READING, WRITING, & DISCUSSION IN EVERY DISCIPLINE

PREPARED FOR THE
READING & WRITING FOR CRITICAL THINKING PROJECT

GUIDEBOOK III

Charles Temple, Jeannie L. Steele, and
Kurtis S. Meredith

The authors gratefully acknowledge the insights, support, and encouragement of Elisabeth Lorant in the design and elaboration of this project.

This manual was prepared for use in conjunction with the Reading & Writing for Critical Thinking (RWCT) project, which is a joint offering of the International Reading Association and the University of Northern Iowa, with sponsorship by George Soros's Open Society Institute and the national Soros Foundations. Co-directors of the RWCT project are Jeannie Steele, University of Northern Iowa; Kurt Meredith, University of Northern Iowa; Charles Temple, Hobart and William Smith Colleges; and Scott Walter, International Reading Association.

This guidebook is intended as supplement to an interactive course. It is not intended for general distribution without an accompanying course presentation. It is intended as a guide for educators participating in the RWCT project who are being prepared to deliver workshops/courses to fellow educators.

CONTENTS

PART I COURSE INTRODUCTION

This course builds on the first two RWCT courses by taking the Evocation/Realization of Meaning/Reflection framework for active learning and critical thinking and applying it to topics in the content areas, especially topics in the humanities and social sciences, but also studies in the natural sciences. Along the way, we introduce a variety of teaching methods for helping students learn at every phase in the framework. The instructional model that forms the backbone of this workshop should be comfortably familiar to the participants by now; nonetheless, they will read about many new teaching techniques here, and these techniques provide new possibilities for tailoring the model to fit a variety of subjects and circumstances.

Note that the methods presented in the body of this guidebook relate to teaching with texts. Applications of the core strategies of RWCT, particularly in the area of science instruction, are found in Appendix A of this guidebook.

Expected Outcomes

At the conclusion of the workshop, it is expected that the participants will

- become comfortably adept at teaching with the Evocation/Realization of Meaning/Reflection model;
- acquire a broad repertoire of strategies that may be used to encourage learning at every phase of the model, so that they will be able to adapt the model to lessons of different scope and for children at different maturity levels; and
- form concrete plans to try the methods practiced in the workshop in their own teaching.

Course Structure and Timing

This course is intended to develop the participants' competence in active teaching for critical thinking across the curriculum. Experience has shown that when we are dealing with instructional approaches, it is advisable to do activities first, and to delay most of the discussion about those approaches until the participants have a base of experience from which to talk about them. The workshop, therefore, begins with a mini-

mum of preamble, and then takes the participants directly into an extended series of reading and discussion exercises.

It is important to reassure the participants, though, that the activities presented here have a strong theoretical basis. You may want to spend a few minutes at the beginning of the workshop explaining that although we will sometimes be talking about explorers and environmental problems, our ultimate aim is to examine methods of pedagogy that promote active learning and critical thinking. Also, you may want to refer your students to the monograph *How Children Learn: A Statement of First Principles* (Temple, Meredith, & Steele, 1997), in which they will find a discussion of the theoretical and research traditions underlying these methods.

The session begins with a *demonstration activity*. This is followed by a *debriefing*, in which participants explore their reactions to the activities, and the steps and procedures are explained in more detail. Then comes another *demonstration*, followed by another *debriefing*. Following that, participants are introduced to many *teaching strategies* arranged according to the phase of the Evocation/Realization of Meaning/Reflection framework that they address. Then comes an opportunity for *guided practice*, giving the participants opportunities to plan and carry out with one another lessons that use several of the strategies introduced. *Texts* are included in Appendix B of this manual that can be used by the participants in planning and "microteaching" their lessons. There are provisions *planning for implementation*, during which the participants should think carefully about ways they could adapt these teaching methods to their own circumstances, and to make specific plans to do so. You should ensure that participants and those who will be assisting them have clear expectations and assignments for the interim meetings. Finally, *it is important that everyone participating carry out an evaluation of the workshop session.*

The course is divided into five parts.

Part I: Brief Introduction to the Course

1. General introductory activities to be decided by workshop presenters.
2. Introduction of the workshop, describing what will happen during the workshop.

Part II: Demonstrations and Discussions

1. First lesson: A reading/discussion activity
   a. Debriefing the lesson
2. Second lesson: A listening/discussion activity
   a. Debriefing the lesson

Part III: Elaboration of Teaching Methods

1. Methods for use in the evocation phase.
2. Methods for use in the realization of meaning phase.
3. Methods for use in the reflection phase.
4. Further methods for using writing to learn.

Part IV: Guided Practice

1. Participants plan at least one lesson in small groups, with the guidance of the presenters.
2. Participants "microteach" the lesson with other participants.

Part V: Planning for Implementation

1. Participants develop a specific plan for implementation, including setting a date for initial implementation and determining a time for follow-up discussion with the group.
2. After the close of this workshop, participants will use some combination of the workshop techniques, recording student responses and their own questions for discussion at follow-up meetings.

Post-Workshop: Planning for Follow Up

The participants will meet approximately once each month between the in-country visits of the volunteers. Some time should be spent going over the plans for these meetings with all the participants, but especially with the people who will be expected to facilitate them.

Schedule of the Course

This short course is scheduled to run 10 to 12 hours or longer. It can be combined with another short course—most logically with the course presented in Guidebook IV—and the two of them together might be presented in a session lasting 4 to 5 days. The timing of activities may be handled several ways. The following is a model for a 4-day workshop in which two courses are presented:

Day 1 (a.m.)	Warm-up activities and preview of the workshop. Discussion of participants' implementations of strategies from the previous workshop.
(a.m.)	First demonstration and debriefing of lesson from Guidebook III.
(p.m.)	Second demonstration and debriefing of lesson from Guidebook III. Focus on further methods for the *evocation* phase, the *realization of meaning* phase, and the *reflection* phase.
Day 2 (a.m.)	Guided practice of lessons using these methods.
(p.m.)	Demonstration lessons, debriefing, and guided practice of techniques from another course (for example, Guidebook IV).
Day 3	Continued demonstration lessons, debriefing, and guided practice of techniques from the other course.
Day 4	Formulating and sharing plans for implementation (including strategies from Guidebook III and the other short course together). Evaluation of the Workshop

Materials Needed for the Workshop

The workshop just described needs relatively few materials. The most pressing need will be for copies of texts in both languages. You will also need a chalkboard and chalk, or chart paper and markers. You also may need an overhead projector and marking pens. Also, take along about 200 blank index cards to use for the daily monitoring.

Key Terms for Careful Translation

Note that many sessions will be translated from English into the local language and back. Moreover, it is likely that more than one translator will be employed. Careful translation is important throughout, but accurate translation of key terms is absolutely essential. Often translation of terms is made difficult when no exact matching terms exist in the two languages. Thus, it is essential that in advance of each workshop you "calibrate" your terms by showing the translators the list of terms found in the glossary in the back of this guidebook, and discuss the terms in English until the translator is satisfied he or she has a closely matching term for it. You also should take a minute and add to the list any other terms you know you will use repeatedly.

The translator should write down all of these terms, not only to aid memory, but also so they can be shared with any other translators who may have a role in the project. In time you may come to use these terms yourself, both to save time and to build bridges of understanding with your in-country counterparts.

Evaluation of the Workshop

Evaluation and monitoring of all of our activities helps us keep our work on track, and also gives us the information we need to make the courses better suited to the needs of the participants. You should plan to set aside time at the end of each day to carry out daily monitoring of the day's activities. You also should plan to conduct an evaluation at the end of the session.

Daily Monitoring

Leave 5 minutes at the end of each day for all participants to answer three questions on index cards, which you will distribute to them. People should sign their names. Explain that these are not test questions; there is no right or wrong answer. The questions are intended, rather, as a way for each participant to communicate with you. It's a good idea to have your translator write these questions on the chalkboard or overhead projector.

1. What, in your opinion, were the most important concepts discussed today?
2. What questions do you have at this point in the workshop?
3. Make any general comment you wish to make.

You will want to read these before the next class gathering, of course. It is a good idea to begin the next session with the comments and answers to the questions.

Final Evaluation

At the conclusion of the workshop, you'll need to set aside time for two kinds of evaluations. One is a free write. The other is the completion of an evaluation form.

Free write. Distribute paper to the participants. Ask them to write for 10 minutes without stopping about the workshop they completed. It would be a good idea for your translator to write the following question on the chalkboard or transparency: What is in your mind right now about the workshop you just completed?

Evaluation form. Distribute the evaluation form on the next page and ask the participants to complete it.

