Skills
- Identifying spatial/procedural design problems
- Designing data collection procedures
- Collecting data
- Organizing data
- Analyzing data
- Communicating results
- Formulating design criteria
- Developing designs
- Presenting designs using maps/models
- Evaluating competing designs
- Implementing a design
- Evaluating implementation

## Standards
- Benchmarks for Science Literacy: 1B1, 1B2, 3B1, 7D1, 7D2, 7D3, 11A1, 11A2, 12A1, 12A2, 12A3
- Principles and Standards for School Mathematics: PS2, PS3, Com1, Com2, C3, R1, M2, DA&P1, G1, G2
- Standards for Technology Literacy: 2A, 2B, 2E, 2L, 8A, 8B, 8C, 8D, 11A, 11B, 11C, 11E, 11F, 11G
- Standards for the English Language Arts: 7, 11, 12
- Curriculum Standards for Social Studies: 3, 10

## Time Frame
This is a long-term classroom project requiring a minimum of two sequential class periods (45–50 min. each) once a week for 2 to 4 months

## Materials
- Large chart/graph paper
- Construction paper
- Rulers and/or tape measures
- String
- Pencils, markers
- Glue/glue sticks
- Scissors

## A. Introduction/ Prerequisites

**Time:** 1-3 class periods

**Procedure**

The redesign project is introduced via review of/connection to previous classroom mapping activities and techniques. (Examples of prior student -made classroom maps should be available for discussion/ review purposes.) An essential part of the redesign project is a "master scale map" or floor plan of the redesign site. Students, therefore, should have a working knowledge of the mathematics concepts of scale, area and perimeter.

1. Lead a discussion with students regarding the choice of a site for mapping that all students have access to and that lends itself to design evaluation. Give an inappropriate example, e.g., Principal's Office, as well as an appropriate one, Cafeteria, Library, etc.
2. Suggest some areas (some appropriate for redesign, such as the cafeteria, and some not, such as the principal's office). Ask students to suggest others. List all suggestions on chart paper. Brainstorm about the following questions regarding each area and record students' answers:
   - What was the space designed to do?
   - What are the problems that exist with the current design? (Remind students to focus on design issues!)
3. Ask students to identify and discuss common themes in the problems they have brainstormed. These will become the categories in which data will be collected. For example, in discussing the school cafeteria project described in Chapter 4, "Stories," many student complaints centered on trash disposal and the frequent food spills and accidents. A possible category for data collection and observation would then be "garbage disposal." List four to five categories of common themes for observation and data collection at the selected site.

## B. Mapping to Scale

**Time:** 2-4 class periods.

**Procedure**

1. Review the work of the previous session and inform students that today they will be gathering data for a "master scale map" of the design evaluation site. Remind students that the "master scale map" will be used throughout the project as a tool and must, therefore, be detailed and accurate.
2. Elicit and record students' ideas for gathering dimensions of the site (standard measuring tools or counting floor tiles for length/width); noting fixed features (columns, doors, and immovable furniture) and their measure; and existing furniture and its measure. Formulate a plan for gathering needed data at the site. (Work teams for gathering specific data? Whole class draws a floor plan?) Be certain students are clear as to expectations when at the redesign site.

3. After data is collected, discuss, share, and compare student drawings of floor plans and measurements of site dimensions and contents. Reach consensus on the shape and contents of the site, and make a preliminary drawing on the chalk or whiteboard based on student observations.
4. Using LARGE graph paper, determine a scale to be used (how many graph squares = feet) for the "master scale map" of the site. Create the map using one or more sheets of LARGE graph paper with student input. Once the scale is established, assign students to create paper representations of furniture and immovable objects at the site, to scale, to be used later on the "master scale map." Laminate all items if possible.

## C. Analysis: Organizing Work Teams for Observation and Data Collection

**Time:** 2–4 class periods.

**Procedure**

1. Divide the class into teams based on list from previous discussion of common themes of problem areas at the site.
2. Assign each team the task of deciding how each team member will observe and record the data (narrative? tally marks? checklist?), and to come up with a plan for doing so.
3. Review all work team observation/data collection plans. Remind teams to observe existing behavior and procedures as dictated by the current design of the site. Try to keep students focused on how to observe and what to observe, rather than discuss what is wrong with current design and procedures. (This takes a lot of management!)

## D. Observation and Data Collection

**Time:** 4-6 class periods

**Procedure**

1. Teams go to the site to observe and collect data for a specified period of time. Teams may be sent individually on a revolving basis, in pairs, or all at once, depending on site selection and students' ability to work independently. Each team should be allowed a maximum of 15 minutes for observation and data collection.
2. When all teams have returned and organized their data, lead a whole-class discussion to share and reflect student observations.
3. Repeat the observation/data collection-discussion sequence for 2-3 more sessions.

## E. Even More Observation and Data Collection

**Time:** 3-4 class sessions

**Procedure**

1. Tell students that they will meet with their team to discuss their observation data with the goal of identifying ONE BIG PROBLEM. The next time they return to the site to observe/collect data, they will focus on the ONE BIG PROBLEM they have identified.
2. Repeat the observation/data collection-discussion sequence for 2 more sessions.
3. Have each team produce a one-page narrative and list describing observed behaviors and procedures, as well as suggestions for redesign based on the observations and data collected.
4. Ask one person from each team to share the information with the whole class.
5. Assign students the task of writing about and mapping their redesigns. Have them think about these questions as they work:
   - Can you show the changes visually?
   - Are all of the proposed changes physical, or are they changes in procedure and routine as well?

## F. Design: Redesign Proposals

**Time:** 2-4 class periods, plus discretionary independent observation time

**Procedure**

1. Have student teams present their maps and descriptions supporting their redesign proposals.
2. Lead a discussion of each proposal in which you focus students on the notion of feasibility. This serves as a reality check.
   - Will the proposal accommodate all the people who presently use the site?
   - Can it be done with the current schedule?
   - Can it be done within the framework of our current resources? If not, who will provide the new resources of money, personnel, furniture and equipment?
3. Inform students that for the next few weeks they will be conducting informal observations and data collection focused on the existing procedures. They are to focus on what procedure students are supposed to follow, what they do instead, and what they don't like about the procedures currently in place.
4. Another team, in the meantime, conducts research by interviewing staff regarding their ideas about procedures at the site. The team gathers factual data on rules, laws, or regulations pertaining to the site and secures a date from the school administration as to when they will be available to entertain a presentation of student redesign proposals for the site.
5. Once a presentation date is secured and the research team has collected their data, reconvene as a whole group to consolidate ideas regarding redesign of the site. Consolidated redesign ideas should be reflected on the "master scale map" (new furniture and seating arrangements, traffic patterns, etc.) as a visual reference. (The map will then be used during the student presentation to the administration.)

6. Inform students that they are to develop and present final redesign proposals based on all the observations they have made, and that each team is to prepare one proposal and select one spokesperson for the team. Teams may start by having each team member write out their best redesign ideas in a proposal, then combining the proposals into a final team effort.
7. All final redesign ideas from each team should be reflected on the "master scale map." (For example, if the "seating arrangements" team has created a new seating plan, then scale paper representations of the furniture at the site should be arranged on the "master scale map" to show the new arrangement.) The map should now reflect the site as redesigned by the students.

## G. Evaluation: Presenting Redesign Proposals

**Time:** 1 class period

**Procedure**

1. After a brief overview of the project is given to the administration by the teacher or student spokesperson, each team presents its ideas for a redesign of the site.
2. What happens next depends upon whether any of the redesign proposals appear sufficiently feasible to implement, and whether administration is friendly to the project. If administration is supportive, the next step is implementation of the redesign.

## H. Implementation: Redesign Implementation and Testing

**Time:** 2-4 class periods

**Procedure**

1. After the redesign proposal of the site has been approved by the administration, students must begin to plan how to implement it. Inform students that the task of this session is to identify one aspect of the redesign proposal that they feel would be simple to implement. Focusing on one aspect, rather than a full-scale redesign of the site, enables students to test and evaluate redesign ideas.
2. Lead a discussion of items students will need to think about to implement the redesign:
   - What will they need to communicate to the school community to prepare them for the change?
   - How will they communicate it? Announcements? Letters? Signs?
   - Do they need help from other adults? Which adults in particular?
   - What materials/resources will be needed?
   - How will the redesign be evaluated? What are the criteria for an effective redesign of the site?
3. Divide the tasks among the work teams. Allow ample time for students to plan and discuss implementation.
4. Once a plan has been formulated, implement the plan and test the redesign. Be sure to appoint a focused team of students to observe/collect data on the effectiveness of the "redesign test." This team will organize the evaluation data they collect and report it to the whole class group.

## I. Another Evaluation: Evaluating the "Redesign Test"

**Time:** 1 class period

**Procedure**

1. Allow ample time for the students from the evaluation team to report their data on the "redesign test." Discuss the evaluation data and query whole class group as to how the evaluation data should be followed-up. What is the next step?
2. If appropriate and/or time permits, discuss other aspects of the site redesign that might be implemented. Begin a plan for implementation of a different aspect of the redesign.

## Assessment/Extensions

- Have students use their journals or logs (in-class or as homework) to record each session's activities and their own reflections.
- Have students write a narrative procedure documenting the process or steps taken towards the site redesign.
- Have students formulate an implementation plan to test another aspect of the site redesign, or formulate a redesign plan for another site within the school facility.
- Have students create a scale map of another site within the school facility.
- Have students create a floor plan detailing another fully realized redesign scheme for the selected site or another site within the school facility or community.

## Strategies and Tips

- This is a long-term project that students get very excited about, as it empowers them by giving them a sense of control over the school environment. It also requires administrative support to be executed undiluted. The point of the exercise is to build upon students' design expertise through the focus of a relevant situation, a larger site for study, and the use of more precise design processes, concepts and skills. However, if necessary, the project can be scaled down to suit the physical or administrative environment.
- The time frame of the project is flexible. It may be completed in two months, or spread out over a semester. Redesign and Evaluation/Testing Phases may be repeated for each aspect of a site redesign as time permits, or the project concluded after the first cycle. If time permits and the cycle is repeated more than once, students should be able to initiate redesign testing independently.
- The teacher should not be the busiest person in the room during the latter sessions of the redesign project. A goal of the project is to enable students to work independently for sustained periods of time on matters of importance to <u>them</u>.
- Initially, the "research" team may be comprised of less able students who interact well with adults as their work is a fairly structured fact-finding mission. During the Redesign Evaluation/Testing Phases, the data collection team should consist of the more focused and independent students as they will need to organize and present their findings to the whole class group.
- Assessment/Extension activities may be done independently and/or cooperatively, or assigned as homework or enrichment projects.

# Activity №7

# Critter Habitats

## Grade Level
4-6

## Overview
Through observation and data collection, students determine the likes and dislikes of a classroom pet in order to design a more suitable habitat.

## Prerequisites
Knowledge of how to conduct an experiment

## Concepts/Skills
- Identifying problems
- Designing an experiment
- Controlling variables
- Designing data collection procedures
- Collecting data
- Organizing data
- Analyzing data
- Communicating results
- Formulating design criteria
- Developing designs
- Implementing a design
- Evaluating implementation

## Standards
- Benchmarks for Science Literacy: 1A1, 1B1, 1B2, 1B3, 3B1, 11A1, 11A2, 12A1, 12A2, 12A3
- Principles and Standards for School Mathematics: PS2, PS3, Com2, C3, R1, DA&P1
- Standards for Technology Literacy: 8A, 8B, 8C, 8D, 11A, 11B, 11D, 11E, 11F
- Standards for the English Language Arts: 7, 11, 12
- Curriculum Standards for Social Studies: 3, 10

## Time Frame
A minimum of 5 classroom periods (45–50 min. each), plus independent observation time.

## Materials
- Chart paper
- Markers
- Containers of various sorts
- Classroom pet*
- Various materials for modeling redesigned habitats

**Note: Mealworms are used for the purpose of this description. Mealworms are a good choice for this investigation because they are inexpensive. When students complete a redesigned habitat, it is easy to maintain a control group of mealworms in an unaltered habitat. However, if your classroom has multiple pets, one or two appropriate animals may be selected beforehand (frogs, gerbils, chameleons, hermit crabs) for work teams to observe. (Nocturnal animals, such as hamsters, are not an appropriate choice as an evaluation of a redesigned habitat may be difficult to ascertain.) Whatever animal is your choice, there should be enough of them for 4 or 5 groups to observe. Additionally, strict guidelines for proper treatment of animals must be discussed with students and closely monitored by you.*

## A. Introduction

**Time:** 1 classroom period

*Note: This is a fast-paced beginning session and it assumes that students are already familiar with the animal chosen through previous observational experiences. This is necessary for students to do intelligent brainstorming about environmental factors.*

**Procedure**

1. With the whole class, brainstorm about and discuss environmental factors to which the classroom pet is likely to respond. What does the chosen animal like or not like? These factors may include temperature, light, moisture, food, noise, materials, etc. Accept all responses without labeling any as right or wrong. Record all responses on large chart paper. Ask students to sort or group similar responses into categories, if possible. (This will focus students during observation and data collection.)
2. Divide students into teams. Have each team choose ONE environmental factor to investigate. Explain that they are to design a plan to carry out the investigation. For example, if an animal regularly receives a certain amount of heat or moisture, how would it respond to more or less? How could you tell if the response was positive or negative? Explain that each team will be responsible for reporting investigation results to the whole class group.

## B. Observation and Data Collection

**Time:** 1-2 classroom periods

**Procedure**

1. Allow students ample time to carry out their investigations and collect data. Circulate among work teams to ensure that observation and data collection are being carried out in some systematic way. Try to keep students focused on how to observe and what to observe. (This will require a lot of management!)
2. Set aside class time for work teams to report investigation results. Record and compile results on large chart paper under the category of the environmental factor chosen by each team. Discuss and compare the results of each team in terms of the implications for designing a new habitat.
3. Allow work teams time to discuss and draw ideas for the redesigned animal habitat.

## C. Design: Redesigning Habitats

**Time:** 1 class period

**Procedure**

1. Bring the whole class together to discuss the notion of design criteria and successful redesign criteria. (For example, if the environmental factor investigated was food, a criterion would then be that the animal eats more of the different food given.)
2. Allow work teams time to develop redesign criteria for their redesigned habitat.
3. Bring the class together again and record each work-team's redesign criteria. Reach consensus as to what design criteria would indicate that the redesigned habitat is successful. Record all responses.

## D. Implementation: Independent Observation of Redesigned Habitats

**Time:** Flexible

**Procedure**

1. Allow work teams time to create the redesigned habitat and place the animal(s) into it.
2. Give each work team initial observation/data collection time. During this observation and data collection phase, work teams observe and collect data on their animal in the redesigned habitat.
3. Allow brief periods each day for (alternating) students from work teams to observe and collect data.
4. Remind students that they are collecting data based on their redesign criteria for a successful habitat. The data is to answer a question: Is this new habitat more successful than the original habitat?

## E: Evaluation: Evaluating Habitat Redesigns

**Time:** 1 class period

**Procedure**

1. Allow time for each work team to describe its redesigned habitat, observation results, and the results of its redesign criteria evaluation.
2. After all work teams have presented, discuss as a whole group whether there should have been other or additional design criteria, more observation time, a redesigned data collection plan, etc.
3. If time permits, students may choose to enter into another redesign and observation/data collection phase with different animals or design criteria. Individual student or work team plans for implementation of different aspects of habitat redesign may then begin. If time is a factor, redesign ideas may merely be discussed and pursued as extra credit or independent projects.

## Assessment/Extensions

- Have students use their journals or logs (done in class, or as homework) to record each session's activities and include their own reflections.
- Have students write a narrative procedure documenting the process or steps taken towards the habitat redesign.
- Have students formulate an implementation plan to test a different environmental factor and attendant design criteria.

# Standards for Activities

## Standards for Technology Literacy

2: Students will develop an understanding of the core concepts of technology:

A. Some systems are made by humans.

B. Systems have parts or components that work together to accomplish a goal.

E. People plan in order to get things done.

L. Requirements are the limits to designing or making a product or system.

8: Students will develop an understanding of the attributes of design.

A. Everyone can design solutions to a problem.

B. Design is a creative process.

C. The design process is a purposeful method of planning practical solutions to problems.

D. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

11: Students will develop abilities to apply the design process.

A. Brainstorm people's needs and wants and pick some problems that can be solved through the design process.

B. Build or construct an object using the design process.

C. Investigate how things are made and how they can be improved.

D. Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements for solving a problem.

E. The process of designing involves presenting some possible solutions and then selecting the best solution(s) from many.

F. Test and evaluate the solutions for the design problem.

G. Improve the design solutions.

## Standards for the English Language Arts

7. Students conduct research . . . by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

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.

# Principles and Standards for School Mathematics

Problem Solving

PS2: Solve problems that arise in mathematics and in other contexts.

PS3: Apply and adapt a variety of appropriate strategies to solve problems.

Communication

Com1: Organize and consolidate their mathematical thinking through communication.

Com2: Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

Connections

C3: Recognize and apply mathematics in contexts outside of mathematics.

Representation

R1: Create and use representations to organize, record, and communicate mathematical ideas.

Measurement

M1: Understand measurable attributes of objects and the units, systems, and processes of measurement.

M2: Apply appropriate techniques, tools, and formulas to determine measurements.

Data Analysis and Probability

DA&P1: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

Geometry Standard

G1: Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

G2: Specify locations and describe spatial relationships using coordinate geometry and other representational systems.

# Benchmarks for Science Literacy

1A

1. Results of similar scientific investigations seldom turn out exactly the same. Sometimes this is because of unexpected differences in the things being investigated.

1B

1. People can often learn about things around them by just observing those things carefully.
2. Describing things as accurately as possible is important in science because it enables people to compare their observations with those of others.
3. Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere. And doing experiments.

3B

1. There is no perfect design.

7C

1. Although rules at home, school, church, and in the community stay mostly the same, sometimes they change . . . because some rules do not work.
2. Rules and laws can sometimes be changed by getting most of the people they affect to agree to change them.

7D

1. In making decisions, it helps to take time to consider the benefits and drawbacks of alternatives.
2. In making decisions, benefits and drawbacks of alternatives can be taken into account more effectively if the people who will be affected are involved.
3. Sometimes social decisions have unexpected consequences, no matter how carefully the decisions are made.

11A

1. In something that consists of many parts, the parts usually influence one another.
2. A system can include processes as well as things.

12A

1. Raise questions about the world around and be willing to seek answers to some of them by making careful observations and trying things out.
2. Keep records of investigations and observations and not change the records later.
3. Offer reasons for findings and consider reasons suggested by others.

12D

1. Write instructions that others can follow in carrying out a procedure.
2. Make sketches to aid in explaining procedures or ideas.
3. Use numerical data in describing and comparing objects and events.

# Curriculum Standards for Social Studies

3. People, Places, and Environments
   Social studies programs should include experiences that provide for the study of people, places, and environments.

5. Individuals, Groups, and Institutions
   Social studies programs should include experiences that provide for the study of interactions among individuals, groups, and institutions.

6. Power, Authority, and Governance
   Social studies programs should include experiences that provide for the study of how people create and change structures of power, authority, and governance.

10. Civic Ideals and Practice
    Social studies programs should include experiences that provide for the study of the ideals, principles, and practices of citizenship in a democratic republic.

Chapter 4

# STORIES

**Yes, I'm sold on *Designed Environments.* I want to do it. This is where I would like to end up with my class, but how is it possible? Where can I begin? My kids don't know how to follow rules, let alone improve them. They are barely able to find their own seats. How can they plan where things should go in a room? And all they know about time is school dismissal and the TV schedule.**

You are not unique. You would quickly find common ground with the teachers who helped develop this guide. Their stories are here to help you see ways to proceed. The teachers who helped develop *Stuff That Works!* teach kindergarten through eighth grade. All work in public schools in low-income areas of New York City. One is a bilingual special education teacher. A few are quite new to teaching. You may see your own story in their stories.