Evaluation of the Workshop

Name of Workshop:

Date and place:

Questions:

1. What in the workshop was most valuable to you?

2. To what extent did this workshop meet your expectations?
   1 2 3 4 5
   very little met all expectations

3. What would have made this workshop more meaningful?

4. What will change in your teaching as a result of this workshop?

5. What was your overall impression of this workshop?
   1 2 3 4 5
   little value great value

5. Suggest topics you would be interested in discussing in future workshops.

6. Please make any general comments on the workshop.

PART II DEMONSTRATION LESSONS

Session Introduction

It is suggested that the workshop begin with a brief preview of what is to follow. The session will begin with two demonstrations. The first demonstration lesson introduces a reader response approach, using a dual entry diary. The second lesson is a listening/discussion exercise with the enhanced lecture model, in which questioning and discussion are introduced in a lecture format. In its own way, each lesson exemplifies the constructivist teaching model we have named Evocation/Realization of Meaning/Reflection. The Evocation/Realization of Meaning/Reflection model is a highly serviceable construct. It is based on sound learning theory. It is specific enough to guide daily lessons, but open enough to apply to a range of topics and purposes. We introduce the model again here so that participants get the opportunity to become practiced with it.

The two lessons are meant to serve as models of teaching strategies that may be used with some amount of adaptation in the participants' own classrooms. Following the demonstration lessons, there will be opportunities to discuss the activities and to carefully consider the teaching procedures that were used.

As they take part in these lessons, the participants should attend on two levels. On one level they should engage the lessons just as a student would. On another level, they should be mindful of what their teachers are doing, and try to be aware of the instructional outcomes of the teaching methods.

Lesson 1: A Reader Response Discussion

Introduction to the Workshop

If one of our goals in teaching is to help students find personal connections to what they are learning, then we should at least occasionally use reader response techniques. Reader response techniques encourage students to reflect on what the material they read or study means to them personally, what in their lives they associate with it, and how it affects their view of the world or makes them feel. In general, the questions asked in reader response questions take the following form:

1. What did you notice?

2. What did it make you think of?
3. How did it make you feel?

Think/Pair/Share

Ask the participants to pair up. One partner should write for 4 minutes about this topic:

> Describe an occasion when you had an unhappy experience with a bureaucrat.

The other partner should write for 4 minutes about this topic:

> Describe a time when you were doing a job and had an unhappy experience with a patron.

When they have finished writing, the pairs should share the experiences with each other. Call on two pairs (but not more) to share their experiences with the whole group.

Now tell the participants that they are about to read a poem involving a patron and a worker in a social welfare agency. As they read the poem, they should take notes, according to the dual entry diary technique (Berthoff, 1981).

Dual Entry Diary

Explain that in order to make a dual entry diary, the participants should draw a vertical line down the middle of a blank sheet of paper. On the left-hand side they should write a passage or image from the text that affected them strongly. Perhaps it reminded them of something from their own experience. Perhaps it puzzled them. Perhaps they disagreed with it. Perhaps it made them aware of the author's style or technique.

On the right-hand side of the page they should write a comment about that passage: What was it about the quote that made them write it down? What did it make them think of? What question did they have about it?

Have them read the poem and make diary entries. Refer the participants to the poem, "As Best She Could," found in Appendix B. Ask them to read the poem, pausing to make at least four entries in their dual entry diary. After they have finished, they may go back through the poem

and make more notes about it. The reading, along with making diary entries, may take 20 minutes. The workshop leader, too, should read and write comments during this time.

After the reading, ask for comments. Ask volunteers to share their comments in the order they appeared in the text, beginning with those that dealt with the earliest part of the poem.

When you hear a comment on a passage, ask follow-up questions: "Why do you think that passage caught your attention? What was it making you think of?"

Ask if others noted the same passage, and, if so, to share what they wrote about it. Point out when there are similarities and when there are differences in participants' responses. Follow these by asking "Why?"

Finally, share one or two of your own comments, too. Make these personal, but not authoritative; you're sharing as another reader, and your contribution should encourage others to speak and should not intimidate or discourage them.

Ask a few "generic" questions. The discussion may develop adequately from the participants' own observations, particularly if you draw them out and link their observations to other people's comments. However, it usually helps to ask a few "generic" questions about the text. One advantage of the generic questions is that they ask students to think over the text as a whole. Another is that you can ask the same set of questions each time, so students will come to expect them, and will get more adept at thinking in the ways the questions ask them to.

You won't want to ask all of these. Just choose three or four that seem most appropriate.

Ask about the meanings.

What will you remember about this material?

What were you thinking while reading?

What is the most important message in this material?

What questions did the material leave unanswered?

Ask about the text as a piece of writing.

If you rewrote this, what would you change?

Is the material unique? Why?

Ask about the author's craft.

How did the author hold your attention?

How did the author signal important information?

How did the author develop his or her ideas?

(Questions are adapted from Moore, Moore, Cunningham, & Cunningham, 1994, pp. 49–50.)

Returning to Think/Pair/Share

Invite the participants to recall the experiences they discussed in the think/pair/share activity that began this lesson. What did their experiences, either as patrons or as "officials," have in common with what happened in the poem?

Ten-Minute Free Write

After the discussion is finished, ask the participants to write freely for 10 minutes about what is on their minds at that moment about the poem. If there is time, ask volunteers to share several of these free writes with the whole group.

Unpacking the Activity

Ask for Holistic Responses

Ask the participants how they are feeling now, having finished this discussion. Ask how they felt as learners in this activity, about their feelings of involvement and the effect of their involvement on their interest in the material. Invite them to compare their experience with the dual entry diary with other discussion methods. (Be prepared if this approach turns out to be very new to some people—in some places, sharing personal opinions and feelings may have seemed foreign to the educational enterprise.) What was gained by this method? What was given up?

Go Back Through the Steps of the Procedure

Recall together the way the activity began: The participants were first asked to recall some personal experiences that were relevant to the topic of the poem, namely an encounter between a patron and an official.

Then they were invited to read the poem and to write comments in a dual entry diary as they read. (Discuss the kinds of comments they were invited to write down.)

Following the reading, the participants were invited to share their responses, going through the text chronologically. The workshop leader shared some of her responses, too, but she mostly played the role of drawing out participants' contributions, encouraging reflection on their responses, and calling forth engagement with one another's ideas.

The workshop leader went on to raise some generic reader response questions, but tried to keep the discussion almost conversational, as the initiative was largely maintained by the participants rather than by the workshop leader's direction. Ask the participants to reflect on the way the workshop leader handled the discussion. It may arise that the workshop leader was practicing certain "moves" or strategies to keep the discussion moving and keeping it student centered, such as avoiding an authoritative tone, asking real questions about what people thought or felt, steering participants to comment on one another's ideas, using nonverbal signals, and allowing silences or *wait time* to occur. (Make a note at this point to refer them to the suggestions found on pages 34-35 for conducting lively discussions.)

Before the end of the lesson, the participants were asked to compare their personal experiences of encounters between patrons and officials with the events of the poem, "As Best She Could." The lesson concluded with a 10-minute free write about the poem.

It will now be useful to ask the participants to decide which of the activities served as an evocation activity, which was a realization of meaning activity, and which was a reflection activity.

Points for Special Attention

Reader response techniques can successfully draw forth strong responses from students that can lead to rich discussions. They will work more effectively, however, if you observe these concerns:

1. *You may need to demonstrate the kinds of responses you are after.* If students (or participants) are used to providing abstract, academic answers to questions, that is likely to be what they will give you the first few times you ask these questions. It will help if the workshop leader begins with a personal response, such as "That story reminds me of an old man who lived in our neighborhood

when I was young. I was afraid of him. I didn't understand at the time that some older people are uncomfortable around children."

2. *You may need to pull the discussion back to the text.* For example, if a *participant* had given a response like the one just mentioned, the workshop leader would want to allow the participant to explore the association, but would want the discussion to come back to the text. Thus the leader might say, "I wonder what was in the story that reminded you of that old man."
3. *Be aware of and cultivate respect for differences.* Students (and workshop participants) will be struck by different parts of the text, and those parts will strike them in different ways. Occasionally this will arise from a misreading, but more often the reaction will be caused by differences in experiences and interests. You can accentuate the differences by making a statement like, "Interesting. *She* thought the most moving part was X; but *he* thought it was Y," and then pausing for other participants to comment.

   You might also explore these differences, too. You could say "I wonder why you chose different parts. Maybe there was an experience you've had, or another book you've read, that made you respond the way you did."

4. *Be careful not to "correct" participants' responses.* Sometimes, students can produce responses that seem bizarre—yet once we know the context of their experiences, the responses make sense. For example, one second-grade boy read a story about a child who lived alone in a Roma caravan with his affectionate and lively father (the story was Roald Dahl's *Danny, the Champion of the World*). The reader indicated that for him the most important issue in the story was whether the father would find a girlfriend, and break up the child's cozy and exclusive relationship with the father. It turned out that this young reader lived with his divorced father, whose recently initiated courtship with a woman was distressing the boy. It would seem natural for an unknowing teacher to say that such a response to the story was "wrong." But to this young reader, the child's relationship with the father was necessarily the most important issue (Lovell, 1992).

Lesson 2: An Enhanced Lecture Activity

Lesson Introduction

The focus of this sample lesson will be a learning activity in which participants are invited to apply the active learning model, Evocation/Realization of Meaning/Reflection, as they participate in a lecture-based lesson. Simultaneously, the lecturer will modify the lecture format so that it engages and encourages active learning and critical thinking. The result is the *enhanced lecture* (Bonwell & Eison, 1991), to which we turn now.

Preparatory Activity #1

The teacher prepares the participants for the activity by saying something like the following:

> The lecture we are about to have has two purposes: One is to describe the effects of Christopher Columbus's trip to the New World in 1492; the other is to explore some of the mysteries surrounding Columbus himself.
>
> The first part of the lecture will describe many of the effects of the contact between the Old World and the New World, but before we begin I would like you to pair up and think about this question: In the years following Columbus's famous voyage, there were many sorts of things in Europe that were introduced into the New World, and many sorts of things in the New World that were introduced into Europe. What were some of those "things"? The pair of you should make a list of all the things you can think of that went east and west after that first contact in October of 1492. You will have 4 minutes to make your list.

After 4 minutes, the teacher invites two or three of the pairs to share some of their findings with the whole group. The teacher lists several of the ideas on the board, and then enlists the participants' help in making categories into which they can group the things that were transferred east or west: such as plants, animals, diseases, and technology.

The teacher proceeds, "I am about to begin the first part of the lecture. Keep your list of ideas handy as I talk."

First Part of the Lecture

REMEMBERING COLUMBUS

Twenty thousand years ago the land bridge over what is now the Bering Strait sank too low to be passable, and two halves of the world began to grow up separately. Plants and animals, peoples and cultures, gods and diseases, all went their separate ways—until one sunny morning, 500 Octobers ago, when a skiff bearing Christopher Columbus crunched into the sand on San Salvador Island and brought the two parts of the world together again.

It is amazing to think that one person could have engineered that first contact, however unknowingly. Having done it, Christopher Columbus was caught in the glare of world scrutiny forever.

The powers that flowed through that point of contact, once made, changed the whole world profoundly and rapidly. The plants that the Indians offered to the Europeans—plants that they had bred carefully and improved through many, many generations—potatoes, corn, long-staple cotton—soon reversed the Old World's cycles of famine and led to population explosions—and changed everything from economies to cooking. Who can imagine Italian food without tomatoes? Or Indian food without hot peppers? Or an Irish meal without potatoes? All came from the New World. Without long-staple cotton, Europe wouldn't have had a textile industry, and maybe not an Industrial Revolution.

Going the other way, who can imagine "the Wild West" without cattle, or the Plains Indians without horses? The Spanish brought both to the New World in 1493, and they quickly adapted, multiplied, and spread. In the 1580s, the Spanish explorer Cabeza de Vaca was blown across the Gulf of Mexico and shipwrecked on the Texas coast. He was the first European to see Texas, but Spanish cattle already had beat him there, and they looked so wild, so much at home, that he assumed they were native to America. The Lakota Sioux have legends about the coming of wonderful animals that improved their lives. The Elk Dogs were said to have been brought up from a magical land at the bottom of a deep lake. They were horses, of course.

On the down side, the diseases Columbus and his followers brought with them wiped out whole civilizations within a few decades. The population of the Caribbean island of Hispaniola, for example, was reduced from half a million indigenous people to virtually none within a space of only 50 years. And even though European explorers didn't arrive on the seaboard of North America until many years after Columbus' voyage, the diseases introduced by the Spanish are believed to have spread rapidly northward, so that by the time Captain James Smith reached Jamestown in Virginia in 1607, the local indigenous population was already in disarray because at least a fourth of them had died from a plague of smallpox that had originated with the Spanish explorers in the south, and had been passed northward from tribe to tribe.

Back a century earlier in the Caribbean, when the indigenous population began dying off at an alarming rate, the Spanish imported forced workers from

Africa, and the troubled heritage of slavery, as well as the multiracial character of the New World, began to take shape.

Taking Stock

The teacher says, "Take a minute and review your lists of ideas: What things did you think of when you made your list that were mentioned in the lecture? What other things did you learn?"

Preparatory Activity #2

The teacher proceeds, "The next part of the lecture deals with the mysteries surrounding what we know about Columbus the explorer. In pairs, please list what you know of the personal qualities and skills Christopher Columbus possessed that enabled him to make a successful journey to the New World."

After 3 minutes, the teacher asks the students to stop writing, and invites a few volunteers to share their ideas. Then the teacher asks students to listen carefully to the next part of the lecture, keeping their own lists of ideas at hand.

The Lecture Continues

Columbus was not the only person of his time who thought the world was round. Many educated people in Europe accepted that. For one thing, they had noted that ships sailing away from port disappeared hull first, then spars. They reappeared in reverse order.

The ancient Greeks not only knew the world was round, but one of them had accurately calculated the circumference of the world to within a few hundred kilometers. But there were many Greeks and many estimates, and up until much closer to our own time, no one had any way of knowing which estimate to believe. As it turns out, Columbus chose the wrong estimate, one that put the circumference of the earth at around 20,000 miles, or 32,000 kilometers. That figure inspired him to make what should have been a fatal journey.

Columbus took a low estimate of the circumference, and plotted on it the latitude that was known to be taken up by the land mass of Europe. He studied Marco Polo's journal of a voyage to China, and tried to calculate from that how much more latitude should be taken up by Asia. He added 1,000 miles or 1,600 kilometers for the Sea of Japan, and when he had finished adding and subtracting, he had convinced himself that Japan lay just 2,000 miles or 3,200

kilometers to the west of Spain. China, he reasoned, was just 1,000 miles or 1,600 kilometers further. Indeed, when he left Grand Canary Island, after putting in for repairs, he wrote in his log that he expected a trip of 21 days—and he provisioned for 28 days, for a margin of safety. In fact, Columbus had 8,000 miles or 13,000 kilometers more ocean to cover than he thought. Had the New World not been there to intercept him, the parched bones of Columbus and his men might still be drifting around out there on the Ocean Sea.

Columbus had more than book knowledge to guide him. As a wool salesman, he had shipped aboard voyages to the south, down the coast of Africa as far as Guinea. He had journeyed to the north as far as England, and perhaps even got to Iceland. In Guinea, it is said, he met African sailors who told him of a New World across the sea—and even gave him maps to show him the way. In Iceland, it is said, he heard stories about a strange land to the west, from men who often fished off the coast of Newfoundland and sometimes camped there. But there's no solid evidence that he did learn of the New World in either of those ways. Everything he wrote in his log not only suggests that he had no foreknowledge of a land mass out there to be discovered, but even that he refused to believe there was, even after he had discovered it!

We may believe that the trips were useful for a different reason. They probably taught him that if you went far enough south from Spain, you reached steady winds blowing toward the west. And if you went far enough north you found steady winds blowing back to the east. It was with this certainty that Columbus had all three ships square rigged—and committed his life and the lives of his crew to running before the wind wherever it took him. He was right, of course, and he discovered the sailing routes that were used to carry boats to the New World and back throughout the age of sail.

It was mentioned that Columbus had been a wool salesman. He was also a map-maker. But he was never a ship's captain. Indeed, before his famous voyage, he had never commanded anything larger than a rowboat.

Columbus was a poor commander who had constant difficulty with his crew. He once wrote in his log that the skippers of two of his three ships were conspiring with the sailors to throw him into the sea. But the crew seems to have had difficulty with Columbus. On his first voyage, he lied regularly about the distances the three ships traveled each day. As he recorded in his diary, Columbus reasoned that if the crew thought they had sailed less distance, they would be less worried (this thinking seems odd; if you were crossing open ocean, wouldn't it be more comforting to think you were making more progress, and not less?). Shortly before making his first landfall, he had to head off a mutiny of the crew by promising a year's wages to the first man who sighted land. A sailor named Rodrigo de Triano was the first, on that morning of October 12, 1492—but Columbus claimed to have seen a light from the landfall the previous night, when they would surely have been too far off shore (40 miles or 70 kilometers) to see firelight. Columbus kept the prize for himself. It is hardly surprising that members of his fleet ignored his orders at least twice after that: once when the skipper of the *Pinta* abandoned the fleet and sailed off on his

own, and another time when Columbus commanded the crew of the *Nina* to heave to and pull the stranded *Santa Maria* off a reef (the *Nina* failed to comply, and the *Santa Maria* was lost).