The first part of this chapter presents teachers' stories about their work with children in analysis and design of procedures and rules: classroom procedures, school rules, and the rules and designed environments of games.

The second part of the chapter focuses on spatial environments: a classroom, a school cafeteria, and environments for class pets.

## Part I: Rules and Procedures

### Classroom Procedures

A procedure organizes how things are done. Classroom procedures give structure to activities as diverse as lining up for gym, sharpening pencils, and preparing to go home. Classroom procedures guide students just as rules do. But they differ in the way students perceive them. Rules often prohibit students from doing what they would do if left to their own desires. The threat of punishment is often used to enforce rules. Procedures, on the other hand, specify ways of doing things that students would as soon do one way as another.

Rules and procedures differ in another significant way. Rules often control behavior all the time: no hitting, no hats in class, no chewing gum in school. Procedures govern particular situations such as taking attendance, responding to a fire drill, or handing in homework. These differences between rules and procedures make it easier to involve children in changing procedures than in changing rules.

The starting point for a procedure-changing activity is a procedure that is not working well. All you need to do is be sensitive to a situation that is not working, and then involve the students in finding the solution.

Tonia Bailey, a third grade teacher, did several *Designed Environments* projects. Two of them focused on classroom procedures:

- Children forget to put their chairs up after school. The custodian will not sweep the classroom if chairs are not placed on tables at the end of the day.
- The children's coats often wind up on the floor of the closet. When this occurs, the coats get dirty, the doors cannot be closed, and the room looks disorganized.

As she worked on *Designed Environments* projects, Tonia found it difficult to engage the whole class from the beginning, so she developed an approach that worked better for her and her students. She had a small group of students do the initial analysis of the problem which they then shared with the rest of the class. From that point on it became a class project. Tonia tells how this worked out with the "Chairs Up and Down" project.

Tonia had another problem situation that she brought to the attention of a small group: coats on the coat closet floor. None of the children had presented this as a problem, even though it involved their coats. Tonia helped students recognize the problem by asking them to collect some data. Here is her story about what she called "Hook Mania."

## "Chairs Up and Down"

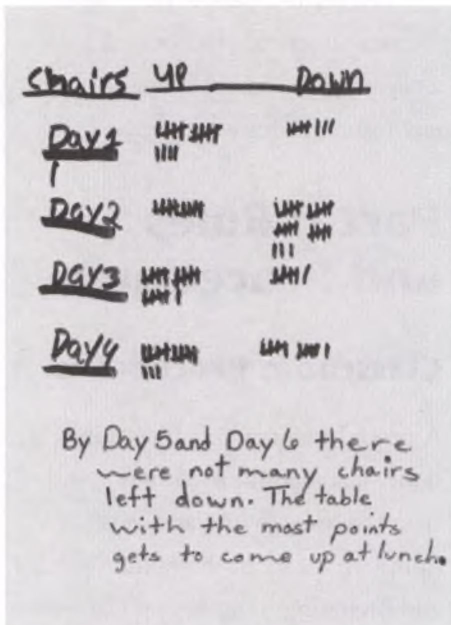
**I had three students collect data. I explained to them that they were working on a top-secret assignment and that they could not mention it to any of their classmates. They were to create a way to check the chairs at the end of each day. They decided to tally each day and record the number of chairs up and down. I did not change the structure of the day and simply told the children to put up their chairs as I always did. This went on for four days.**

**The children presented their data to the class. Two children presented a tally graph (Figure 4-1) and the other one presented a double bar graph.**

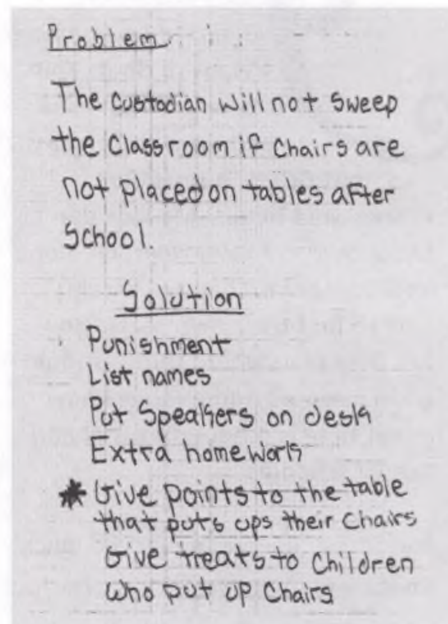
**The class was then divided into five groups and each group was told to develop a way to encourage children to put up their chairs. The groups generated many ideas. They put them on chart paper in small groups (see Figure 4-2), then we met as a group to discuss and share. The children came up in groups and shared their solutions.**

**The children decided to try out one of the solutions for two days: "Give points to the table that puts up their chairs, then let the winning table come up at the end of the week for lunch." (Figure 4-3 is a graph showing four days of secret record-keeping and two days after a solution was tried.)**

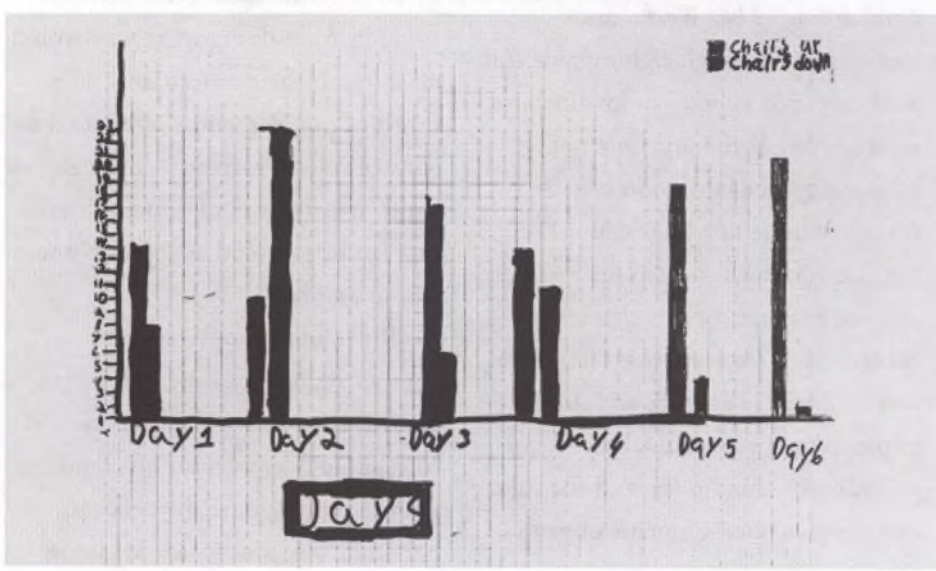
4-1: **A tally graph documenting the extent of the "Chairs Up and Down" problem**




4-2: **One group's brainstorming list about solutions to the "Chairs Up and Down" problem**




4-3: **Bar graph showing the number of chairs up and down before record-keeping became public (Days 1-4) and after a solution was tried (Days 5-6).**



## "Hook Mania"

**I gathered four children to consider a problem: the coats that belong to the children are often thrown on the floor of the closet. When this occurs, the doors cannot be closed, and the room looks disorganized. The four children had the task of counting the coats on the floor in the morning after the children unpacked and began their day. The group charted the number of coats for five days (Monday-Friday).**

**They presented their data to the class. The children had a brainstorming session where they listed possible solutions. They were to discuss the solutions and list the ways they would solve the problem.**

**The groups varied in their solutions (see Figure 4-4 for one group's solutions) and the class had difficulty determining which solution they would try first. I had to explain that only one solution can be tried out at a time. I let children explore possible solutions even if it seemed to me they would fail. I discouraged solutions which directly involved me (e.g., detention, keeping children upstairs. etc.)**

**The children decided to put a number next to each hook. Every child received a hook number (alphabetical order). The data was collected again for five days, Monday through Friday. The results are seen in Figure 4-5.**

4-4: **One group's proposed solutions to the coat problem**

### Coats on the Floor

Problem:

The children's coats are getting dirty because they are thrown in the closet.

Solutions:

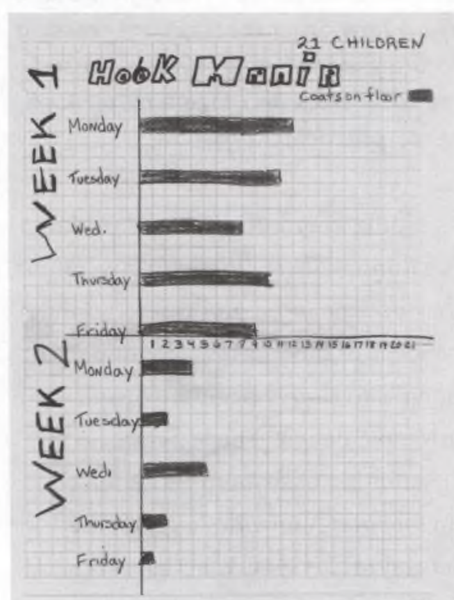
1. Closet monitor
2. Detention
3. Put smallest coats first
4. Assign numbers to students that correspond to hooks.
5. Put names on wall next to hooks.

The graph of "Hook Mania" (see Figure 4-5) shows a marked decrease in coats on the floor after children had become aware of this as a problem and after they had designed their own solution. Again, the results underline how important it is to have children collect and represent real data-data that represents their behavior. Such data are a major impetus for changing behavior.

If you have planned instruction that meets national and/or state standards, you are probably saying "Hey, this meets many of my Mathematics standards and English Language Arts standards." Indeed, *Designed Environments* projects tend to meet standards of several disciplines. When children think about real problems, plan ways to collect and represent data on those problems (i.e., do analysis), then plan, implement, and evaluate solutions (i.e., do design), they are engaged in integrated activities that meet many goals. (See Chapter 3, "Activities," for the national standards addressed by these activities.)

When you allow children to do these kinds of projects you need to consider the amount of time this sort of learning takes. There are also effects on you as a teacher. Tonia Bailey gives voice to these concerns in her reflections on *Designed Environments.*

4-5: **Number of coats on floor before (Week 1) and after (Week 2) hooks were numbered**



## Tonia's Reflections on *Designed Environments*

**Each of the projects took more than two sessions and many are ongoing (try it out, design, try it out, redesign, ...) Because of this I was not able to cover all the topics I intended.**

**I realized that because the children were more engaged and relied less on me (after the first *Designed Environments* lesson), I wasn't the center of their development. This is something I am trying to do less of (being teacher-centered). As an eighth year teacher, I am attempting to become less of an instructor and more of a facilitator. Because we tend to want control, we as teachers usually feel uncomfortable as facilitators.**

**The process involved in the *Designed Environments* unit really makes the children accountable. *They* gather the data, *they* analyze the material, and *they* design. I don't know how other teachers are reacting to the experience, but it has caused me to sit back and take a closer look at my practice.**

Tonia found that as she involved her third graders in designing solutions, they became more proficient and independent in the process. The important thing is to simply begin involving them in simple design. The activity "Examining Classroom Procedures" in Chapter 3 provides a generalized version of Tonia's two design projects to help you get started.

## Classroom Rules

A good way to help children become better observers is by having them count things or instances of an event. Tonia's children became more sensitive to coats on the floor and chairs left down by counting them. Similarly, as children tally incidents of rule-breaking, they become more sensitive observers of these events and, usually, more concerned about these infractions.

The next two stories are about school rules. Mary Flores is a resource room teacher, who teaches language arts to bilingual special education students. They range from second to fifth grade and come to her tiny room in groups of six or seven. This project, a study of rule-breaking behavior, was carried out over a ten-week period. Mary fit this project around reading and language arts activities, which were her major focus. The work described below was done with each of two fifth grade groups. It was late September when the class began discussing who controls their behavior.

**NICOLE:**
My mother, father, aunt, uncle and neighbors control me.

**RICARDO:**
Clean-up people (sanitation).

**TRACY:**
Clean-up people control the Earth.

**RICARDO:**
Police control gangs when they shoot people.

**JONEE:**
The fireman controls the fires.

**TRACY:**
My teacher controls me.

**TEACHER:**
How does the teacher control her class?

**TRACY:**
We got rules. We gotta follow them rules.

**I decided that this was the time to introduce the initial activity. I handed out the inquiry sheet "Rules To Live By." (See page 64 in Chapter 3, "Activities.") I informed the students that they would have one minute to list all the rules they are required to follow in school. I quickly realized that a minute was not enough time. I allotted an additional four minutes. When they completed the sheet (see Figure 4-6), I gathered them in a group for sharing. I listed the rules on a chart tablet. Some of the rules were particularly interesting. For example, I asked Ricardo to elaborate on his "no walking with food in your hands" response. He explained that in the lunchroom, "The students are not allowed to walk while picking food from their trays."**

4-6: **"Rules to Live By"**

Name: Nicole Branson Date: Sept 28, 98

**Rules To Live By**

You have one minute to list the rules you are required to follow in school. Ready, set, go!

1. When can not go out side of the playground
2. No fighting
3. No curse at the teacher
4. No thouring the ball over the fines
5. No siuping on the ground
6. No Chewing Gum
7. No lieing to the teacher
8. No Kicking
9. No chowing
10. No gradding
11. No [illegible]
12.
13.
14.
15.

4-7: **Jonee's responses to "Rules, Rules, Rules"**

Name: Jonee' Kimber Date: October 7, 1998

**Rules, Rules, Rules!**

1. Why must school rules be followed? School rules must be followed because if there weren't school rules kids would act very bad.

2. Who makes the rules? Mrs. Kase, Mrs. Mounsey, and the school district makes the rules.

3. Who enforces the rules? Mrs. Kase, Mrs. Mounsey, mrs. Camacho, Mrs. Maynard and Mrs. Thomas enforce the rules.

4. Which rules are broken on a daily basis? Foul Language, screaming, talking while the teacher is talking, stealing, chewing gum. are broken on daily basis.

5. Why do you think these rules are broken? I think they break the rules because they don't listen.

6. How could you change the behavior? I haven't thought of one

I thought about some of the rules the students listed and wondered whether these are spoken rules or rules the students automatically know. How many educators allow the students to determine the rules for their classrooms? I am convinced that if students are allowed to partake in designing the rules, they will think twice before breaking them. In the past, I have allowed students to decide the consequences for breaking the rules. In some cases, their punishments for these infractions were worse than mine.

## October 7, 1998

I handed out the "Rules, Rules, Rules" worksheet. I had different students read the questions. After each question we took time to clarify it. Then I gave time for them to write full responses to the questions. (See Figure 4-7 for Jonee's responses.) When we finished "Rules, Rules, Rules," I informed the students that we would be "spies." I told them that we would be investigating the rules that are broken the most. Of course, they will have to do this covertly. They became excited by the challenge. I've got them now!

## October 26, 1998

My fifth grade group has been asking when they would have the opportunity to "spy." I think that is what motivates them.

I told them to begin thinking about which rules are broken on a daily basis. I informed the group that we would be going on an outing. I handed them the inquiry sheet entitled "Peek-A-Boo, I'm Watching You." We read the questions for clarification. I told them to think about these questions as we walked around. The students were thrilled to be out of the room. As we toured the school building, Heriberto looked up at one of the closets in the hallway and said, "I could hide up there. Nobody will know I am spying on them." They are beginning to think about the prospects of this inquiry.

We returned to the class and I asked them to re-read the questions and answer them. (See Figure 4-8.)

The first question asks them to predict where in the school rules are broken the most. No problem. The second question asks what rules are being broken. No problem. The third question asks them to develop a plan to determine how many times the rules are broken. It also asks the students to indicate how they will collect and record the data. Problems! I foolishly assumed that they would understand what was being asked of them. Not so! So, I gathered the group and led them in a discussion:

**TEACHER:**
OK, let's look at the question together. It says, "Develop a plan to determine how many times the rules are broken. Indicate how you will collect and record the data." What does the word data mean?

**HERIBERTO:**
*I think data means like writing it in a little notebook?*

**MOISES:**
*Information.*

**TEACHER:**
What does that mean?

**MOISES:**
*We're collecting information on other people and what they are doing.*

**TEACHER:**
How are you going to collect that information?

**MOISES:**
*I'm gonna write everything they do wrong in my little notebook that I have at home.*

**DERRELL:**
*The way I'm going to collect my data is look and see, look and see who's doing the wrong things in the school. And by writing the information of the human beings doing their things.*

**CYNTHIA:**
*I think data means you're spying on someone that's doing the bad things.*

**TEACHER:**
Let's backtrack a little bit. Let's think about the rule that you think is being broken the most.

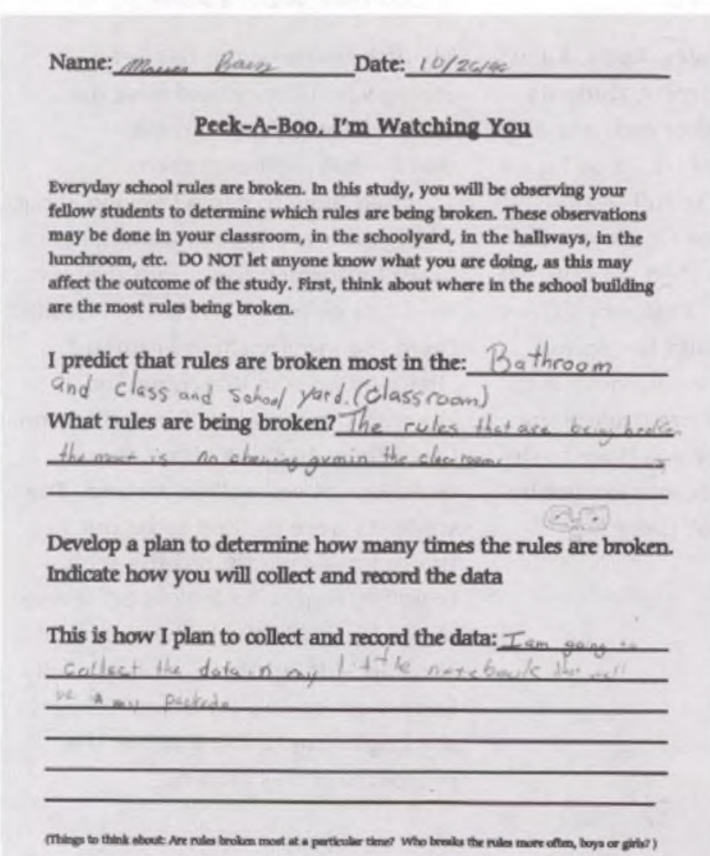
**EBONY:**
*Gum chewing?*

**TEACHER:**
How are you going to prove to someone how many kids are breaking that rule?

**CYNTHIA:**
*By tape recording it on some small camera.*

**TEACHER:**
We don't have access to a camera. Remember, you don't want anyone to know you're spying on them. If you use a camera people will know you're watching them.

4-8: **"Peek-A-Book, I'm Watching You"**


Name: [illegible] Date: 10/26/9[illegible]

**Peek-A-Boo, I'm Watching You**

Everyday school rules are broken. In this study, you will be observing your fellow students to determine which rules are being broken. These observations may be done in your classroom, in the schoolyard, in the hallways, in the lunchroom, etc. DO NOT let anyone know what you are doing, as this may affect the outcome of the study. First, think about where in the school building are the most rules being broken.

I predict that rules are broken most in the: Bathroom and class and School yard. (Classroom)

What rules are being broken? The rules that are being broken the most is no chewing gum in the classroom.