Columbus was, however, a consummate navigator. After making by far the longest voyage of his time, Columbus found his way back home through terrible winter storms. The following year he was able to navigate his way back to the island of his destination with remarkable accuracy. This with only a compass and a primitive astrolabe that could give a rough measure of latitude, but not longitude.

Taking Stock

Now the teacher asks the participants to compare their list of Columbus qualities and skills with the points just made in the lecture. The teacher may ask volunteer groups to share some of their findings.

Ten-Minute Essay

The teacher now puts a question to the class for answering in a free-written essay of 10 minutes' duration: "What are your impressions of Columbus now? He did momentous things: Is he *a hero*?" Some of these essays may be shared aloud and discussed.

Unpacking the Methods

Now guide the participants back through the experience of the lesson. Ask them first about the broad effects the activity had on them as learners. Invite them to talk about the amount of information about the consequences of 1492 that they summoned at the beginning of the activity. Were they surprised at how much they came up with in pairs? As a whole group?

Invite them to talk about the way they attended to the lecture. How much of it did they remember afterward? How much did their "having a stake" in the meaning of the lecture—by virtue of having implicitly compared their own knowledge of the topic to what the lecture contained—affect their concentration and their learning?

Ask them to talk about the 10-minute essay. How did this writing exercise feel to them as a way of gaining closure on the information and the issues raised in the lecture? How would the experience have

been different if they had not been asked to make the sorts of judgments called for in the writing assignment?

Ask the participants to reflect on the kinds of thinking this activity invited them to do. From the range of possibilities—remembering facts, understanding concepts, combining ideas to form new insights, applying concepts to situations to make judgments—which ones did they practice?

Finally, invite them to compare the enhanced lecture to the traditional lecture. You may share with the participants at this point the summary of research on students' attention during lectures. The research makes clear that the traditional lecture is inefficient at conveying information that will be remembered, and especially at empowering students to use whatever knowledge they gain. But ask the participants to note the specific ways the enhanced lecture improves on the traditional lecture. How does it cope with the common problem of students' attention flagging after a short time—usually 15 or 20 minutes (see Figure 1)? How does it deal with the problems of student passivity? How does it address the problem of the lower-order thinking that traditionally is evoked by lectures?

The participants may conclude that in the enhanced lecture, some lecture time is sacrificed while students do other kinds of activities such as thinking, discussing, and writing—but the activity is usually more productive in terms of the usable knowledge that students take away from it.

The Enhanced Lecture Procedure Explained

Now take the participants through the steps of the activity, one by one. The enhanced lecture procedure unfolded as follows:

Preparatory phase (evocation). At the very beginning of the lesson, the teacher leader assigns a task that focuses participants' attention on the material to come. The teacher has two purposes here: to invite students to survey their prior knowledge about a topic, and to challenge them to formulate questions to pursue as the lecture unfolds. The teacher may choose from several different strategies here. He or she may

- ask the class to write for 5 minutes on a question (such as a prompt to list ideas) that surveys their prior knowledge about the topic to be discussed;
- put a question to the participants to be discussed and answered by pairs;

Figure 1 What Research Says About Lectures as a Teaching Tool

There are two main drawbacks to lectures, according to voluminous research:

1. *Normally, relatively little of what is conveyed in lectures is retained by participants.* One study of participants' concentration during a 50-minute lecture, as measured by the contents of the lecture mentioned in the students' notes, found that they recorded 41% of the contents presented during the first 15 minutes, 25% of the contents presented over 30 minutes, and 20% of the material presented in the full 50 minutes (McLeish, cited in Penner, 1984). Another researcher summarizing a close observation of the attentiveness of students in one lecture wrote this description:

   > Ten percent of the audience displayed signs of inattention within 15 minutes. After 18 minutes one-third of the audience...were fidgeting. After 35 minutes everyone was inattentive; at 45 minutes, trance was more noticeable than fidgeting; and at 47 minutes some were asleep and at least one was reading. A casual check 24 hours later revealed that the audience recalled only insignificant details, which were generally wrong." (Verner & Dickinson, p. 90, cited in Bonwell & Eison, 1991)

2. *Lectures tend to require of the participants only lower order thinking: usually recognition and recall.* Remembering ideas arrived at brilliantly is not the same thing as thinking brilliantly. Lectures have been found to be no better than discussions for transmitting information, and considerably *less* effective than discussions in changing attitudes or encouraging analytical thought or problem solving (Costin, 1972)

Lectures do have some limited advantages, though: (1) They can be an effective way to present an overview of a topic, so that students' inquiry into the topic will be better informed and more rewarding. Also, (2) lectures may be a reasonably effective way to get information across when multiple copies of written texts on a topic are not available.

- give participants a list of terms from the upcoming lecture, and ask them in 2 or 3 minutes to come up with a plausible explanation for ways they may be related.

In the sample lesson, the participants were asked to prepare lists of ideas, and to compare those ideas against what would come in the lec-

ture. Lists have the advantage of inviting brief answers quickly, and they also can be quickly compared to the information in the lecture.

Partial lecture (realization of meaning). The teacher then lectures for 10–15 minutes (no more than 20 minutes). The timing is deliberate, because the studies of students' attention during lectures suggest that attention falls off precipitously after a 15 or 20 minutes.

Taking stock (reflection). After the first portion of the lecture has been delivered, the teacher asks the participants to compare their own ideas with those that were presented in the lecture.

Note that if the teacher had desired more interpretation and debate at this stage, rather than a confirmation of the participants' predictions, he or she might have substituted a think/pair/share question for the stock-taking exercise. The teacher might have asked individuals, then pairs, to answer a question such as, "What do you think were the *two most important elements* that went from one part of the world to the other after 1492?"

Another preparatory activity (evocation). Now the teacher should set another brief task for individuals or pairs of students to summon their prior knowledge and have them set purposes for listening to the next segment of the lecture.

Continue with the lecture, and another stock-taking session. The teacher presents another 10- to 15-minute segment of the lecture, followed by a stock-taking session, in which the participants compare their own ideas with the ideas presented in the lecture. Again, at the teacher's option, a think/pair/share question could be substituted for the stock-taking exercise.

Summary exercise (reflection). The teacher should assign an exercise that helps the participants reflect on the materials presented in the lecture. This exercise may take one of several forms. The teacher may

- ask participants in pairs to answer an open-ended question that draws on the main issues of the lecture;
- ask participants to write a 10-minute essay that probes some issue raised in the lecture (as we did in the example);
- ask participants to write an even briefer 5-minute essay, in which they make a brief statement about one thing they learned during

the class, and write one question that remains. (The teacher collects these afterward, because they offer excellent pointers for a way to begin the next class, and also provide important diagnostic information as to how and how well the material is being understood by the students.)

PART III MORE ACTIVITIES FOR THE EVOCATION/ REALIZATION/ REFLECTION CYCLE

Now that we have had two demonstration lessons built around the Evocation/Realization of Meaning/Reflection framework, the time has arrived to consider some alternative strategies that can be used in each phase.

It probably will not be possible to cover all of the following strategies in detail. You may prepare short demonstration lessons around some of these strategies—or simply refer the participants to them to try on their own.

As you introduce the following strategies to the workshop participants, it will be important that the participants keep clearly in mind which of these and the previously covered strategies serve each part of the Evocation/Realization of Meaning/Reflection framework. An effective way to ensure this is to prepare a chart with three columns for Evocation, Realization of Meaning, and Reflection. As a technique is discussed it is added to the appropriate column.

For the Evocation Phase

Activities in this phase are intended to summon prior knowledge about a topic, arouse curiosity, and set purposes for the investigation.

Scrambled Sequences

As a whole-group activity, the teacher may write five or six individual events from a sequence of events or from a cause-and-effect chain, each on its own piece of paper. The papers are scrambled and placed on the chalk tray of the chalkboard (or else individual students are asked to hold them up). Members of the class are asked to decide on the proper ordering. One at a time, students are invited to come forward and place one item in what they think is its proper place. Once the class has more or less agreed on an order, the teacher asks them to scrutinize the text carefully as they read it to see if the text arranged the elements in the same order that the students did.

Free Writing

We can invite students to write down in 5 minutes, without stopping, everything that comes to mind when they think about a topic. After the 5 minutes are up (and it's a good idea to call time after 5 minutes and give them one more minute to finish, because good ideas often come out under pressure), we might ask them to read their paper aloud to a partner.

At this point, many options are available. We can invite pairs to share ideas with the whole group, or we may ask the students to underline the ideas in their paper that they are least sure about, and pay close attention to the reading to see if it sheds light on their areas of uncertainty.

Semantic Feature Analysis

Another strategy for activating and developing background knowledge is *semantic feature analysis*. This strategy is useful when students are studying a topic about which they have little background knowledge. The essence of the strategy is to compare the features of the new and lesser known item or topic with those of two more familiar items or topics.

A chart to guide this activity is prepared in advance by the teacher and presented on a transparency or a large piece of paper. The names of the three items are listed in a column down the left side of the chart, and a series of features on which the items will be compared are listed in a row across the top of the chart (see Figure 2).

Figure 2 Semantic Feature Analysis: Whales

	Lives?		**Moves?**			**Eats?**			**Type of Animal?**			**Size?**		
	in ocean	on land	flies	swims	runs	meat	fish	plants	fish	mammal	bird	like... a cat	a cow	an elephant
camel	-	+	-	-	+	-	-	+	-	+	-	-	+	-
eagle	-	+	+	-	-	+	+	-	-	-	+	+	-	-
whale	+	-	-	+	-	?	+	?	+	-	-	?	?	?

As a preliminary activity (as the evocation phase), the students discuss the two familiar items, and suggest the appropriate markings (+ for "yes" and – for "no") for each item under each semantic feature. Then, before reading, hearing a lecture about, or otherwise studying the new topic, the students also suggest marks for that topic's semantic features: (+ for "yes," – for "no," and ? to indicate that they are unsure of a feature). The teacher presses them here to make predictions about the topic, even when they are unsure. The students now do the reading or other exploration about the new topic (the realization of meaning phase). Following the exploration, they discuss what they learned.

Then as a follow-up activity (considered part of the reflection phase), the students return to the chart, and confirm or suggest corrections for the markings they made during the preliminary activity.

The semantic feature analysis works nicely with lessons that are not text based. The strategy has many applications in the sciences and in math.*

For the Realization of Meaning Phase

Once students have summoned their prior knowledge, examined what they were sure of and not-so-sure of, raised questions, and set purposes for learning, they are ready for the next phase, the realization of meaning. There are several strategies available to students in this phase.

ReQuest Procedure

When participants need support in reading text for information, one way to provide that support is to use the *ReQuest procedure* (Manzo, 1969). By this procedure, two students read through a text, stop after each paragraph, and take turns asking each other questions about it. It helps a great deal if the teacher serves as a partner when the technique is first introduced. Let us assume, for example, that the teacher is engaging in the ReQuest procedure with a student, David. After reading the first paragraph (silently) about Marco Polo, the teacher asks David several good questions about that paragraph. She asks questions about main ideas. She asks questions that probe beneath the surface. She asks what

* Our thanks to Alan Crawford for this suggestion.

importance some item in this paragraph might come to have later in the text (she is trying not only to get David to think, but also to model for David the kinds of questions he might ask when it comes to be his turn). David has to answer those questions as well as he can. After David has finished answering the teacher's questions, they both read the next paragraph. Now it is David's turn to ask the teacher questions about the new paragraph, and the teacher has to answer them. When they both have brought to light the information in that paragraph, they read the next one. After that paragraph is read, the teacher now gets the first turn at asking David several good questions about that paragraph. When both are finished, they read the next paragraph, and so on. After the teacher has introduced the activity by being a questioning partner, the teacher sets up pairs of students to ask questions of each other.

The ReQuest procedure may be used with a whole class, too. One way is for the class to read one or two paragraphs from the text. Then the students pause and close their books, and students take turns asking the teacher all the questions they can think of. Following that, they read a new paragraph and the roles are reversed, and the teacher asks the students several good questions—taking care to model not just factual questions, but those that probe concepts and implications. After several such exchanges, the teacher may shift the activity to ask students to predict what the rest of the assignment will be about, and to state why they think so (Vacca & Vacca, 1996).

Another possibility for a whole class use of the ReQuest procedure is to assign students to teams of three, and have them take turns asking and answering questions.

Reciprocal Teaching

It is well known that the act of teaching is the best way to learn. *Reciprocal teaching*, like the ReQuest procedure, was developed to enable all students to experience the role of teacher in leading others through a text. The procedure is especially well-suited to an informational text.

Reciprocal teaching (Palincsar & Brown, 1984) is done in groups of four to seven students. The students all have copies of the same text, and take turns being the teacher, a role that requires them to perform five tasks. After the students have read a paragraph (usually silently), the person acting as teacher

1. summarizes what has just been read;
2. thinks up two or three questions about the passage and elicits the students' answers to it;
3. clarifies issues the other students are unclear about;
4. predicts what the text will say in the next passage; and
5. assigns the next passage for everyone to read.

As an example, assume that a teacher and five students are reading the text "The Pollution of the Air" (found in Appendix B of this guidebook). The lesson proceeds as follows.

First, the teacher announces that he will be the discussion leader for the first paragraph. The students should not only pay attention to the paragraph and participate in the discussion, but also observe carefully how the teacher conducts the discussion. That is because each of them will play the role of the discussion leader when the subsequent paragraphs are read. The teacher has prepared a chart that lists the five steps that are taken after each paragraph is read. He refers the students to it to help them follow the procedure he is using as he leads the discussion.

The teacher has decided in advance that this text is best read in units of paragraphs (his goal is a unit of text that can be discussed in 5 to 7 minutes. He thus might have chosen longer or shorter units, depending on the informational density of the text). The teacher asks everyone to read the first paragraph silently.

When they are finished, the teacher gives a verbal summary of the paragraph, and he looks around at the students as if to ask if they would summarize the passage the same way.

Next, the teacher formulates a question. He takes care with the question, because as well as eliciting their ideas he is demonstrating for the students the art of questioning. His question might address a complicated idea that is stated explicitly in the text, or it may probe an unspoken implication. The question also may ask students to compare an assertion made by the text with their own common-sense ideas. The teacher draws out the students' ideas on these questions.

Next—although this often happens simultaneously with the preceding step—the teacher attempts to clarify any parts of the passage that are unclear to the students. He can do this by pointing out disagreements or unclear points in what the students have said, and inviting them to clarify disagreements and misunderstandings. Or he may say, "Here is

how I would resolve this issue..." and then proceed to present his own understanding (the reader should bear in mind that students will have opportunities to do themselves whatever the teacher does at this moment; as the lesson proceeds, the teacher will automatically yield the floor to others' opinions).

Now the teacher makes a prediction as to what the text will say next. If time allows, he may ask others for their predictions. Then he assigns the next section of the text.

After the next paragraph is read, if this is the first time this activity has been used with these students, the teacher takes another turn at conducting the discussion. He takes the extra turn in order to make sure the students fully understand how to carry out the five steps in conducting a discussion before it becomes their turn. The teacher often refers to the chart as he conducts each step in the discussion. He knows that if the students do not clearly understand how to conduct the procedure, he will have to intervene later, which will undermine the students' autonomy and confidence.

Before the third passage is read, the teacher points to the student on his left and asks her to lead the next discussion. After that student has had her turn, the role of discussion leader passes to the student on her left, and so on.

Study Guides

Study guides help guide participants' processes of inquiry even when the teacher is not present, as when participants are reading an assigned reading independently. Recall that the sheet guided the participants' attention to certain ideas that were woven through the text about corn, even as they read the whole piece, and that they also framed the small-group discussion about the text that took place after the text was read.

For the purposes of promoting critical thinking, study guides work best when they

1. help participants follow intricate patterns of thought or subtle ideas that they probably would not have reached on their own, but they *do not* serve as a substitute for a careful reading of the text;
2. invite critical or higher-order thinking at every step; and

3. are used as a springboard to discussion or writing, and not as an end in themselves.

Figure 3 is an example of a study guide for an article about corn. Students are given this sheet *before* reading the lengthy passage, to guide their realization of meaning.

Figure 3 Study Guide on the Origin and Uses of Corn

1. In what ways have humans adapted corn to our own uses?

2. How long have humans been manipulating corn plants for their own purposes?

3. Some people claim that it is unnatural, and therefore wrong, for people to "tinker" with nature. Using what you know about corn, construct an argument that agrees or disagrees with that position.

By design, the answers to the first two questions in the figure were woven through many parts of the text on corn. Note, too, that the third question asks readers to engage in higher-order thinking about the insights they were guided to assemble in the first two questions.

Dual Entry Diaries

As we saw in the demonstration lesson earlier in this guidebook, dual entry diaries (Berthoff, 1981) are ways for readers to closely link material in the text to their own curiosity and experiences. They are especially useful when students are reading longer assignments, out of class.

For the Reflection Phase

Many of the strategies that are followed during the evocation and realization of meaning phases are designed to culminate during the reflection phase. Here are several that do.

Key Terms Revisited

Students who were given key terms in advance of a reading and asked how they might relate can be asked to construct a description of how those terms do relate now that they have read the text.

Scrambled Sequences Revisited

Some students were given items, terms, or events prior to the reading and asked to predict the proper order in which they should be arranged (following cause-and-effect chains or chronology). They can be asked to arrange those terms properly, now that they have read the text. Pairs of students should prepare to explain to the class why they arranged the terms as they did.