Develop a plan to determine how many times the rules are broken. Indicate how you will collect and record the data

This is how I plan to collect and record the data: I am going to collect the data in my little notebook that will be in my pocket

(Things to think about: Are rules broken most at a particular time? Who breaks the rules more often, boys or girls?)

**ALL:**
*Yes!*

**DERRELL:**
*How do we know if other people are spying on us, when we're spying on them?*

**TEACHER:**
**How are you going to collect numbers, if it is numbers that you want to collect? How are you going to prove to me that so many students broke the rules? I'm going to ask you at the end of the week to show me your data. What will you use?**

**MOISES:**
*A graph.*

**TEACHER:**
**What will the graph show?**

**MOISES:**
*One that says, um, number of people chewing gum, the other one will say number of people fighting, number of people cursing, number of people running. Then it can be a tally mark.*

**HERIBERTO:**
*You can make a chart that says, "Rules that are broken in the classroom"*

**MATTHEW:**
*We'll collect a big calendar and bring it in to teacher, to tell them how many people have been cursing at the teacher.*

**TEACHER:**
**How will you use a calendar?**

**MATTHEW:**
*We'll just write how many people are breaking the rule on the calendar. Like on the first day, you'll put it on the first date, then the second then the third.*

**HERIBERTO:**
*That's what I was going to say.*

**TEACHER:**
**What other ways are there of collecting data besides tally marks?**

**HERIBERTO:**
*Number graphs. Like you put 5, 10, 15, 20 going up and then you put the rules that are broken on the bottom and you go coloring like that until the last number. I think that's called a bar graph.*

**MOISES:**
*Like a line graph. You do the same thing like 5, 10, 15, 20 or you can do 10, 20, 30, It doesn't make any difference, going down this way and then you write a dot and then you make another dot and then you connect it.*

**HERIBERTO:**
*We can use a color graph.*

**TEACHER:**
**What is that?**

**HERIBERTO:**
*Like you're coloring on the graph. That you go coloring up and you stop at what number the rules are broken in different colors and all that.*

**MATTHEW:**
*Can't we just put the numbers for the week? We'll put one week for how many days if the rates are getting higher from what it was the first day. Or if the rates are dropping, it will be good.*

**TEACHER:**
**How else can you collect information?**

**HERIBERTO:** *Taking a notebook and writing it down, everything they do bad.*

**TEACHER:**
**Once you collect all the information what will you do with the information?**

**HERIBERTO:**
*You write it down nice and neat on a piece of paper? Um, when we finish spying, then we could tell, like, the teacher and they could, like, help us spy on them.*

**MOISES:**
*The teachers wouldn't help.*

**HERIBERTO:**
*They will help us spy on them and then everything they do wrong they'll tell us and we'll write it in our handy dandy notebook.*

**EBONY:**
*I will save it and write all the information of the bad things they used to do and the things they doing now.*

**CYNTHIA:**
*It's like um, um the government or something like that. You know what I mean. And you have all this stuff and we let them know all the stuff we're doing in this school.*

**HERIBERTO:**
*You can copy it down on the computer and then after that you can give it to the teacher and the teachers can give it to the kids and see what they been doing wrong and they can adjust, change their behavior and stop doing things cause there's consequences for these things. You could, like, get suspended and get in trouble.*

We ended the discussion here. But, I must say this discussion gave the group food for thought. Touring the building was a good idea. Although they know where rules are broken the most, they confirmed their predictions as they observed students breaking the rules. I believe that further understandings came as the discussion unfolded. They wanted to continue the discussion, but time ran out. I'm glad that they are excited by the project. It remains to be seen whether they will collect the data independently. They are pretty much on their own. If it doesn't work, then I will have to go to plan #2, which is to do an observation with the group. Will they be disciplined enough to see this through?

## November 4, 1998

Two of the students, from my fourth group, were excited about getting the investigation started. I decided to have them write the step-by-step directions for their inquiry. (See Figure 4-9.)

Moises and Heriberto decided to work together. They are investigating what goes on in the fourth floor boys' bathroom. As soon as they had written their detailed account of the study, Heriberto asked if they could begin. I allowed them to go on their mission. They were ready. They walked up to the fourth floor bathroom with the "spy book" they created. I could not leave the remainder of the group, so I couldn't see first-hand what they were doing. I had to trust that they'd do the right thing. At some point, a colleague, Al Camacho, happened to come into my classroom. I asked him if he would check in on the boys and photograph them engaging in their study. He did. He reported later that the boys were indeed involved in documenting the behaviors. When they returned I asked them to write a reflection about their study. (See Figure 4-10). The journal entries will be used to determine what, if anything, they are gaining from this study.

4-9: **Moises' plans for a project on rule-breaking**

Moises Baez' Step-by-Step Directions

Step 1: Get a notebook that can fit in your pocket.

Step 2: Get a good pencil.

Step 3: Go and spy in the bathroom for 5 minutes.

Step 4: Spy in the four floor bathroom because the kid like to play what the paper tolits.

Step 5: Give the note to Mis Flores.

Step 6: Give the notes to the teacher of the class

Step 7: Make a big, big graph.

Step 8: Put it where every one can see it.

Step 9: The graph will show what the people did wrong, I will be in the first floor.

4-10: **Heriberto's and Moises' reflection on the rule-breaking study**

Heriberto and Moises 11-5-98

Reflection

Today no one have Broken the rules today. H siting on the Radator and his butt got hot. M was pretending to go to the Bathroom. We are not spending a lot of time in the Bathroom. that is why we have no data.

During November Mary realized that, in spite of the children's enthusiasm, they did not spend enough time with her in the resource room to both do the resource room work and be out of the room to collect data for the project. She began to move toward closure.

## December 1, 1998

**I engaged my fourth group in a directed writing activity. The way it works is that I pose questions for students to use as prompts. These prompts are meant to nudge their thinking with regards to their learning:**

- **What did you learn by conducting this study? Elaborate.**
- **Who breaks the rules more often, boys or girls?**
- **Based on your observations, which rule is broken the most?**
- **If you had to do it again, what would you do differently?**
- **How would you attempt to influence positive behavior?**
- **Did you enjoy this study? Why or why not?**

**They wrote uninterrupted for about 30 minutes (well, almost uninterrupted), I could tell that they were engaged in the activity because you could hear a pin drop. When I posed the question, "Who breaks the rules more, boys or girls?" the boys yelled out, "The girls!" and, of course, the girls yelled out, "The boys!" I called the class to order and they wrote down their responses to the question. Interestingly enough, all except one indicated that boys break the rules more often. Derrell claims that boys and girls break the rules equally.**

## Final Reflection

**Although, the students in my fourth group continue to be interested in the project, I have decided to move on. Why the sudden exit from this project? One of the reasons is that they only document rule infractions when they are in my room. Also, they spend time out of the classroom and return with limited data. How many students could they possibly observe breaking the lavatory rules, in a 15 minute period in the afternoon? The students could not implement a plan for changing behavior, because there was not enough data on which to base a change.**

**However, in reading their final reflections I've assessed that they've drawn their own conclusions and thus gained new understandings in the area of social controls. The students' final evaluations show they were able to respond thoughtfully to the questions posed. When I initially asked students to answer the question, "How would you change the behavior?" (in October), many of them could not answer the question or wrote responses without giving the question careful thought. However, when I posed the question again, in their final reflection, all of them offered a solution. They were not able to affect a school-wide change in behaviors, but they were able to reflect on their own behavior. Will they now think twice before breaking a rule? I would hope so.**

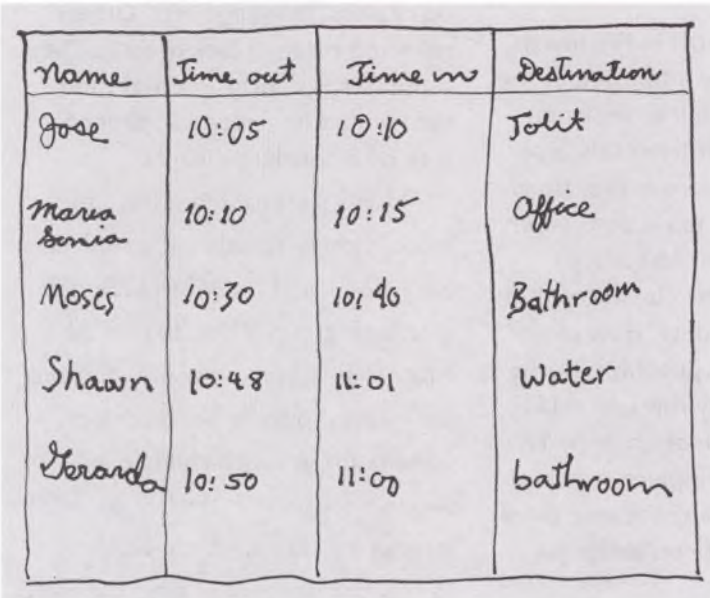
**Two students indicated that they'd write a newspaper article in the "Green Pages" (our garden newsletter) indicating the rules that are being broken on a daily basis. This was their method of influencing behavior. They are integrating technology into another area of the curriculum, language arts. Others reflected on their lack of data. They came to the conclusion that more data would be needed in order for it to be a conclusive study.**

Mary's resource room had little space, there were only a few students in each group, and Mary had little time with each group. These factors led Mary to focus the study of rule-breaking on areas outside her classroom. Classrooms in which children are together for most of the day are better settings for studies of rule-breaking. In regular classroom settings the object of study can be simple classroom rules such as no interrupting, no calling out, or whatever else children may choose. After the children have designed the study, data collection can be carried out by designated data collectors. Children are able to keep track of simple rule-breaking-interrupting, for example-alongside their normal classroom work. In Chapter 3, the plans for "Peek-a-Boo" are Mary's plans, modified for use in comprehensive elementary classrooms.

## Recording Behavior

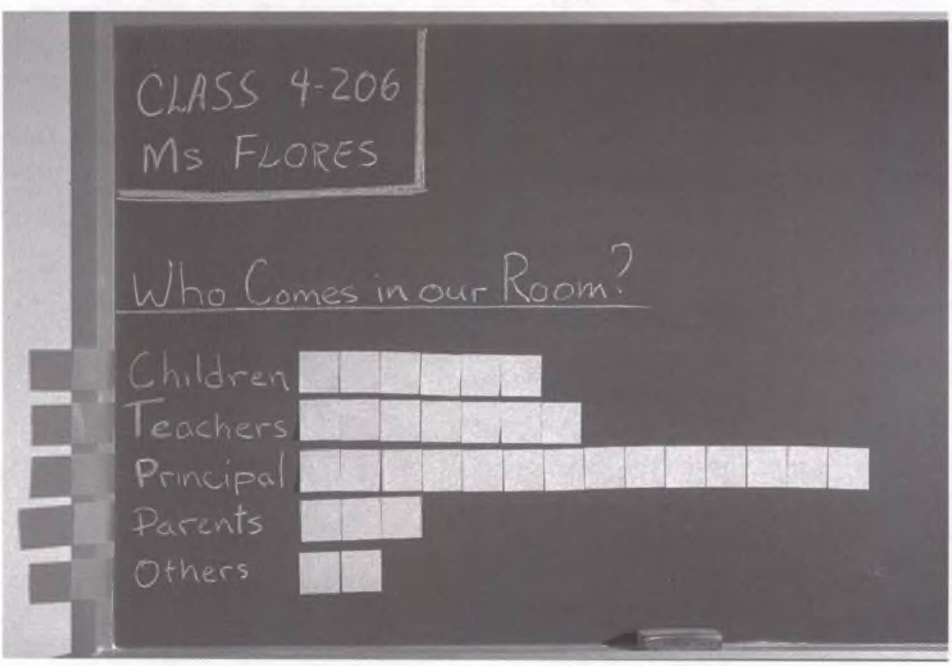
Mary knew that counting instances of particular behaviors was an excellent way to make children aware of the behavior. Two years earlier in another special education class, Mary engaged her students in a study of their time outside the classroom. Students left the room for many reasons. Some went on errands to the principal's office or other

4-11: **Keeping track of time out**



| Name | Time out | Time in | Destination |
|---|---|---|---|
| Jose | 10:05 | 10:10 | Toilet |
| Maria Sonia | 10:10 | 10:15 | Office |
| Moses | 10:30 | 10:40 | Bathroom |
| Shawn | 10:48 | 11:01 | Water |
| Gerardo | 10:50 | 11:00 | bathroom |

4-12: **Interruption data**




classrooms. More left the room for water or the bathroom. For some, it never was clear why they had left the room. The study Mary had them do was simple. On a chart posted next to the door there were four columns: name, time out, time back, and destination. When a student left the room he recorded his name, the time and the destination. Upon returning he wrote the time he returned. (See Figure 4-11.)

At the end of the week they looked at the data on trips outside the room. Mary helped them look at the data in different ways. How many trips were to the bathroom? To other destinations? How much time was spent on trips to each destination? How much time was spent by boys? How much by girls? In the successive weeks the trips changed, especially the time spent on them. Students became self-conscious about the time spent out of class. They cut the time they were gone. One boy made trip to the bathroom in no time: the time when he left and the time when he got back, to the nearest minute, were the same!

The consciousness-raising effect of recording behavior is not limited to special education students. It works for adults too. In fact, Mary's first experience with this technique involved her principal. Mary's room had many special programs which attracted many visitors. Each visitor, no matter how well behaved, was an interruption. The class decided to do an interruption study. They developed categories of interruptors: children from other classes, other teachers, the principal, parents, and others. (See Figure 4-12.) One day when the principal entered, she noticed a child get up and put another mark at the end of a long line of tallies that followed the word "principal." "What are you doing?" the principal asked. "Oh, this is our interruption study and I'm the recorder today." Mary's principal cut back on her visits. Even principals are not aware of their behavior and its effect. Recording behavior helps raise consciousness about that behavior. Such awareness is a prerequisite to changing behavior and to changing the rules applying to the behavior.

One answer to the question "How do I begin?" is to create situations where the students' behavior is recorded in a public way. This will help them become better observers of their own behavior. Another answer is to engage them in a project where they observe (tally) the behavior of others. When students carry out a study of other students' behavior, they are doing analysis. Analysis projects may or may not become design projects at some later date. Often the more we know about a situation, the more we want to do something about it. This is what leads analysis into design. "An Introduction to Data Collection" and "Interruptions" in Chapter 3 are good places to begin.

## Rules of Games

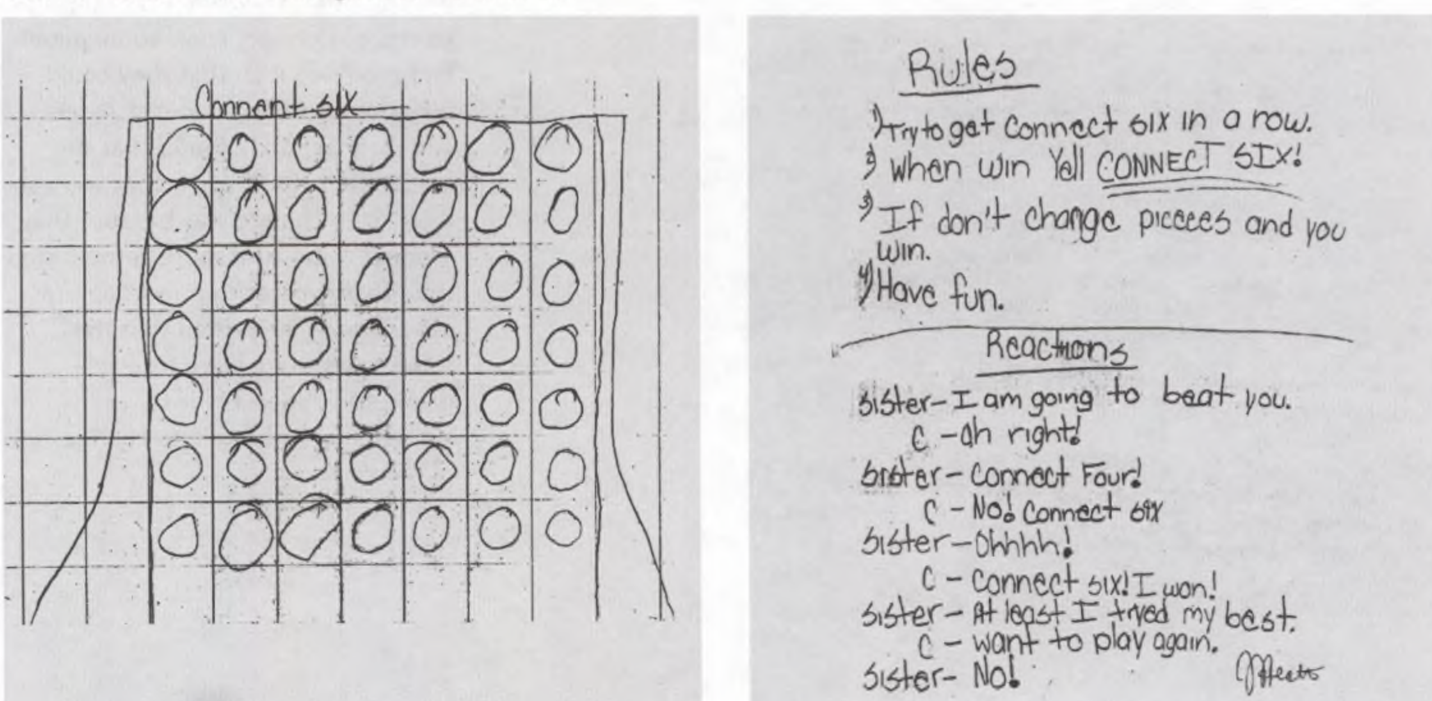
Games create their own miniature environments. Once you enter a game, you play according to its rules. Sometimes you want to change the rules, thus changing the way you do things in the world of the game. To do this, you step outside the game, reach agreement with other players as to the new rules, then step back into the newly redesigned environment of the game. The winner is the one that is best adapted to perform within the game (if the game does not depend on luck).

Games are wonderful vehicles for studying the rules that govern an environment. Children know the rules of many games. They have probably modified the rules of games to make them easier to play. And they know about breaking the rules: they call it "cheating."

What children don't know about games is how to plan the rules you want to change, and how to tell if the new rule is an improvement. They don't know about the analysis and design of the game environment. But since they already are familiar with games, a game environment offers one of the best ways to study *Designed Environments.*

Minerva Rivera, a fifth grade teacher in a small alternative school, was fascinated with the notion of having children make modifications of games and invent new games. So she embarked on an extended unit on games. In the first part she had children modify existing games. The activities in Chapter 3 (pages 67-71) are based on this part of her work. The second part of her work is itself a unit. In this unit Minerva's students designed their own games and evaluated them.

4-13A-B: **"Connect Four" redesigned as "Connect Six"**



## Modifying Games

## October 16, 1999

Minerva began with games of Checkers, Connect Four, Chess, Mancala, and Bingo.

I decided to let the children play the games first, before requesting that they change a particular rule. I gave them approximately half-an-hour to play according to the rules of the game. This was done at the end of the day on Friday, the period allotted for "choice time." The children paired up and spent the full half-hour playing with the games. I told them they could play more than one game during that time. Many of the children decided to play their games more than once instead of switching to another one. I noticed that many of the children didn't bother to examine the rules of the games because the children were so familiar with them.

## October 19, 1999

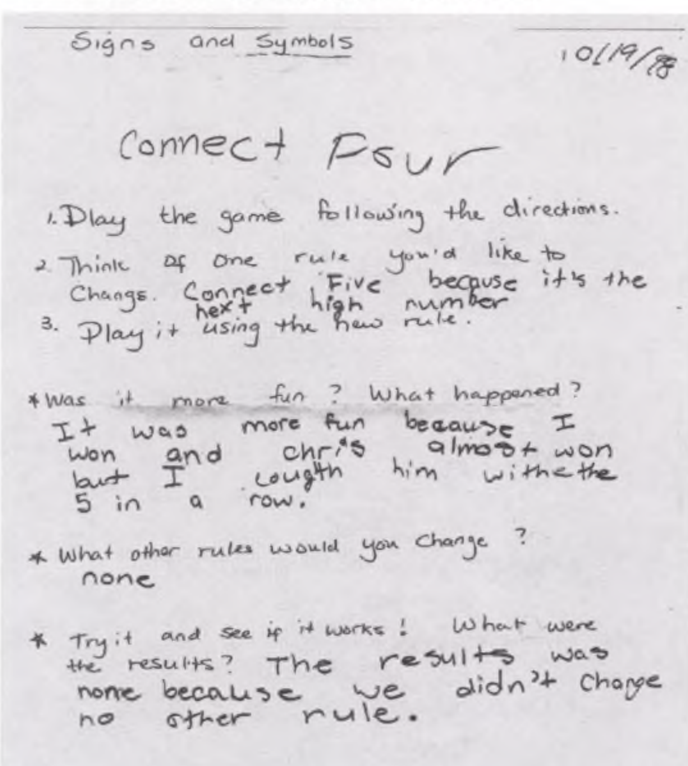
I requested that the students work in pairs again with the same games they had used on Friday. This time I instructed them to take one rule and change it. They were to decide which rule they would change and explain the new rule. They were then to play the game according to the new rule. (See Figure 4-13.)

As I went around to check on their progress, I found those students who had elected to play Chess, Checkers, Mancala, and Bingo had an extremely difficult time finding a rule that would be different from the official rules. What I found was that Connect Four was the only game that lent itself readily to this activity. The other games posed difficulties for the children in that it was harder for them to come up with a change that they could implement with ease. (See Figure 4-14.)

One set of partners playing checkers kept coming up with rules that were similar to the original rules; for example, when I asked Stephanie what new rule she and her partner had decided upon, she told me that you couldn't play on the black squares, you could only play on the red ones. I pointed out that meant the rules were unaffected because it would still be played the same. Then she suggested that the pieces could only be played diagonally. After discussing the fact that this too was already a rule, I suggested that she and her partner think about other games they have played and that it might be fun to try one of those other rules with this game.

The other children were playing games of Connect Four. Some people had modified it so that they could play Connect Five, Connect Three, and Connect Six. I found that the reason that the other games were so difficult to change was because they seemed to be a bit more complicated than the game of Connect Four. In other words, it seemed that the fewer rules there were to play a game, the easier it was for my students to find a rule to change.

4-14: **Reflections on the redesign of Connect Four**



Signs and Symbols 10/19/98

Connect Four

1. Play the game following the directions.
2. Think of one rule you'd like to change. Connect Five because it's the next high number
3. Play it using the new rule.

*Was it more fun? What happened? It was more fun because I won and chri's almost won but I cougth him withe the 5 in a row.

*What other rules would you change? none

*Try it and see if it works! What were the results? The results was none because we didn't change no other rule.

After three weeks with no games, Minerva told her class:

1. Pair up with a classmate.
2. Using the materials provided, create a game like Connect Four,
3. Change one rule in the game,
4. Play it once through with your partner,

Minerva provided them with 1-inch grid paper, pencils to mark off a playing area, and objects (such as pattern blocks) to serve as playing pieces. These new games were played on a horizontal surface like a checkerboard. Since gravity did not pull the pieces to one side, as with the vertical Connect 4 board, the children decided whether to play "with gravity."

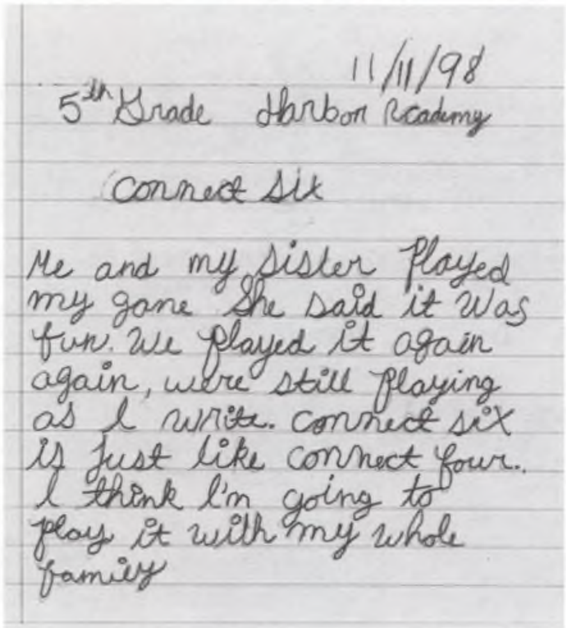
For homework, the students were asked to try out the games they redesigned in class with their families.

**I requested that they write about what the results were. It is interesting to note that many of the students felt that this exercise was extremely fun and that it did not feel like homework at all. Quite a few (see Figure 4-15) even told me that they were going to continue playing the games even though they were not required to do so.**

## Inventing New Games

Minerva now shifted the focus of game-making from the redesign of existing games to the creation and evaluation of a new game. The games were created in November then played, evaluated, and revised in December and January. Minerva began this project with the following homework assignment:

4-15: **One student's homework about Connect Six**



11/11/98
5th Grade Harbor Academy

Connect Six

Me and my sister played my game She said it Was fun. We played it again again, were still playing as I write. connect six is just like connect four. I think I'm going to play it with my whole family

**Create a blueprint for a new game, including instructions. Come up with a design for a wonderful new game that children can play.**

## November 17, 1998

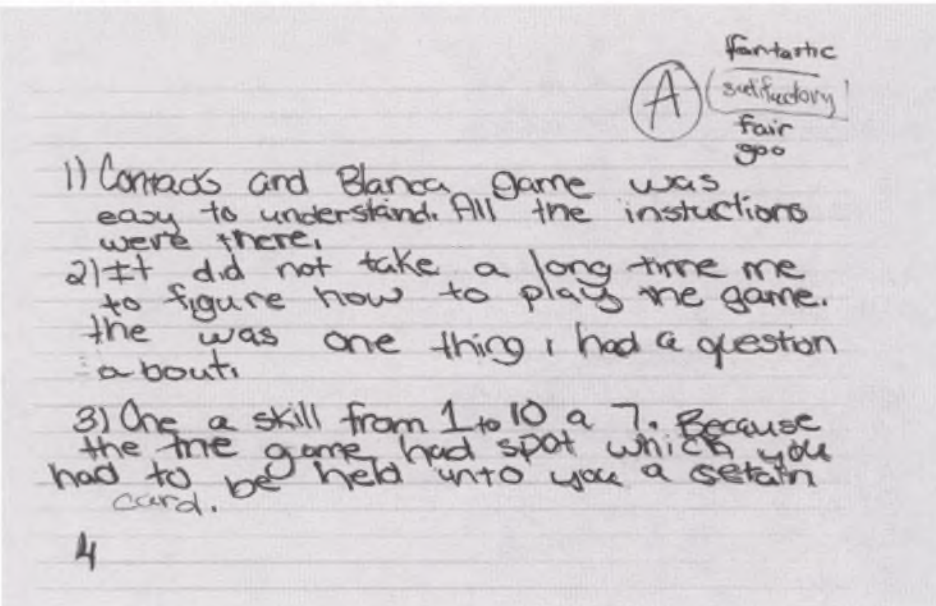
**Almost everybody came back to class the following morning with a design and some idea of what the procedures would be to play the game. Most of the designs were quite simple and not very detailed. The session went very quickly because I did not want the students to get bored with the discussion going on. I also wanted the children to let their own ideas come out and didn't want the discussion to produce a slew of games that were too similar.**

Following this session Minerva told the students to work in pairs to develop the games. They were to be clear about the main point of the game, organize the details they wanted to include in the game, plan the design of the board (all the students intended to make board games), and pay special attention to the rules of the game. She provided them with various colors of oak tag and construction paper, rulers, pencils, glue sticks, and tape. The students completed most of the initial work in the 30 minutes following the brief discussion. They finished their game boards and directions in free time during the following days. By December 8 the games were ready to be played.

## Evaluating Student Designed Games

Minerva wanted to engage students in the evaluation process. The games seemed an ideal vehicle for evaluation because of the children's high level of interest in playing them. Her goal was for children to become more and more specific about the criteria for a good (or bad) game. She outlined these plans.

4-16: **One student's evaluation of Speed Racer**


fantastic
(A) satisfactory
fair
goo

1) Conrad's and Blanca game was easy to understand. All the instructions were there.
2) It did not take a long time me to figure how to play the game. the was one thing i had a question about.
3) One a skill from 1 to 10 a 7. Because the tme game had spot which you had to be held unto you a setain card.
4

4-17: **New evaluation instrument for redesigned games**

| | Rules of the Game | | | | |
|---|---|---|---|---|---|
| | Clear | Unclear | Easy | Hard | Interesting |
| Length of game | | | | | |
| Who starts first | | | | | |
| How many people play | | | | | |
| Who wins | | | | | |

- **Have students play the games according to the rules written by the students.**
- **Equip each student with a sheet that has a few questions for the evaluators to answer.**
- **Give evaluation papers to creators of games to review.**
- **Discuss what changes need to be made.**

Minerva was trying to have her students develop criteria for deciding what was a successful design. She listed three questions for the evaluators to answer:

- Were the rules easy to understand? Why?
- Did it take a long time to figure out how to play?
- Did the game maintain your interest?

In figure 4-16 is one student's evaluation of the game "Speed Racer."

**I kept revisiting this part of the process because I wanted to see what the students would say each time. Every time the students reviewed the games, the information served to help the creators to work on their designs and correct any areas that needed work. There were some students, however, who did not care what was said about their games. They weren't going to tamper with what they felt was perfection.**

For the next session of playing each other's games and evaluating them, Minerva modified the evaluation instrument to be a table. (See Figure 4-17.)

**With their responses to this evaluation instrument, students were starting to pinpoint some difficulties that they encountered playing the games. Many students mentioned the fact that they had to keep asking the creators of the game what to do next because it was not included in the instructions or not very clearly stated. There were some games that were clearly more popular than others. Everybody wanted to play "Get Off My Property." It was the most requested game. I think this was so because of the fact that it was colorful, the directions were rather clear, the set-up of the game was familiar, and it was fun as well as challenging. Most of the children borrowed ideas from other games in creating their rules, in the physical look of the game as well as the objective of the game.**

**After all the evaluations the children made, I found that the results were still not as conclusive as I thought they would be. I kept revisiting the material because I hoped that the answers would be more**

**organized, detailed, and explicit. What I found was that I needed to help many students by asking questions and taking down their responses. I found they were able to elaborate with less difficulty. Asking the students to respond in written form gave me an opportunity to assess their writing skills.**

Minerva felt the last evaluation instrument she had given the children was too complicated. She would modify the chart to include only the first two response columns, "Clear" and "Unclear." The other information she would get from questions:

- Was the game hard or easy? Why?
- What captured your interest?
- What would you change, if anything?

Minerva understood how important it is to have children evaluate what they have done, then to make the evaluation results the basis for further changes. This is fundamental to technological design and a major goal of *Designed Environments.* In spite of her efforts, she was not satisfied with the results. What she tried may simply have been too difficult. The difficulty lay in the diversity of games being developed, and in the open-endedness of designing a whole new game. It is much easier to take a game that exists, make a small change, then evaluate the effect of that change.

Evaluation requires, first, that the evaluator have a frame of reference for understanding the thing being evaluated. In the case of a game that has been modified, the frame of reference is the game as it was played in its original form. This is the reference to which the modified game is compared. When looking at a new game, an evaluator has to seek an appropriate frame of reference. This is a difficult task for any evaluator, let alone for one just learning about evaluation.

Secondly, the evaluator needs to know what to look at during the evaluation and what criteria need to be met by the new design. We encourage teachers to have students consider the criteria to be met by their designs before they begin designing. This is much easier if there is an existing game or design that is being modified. The criteria can then be stated in terms of how the new design compares with the old—e.g., "Connect Five will be slower and harder to win than Connect Four." Minerva's students invented different games with no explicit criteria. Minerva's solution was to develop criteria that were generic such as, "Were the rules easy to understand?"

4-18: **Connect Four game with some pieces in place**

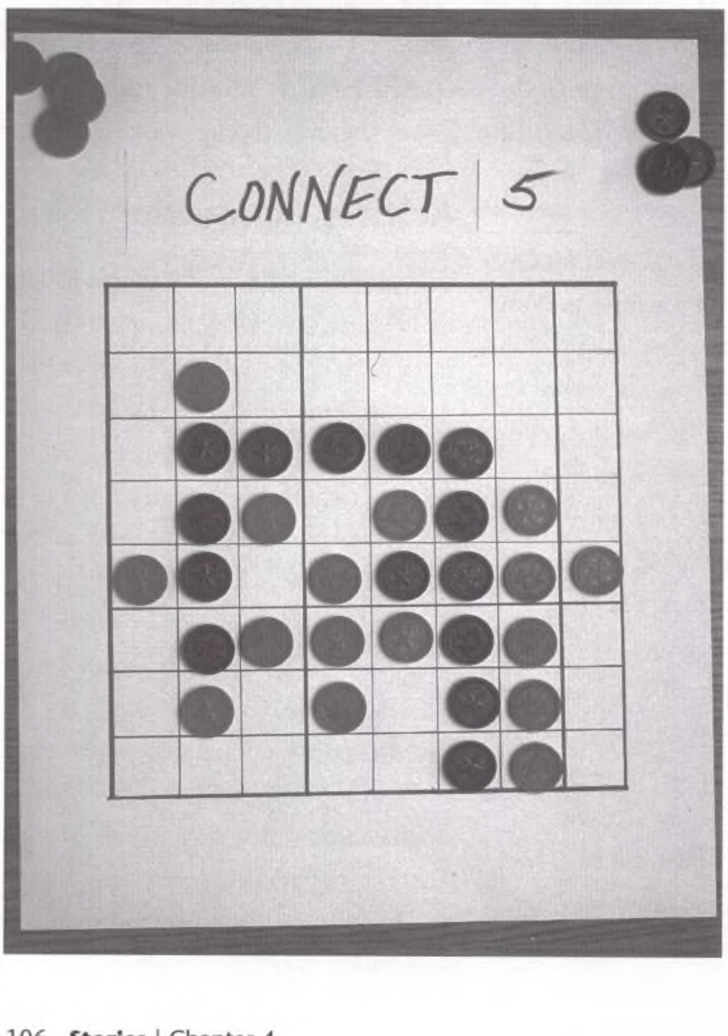
## Activity Connection

The activity in Chapter 3 that is based on Minerva's work involves modifications to the game which Minerva's students found easiest to change: Connect Four. This is the game that, when her students changed it, they enjoyed so much they continued to play it at home.

We found Connect Four works equally well with adults. The game is played on a 6 x 7 vertical, checkerboard-like "playing field" in which two players drop checkers down any one of seven columns. The goal is to be the first to get four checkers in a row horizontally, vertically, or diagonally. (See Figure 4-18.)

The homemade varieties of Connect Four boards are more like checkerboards, played on the horizontal. Players decide the size of the playing field. Do they stay with 6 x 7? Do they play the game "with gravity"—i.e., is there a "top" and "bottom" and do all pieces go to the "bottom?" If not, are there any limits on where you can place your pieces? How many must you have in a row to win? Do you play until one person has four in a row, or do you use all the pieces, then see who has the most rows of four? Figure 4-19 shows a homemade Connect Five game being played "without gravity."

4-19: **Homemade Connect Five being played "without gravity"**




After trying such variations, players get a sense of how different kinds of changes affect the game. They are then in a position to think about redesigning the game to meet specific criteria. When a game is designed to meet a criterion, it is much easier to evaluate. The evaluator can tell if it meets an objective goal such as "it takes a shorter time to win." The evaluator can also compare it to the unchanged game to see if it meets more subjective goals such as "it is more fun."

# Part II: Analysis and Redesign of Spatial Environments

The teachers' stories in this section are about designing and changing spaces. The first two accounts are about school spaces: a classroom and a cafeteria. In both cases you will see students deeply involved in projects that recognize their ability to make real contributions to the environments of their daily lives.

The next two accounts are of animal habitats. There are many good science units through which children investigate the behavior of classroom animals. A natural extension of such studies is to use the information learned about the animal to guide the design of an animal environment. For example, what children learn about the behavior and preferences of a mealworm can be translated into the design criteria for mealworm environments.

## Redesign of a Classroom

Angel Gonzalez is the science cluster teacher at the Family Academy School, a small school-within-a-school in central Harlem. He is the science teacher for most of the children in the mini school. Children in his classes had done a lot of mapping earlier in the semester. They began work in environmental design in December with discussion and brainstorming about what "environmental design" might mean. After batting it around for a while, Andreas, a third grader, came up with this:

First you draw a map of your house like it is. Then you make a map of how you are going to change it. Then you change your house.

The class added:

Then we check to see if we like the changes. We check what works better and what doesn't work.

Angel explained:

**After discussion and brainstorming, I developed a working definition of environmental design for students:**

**"Environmental design is the planning and organizing of your surroundings to meet certain needs of people or animals. Surroundings can include space, time, and physical things."**

Angel experimented with different possibilities for *Designed Environments* activities. Second graders proved to be too young to do a habitat design project. Their work with mealworms stopped with observation and recording of mealworms' behavior. Most successful was a project to rearrange the desks in fourth and fifth grade classes.