Study Guides Revisited

If a study guide has been constructed well, it will have begun by asking students to gather insights from several parts of the text. These will be worth reviewing, because students are likely to have gathered different information. It also will have asked students to form an opinion or construct an argument, about which there are likely to be different points of view. These also are worth revisiting, because they are likely to yield lively discussion.

Dual Entry Diaries Revisited

After students have done the reading, dual entry diary entries can help in the reflection phase as the teacher moves through the text, asking students to share the comments they made on each page. The teacher should have prepared comments too, in order to call attention to parts of the text that he or she wants to be sure to discuss.

Think/Pair/Share

As explained earlier, think/pair/share is a quickly performed cooperative learning activity that invites students to reflect on a text and have the help of a colleague in giving shape to their ideas. It may be done sev-

eral times during the course of a reading or lecture. The teacher prepares a question in advance, usually of an open-ended nature, and asks individuals to write a brief answer to it. Then, students pair up and share answers with each other, trying to arrive at an answer that incorporates both people's ideas. Finally, the teacher calls as many pairs as time permits, and has them give a 30-second summary of their discussions.

Techniques for Guiding Discussions

There is an illusive difference between a rich and dynamic discussion and one that degenerates into the teacher doing the talking with the students sitting in silence. Generally those discussions are best when the students' curiosity sets the direction. The teacher has a critical facilitative role, though. Dillon (1988) has identified four "moves" or strategies the teacher uses to keep a discussion going and keep it student centered.

1. *Statements.* Statements are a way of expressing your own response, understanding, or need for clarification of what has been said. They are less directive than questions, though, and thus they often invite a freer response in return. You may say, "So as I understand it, you're saying _____"; "That reminds me of something ____ said earlier"; "Wait a minute, though. You're saying _____ , but Dan just said _____"; or "I'm confused about _____."
2. *Questions.* Students will discuss their own questions more enthusiastically than the teacher's. Cultivate ways to ask students to venture asking questions about the text. Here are some useful prompts: "So what should we be asking about this text?" "What's been left out of our discussion so far?" "What's not clear about what has been presented in this text?" "What does anyone agree or disagree with in this text?"
3. *Signals.* Because the teacher's comments often can carry inordinate weight, it is often best to keep the discussion going with gestures and signals, rather than with comments. A quizzical expression can invite clarification. Two hands held out as if weighing two items can invite students to choose between agreeing with one statement and another. A look of friendly concern can encourage a student who is struggling to give words to an idea.

4. *Silence*. When a question is on the floor, allow time for it to be answered. A wait time of 3, 4, or 5 seconds serves as a powerful motivator for someone to fill the void. If the teacher doesn't fill it, someone else will.

Save the Last Word for Me

"Save the last word for me" is another activity to facilitate postreading contemplation and reflection. It provides a framework for class discussion of a text, either narrative or expository. This strategy is particularly helpful in getting the quieter and more reluctant students to participate in class discussions. The steps of the strategy should be explained as follows:

1. While reading a piece of text, students are asked to find one or more quotations that they consider particularly interesting or worthy of comment.
2. The student writes the quotation on an index card or small piece of paper, being sure to include the page number citation.
3. On the reverse side of the card, the student writes a comment about the quotation. The student may choose to disagree with the quotation, elaborate on it, or whatever he or she chooses.
4. The students bring their quotation cards to class the next day and the teacher calls on someone to read one aloud. (It helps if the student tells everyone what page in the text the quotation came from, so that everyone may follow along.)
5. After the quotation has been read, the teacher calls for comments and reactions from other class members. Be sure to keep the discussion on target and limit comments that may become caustic or petty. The teacher also may comment on the quotation at this time.
6. To conclude the discussion of the quotation, the teacher has the student who chose it read his or her comments aloud. Here's the catch: There can be no further discussion. The student who chose it gets to have the last word. (Teachers, you will find it very difficult at times to keep from interjecting some final comment, but no fair! That's against the rules.)
7. The teacher now can call on another student to share his or her quotation and begin the process anew. It is unlikely that the

teacher will want to call on every class member to present a quotation in the same class period, but will select a few students each time.

(Please note that more discussion strategies will be introduced in Guidebook IV, and these can be added to the appropriate columns in the chart of strategies.)

Ten-Minute Essays and Other Free Writes

Following a reading or a class discussion, students can be helped to collect their thoughts if they are asked to write a 10-minute essay, using the free write technique. To set up a 10-minute essay, the teacher asks students to write without stopping on a given topic.

Some writing teachers insist that the act of writing itself can open wells of creativity that are unlike the more deliberate sort of thinking we do when we plan what we are going to write (Elbow, 1982). Thus, in producing a free write, students write continuously without stopping. If they can't think of anything to write, they should write *I can't think of anything to write*. The point is to keep writing without going back over it, examining it, or being critical of it.

Many teachers occasionally follow free writes with the invitation to go back through the free write, choose the most promising ideas, and craft a new essay using these insights as the core of the paper—and eliminating all the other less-important information that usually comes out in a free write.

Five-Minute Essay

The 5-minute essay is used at the end of class to help students get closure on their thoughts about the topic of study, and to give teachers a better connection to the intellectual happenings of the class. The 5-minute essay asks students to do two things: Write one thing you learned about the topic, and write one question you still have about the topic. The teacher collects these as soon as they are written, and may use them to plan the next day's lesson.

Graphic Organizers

Graphic organizers are ways to make visible the thought processes used in a process of inquiry. Besides clustering (presented in an earlier guidebook), three other useful forms of graphic organizers are concept charts, T-charts, and Venn diagrams.

The concept chart. A useful way to graphically organize information after a discussion is the concept chart. The concept chart is especially useful when three or more items or issues are being compared. The chart is set up by assigning the rows to the items being compared, and the columns to some feature according to which they are being compared.

For example, a concept chart might compare several vocations, as follows in Figure 4:

Figure 4 Concept Chart

	Preparation Required	Job Stability	Salary Level	Job Satisfaction
Physician	Extensive: University, plus medical school, plus internship	High	High	Moderately high
Artist	Moderately extensive: training, plus long practice to reach proficiency	Low: Expect long periods of hunger!	Uncertain	Highest
Factory worker	Less extensive	Moderate: Jobs can change, or move away.	Moderate	Can be low

Concept charts can be set up as an exercise during a whole-class discussion. The information they elicit is more restricted than that generated using a clustering exercise, but the teacher still may wish to demonstrate the process of framing a topic for writing from a concept chart, so that the students will clearly see how to do it.

The T-chart. A T-chart is a versatile graphic organizer for recording binary (yes/no, pro/con) or comparison/contrast responses to a discussion.

After reading two editorials on the pros and cons of preserving minority cultures, for example, pairs of students can construct a T-chart like the one shown in Figure 5, and, in 5 minutes, list on the left-hand side of the chart as many reasons as they can think of *for* preserving minority cultures. Then for 5 minutes they should list as many reasons as they can think of *against* this idea. At the end of that period during another 5 minutes they can compare their T-charts with those of another pair. Later the teacher can lead the construction of a whole-class T-chart on that issue.

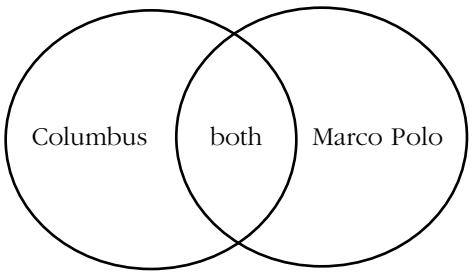
Figure 5 T-Chart

Reasons *for* preserving Minority cultures	Reasons *against* preserving Minority cultures
encourages diversity; individuals want it; encourages traditional values	"disunites" the society; goes against community interests; some traditional values shouldn't be preserved

Venn diagram. A Venn diagram is constructed on two or more large partially overlapping circles with space in the middle. It can be used to contrast ideas and show overlap between them. Suppose, for example, that the students are comparing Christopher Columbus's expeditions with those of Marco Polo. A Venn diagram with two overlapping circles would enable the class to contrast features about these expeditions, while also displaying the elements they had in common.

The teacher might ask pairs of students to construct Venn diagrams by filling in only the two parts of the circle devoted exclusively to Columbus and to Marco Polo, respectively. Then pairs could join other pairs, and the foursomes could compare their diagrams and then list in the middle section the features they saw that were common to both expeditions (see the example in Figure 6).

Figure 6 Venn Diagram



PART IV WORKING WITH THE TEACHING METHODS

Guided Practice

Participants will need opportunities to practice these methods themselves before the workshop is over. For this purpose, several other texts with suggestions for their use have been included as Appendix B in this guide. Alternatively, you may decide to conduct more whole-group practice in the workshop.