## December

**I spoke to all the classroom teachers before the holidays to request permission to do environmental design in their classrooms. The desks would be rearranged based on students' thinking and criteria that they felt would work best for them. I explained to them that changes would remain as long as the felt it was working productively.**

## January

**Students were asked to determine what factors were important in setting up the seating arrangement. After that discussion, I asked groups of four students to draw blueprints of their proposed desk setups. The class then voted on the proposal that they wanted to adopt. The method of voting, which is also an issue of environmental design, was decided by me because to engage in this discussion would be lengthy and would divert us from the room rearrangement task. Time was of the essence. I decided that students would vote with a show of hands and that a simple majority would be decisive. After their decision, we proceeded to rearrange their room according to their map.**

**One of the fifth grade teachers, Ms. Hicks, had already arranged her classroom desks in a "U" shape pattern, with some desks individually separated for behavior management reasons. Ms. Hicks' students defined the following as important needs to consider in setting up a classroom:**

- **Walking space**
- **Visibility**
- **Space for the pet areas**
- **Play area**
- **Teacher area**
- **Personal breathing space**
- **Storage**
- **Safety**
- **Health**
- **Behavior**
- **Compatibility with neighbors**

**I suggested that we could go back to these as criteria for evaluating whether the new setup was better or not.**

**Five teams of four students each made their separate design proposals. All wanted to increase the open walking and play space. Most groups felt that by separating the class into clusters based on gender would help improve behavior They felt that taunting and bickering between boys and girls would diminish. One team, "W," felt that students should group themselves based on friendships.**

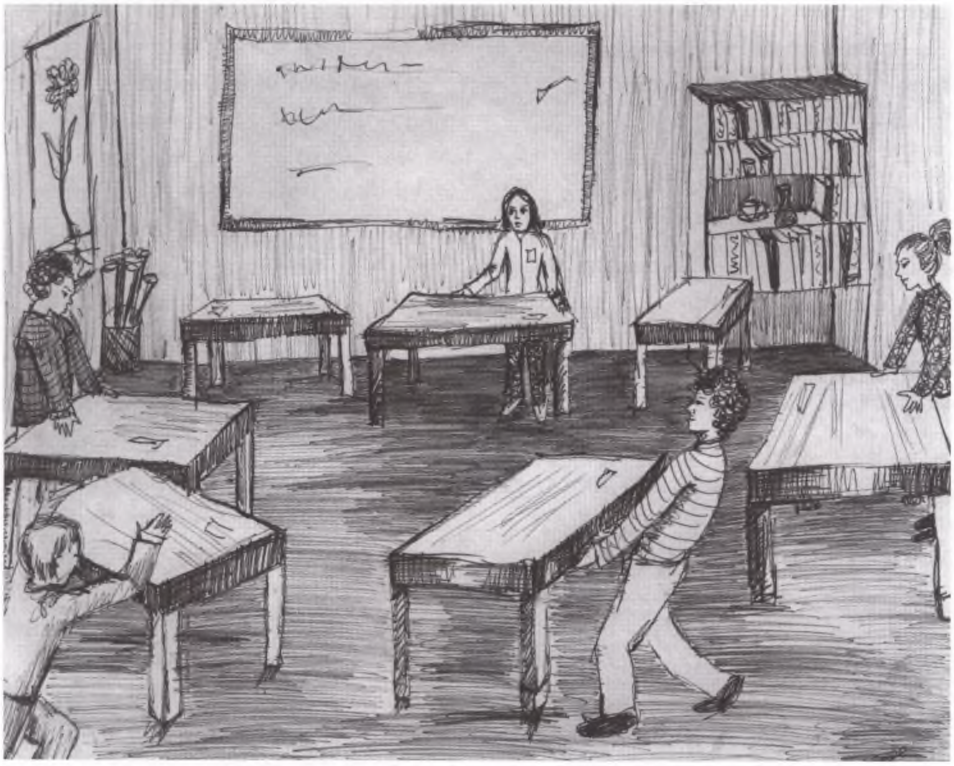
**After each team made its proposal and received feedback from the rest, we held a vote. The majority decided that clustering desks based on friendship was best and the "W" proposal was adopted. They felt that this setup would create more play and walking play space, and that grouping by friends would improve behavior and work.**

**I then had students regroup in the four corners of the room and the center into clusters of 4 to 6 students based upon those who wished to sit next to each other.**

**This process took two sessions of 90 minutes each. One session allowed them to draft and draw up their proposals and the second was dedicated to their debating over what was the best plan and the actual reorganizing of the desks. Ms. Hicks class seemed so elated that they were empowered to decide their fate and appeared determined to make it work so that Ms. Hicks would not veto their decision.**

**The room rearranging was somewhat chaotic and one student, Shatika, disagreed with the new setup and insisted that she be alone. Materials were falling out of desks and paper ended up strewn over the floor. Changing the room was messy**

4-20: **Rearranging desks**



**and the raucous behavior initially threw Ms. Hicks for a loop when she returned to take the class to lunch.**

**She quickly took up my offer to take them to lunch after all had helped to tidy up the room. It took 20 minutes more into the lunch period until we were ready to depart. All, except two or three students, were excited about the changes.**

**After lunch, I cautioned them that the five students who were absent on the day we decided on the rearrangement might be resentful of the changes, which had taken place without them. Also, they might dislike the new groupings in which they found themselves. I also warned them that large clusters of friends could result in more talkativeness. One group of boys was situated too close to the pet tanks and I advised them to move close to the center to allow more space for movement. I didn't want their rearrangement to be nullified by Ms. Hicks.**

## January, a week later

**I visited Ms. Hicks' fifth grade class to observe their classroom seating redesign. It is the only classroom where the students' rearrangement continued successfully. Apparently both the students' and the teacher's criteria for seating arrangements were satisfied. The students definitely are happier with their "empowered" choice of room design. When a student acts out, Ms. Hicks just isolates that particular student's desk without penalizing the entire group.**

What Angel accomplished was impressive. With his help, the children redesigned their regular classroom and the room of another teacher. Some aspects of this project are much easier if the room being redesigned is your own. For example, planning how to move the desks, and carrying out the move, is more manageable if it can be done on your own schedule. In the activity sheets based on Angel's work, we suggest that teachers have their students actually walk through the expected change of position of their own desks (without moving the desk). This allows them to visualize what is to happen. If children disagree about where they will end up, it is much easier to sort out when the desks have not yet been moved.

When the redesign is in your own room, it is also much easier to follow up with the evaluation. Angel suggested that the children use the criteria they had established to evaluate the new design, but he was not in the room to lead the evaluation.

## Redesign of a Cafeteria

We turn now to the story of cafeteria planning by Felice Piggott's fourth grade class in a large school in Manhattan Valley, New York City. It began in December 1997 following several months in which mapping had been a continuing theme. The mapping project culminated in mapping the classroom to scale (see ***Stuff That Works!: Mapping***). The kids now wanted to go on to bigger things. Cafeteria redesign was definitely a bigger thing. They didn't know what they had gotten into. The project continued through the winter and spring, not on a regular basis, but as an already packed schedule would allow. Felice wrote the following in early spring.

**This is an ongoing project. This is a HUGE project. This is a project that I rue the day I ever started it. WHY? Because the kids are very excited about having their opinions count for something—they want to effect change—the Administration is sincerely hoping for some solutions to what they essentially refer to as a "prison cafeteria" with an unpleasant atmosphere and routine. SO solutions are hoped for and, I think, expected.**

**I told the kids that opinions weren't enough—we had to have evidence: observations and data that show why things don't work or need to be changed. And we had to have alternatives. (I made it sound grim, but they were still game.) So that's what we are doing.**

**We've done the mapping and the observing and what is still to be done is the redesign (with mapping) and a presentation to the Administration.**

**I'm not entirely happy with their observation/data recording skills and there was also a problem with the scale map of the cafeteria. I feel that I'm slamming past them due to time constraints (missed teaching opportunities), and thereby cheating the kids...BUT, they are wildly excited about making their lunch time more pleasant and I think they hope that they, in fact, will.**

A wonderful thing about *Designed Environments* is that teachers see how students can use the knowledge and skills they have "learned." Projects of this kind are self-assessing because they clearly reveal gaps in students' knowledge and skills. They can be problematic for the same reason: when students don't know something they should, or can't do something they ought to have learned, teachers often want to take time to teach the knowledge or skill. This is the pressure Felice felt. Now we will back up to December for more detail on what happened during the project.

## December 10, 1997

**The kids were looking to continue mapping and had suggested that a larger space would be challenging. Mapping and then analyzing the activities within the space seemed a natural progression. Since none of the humans in P.S. 145 like the current operations in the cafeteria it seemed an apt site.**

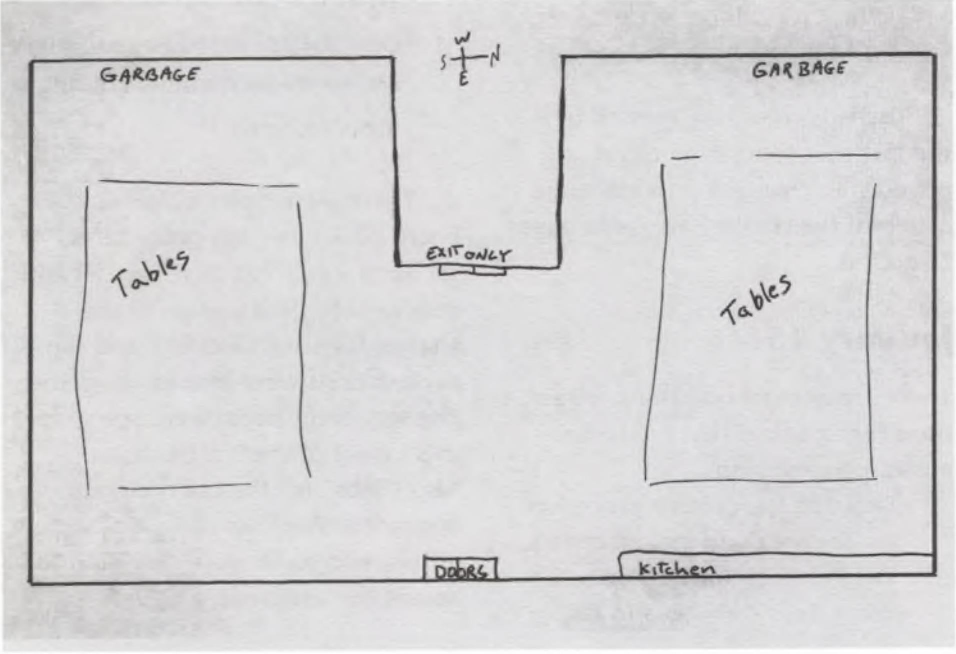
Felice got out the classroom map to begin the brainstorming and discussion that would lay the groundwork for the cafeteria redesign project. They reviewed what they knew of mapping, then switched to the cafeteria. Here are some of the ideas about what was wrong with the current design:

- It is too crowded.
- You have to cut through the line to get to the garbage and you always bump someone.
- There are fights because you bump and spill stuff.
- The lines are too long.
- It's too slow.

## January 14, 1998

This was the day to begin redesign work. Felice recalled the brainstorming of a month ago and the previous work on mapping the classroom. They would begin by mapping the cafeteria in its current condition. The map would assist in planning observations and data

4-21: **The U-shaped cafeteria**



collection. It would also be the baseline for redesign.

Before the class, Felice made arrangements both for visiting the cafeteria this afternoon for the mapping activity and she cleared future times for the children to make observations in the cafeteria.

**The observations and sketches in the cafeteria were confounded because appearances were at odds with tile counts. The cafeteria is shaped like a "U." (See Figure 4-21.)**

**Due to the arrangement of objects, the room appears larger on the left side than right. We had a long discussion about this which was only modulated by the "tile" counts and the custodian's intervention. "You know, contractors come in here and say, 'Hey, you know you got one side bigger here?' and I have to tell them, no, the room is symmetrical. It's an optical illusion because of the way the tables are arranged."**

**CLASS:**
*Ooooohhh. . .*

**The kids were very excited by the fact that something could possibly be changed through some action of theirs. They are quite eager to do this.**

## January 15

**There are general questions/ directions for all teams that are to be answered in writing:**

- **Describe the current procedure for the area you are observing.**
- **What do kids have to do?**
- **What does staff have to do?**
- **What aspects of current procedure work well? What aspects do not work well?**
- **What is our biggest problem with the current procedure?**
- **Based on observations, brainstorm solutions with your group.**

**The teams met as requested. Some teams had difficulties describing the "existing routine" while others could not come to a consensus on team members' jobs.**

**The children met with their teams and decided what they would observe and who would do what. For example, the Garbage Team had the following questions:**

- **Who will watch the left side and who will watch the right side?**
- **Who will count how many children throw out their garbage "correctly" and who does not?**

**When we met as a group again we heard reports from each team as to:**

- **What the existing routine is**
- **How they planned to position or employ team members during observations.**

**There were many opinions heard about existing procedures for each area ("No, first you get your milk carton, then you go to the kitchen for your lunch!!!") and some explanations were junked altogether. Consequently, notes were scarce for this aspect of the "instructions." Also, "jobs" for the team members appeared "fluid" as some kids were absent and some were unwilling to accept the assignments given.**

**This was a prickly lesson because there was a lot of simultaneous management required and a lot of heated discussion about team "jobs." Again, keeping kids focused on how to observe and what to observe rather than discussing what's wrong with how things are was difficult.**

## January 16

On January 16, teams were sent to the cafeteria for 10-minute intervals to observe the lower grade lunch period; first the Traffic Team, then the Food Service Team, next Garbage Team, and last, the Seating Team. This was a time to work out some of the difficulties they might face in collecting their data.

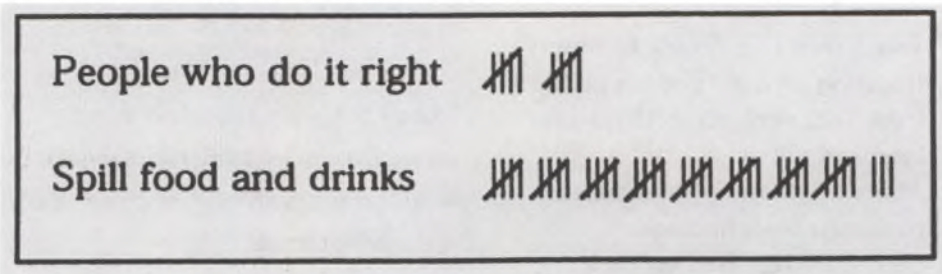
**The Traffic Team was the first team sent to observe and they were one of two teams with good evidence of observations.**

**SHANDRA:**
*The kids were staring at me with my clip board, but I just ignored them-they were so noisy! But I saw a lot of things about the line-up and when they came in! God! Those little ones are something else!*

**Although their observations also include their opinions, this team did a lot of writing to support what they saw. Shandra was stationed by the garbage to observe the traffic. She noted:**

1. **The line moving, kids trying to put stuff in the garbage.**
2. **Kids talking on line.**
3. **People not watching where they are going.**

4-22: **Orlando's data on throwing out garbage**




4. Skipping, dancing, playing on line.
5. Nobody to guide them when they put in garbage.
6. Don't put garbage in carefully.
7. Pushed by people in line.
8. They throw in garbage, in rush, dump it.
9. Not watching where they are going.
10. Running and jumping.

The Garbage Team was quite eager to observe because they had a lot of ideas about what they would see and how they would keep track of it all.

STANSKY:

*Finally Orlando agreed. He will cover the NE corner of the cafeteria, Shanon the NW, Derek SE, and me, SW. We hope to be able to see everything that way.*

And with that kind of organization, they were the team with the best-written evidence of their observations. They were also the only team with any kind of quantitative data as they tried to track who "did it right" (garbage disposal) and who did not. (See Orlando's data, Figure 4-22.)

Stansky took these notes:

1. There is food all over the floor.
2. Kids were running, food fell.
3. Kids are talking and food comes out of their mouth.
4. Kids get two trays and go throw them in the garbage. It falls.
5. Kids can't throw all their food away so they take it outside.
6. Sporks are all over the table and floor.
7. They take the milk and put it in a slop sink.

The Seating Arrangement Team was not able to do much of anything, as when they arrived most classes had already left the cafeteria.

Problems started occurring after this first class trip to the cafeteria. Felice had planned to send students in teams to do follow-up observations. They were told by cafeteria workers they couldn't be there alone. A few days later Felice wrote:

## January 22

Whole class went down early to observe grade 1-3 lunch hour. We planned to split into teams and observe/record data.

FIRST the lunch card lady starts screaming at the kids like a mad woman until finally I have to tell her to "back-off and let them do their assignment." AT WHICH POINT the principal has to speak to her and then tell me that we can't be there all together because "there is no room to stand and all the tables are used," and clearly she is right because I watch while kids collide with each other and with my kids (who are in the way), spilling milk and food and whatever. SO, we retreat to a stairwell and designate team members to go back in to observe and then realize we are in the way of arriving classes.

SUBSEQUENTLY, we "rotate" observing team members to observe. I give my student teacher instructions to "observe and protect" remaining team workers in the cafeteria, and I give another kid the camera and ask her to take pictures. The rest of us go back to the classroom. Once there the kids broke into team groups and discussed what they had observed. When remaining team members returned, they contributed their observations to the group.

Groups were then asked to report on what they saw as the most problematic areas within their scope. ("What was the biggest problem you saw happening today?") After all groups shared their observations, I encouraged the children to remember to focus on that particular thing when we observed again.

4-23

## Recommended changes in the cafeteria

**Food Service**

1. Lunch should be self-serve.
2. Classes should be called one at a time for food collection.
3. Food selection should be more varied, with more vegetables and fruit.

**Garbage**

1. They should have two tray cartons to put trays in.
2. There should be directions telling where to put your garbage.
3. Kids should be able to go to either garbage station.
4. There should be people at each garbage station to keep it clean.

**Seating Group**

1. Put class name on table.
2. Put arrows on the wall so people know which way to go in the line.
3. Make the line to get to lunch different.
4. Arrange the tables differently to make more spaces between them.

**Traffic Group**

1. Assign times to go to the lunchroom and to leave there.
2. Signs to tell where to go.
3. One entrance, one exit.
4. Move tables away from columns.
5. Make the line in the cafeteria shorter

## January 27

1. **Teams sent to cafeteria to observe (focusing on that "one big problem' from 1/22 session) at 15-minute intervals.**
2. **Afterwards teams reassembled to discuss their findings.**
3. **Each team reported on their observations.**

## January 28

1. **Teams sent out at 10-minute intervals for final observations.**
2. **Teams reassemble and discuss observations.**

**I tell them that I would now like a list of the things, based on team observations, that need to be changed in the cafeteria. The list should be one page and should include everyone's ideas. One member from each team should "share" the list and then meet with me. See Figure 4-23 for each group's recommended changes.**

**After each team shared their list and met with me, I instructed the teams to think about how we could show these changes on a map. Would all the changes be able to be shown visually? Are all changes suggested physical changes or changes in routines or procedures?**

The next assignment (January 29) was to make individual maps of the changes they would like to see in the cafeteria and to write about the changes. Amanda knew what she would like (see Figure 4-24), and she knew its limitations. "This is an example of what I would like the cafeteria to be like. Ten kids can sit at each table. I know that's not enough and there would have to be more tables, but it would be nicer." Matt (see Figure 4-25) was more practical.

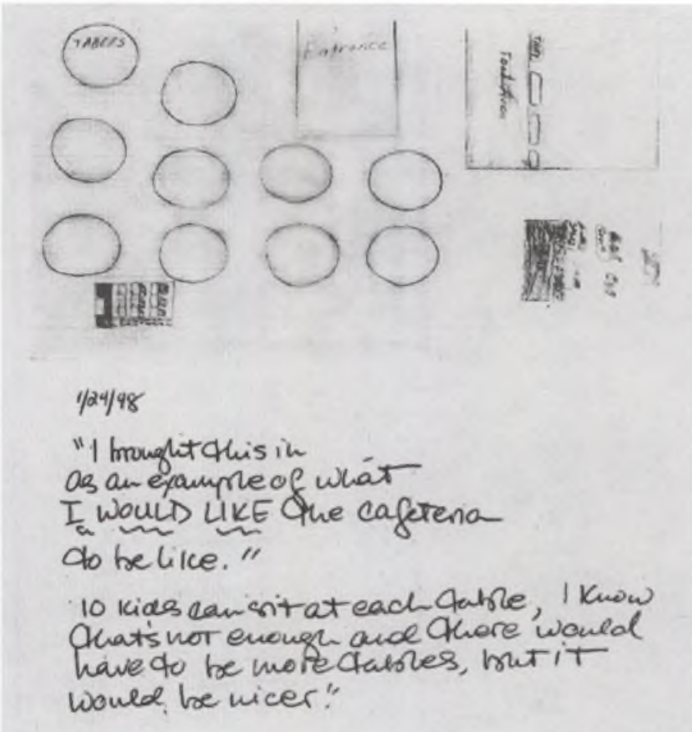
**Children were very eager to redesign seating arrangements using round tables. Currently there are 47 tables in the cafeteria (none of which are round), which seat four kids on either side. Proposed round tables would have to seat as many. "How could you be sure they would fit in the space we have now?" I tried to make the point that the redesign should have some element of reality to it, which some children found hard to incorporate in their redesigns.**

## February

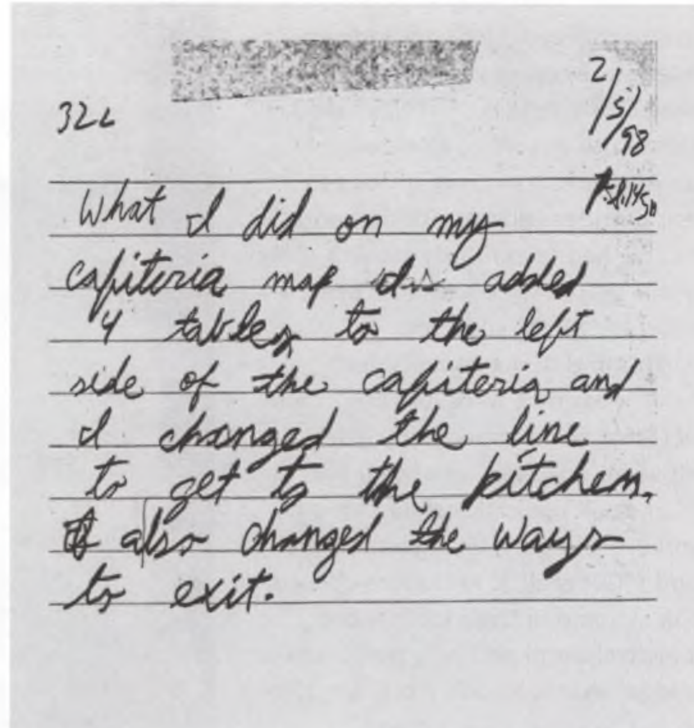
**We had many discussions as to procedures observed-redesign is not just a redesign of the physical space, but of the procedures in that space as well.**

- **"Family-style service would be better because then there wouldn't be as much traffic-the lunch ladies are too slow."**
- **"I think the food itself contributes to the traffic because sometimes kids go back for seconds, or sometimes, when there is a choice, they take too long to decide."**

4-24: **Amanda's recommended changes in the cafeteria**



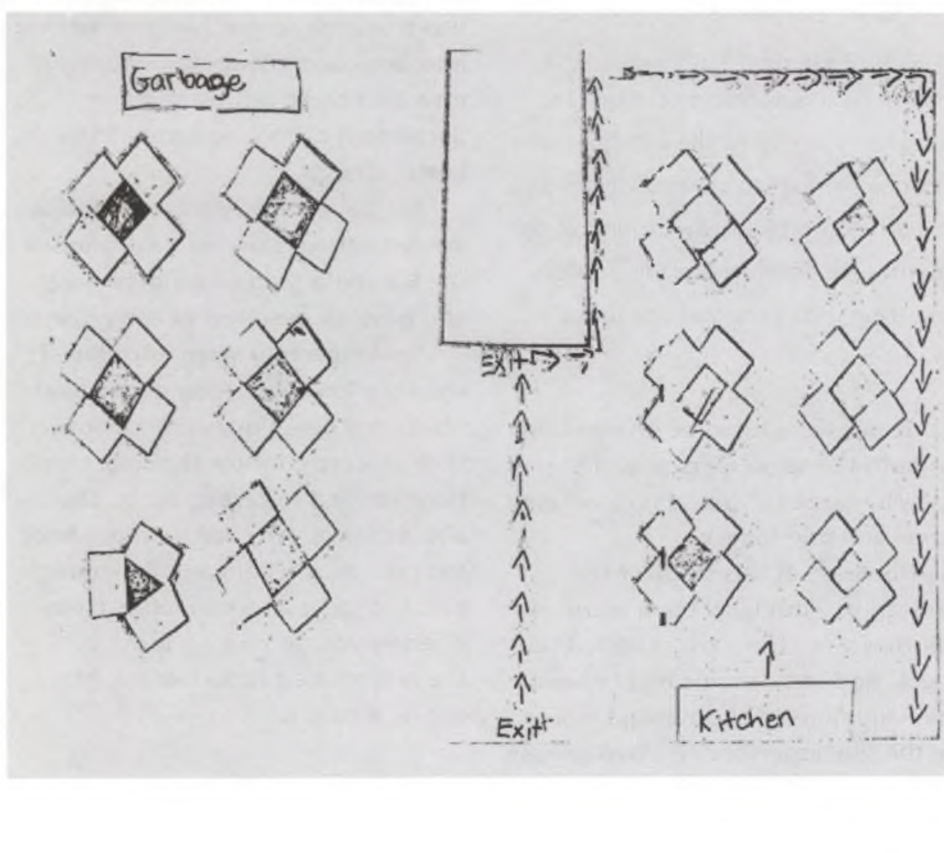

4-25: **Matt's recommended changes in the cafeteria**




- "I made my tables into a square leaf clover arrangement, but I don't think that it will work, because I noticed today that the tables are attached." (See Figure 4-26.)

As time went on, students became more aware of how the cafeteria was operating, and what they didn't like about it. Even though we had done individual maps of redesigns, there were more ideas each time we returned to a discussion about procedures or physical space. We were getting more information about what was possible to be changed and what was not, what was mandated by law, and so on. Clearly, we had to rethink things…

4-26: **One proposed cafeteria redesign**

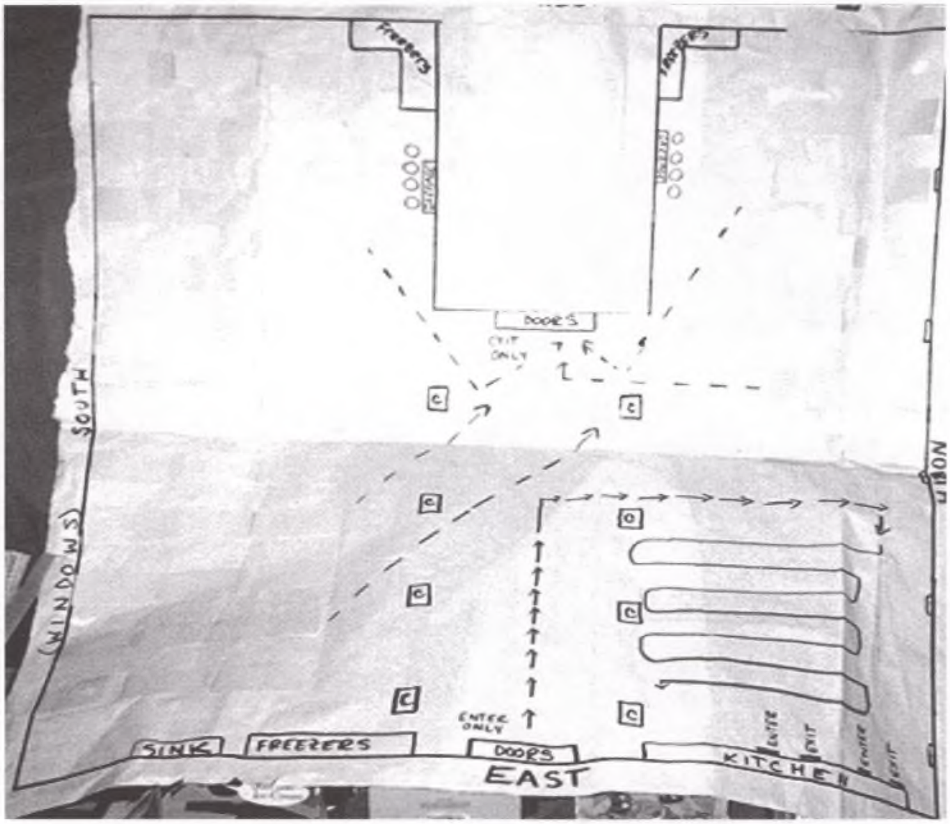


## March 11 and 12

**"I'm giving you back your individual redesigns because we need to rethink some of the details..." That's how I started the lesson. I explained that the Administration was curious to hear our ideas about redesign and that we had to seriously rethink some details before we could do a presentation to "pitch" to them.**

**This initiated a conversation about ideas that were just not practical (table arrangements in circles), self-serve salad and sandwich bar ("Get real!"), additional lunchroom workers (budget), or higher quality food ("Get real!"). Kids were able to look at some of their ideas more objectively, and add new perspectives to ideas that wouldn't work. So then we got to brainstorming and " distilling" some common ideas, and agreeing on new solutions.**

4-27: **The plan to redesign the cafeteria**




Out of the brainstorming came the need for more information, but they were in basic agreement on a design. Students interviewed the custodian and cafeteria workers to clear up details and to get their opinions. By the end of the month each group was ready to begin preparing their presentations to the administration.

**Teams were to agree unanimously on both the spokesperson and the speech-meaning I would receive one name and one speech.**

**However, at this stage of the project, practically all team members felt they were the most qualified to speak, and some teams had to have mini-auditions to choose who would be the spokesperson. Also two groups had to merge several pieces of writing into one coherent speech because members could not come to an agreement as to who had written the better speech.**

**Ms. Lesley, the Assistant Principal, arrived and was seated. I introduced the Cafeteria Map (see Figure 4-27) and gave an overview of the project.**

**Spokespersons were introduced and they took over. After each speech, Ms. Lesley asked questions about their research or how their observations had led to certain ideas. She also explained why certain procedures must remain a certain way. For example, milk has to be a certain temperature when served, so moving it out of the refrigerated container might not be possible.**

**After the spokespersons finished, then all the children in the class began asking questions, or rethinking ideas ("Well, maybe the utensils and the milk should be near each other so children could move out of the kitchen faster"). A back-and-forth dialogue began between Ms. Lesley and the children... AND THEN, much to my surprise and delight, Ms. Lesley suggested that we implement our redesign on Friday, to see if it actually works!**

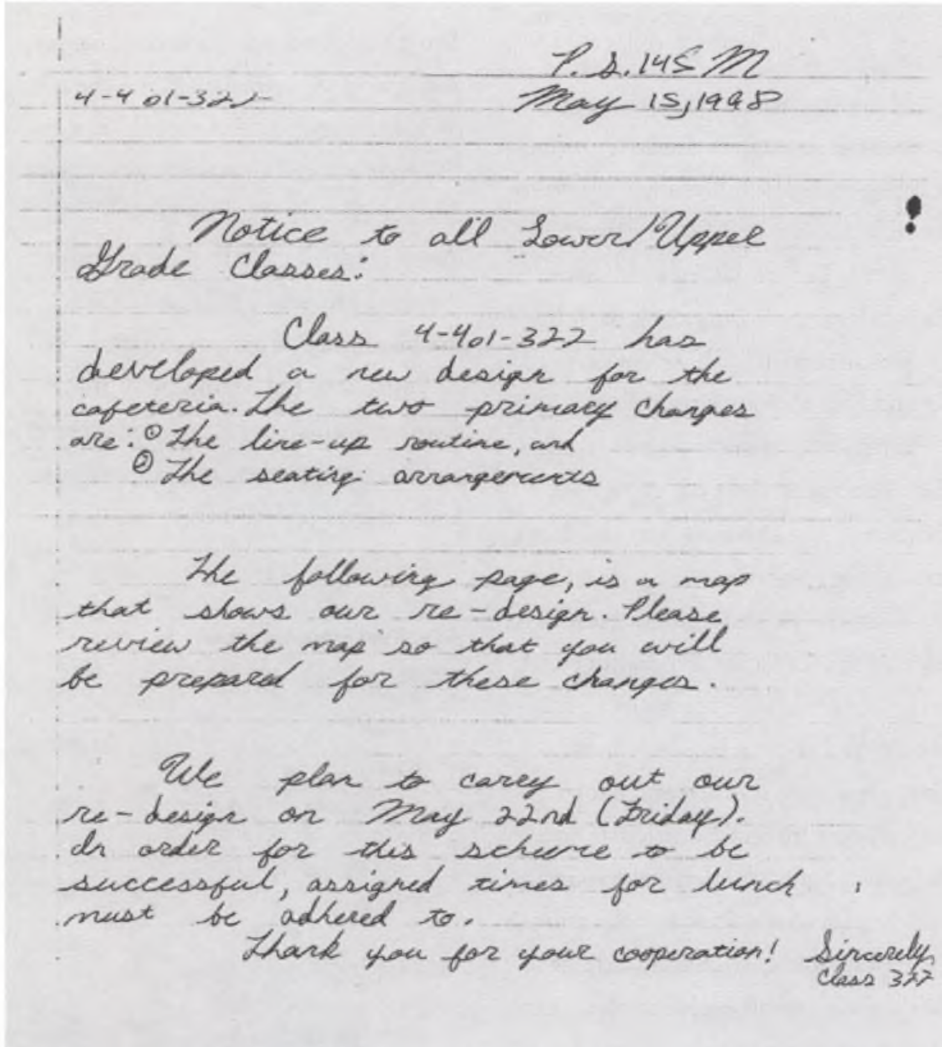
In fact, enacting a plan as ambitious as this one takes time. In a week (it was May 29) the children were ready for a dress rehearsal. They met the custodian in the cafeteria early in the day and, with his help, began moving tables. They set up the guides for the snake-like cue that was to replace the old mode of lining up, and then began to have some questions. This was the first time they had actually seen their ideas take shape. The possibility of conflicts while waiting on line for food was real. They also wondered whether the instructions they had sent around to the other classes would be adequate. (See Figure 4-28.)

They decided that instead of trying out the new arrangement that day, they would think more about the design, or perhaps get more adequate guides that would really separate children on the line. This was too much to do, however, before the end of the year.

In Felice's work, we see a long-term project that doesn't accomplish its stated goals, namely to improve the cafeteria. Interestingly, this did not seem to upset the children; the teachers themselves appeared to have more invested in achieving a solution.

The development that took place in these children was far more important than whether the particular problem was solved. Felice's students gained markedly in their abilities to plan and carry out projects. They began to think of the implications of their ideas. They began to see the cafeteria as a system with interacting sub-systems. They became more proficient in presenting ideas visually and in words. And when they saw what their redesign looked like in real life, they were able to evaluate it in terms of its likely consequences, because now they really understood their problem. We don't want to underplay the satisfaction of designing a solution that really works. In smaller scale classroom projects such as "Hook Mania" and "Chairs Up and Down" at the beginning of the chapter, it is much easier to implement successful solutions. Felice took on a school-wide project. This involves the children deeply, has many satisfactions along the way, and is an integrated learning experience. But it does not always lead to a solution that can be implemented. We believe the value of the process far outweighs the product of an implemented solution.

4-28: **Instructions for using the redesigned cafeteria**



P.S. 145 M

4-401-322 May 15, 1998

Notice to all Lower/Upper Grade Classes:

Class 4-401-322 has developed a new design for the cafeteria. The two primary changes are: ① The line-up routine, and ② The seating arrangements

The following page, is a map that shows our re-design. Please review the map so that you will be prepared for these changes.

We plan to carry out our re-design on May 22nd (Friday). In order for this scheme to be successful, assigned times for lunch must be adhered to.

Thank you for your cooperation! Sincerely, Class 322

## Designing Environments and Solving Problems for Classroom Pets

In Felice's story you see the motivational power of a design problem whose solution has a direct effect on children's lives. Projects such as this engage children's best thinking and stretch their capacities. For many children, projects involving pets motivate them in a similar way.

Many teachers keep pets in their classrooms because of children's interest in living things. Children are drawn to the busy activity and furry warmth of the gerbil. The initial frightfulness of the Madagascar hissing cockroach has its own attraction, pulling children beyond first responses to a close examination of their anatomy, habits and preferences. Animals engage children. They also draw out children's care-taking responses.

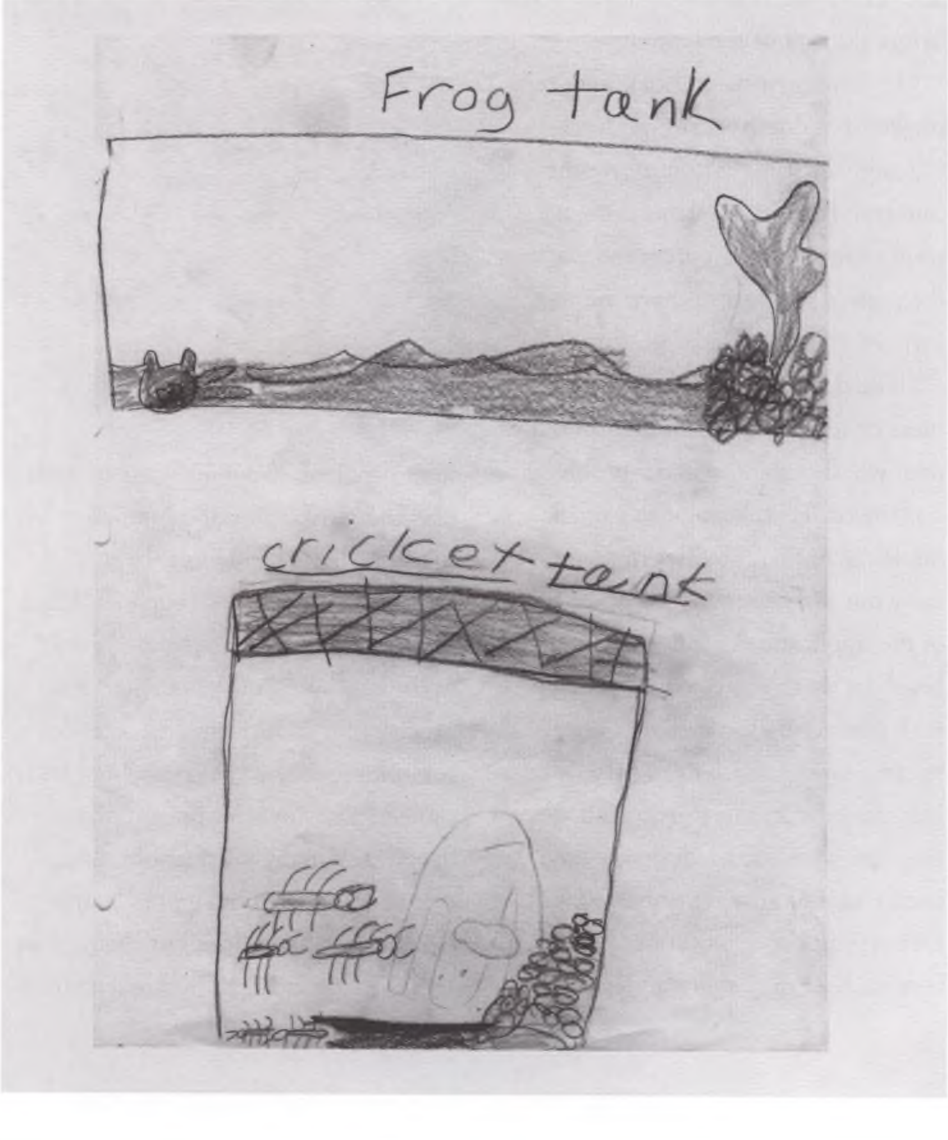
Teachers use children's interest in animals as motivation for reading and writing. Animals are the focus of mathematics and science investigations. They are a long-term resource for projects that integrate curricular areas and goals. Some teachers have found that the characteristics that make animals such a valuable curriculum resource also make them an excellent focus for *Designed Environments* projects.

The next two teacher stories are about analysis and design projects with classroom animals: frogs, crickets, and mealworms. Tonia and Angel, teachers you met earlier, each had animals in their classrooms for other curricular purposes. They saw opportunities to have children use them for analysis and design projects.

## Cricket Suicide

Tonia Bailey's third-grade class has an assortment of animals, among them a frog. During the third month of school children noticed that there were many dead crickets in the frog tank. They questioned why the frog hadn't eaten the dead crickets. Tonia saw this as the beginning of an investigation. As you saw at the beginning of the chapter, Tonia has a knack for turning a classroom problem into an analysis-and-design opportunity.

4-29: **Two environments**




First, Tonia directed children to the library. There they discovered that frogs prefer live food (mealworms or crickets were suggested). Then she led them to observe more closely. An excellent way to sharpen observational skills is through drawing. They drew the habitats of the frog and cricket. Figure 4-29 shows the essential difference: there is no water in the cricket tank and almost no dry land in the frog tank.

Further observation revealed that after a short time in the tank, the crickets' jumping landed them in the water. Clearly they could not swim. If the frog did not eat them quickly, they died and were beyond eating. The students discussed possible ways to determine the number of crickets that die at each feeding. The class decided that the crickets should be counted after feeding every other day. They chose the monitors who would do this.