Assign different texts to small groups of participants, grouped by level and subject area they teach. The texts in Appendix B vary between those more suitable for older or younger children, or between classes for literature, or those for civics. Ask different groups of participants to design lessons incorporating activities for each of the phases of evocation, realization of meaning, and reflection.

Allow time to review the plans with each group before they try the lessons in a microteaching situation with their peers. *Also note: Because the element of surprise may be important, take care when assigning the texts to different groups, so that the participants who are intended to serve as "students" will not have read the texts until they are asked to by their "teachers."*

Then, have the groups take turns conducting a lesson with their text with the whole group.

Planning for Implementation

The next step in the process is to have the participants plan at a practical level for the implementation. To make the content of the workshop real and transferable to classrooms, specific plans need to made for implementation, using actual content materials. Allowing for this step is critical. Participants just starting with these methods will need encouragement and support. This phase of the workshop can become a very creative and rewarding experience for all.

Planning for implementation is always difficult to start. Some initial questions can serve as prompts for thinking. A suggested set of questions are the following:

- Let's imagine that tomorrow you are going to do what we have just done in your own classroom. In what class and subject might you employ the writing workshop activities?

- Which of these methods would make the most positive contribution to your class?
- How would you go about working in these methods? How would you start? What would you do?
- How much time would you need?
- What questions do you have about what we did today? What needs to be clarified before you proceed?
- What would you want students to learn or be able to do? What exactly would you do to help them?
- What impediments would you face? How would you overcome them?
- Finally, how will you make this hypothetical plan a reality? What activity will you actually try? When? How often?

Plans, once developed, should be shared with the whole group. The group should look for good, creative ways of implementing as well as potential pitfalls or gaps in the plans.

During the sharing of plans the group may individually take notes on their response to the plan. A good way for people to respond to plans is by giving a "praise" and a "question" response, just as they would in a writing workshop. The responder should begin with the praise and be specific about what was praiseworthy. Framing questioning responses as "I statements" ("I did not understand...", "I would like more information about...") allows responders to explores gaps and potential pitfalls while maintaining a positive tone.

Planning for Follow Up

In the design of the RWCT Project is the expectation that participants will meet during the intervals between workshops for the purpose of sharing their experiences in putting to use in their classrooms the techniques introduced in the workshops. These sessions form an important part of the RWCT project, and they must be approached planfully. Specific dates for the sessions should be identified, and responsibilities for reporting should be agreed upon (that is, who should have tried what by the time the session convenes? Who has responsibility for

securing the space? For chairing the proceedings?). Participants should be planning ahead to be prepared to discuss the following:

- In general, how did the implementation go?
- What were the successes or the most successful parts?
- What failures or difficulties were encountered?
- How did students respond?
- How might they do differently next time?
- How high was their interest level?
- How much did they learn?
- How did the lesson feel to the teacher? Did it feel right, or were there parts that seemed difficult or cumbersome?
- How many times was the implementation attempted?

Participants should be encouraged to work in small groups again to share their experiences, and then share with the whole group. Discussion should be encouraged regarding successes and failures, and how the procedures might be modified to fit the local culture, circumstances, and teacher preferences.

Participants should be reminded to continue to try the techniques, because it often takes several experiences with a procedure for the students to come to believe that the teacher really wants them to participate. Students also have to come to trust the learning environment as a safe place to share their ideas. All of this can take time.

REFERENCES

Berthoff, A. (1981). *The making of meaning: Metaphors, models, and maxims for writing teachers*. Portsmouth, NH: Boynton/Cook.

Bonwell, C.C., & Eison, J.A. (1991). *Active learning: Creating excitement in the classroom* (ASHE-ERIC Higher Education Report No. 1). Washington, DC: The George Washington University, School of Education and Human Development.

Carin, A. (1997). *Guided discovery activities for elementary school science* (4th ed.). Upper Saddle River, NJ: Prentice Hall.

Costin, F. (1972). Lecturing versus other methods of teaching: A review of research. *British Journal of Educational Technology*, *3,* 4–30.

Dillon, J.T. (1988). *Questioning and teaching: A manual of practice*. New York: Teachers College Press.

Elbow, P. (1982). *Writing without teachers*. New York: Oxford University Press.

Gallas, K. (1995). *Talking their way into science: Hearing children's questions and theories, responding with curricula*. New York: Teachers College Press.

Gardner, H. (1993). *The unschooled mind: How children think and how schools should teach*. New York: Basic Books.

Lovell, J. (1992). Response journals in a second grade classroom. In C. Temple & P. Collins (Eds.), *Stories and readers*. Norwood, MA: Christopher Gordon.

Manzo, A. (1969). The ReQuest procedure. *Journal of Reading*, *31*(11), 123–126.

Martin, R., Sexton, C., Wagner, K., & Gerlovich, J. (1998). *Science for all children: Methods for constructing understanding*. Needham Heights, MA: Allyn & Bacon.

Moore, D., Moore, S., Cunningham, P., & Cunningham, J. (1994). *Developing readers and writers in the content areas, K-12*. White Plains, NY: Longman.

Palincsar, A., & Brown, A.L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction*, *1*, 117–175.

Penner, J.H. (1984). *Why many college teachers cannot lecture*. Springfield, IL: Charles C. Thomas.

Pittelman, S.D., Heimlich, J.E., Berglund, R.L., & French, M.P. (1991). *Semantic feature analysis: Classroom applications*. Newark, DE: International Reading Association.

Temple, C., Meredith, K., & Steele, J. (1997). *How children learn: A statement of first principles*. Geneva, NY: Reading & Writing for Critical Thinking Project.

Vacca, R., & Vacca, J.A. (1996). *Content area reading* (5th ed.). New York: HarperCollins.

Verner, C., & Dickinson, G. (1967). The lecture: An analysis and review of research. *Adult Education*, *17*, 85–100.

GLOSSARY

Evocation	a phase in a lesson in which students are asked to think about what they already know about a topic, to raise questions about the topic, and to set purposes for learning.
Realization of meaning	a phase in a lesson in which students inquire and search for knowledge, and, as a result of their activity construct or realize meaning.
Reflection	a phase in a lesson in which students look back over the ideas they have encountered and the meaning they have realized, and question, interpret, apply, debate, challenge, and extend that meaning to new areas of endeavor.
Content areas	as opposed to study that develops the abilities of reading, writing, and thinking, this term refers to that which is studied, such as history, mathematics, science, and literature.
Constructivism	a branch of learning theory in which it is held that people create or construct meaning through acts of discovery and interpretation.
Prediction	anticipating the yet-to-be-revealed on the basis of what has been revealed.
Confirmation	verifying that a prediction or a speculation is borne out by what has been revealed.
Active learning	an approach to learning that encourages inquiry and discovery.
Debriefing	following an activity, a period of review and reflection on that activity.
Implementation	putting an idea into practice, as in trying new teaching methods in a classroom.

Comprehension	understanding; linking what is unfamiliar with what is familiar, and hence expanding what one knows.
Critical thinking	having ideas that go beyond what is given; seeing new dimensions in a topic; finding and solving problems; also discrimination among ideas, as in argumentative writing or debate.
Modeling	demonstrating; providing an example that can organize someone else's ideas or activities.
Framework	a set of (often substitutable) ideas in relation to one another; for example, the Evocation/Realization of Meaning/Reflection framework allows the substitution, within categories, of teaching strategies that serve similar purposes.

APPENDIX A

Science Teaching Applications of RWCT

The Reading & Writing for Critical Thinking Project promotes active learning by means of a teaching model that is based on the findings of cognitive psychology. Constructivist learning theorists since Piaget have stressed the importance of the learner's own questioning and discovery processes in meaningful learning. Progressive educators now think of teaching as a process of helping students extend and restructure the ideas they already had, rather than passively transmitting ideas to them.

If we take a constructivist approach to teaching and learning, if we understand teaching as helping learners to interpret and understand new phenomena in light of what they already knew, two immediate consequences follow. On the positive side, there is the importance of having students raise questions and actively seek to discover answers. Students must remind themselves of the knowledge they already have and what they want to know. On the negative side, there is the danger of *not* having students bring their misconceptions to light before trying to learn new concepts. If students interpret the new concepts in terms of what they already know, a faulty base of knowledge will lead to incomplete or distorted learning. A responsible teacher, then, will lead students to bring their prior conceptions into the light to examine them, even as they learn new things (Gallas, 1995).

Nowhere are these ideas more relevant than in the teaching of science. Science is the study of the natural and physical world, a world that each student has been trying to make sense of from his or her youngest days. Children form working theories of the world in early childhood, and they revise these theories with further learning throughout their lives. Science instruction, ideally, works in harmony with children's own discovery learning, and leads them to revise their thinking about the world in more and more sophisticated ways that are congruent with the ways the consensus of scientists have described it: a spherical world that rotates on its own axis, with one satellite moon, revolving with eight other planets around the sun.