Note that the children have already been involved in a miniature analysis and design project. They have done an initial analysis through a qualitative observation and determined the data that they needed. Then they designed a procedure to gather the data.

The data collection phase of the project began. On Wednesdays and Fridays the monitors fed ten live crickets to the frog, and at the end of the day counted and threw out the dead ones. They organized the data and made charts of the results.

The monitors shared the results with the rest of the class. After a brief initial discussion, the class broke into groups to discuss the problem further, and then to brainstorm possible solutions. The class gathered together to discuss the solutions of the various groups. They came up with three solutions.

Tonia writes:

**The children chose to place a piece of driftwood in the tank. Through the discussion, I was able to tell that the children understood the process. Because this was not our first *Designed Environments* project, they created a format, and I merely served as the facilitator. There was no data to collect after the solution was tried out because no crickets were found in the water.**

### Solutions to Save the Crickets

1. Place the crickets in a box and instead of placing the crickets in the frog tank, put the frog in the cricket tank. While the frog is there he can feed. Then return him to the frog tank.
2. Make a safe spot for the crickets so they won't die so fast.
3. Put a piece of wood in the frog tank so the crickets can jump on the wood.

## Designed Environments for Mealworms

Tonia Bailey began with a problem that faced the children. Angel Gonzalez (a science cluster teacher) made use of a familiar curricular unit, the behavior of mealworms, and extended it into a design project. Angel's children had already been introduced to mealworms and had carried out initial observations. Here he describes how he continued.

**I explained that in exploring animal preferences, their likes and dislikes, we would in fact be helping to determine what would go into creating an environment for a particular animal. I linked it to what zoologists must do in order to create zoo habitats for animals.**

As with many ***Stuff That Works!*** units, Angel began with brainstorming as a way of helping students recall what they already knew and to extend the applications of their knowledge. They brainstormed the sorts of things that mealworms might react to. (See Figure 4-30.)

**In exploring food preferences, I told students that it was important that they not disturb the critters because their actions could inhibit their eating habits. I also posed these questions:**

- **Do they refuse to eat because they are not hungry or because they are intimidated by the huge overbearing stature of alien-monster-students?!**
- **How long did you observe the mealworms? Do you need more time?**
- **Does the room temperature effect the animals' behavior and preferences?**

4-30: **Mealworm preferences**

### Do mealworms prefer particular...

- **Foods?**
- **Liquids?**
- **Colors?**
- **Terrain?**
- **Wet or dry areas?**
- **Temperatures?**
- **Music?**

**Students were given the freedom to choose one of these areas and develop a question and plan an exploration to find out what the mealworm preferred. During the following week, all classes explored animal preferences as a way to determine the habitat design features for a critter. I made plastic Petri dishes available with mealworms or beetles in them. These were used by those who were interested in specific food choices. Magnifiers were also available.**

**In addition to food preferences, they designed experiments to answer whether mealworms/beetles prefer:**

- **Darkness or light?**
- **The colors blue or red?**
- **Wet or dry soil?**
- **Hot or cold temperatures?**
- **Loud or low music?**

**With regard to music and temperature, I asked how would one determine whether a mealworm/beetle is showing a like or dislike of it? What body language would demonstrate a preference? Also, I mentioned the importance of doing several trials before reaching conclusions.**

Angel collected the data on animal preferences from all his classes and combined it on one large chart. During the next session they discussed the overall picture of mealworm preferences. As a final activity he asked the students to write down the five things that they would place in a mealworm zoo habitat.

During the work with mealworms, Angel's students were regularly involved in designing experiments that tested preference for heat or cold, apples or bananas, wet or dry, and other such environmental variables. Mini environments were integral to these experiments. From these little experiments, students are guided to create new environments. They can test this new environment by evaluating how the mealworms' behavior has changed in it.

## The Stories

These teacher stories present a wide range of the *Designed Environments* projects. They range from simple classroom procedures, such as ways to get coats hung up properly, to the very complex task of rearranging the cafeteria space and procedures. They range from these real life environments to the environments of games, from human environments to animal environments.

What all of these projects provide is an opportunity to be engaged in design projects that really make a difference. They are design projects that can be tested by actually living with them and seeing if we (or our animals) like them, or if the environments need further redesigning.

There are common features shared by these projects. All have deeply engaged students' interest and their energy. They have provided real-life introductions to the core processes of technology: analysis and design. In the process, the projects have provided contexts in which students can practice and develop a wide variety of skills. These go well beyond the immediate skills of technology to the skills of:

- working collaboratively in groups,
- expressing one's self to one's peers,
- writing through all stages of the project,
- using mathematics in real life contexts,
- developing responsibility for things which shape everyday life.

Chapter 3 includes activities developed from these teachers' experiences. You will find it useful to refer back and forth between the activity and the narrative, which provides images of doing *Designed Environments* with children.

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 *Designed Environments: Places, Practices, and Plans.* We've included an annotated list of quality books of all kinds on the following pages. They include storybooks that demonstrate the benefits of organizing and designing the environments we occupy and use—places and spaces as well as ways of doing things; and nonfiction books on the many facets of environmental design—human-made and nature-made—that play a role in our daily lives. But don't stop with these. You know your students and how they learn better than anyone else. 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.

*Amber Brown Wants Extra Credit*, by Paula Danziger. G.P. Putnam: New York, 1996. (Recommended grades: 3-6)

This Amber Brown adventure finds the funny, spunky girl dealing with some unexpected changes. Her room is a mess, her homework is late, and her schoolwork is suffering. Amber needs to get organized at home and in school.

*And So They Build*, by Bert Kitchen. Candlewick Press: Cambridge, MA, 1995. (Recommended grades: PreK-3)

Students explore the extraordinary world of animal behavior with descriptions of 12 astonishing animal architects and explanations of why and how they build their marvelous structures. Color illustrations show animals and insects as they work building their structures.

*Ant Cities*, by Arthur Dorros. HarperCollins Children's Books: New York, 1988. (Recommended grades: K-3)

This "Let's-Read-and-Find-Out-Science" book examines the harvester ant and introduces ant communities. Includes information on the organization of the ant community, and some of the physical characteristics of different types of ants.

*Arthur, Clean Your Room!* by Marc Brown. Random House: New York, 1999. (Recommended grades: PreK-3)

When Arthur's mother orders him to get rid of the old junk cluttering his room, Arthur decides to have a garage sale. Things do not work out exactly as he had planned.

*Be a Perfect Person in Just Three Days*, by Stephen Manes. Bantam Doubleday Dell Books: New York, 1983. (Recommended grades: 3-6)

Milo, tired of problems with his sister, parents, and classmates, finds a book in the library that promises to make him a perfect person in just three days. Is it possible?

*Being Bullied*, by Kate Petty. Barron's Educational Series: New York, 1991. (Recommended grades: PreK-2)

Rita is bullied by another girl at school, but finds relief when she stands up to her. Analyzing and redesigning the environment eliminated the problem.

*The Berenstain Bears and the Messy Room*, by Stan and Jan Berenstain. Random House: New York, 1983. (Recommended grades: PreK-3)

The entire Bear family becomes involved in an attempt to clean and organize the cub's messy room.

*The Best School Year Ever*, by Barbara Robinson. HarperCollins: New York, 1997. (Recommended grades: 3-6)

The six horrible Herdmans, the worst kids in the history of the world, cause mayhem throughout the school year until a school project called "Compliments for Classmates" changes things.

*The Big Box*, by Toni Morrison. Hyperion Books: New York, 1999. (Recommended grades: 3-6)

Because they do not abide by the rules written by the adults around them, three children are judged unable to handle their freedom, and they are forced to live in a box with three locks on the door.

*The Big Idea, Vol. 1*, by Ellen Schecter. Hyperion Books: New York, 1996. (Recommended grades: 3-6)

Eight-year-old Luz is determined to transform a vacant run-down lot into a garden like the one her grandmother had in Puerto Rico. She must now convince her reluctant neighbors to help. Cooperation and environmental design are the key to her success.

*The Boxcar Children (The Boxcar Children Series #1)*, by Gertrude Chandler Warner. Albert Whitman: Morton Grove, IL, 1989. (Recommended grades: 2-6)

The story of four orphans, Henry, Jessie, Violet, and Benny, who set out to find a safe place to live. They find an abandoned boxcar near a dump and make a home in the boxcar using junk they find in the dump. Against all odds, they do make it into a home.

*The Chalk Box Kid*, by Clyde Robert Bulla. Random House: New York, 1987. (Recommended grades: 2-6)

A new neighborhood in the poorer part of town, a smaller house because Gregory's father has lost his job, a new school, and an unhappy birthday. Gregory discovers an abandoned chalk factory behind his house and creates a fantastic chalk garden on the charred walls. As his garden grows and flourishes, something magical happens. A very different garden and a quiet friendship spring up within its walls.

*Charlie and the Chocolate Factory*, by Roald Dahl. Penguin Putnam Books: New York, 1998. (Recommended grades: 3-6+)

A magical tour where the selfish and undeserving are nastily punished and the good are sumptuously rewarded. Each of five children lucky enough to discover an entry ticket into Mr. Willy Wonka's mysterious chocolate factory takes advantage of the situation in his own way, but only Charlie Bucket follows the rules.

*City: A Story of Roman Planning and Construction*, by David Macaulay. Houghton Mifflin Co.: Boston, 1983. (Recommended grades: 4-6+ and Teacher Resource)

Text, and black and white illustrations show how the Romans planned, mapped out, and constructed their cities.

*City Green*, by Dyanne DiSalvo-Ryan. William Morrow & Co.: New York, 1994. (Recommended grades: K-4)

Marcy and Miss Rosa start a campaign to clean up a garbage-filled empty lot and turn it into a community garden. The last page gives steps to follow in creating a community or classroom garden.

*Class Clown*, by Johanna Hurwitz. Scholastic, Inc.: New York, 1988. (Recommended grades: 3-6)

Lucas is one of the smartest kids in third grade, but he's always in trouble. When he tries to change his ways, the most unexpected things happen.

*Clean Your Room, Harvey Moon!* by Pat Cummings. Simon & Schuster Children's Books: New York, 1994. (Recommended grades: K-2)

Harvey Moon's room is a mess! No cartoons until his room is absolutely spotless. Just when he thinks he's finally done, he discovers that his idea of clean is not the same as his mother's!

*Cleversticks*, by Bernard Ashley. Crown Publishing Group: New York, 1995. (Recommended grades: PreK-2)

Illustrates classroom organization in a tale of cultural integration. Ling Sung dreads going to school. There are too many things the other kids can do that he can't. Then he discovers that everyone admires his prowess using chopsticks.

*David Goes to School*, by David Shannon. Scholastic, Inc.: New York, 1999. (Recommended grades: K-3)

In his very traditional school, David is expected to follow all of the rules. But, David's activities include chewing gum, talking out of turn, engaging in a food fight, and drawing on his desk. In a punishment that fits the infraction, David redeems himself and is rewarded with praise.

*Evan's Corner*, by Elizabeth Starr Hill. Penguin Putnam Books: New York, 1992. (Recommended grades: PreK-3)

Evan's family lives in a crowded apartment too small for privacy, but Evan's mother lets him choose his own special corner. Evan maps out the room, picks a corner by the window, and fills the space with a milk crate table, a drawing, and even a pet turtle.

*Franklin Is Messy*, by Paulette Bourgeois. Scholastic, Inc.: New York, 1994. (Recommended grades: K-3)

Franklin learns it's easier to find toys when his room is neat and organized.

*Fritz and the Mess Fairy*, by Rosemary Wells. Dial Books: New York, 1996. (Recommended grades: PreK-3)

Fritz has a terrible problem keeping things neat. One evening when his science project goes wrong, the Mess Fairy appears. How can he get this genie back in the bottle?

*Games from Long Ago*, by Bobbie Kalman. Crabtree Publishing Company: New York, 1995. (Recommended grades: 3-6)

An entertaining look at the board games, parlor games, and other games that children played in the nineteenth century, including the rules, procedures, and play.

*Geography Wizardry*, by Margaret Elizabeth Kenda. Barron's Educational Series: Hauppauge, NY, 1997. (Recommended grades: 3-6+)

Introduces the world of maps and mapmaking and environmental design. Contains over 150 fun projects, maps, and experiments for junior explorers.

*George Shrinks*, by William Joyce. HarperCollins: New York, 1987. (Recommended grades: K-2)

George wakes up one morning to find he's shrunk during the night. With a new pint-size perspective of his environment, mundane chores become more exciting.

*A House Is a House for Me*, by Mary Ann Hoberman. Penguin Putnam Books: New York, 1982. (Recommended grades: PreK-3)

A lively rhyme about houses introduces all types of homes for both people and animals.

*If You Sailed on the Mayflower in 1620*, by Ann McGovern. Scholastic, Inc.: New York, 1992. (Recommended Grades 2-6)
Shows how the Pilgrims worked together and created rules to help them survive on the Mayflower and once they had arrived in a new land.

*I Like Mess*, by Marcia Leonard. Millbrook Press: Brookfield, CT: 1998. (Recommended grades: PreK-2)
Messy Tess cleans up her room to please Mom and Dad, and then begins her messy cycle again.

*It's Mine*, by Leo Lionni Alfred A. Knopf : New York, 1996. (Recommended grades: K-2)
Three selfish frogs quarrel over who owns their pond and island until a storm makes them value the benefit of sharing.

*John Patrick Norman McHennessy—The Boy Who Was Always Late*, by John Burningham. Crown Publishers: New York, 1987. (Recommended grades: K-3)
Every day, John Patrick Norman McHennessy sets off along the road to learn, and every day strange and improbable happenings make him late. His teacher never believes his stories. One day he is able to make it on time and finds an unlikely and strange thing has happened to his teacher.

*Jumanji*, by Chris Van Allsburg. Houghton Mifflin: Boston, 1981. (Recommended grades: K-3)
When a bored brother and sister are left on the own one afternoon, they find more excitement than they bargained for in a mystical and mysterious jungle adventure board game that they find under a tree. The rules are firm: once started, the game must be played to the finish.

*Just a Mess*, by Mercer Mayer. Golden Books: New York, 1987. (Recommended grades: PreK- 2)
Little Critter is forced to clean up his room in order to find his lost baseball mitt.

*The Man Who Didn't Wash His Dishes*, by Phyllis Krasilovsky. Doubleday: Garden City, 1950. (Recommended grades: 1-4)
There was a little man who kept house all alone. He liked to cook and eat but he didn't like to wash his dishes, so he stopped. The accumulating dirty dishes became a very big problem, but the man found a solution to these difficulties.

*Manners*, by Aliki. Greenwillow Books: New York, 1997. (Recommended grades: K-4)
Examples of how good and bad manners affect a child's environment and how good manners make good sense.

*Messy Bessy's School Desk*, by Patricia and Frederick McKissack, Children's Press: New York, 1998. (Recommended grades: K-3)
When Messy Bessy starts to clean up her desk at school, she assesses the condition of the desk, and cleans out the useless things. She then inspires the rest of the class to straighten their desks, as well as clean up the entire room.

*Miss Nelson Is Missing*, by Harry Allard. Houghton Mifflin Company: Boston, 1985. (Recommended grades: K-3)
The unruly kids in Room 207 take advantage of their teacher's good nature until she disappears and they are faced with a substitute, the horrid Miss Swamp. Some well behaved children start longing for Miss Nelson's return.

*More or Less a Mess*, by Sheila Keenan and Marilyn Burns. Scholastic, Inc.: New York, 1997. (Recommended grades: K-3)
Humorous, rhyming story that follows the adventure of a little girl who must clean up her room, from the pants on the dresser to the shirts on the lamp to the wet sock in the fish bowl.

*Pigsty*, by Mark Teague. Scholastic, Inc.: New York, 1994. (Recommended grades: PreK-2)
Wendell Fultz's room isn't a mess; it's a total pigsty. When the pigs move in, Wendell comes to appreciate order.

*Recycle: A Handbook for Kids*, by Gail Gibbons. Little, Brown & Company: Boston, 1996. (Recommended grades: K-3)
Explains the process of recycling from start to finish, focusing on the path of five different types of garbage—paper, glass, aluminum can, plastic, and polystyrene—and describing what happens to each of them when they are recycled into new products.

*School Days*, by B.G. Hennessy. Penguin Books: New York, 1992. (Recommended grades: K-2)
Pictures and simple rhyming text, written in someone's best printing on school penmanship paper, show how a classroom is organized.

*The Secret Life of the Underwear Champ*, by Betty Miles. Random House: New York, 1981. (Recommended grades: 4-6)
To be discovered by an ad agency looking for the perfect kid for a TV commercial is a dream come true for Larry Pryor until he discovers that the ad shooting will conflict with baseball practices and that the TV commercial is for underwear.

*Stay in Line*, by Teddy Slater. Scholastic: New York, 1996. (Recommended grades: K-3)
Combines simple math concepts in an easy to read story about twelve kids and their trip to the zoo. Structure and organization are combined with hands-on math activities.

*The Terrible Thing That Happened at Our House*, by Marge Blaine. Four Winds Press: New York, 1975. (Recommended grades: K-4)
A family works together to organize themselves to solve a problem, when the mother returns to work as a science teacher.

*Where Does the Garbage Go?* by Paul Showers. HarperCollins Children's Books: New York, 1993. (Recommended grades: K-4)
This book follows the garbage truck to the landfill to see how trash keeps piling up, to the incinerator to see how trash can be turned into energy, and then to the recycling center to see how a soda bottle can be turned into a flowerpot.

# 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.

## Educational Goals

In order to assess the learning outcomes of an activity, it is necessary to know what the educational goals were. However, the purpose of a curriculum unit may not be so clear-cut. Any worthwhile educational activity probably has more than one goal. Also, a teacher's goals may (and often do) change as the activity progresses, or there may be unintended outcomes that are far more significant than the original goals.

When Tonia Bailey planned the outcomes for "Hook Mania," she was thinking in terms of children gathering and representing data, then designing solutions to a problem and evaluating them. She hadn't thought of this as an opportunity to evaluate children's grasp of the concept of a controlled experiment. As the children discussed which solution to select, it became clear that they didn't understand the need to implement only one solution at a time, then to see if that solution worked. They would have implemented multiple solutions, then not known which one was the effective one. Tonia easily added one more goal to those for this project, and helped children better understand the notion of a controlled experiment.

Rigid adherence to an initial set of goals assumes that the educational process is entirely predictable, which is not the case. Every teacher has both short- and long-term goals for her students, and it is difficult to know in advance when something will happen to advance the long-term goals unexpectedly. As one teacher put it during a discussion on assessment, "You can talk about goals all you want, but what I really care about is that they feel good about themselves and about what they are able to accomplish."

## 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. When students talk about their ideas, they provide useful data about the learning process. This was evident in the confusion of Tonia Bailey's students in the above example.

## Curriculum as a Major Source of Assessment Data

In order to maximize the amount of information available, the curriculum itself must be seen as a rich source of assessment data. As children discuss their ideas and carry out projects, they reveal their strengths and weaknesses more clearly than they do through more formal assessment devices. When Mary Flores' class reviewed the "Peek-a-Boo I'm Watching You" worksheet, she discovered her children did not know what it meant to "collect and record data." The ensuing discussion helped clarify the differences among collecting, recording, and portraying data. When Tonia Bailey's children prepared reports of their study of "Chairs Up and Chairs Down," she saw the extent to which they could use their math skills in communicating their ideas. Virtually any activity associated with a curriculum unit can provide insights to children's command of knowledge and skills. Brainstorming sessions, scavenger hunts, design activities, presentations to the class, journals, and discussions within a work group are all potential sources of assessment information.

## 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, and the outcomes of assessment often have high stakes. Both of these factors contribute to the view of assessment as an antagonistic process. How can students gain access to candid data about their own learning without interpreting it as somehow the produce of bad intentions?

A way out of this dilemma is suggested by some of the activities in Chapter 4. Technological analysis and design activities often provide occasions for self-assessment, where students evaluate their own work against an objective standard, rather than one arbitrarily set by adults. As part of their design of games, Minerva Rivera's class developed instructions for their new games. They evaluated one another's instructions by whether they could follow them. Tonia Bailey's class discussed each group's solutions to the problem of cricket drowning. As a group they were able to evaluate the solutions and select the best one.

Part of the attraction of teaching is that much of what happens in the classroom is unpredictable, and some of the surprises are pleasant or 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. After Felice Piggott's class completed a major classroom mapping project, they wanted to continue with an even larger project that would extend beyond their classroom. When children want to continue and expand upon prior work, it is an evaluation of the extent to which that work is internalized and valued.

## Assessing the 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 many 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 appear in the teachers' stories in Chapter 4. Tonia Bailey captures the essence of these when she writes of her children solving the "Cricket Suicide" problem: "The children chose to place a piece of driftwood in the tank. Through the discussion I was able to tell that the children understood the process. Because this was not our first environmental analysis and design project, they created a format, and I merely served as the facilitator." Here is testimony to teaching that has empowered children.

# 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 new program, particularly one such as *Designed Environments,* which 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 club house 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 ed 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 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. Here are some methods that have worked.

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.

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 ***Stuff That Works!*** 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);
- *Standards and Principles 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
- *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 1970's, 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, such as the one quoted above.

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 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 above 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 a positive feeling 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 remainder 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 of the *Standards,* "Can you Help Mike Mulligan?", is based on a literature connection rather than on problems that arise from children's lives.

*Designed Environments: Places, Practices, and Plans* provides numerous examples of how younger and older children can become involved in solving problems from their own environment. They brainstorm about problems and issues that concern them, develop solutions in collaborative groups, and evaluate them. The problems range from finding a way to limit classroom interruptions to redesigning lunch schedules and lunchroom furniture to reduce waiting times, litter, and confusion in the cafeteria. By solving problems such as these, children develop an understanding that they themselves can design solutions to a problem.

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 ***Stuff That Works!*** 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. The *Benchmarks* draw 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. *Benchmarks* recast 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* present 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.

In the chapter "Common Themes," *Benchmarks* identifies several "big ideas" that recur frequently in science, mathematics, and technology, and are powerful tools for explanation and design. One of these themes, **systems**, is at least as important in technology as in science, and is squarely addressed by work with social systems found in *Designed Environments: Places, Practices, and Plans.* The section on systems begins, "One of the essential components of higher-order thinking is the ability to think about a whole in terms of the sum of its parts and, alternatively, about parts in terms of how they relate to one another and to the whole." (p. 262) The section goes on to point out that these ideas are difficult, and learned only through studying progressively more complex examples. The social systems analyzed and designed in *Designed Environments: Places, Practices, and Plans* represent such complex examples. A major theme in the chapter on "The Nature of Technology" is Design and Systems. "Perhaps the best way to become familiar with the nature of engineering and design is to do some. By participating in such activities, students should learn how to analyze situations and gather relevant information, define problems, generate and evaluate creative ideas, develop their ideas into tangible solutions, and assess and improve their solutions." (p. 48)

Processes similar to those advocated above characterize most of the activities in *Designed Environments: Places, Practices, and Plans.* For example, in "Classroom Procedures" the teacher helps students to identify a classroom problem, usually resulting from procedures that are not working well. The students then collect data to further define the nature and extent of the problem. They describe what an improved situation would look like, develop plans for a better classroom procedure, then select the new procedure they think is best. After it has been in place for a while, the new procedure is assessed.

Through a design process such as that seen in "Classroom Procedures" students begin to see the interconnectedness that typifies a social system: when procedures are changed, different results follow; different enforcers result in differences in the extent to which procedures are followed.

In its chapter on "Human Society," *Benchmarks* recommends that children also learn about social structures first-hand: "Students can begin by finding out what the rules are in different classrooms and families, observing how children respond to the rules and recording their findings." (p. 154) A similar suggestion appears in the *National Standards for Social Studies Teachers:* "Teachers of the early grades can introduce learners to civic ideals and practices through activities such as involving them in the establishment of classroom rules and expectations." (NCSS, 1997, p. 24) Analysis and redesign of classroom rules are a major component of *Designed Environments: Places, Practices, and Plans.*

As they test alternative designs, whether for cafeterias, furniture arrangements, or classroom procedures, students find it necessary to collect data and make judgments based on evidence, not opinion. These analysis and design activities lead to important "habits of mind": "By the end of second 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) By comparing one another's designs and using data to assess them, they develop "critical response skills": "By the end of second grade, students should ask 'How do you know?' in appropriate situations and attempt reasonable answers when others ask them the same question." (p. 298)

## 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)

More specifically, Content Standard E, "Science and Technology." strongly supports the approach of ***Stuff That Works!*** Although this standard focuses on the study of mechanical systems such as zippers or can openers, it also recognizes the value of the types of activities found in *Designed Environments: Places, Practices, and Plans:* "It is important also to include design problems that require application of ideas, use of communication, and implementation of procedures—for instance improving hall traffic at lunch and cleaning the classroom after scientific investigations." (p. 137)

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)

A central theme of *Designed Environments: Places, Practices, and Plans* is that teachers should involve children in both analyzing and designing aspects of the classroom environment, although these tasks have traditionally been reserved for teachers. These aspects include the physical arrangement of the space, as well as the schedules followed, and the rules and practices that govern behavior. The "Teaching Standards" section of the NSES makes the same point:

> "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, which 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.

*Designed Environments: Places, Practices, and Plans* involves students in identifying real problems in their own immediate environments and in designing and testing solutions to these problems. In the course of these activities, they have to decide what kind of data to collect, and how to analyze it, both in order to explore the problem and also to evaluate their solutions. This process of problem formulation, data collection, and analysis is advocated by the NCTM:

> "The Data Analysis and Probability Standard recommends that students formulate questions that can be answered using data and addresses what is involved in gathering and using data wisely. Students should learn how to collect data, organize their own or others' data, and display the data in graphs or charts that will be useful in answering their questions. This Standard also includes learning some methods for analyzing data and some ways for making inferences and conclusions from data." (p. 48)

In the context of *Designed Environments: Places, Practices, and Plans,* students have a powerful stake in learning these processes well, because the problems they are attempting to solve are *their* problems.

## 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 using visual language, 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:

- 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.
- The activities in *Designed Environments: Places, Practices, and Plans* engage students in identifying problems in their own classrooms and schools, and in proposing, testing, and evaluating their own designs for solving these problems. Each of these endeavors requires extensive use of language in a group setting to accomplish purposes of real importance to the children.

*Designed Environments: Places, Practices, and Plans* engages students in recognizing soluble problems in their classroom and school environments and in designing and testing ways to organize things better. Many of these problems deal directly with the use of language, such as designing a way to answer the classroom telephone that limits the amount of interruption. Others have to do with the rearrangement of space in the classroom, rescheduling cafeteria time for better traffic flow, redesign of games, and reorganization of storage space. Each of these design projects requires considerable discussion, as well as more formal oral, written, and graphic presentations.

First, students identify the problem they want to solve, either through a brainstorming session or because it is already an obvious concern. Next they decide on the kinds of information they need to understand the problem better. At some point, they brainstorm about the criteria that a successful design would have to meet; in other words, what the design would have to do in order to solve the problem. Subsequently, they meet in small groups to come up with possible solutions. The whole class then selects a solution to implement, usually by merging some of the proposals from the groups. The students subsequently implement this design and collect data to see how well it meets the criteria.

Each of these steps engages students in using "spoken, written, [or] visual language to accomplish their own purposes." (ELA Standard #12, p. 45) The purposes are genuinely the students' own, because the design projects address problems they themselves have raised. To accomplish their goals, they have to brainstorm about the criteria the design should meet, how to collect data, and how to test the design. They have to negotiate with one another to come up with a solution everyone can accept. They have to present their ideas to one another, and sometimes to school administrators, in written, oral, and graphic forms. *Designed Environments: Places, Practices, and Plans* activities are problem-driven and social, and provide rich opportunities for developing language proficiency.

## *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 1990's major standards-setting efforts were underway for civics, economics, geography, and history. In an effort to provide a framework for these separate disciplinary standards, the National Council for the Social Studies (NCSS) issued *Expectations of Excellence: Curriculum Standards for Social Studies* in 1994. 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: students 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* (1997) 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 *Standards* outline five basic "Principles of Teaching and Learning." To begin with, these 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." (NCSS, 1997, p. 35)

***Stuff That Works!*** offers these sorts of opportunities, particularly through the guide *Designed Environments: Places, Practices, and Plans,* but also via activities in *Packaging and Other Structures* and *Signs, Symbols, and Codes.* In these activities, students begin with problems of real concern to them: lack of storage space in the classroom; the need to stop children from running on the stairway; frequent classroom interruptions; congestion and long waiting times in the cafeteria. To understand a particular problem better, they need additional information. Research questions might include: How much space do we have in the classroom that we could use for storage? What are the sources of the interruptions? How long do children actually have to wait in the cafeteria? How do these waiting times vary with the menu, time of day, or day of the week?

Having collected and analyzed some data, students then try to come up with solutions to one of the problems they have identified. Of course, everyone has a different idea about what would work best, and the students have to negotiate these differences. In evaluating alternative designs, they need to refer to the original design criteria. Any real design must solve more than one problem and satisfy more than one criterion. Therefore, conflicts naturally arise about which criterion is most important. Ultimately, the answer must be based on values, which are weighed in examining trade-offs. By designing solutions to their own problems, students gain meaningful experiences in democratic decision-making.

Felice Piggott's cafeteria redesign project, 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 related to the cafeteria. They noted, for example, that there was food all over the floor, because children trying to throw out their garbage bumped into students who were first waiting on line to be served.

The next phase of the project was to collect data, both qualitative and quantitative, about how the space was used and organized. For this purpose, the class divided into four groups: the Traffic Team, the Food Service Team, the Garbage Team, and the Seating Team. In the course of these investigations, Felice encouraged them to distinguish between their observations and their opinions. After several weeks of collecting and organizing data, each team came up with its recommendations for improvement. For example, the Garbage Team suggested that there be an additional tray carton for soiled trays, better access to the garbage, and staff available to keep the garbage areas clean.

Each group constructed a map showing how its recommendations would look in the physical space. In examining these maps and reflecting on their proposals, students realized that some of them weren't practical, and they made further revisions. Finally, the students made a formal presentation of their ideas to the Assistant Principal, who agreed to let them implement nearly the entire plan! Through their own activity, these students learned first-hand about their power to solve problems responsibly and democratically. (See Chapter 4, pp. 108-115.)

# REFERENCES

## Chapter 2

Allen, Edward. ***How Buildings Work: The Natural Order of Architecture.*** New York: Oxford University Press, 1980.
This is a very accessible account of building systems, including plumbing, electrical systems, heating, cooling and ventilation, waste control, "fitting buildings to people," and much more. The illustrations are particularly good.

American Association for the Advancement of Science. ***Benchmarks for Science Literacy.*** New York: Oxford University Press, 1993.
A comprehensive statement by Project 2061 of science education goals for K-12. Chapters on "The Nature of Technology" and "The Designed World" are included.

Benenson, Gary. "The Unrealized Potential of Everyday Technology as a Context for Learning." ***Journal of Research in Science Teaching,*** 38:7, September 2001.
An analysis by the director of the City Technology project of ways in which everyday design projects support broad and deep learning across the curriculum.

Clay, Grady. ***Close-Up: How to Read an American City.*** New York: Praeger Publishers, 1973.
An entertaining look by a journalist at public urban space, including how turf is defined, how sinks form, and the evolution of commercial strips.

Dargan, Amanda and Zeitlin, Steven. ***City Play.*** New Brunswick, NJ: Rutgers University Press, 1990.
A history of how children have appropriated city space for play and created their own play activities. It is full of photographs and short quotations documenting the history of play, particularly in New York City.

Department of Education and Science (UK). ***Design and Technology for Ages 5 to 16.*** York, UK: Author, 1989.
An extensive summary of the British National Curriculum in Design and Technology, including examples of what children should learn at each level about both process and content.

Fitch, James Marston. ***American Building: Vol. 2, The Environmental Forces That Shape It.*** Boston: Houghton Mifflin Co., 1972.

Fitch is an architect who pleads with his colleagues to design buildings for more than visual impact. A building is a shield between humans and the outdoor environment, and must meet a whole variety of sensory and metabolic needs.

Gilligan, Carol. ***In a Different Voice: Psychological Theory and Women's Development.*** Cambridge, MA: Harvard University Press, 1982.

Based on research and rooted in common sense, Gilligan's analysis of female moral development causes us to look differently at all human development.

Givoni, B. ***Man, Climate and Architecture*** (Second Edition). New York: Van Nostrand Reinhold, 1981.

A fairly technical book, which focuses both on the human physiological response to environmental factors and the role of buildings in meeting human needs.

Graves, Ginny. ***Walk Around the Block.*** Prairie Village, Kansas: Center for Understanding the Built Environment, 1992.

A compendium of one-page curriculum ideas for looking at buildings, city blocks and neighborhoods, mapping, exploring environmental issues, and taking action. The intended audience is upper elementary and junior high school levels.

Hall, Edward T. ***The Dance of Life: The Other Dimension of Time.*** New York: Anchor Books, 1989.

This book reveals many of the subtle assumptions built into different cultures about the handling of time. Much of it compares the handling of time in European and non-European societies.

Hall, Edward T. ***The Hidden Dimension.*** New York: Anchor Books, 1990.

This is Hall's groundbreaking account of spatial behavior, originally published in 1966, which established the field of proxemics. Hall discusses territorial behavior in animals and humans, and considers the ways in which different cultures handle space.

Halprin, Lawrence. ***The RSVP Cycles: Creative Processes in the Human Environment.*** New York: George Braziller, 1970.

The author, an architect, uses the musical score as a model for producing "scores" or schedules to describe and/or plan a wide variety of activities and events. This book is very broad in scope and offers a wealth of ideas for expressing schedules.

Hart, Roger. ***The Changing City of Childhood: Implications for Play and Learning.*** New York: The City College Workshop Center, 1986.

Hart argues that modern cities and changes in society have robbed most children of opportunities to create and learn from their environments.

Hart, Roger. "Children's Participation in Planning and Design" in C. Weinstein and T. Davids (eds.), ***Spaces for Children.*** New York: Plenum, 1987.

Hart presents theory, research, and practice that relate to children constructing environments for their own use.

International Technology Education Association. ***Technology for All Americans: A Rationale and Structure for the Study of Technology*** (draft). Reston, VA: Author, 1995.

Preliminary effort to define what all students should learn about technology.

Kunstler, James Howard. ***The Geography of Nowhere: The Rise and Decline of America's Man-Made Landscape.*** New York: Simon & Schuster, 1993.

This book is partly a history of the takeover of our landscape by the automobile, and partly an examination of the social, economic, and environmental effects. The final chapter suggests ways to design more livable cities.

National Research Council. ***National Science Education Standards.*** Washington: National Academy Press, 1996.

The most authoritative statement to date of what the goals of K-12 science education should be. Each set of content standards, for grades K-4, 5- 8, and 9-12, respectively, contains a section on "Science and Technology."

New York State Education Department. ***Learning Standards for Mathematics, Science and Technology.*** Albany, NY: Author, 1996.

A curriculum standard which develops a paradigm for integrating math, science, and technology from K-12.

O'Connor, Maura and McGlauflin, Kathy. ***Living Lightly in the City: An Urban Environmental Education Curriculum Guide.*** Milwaukee: Schlitz Audubon Center, 1990.

This loose-leaf book includes teacher information and activity sheets for introducing global and local environmental issues in the upper elementary grades. The teacher information is in the form of lesson plans.

Olgyay, Victor. ***Design with Climate: A Bioclimatic Approach to Architectural Regionalism.*** New York: Van Nostrand Reinhold, 1992.

A classic work, originally written in 1963, which shows architects how to take account of sun and wind patterns in creating energy efficient designs. This book has a wealth of information about the effects of climate on buildings and people.

Sommer, Robert. ***Design Awareness.*** San Francisco: Rinehart Press, 1972.

Sommer develops his ideas on the roles consumers should play in the design and management of their environments. He then provides ways to assess existing designs and use the resulting information to develop new and better designs.

Sommer, Robert. ***Personal Space: The Behavioral Basis of Design.*** Englewood Cliffs, NJ: Prentice-Hall, 1969.

A social psychologist's survey of empirical research on how people use space. Included are studies of where students sit in libraries, use of territorial markers to define personal space, and how people react to invasions of their space.

Vergara, Camilo José. ***The New American Ghetto.*** New Brunswick, NJ: Rutgers University Press, 1995.

A beautiful but very disturbing book of photographs and text documenting the decline and abandonment of inner cities over the last twenty to fifty years. Through individual photos and sequences, Vergara shows how once proud, vibrant cities have been reduced to rubble, overgrown, or converted to marginal uses.

Whyte, William H. City: ***Rediscovering the Center.*** New York: Anchor Books, 1990.

Whyte is a well-known sociologist who has done extensive studies of how people use public urban spaces, including streets, sidewalks, and plazas. In part, this book is an account of his research; in part it is a plea for restoring cities to their historic role as public gathering places.

Wilson, Forrest. ***A Graphic Survey of Perception and Behavior for the Design Professions.*** New York: Van Nostrand Reinhold Co., 1984.

A compendium of information about human behavior that is relevant to architecture and interior design.

# Chapter 6

American Association for the Advancement of Science. (1989) ***Science for All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics and Technology.*** Washington, DC: Author.

American Association for the Advancement of Science. (1993) ***Benchmarks for Science Literacy.*** New York: Oxford University Press.

American Association for the Advancement of Science. (1997) ***Resources for Science Literacy.*** New York: Oxford University Press.

American Association for the Advancement of Science. (1998) ***Blueprints for Reform.*** New York: Oxford University Press.

American Association for the Advancement of Science. (2001) ***Designs for Science Literacy.*** New York: Oxford University Press.

International Technology Education Association. (1996) ***Technology for All Americans: A Rationale and Structure for the Study of Technology.*** Reston, VA: Author.

International Technology Education Association. (2000) *Standards for Technological Literacy: Content for the Study of Technology.* Reston, VA: Author.

National Center on Education and the Economy. (1997) *New Standards Performance Standards; Vol 1: Elementary School.* Washington, DC: Author

National Council for the Social Studies. (1994) *Expectations of Excellence: Curriculum Standards for Social Studies.* Washington, DC: Author.

National Council for the Social Studies. (1997) *National Standards for Social Studies Teachers.* http://www.social studies.org/standards/teachers/standards.html

National Council of Teachers of English and International Reading Association. (1996) *Standards for the English Language Arts.* Urbana, IL: Author.

National Council of Teachers of Mathematics. (1989) *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2000) *Principles and Standards for School Mathematics.* Reston, VA: Author.

National Research Council. (1996) *National Science Education Standards.* Washington, DC: National Academy Press.

# Designed Environments
## Places, Practices & Plans

**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*

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- introduce the fundamental theme of environments as complex systems that are designed and evaluated
- provide a broad view of technology and its role in everyday life
- demystify technology design
- develop process skills in observation, data collection, categorization, problem identification, data organization and presentation, design, and evaluation
- encourage communication and group work
- promote awareness of problems in the immediate environment and responsibility for solving them
- foster a sense of control in relation to everyday problems.

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