If science is pursued as content to be acquired passively, however, scientific knowledge can be memorized without changing the ways we think about the world (Gardner, 1993)—and we may walk around as

adults with many of the ideas we formed as young children still unchallenged. A constructivist approach to the teaching of science puts a heavy emphasis on students' acts of inquiry, and attempts to make connection with the ways students think about the world.

Science instruction seeks to nurture a scientific attitude in students, an attitude characterized by:

- curiosity (the desire to know) and activity (the willingness to do things in order to find out);
- skepticism (the willingness to hold long-standing ideas up to scrutiny);
- reason (the ability to use logic and rules of evidence in pursuit of knowledge);
- being informed (having a fund of information about the world with which to think);
- strategies (having procedures for inquiry, and the willingness to use them); and
- commitment (putting one's ideas and beliefs "on the line," so that as a result of new learning, the learner begins to restructure the way he or she thinks about the world).

The antitheses of a scientific attitude are:

- passivity (an unwillingness to inquire and explore);
- prejudice (assuming we already know, on the basis of received beliefs, rather than on the basis of evidence);
- misinformation (holding faulty ideas about the natural world, which cause us to ask the wrong questions and distort our perceptions);
- carelessness (the want of the habits of systematicity, careful observation, and reasoning); and
- detachment (keeping the findings of one's inquiries compartmentalized away from one's everyday ways of seeing things).

Strikingly, this list of the attributes of a scientific attitude would be the same if we were talking about active learning and critical thinking in general, not just scientific inquiry.

The name of the project implies that Reading & Writing for Critical Thinking is focused on the use and the production of written texts as

ways of knowing. Although that is partly true, the same approaches to inquiry used in the RWCT Project are applicable to the investigation of direct experience. Moreover, the methods are certainly applicable to scientific texts.

The terms we have used to frame the approaches to inquiry in the RWCT project are not those that are typically used by science educators, so some translation of terms, as well as some illustrations of methods, is in order.

Evaporation From Different Surfaces: A Sample Lesson

First, have students paint water on a variety of surfaces, and time how fast it takes the water to evaporate. Move among them and draw out some of the factors that affect the rate of evaporation.

Take a piece of chart paper and invite students to brainstorm what they know and want to know about the factors that affect the speed of evaporation (put question marks by the parts they want to know about). These are likely to include the amount of water that was spread in the first place, the kind of surface on which it was spread, and the amount of exposure to sun or wind the surface receives. Now have the students return to their activities, and record both their predictions and their observations on charts they have made.

Second, lead the students in a discussion of what questions they now want to answer, and how they will answer them. If scientists, as Steven Fields said, "Make up stories and then test to see if they're true," what "story" can they make up that will explain what speeds up or slows down evaporation? How can they test to see if the story is true?

By questioning, it may emerge that to test factors in the rate of evaporation, they will have to isolate factors from one another—that is, in each test, they will need to keep all of the factors the same but one. They also will have to watch carefully, and keep good records of what happens.

Third, once they have reached conclusions about what factors facilitated and impeded evaporation, ask them to make predictions and test them vis-à-vis the rate of evaporation from other materials, for example, thick wool versus thin cotton. Give them sticks, a clothesline, and damp towels. Where should they erect the clothes line for best effect, that is, to make the clothes dry the fastest? (This exercise adapted from Carin, 1997.)

Models of Science Instruction

The preceding activity unfolded according to a model of science instruction that is often used in schools, particularly at the lower grades. The model consists of three parts: *exploration*, *explanation*, and *expansion* (Martin, Sexton, Wagner, & Gerlovich, 1998).

Phase I: Exploration

This is a stage of the lesson in which students are presented with interesting and puzzling phenomena and an implicit or explicit challenge that they find out more: to find an explanation, make a comparison, advance a prediction, and so on. The teacher refrains at this point from explaining the concept, having carefully laid the groundwork for students' curiosity and puzzlement (Piaget's term is *disequilibrium*) to have been evoked.

As Martin et al. suggest, the teacher's role is to pique curiosity, by

- answering students' questions;
- asking questions to guide students' observations and to cause students to engage in science processes or thinking skills; and
- giving hints and clues to keep exploration going. (p. 304)

The teacher must structure this phase of activity carefully, asking these preliminary questions:

- What is the concept the students will explore?
- What activities must the students do to become familiar with the concept?
- What kinds of observations or records must the students keep?
- What kinds of instructions will the children need? How can I give the instructions without telling the concept?

(Martin et al., 1998, p. 304).

Phase II: Explanation

Once the students have explored the phenomena and made their observations, the teacher leads them toward an articulation of what they have observed. The goal here is something like a statement of the con-

cept. Because the teacher is interested in having the students redirect their own thinking, he or she refrains from lecturing, but attempts to draw a statement about the concept from the students, proceeding dialogically or Socratically.

Martin et al. (1998) suggest that the teacher keep the following guidelines in mind while thinking through this second step:

- What kinds of information or findings should the students talk about?
- How can I help the students summarize their findings?
- How can I guide the students and refrain from telling them what they should have found, even if their understanding is incomplete? How can I help them use their information to construct the concept correctly?
- What labels or descriptions should the students attach to the concept?
- What reasons can I give the students if they ask me why the concept is important? (pp. 305–306)

Phase Three: Expansion

In the expansion phase the students link their discoveries to their prior knowledge, and they also apply their insights and link what they have discovered to larger concerns. The purpose of activity in this phase is to help the students reorder their prior understandings, and be able to apply their newly organized understandings to the ways they think about the world. This is a critically important phase, if we are concerned not just with what students know, but what difference it makes in the way they think.

Martin et al. (1998) encourage teachers to ask the following questions of themselves as they plan instruction for this phase:

- What previous experiences have the students had that relate to the concept? How can I connect the concept to those experiences?
- What are some examples of how the concept encourages students to see science's benefit to themselves? to help them understand the relationships among science, technology, and society? to help them develop science inquiry skills? to help them be informed about the history and nature of science?

- What new experiences are needed to apply or expand the concept?
- What is the next concept related to the present one? How can I encourage exploration of the next concept? (p. 306)

A Secondary Science Teaching Lesson: Sow Bug Experiment

Sow bugs, or "roly-polies," are often found underneath logs or rocks. Why do the bugs choose such environments? Is there an experimental way to find out?

First, ask the class as a group to venture hypotheses about why the sow bugs prefer the under-rock or under-log environment. Write their ideas up on the board in the form of a concept chart. The chart should include not only reasons for the preference (such as hiding from predators, or being near sources of food) but "triggering mechanisms": On the most concrete level, what characteristics of an environment attract the sow bugs? How does a sow bug "know" which way to turn, which way to go toward a desirable environment?

Make sure there is a list of testable hypotheses on the board before proceeding to the next phase.

Second, assign students to groups of five. Ask each group to select a hypothesis to test (make sure the main hypotheses are covered). Give each group a shallow cardboard box, some sand, access to water, a large piece of cardboard (for shade), and 10 sow bugs. Have the groups design an experiment to test their hypothesis.

You may wish to use cooperative learning techniques. For example, you may assign roles to students within each group, such as materials captain, summarizer, recorder, envoy (this person meets with representatives of other groups to find out how others are proceeding), and animal rights monitor (this person makes sure the sow bugs are treated gently and humanely).

Third, after the several experiments have been conducted, pull together the whole class again and ask groups to share their results. Conduct a discussion to determine which of the original questions have been answered. How certain can the class be of their results? What other possible explanations might there be that have not been tested? What are the implications of their findings? *Why* would the sow bug seek a certain

environment? How many ways can the class think of that this preference might be advantageous (for avoiding predators, finding nutrition, or reproducing the species)?

The sow bug experiment followed a model that is typically used when secondary science students are working in a laboratory. The model follows three phases.

Phase One: Arousing interest. In the initial phase, students are exposed to a phenomenon that arouses interest, and are encouraged to raise questions about it. Students are further encouraged to restate their questions in the form of hypotheses that can be tested.

Phase Two: Investigating to answer questions. Students are now asked to design tests of their hypotheses. The teacher discusses the experiments to see which ones will be feasible.

Phase Three: Drawing conclusions and reflecting on the results. The act of drawing conclusions may be simple, or it may lead to the application of statistical formulas to decide if the findings are more likely to be related to one of the variables than to chance. Beyond drawing of conclusions, however, students should ask the next question: "So what?" How does this knowledge about sow bugs' environmental preferences relate to larger issues, such as their survival?

Science Teaching Models and the RWCT Learning Cycle

The teaching and learning model advanced by the RWCT Project has three parts. It begins with a stage we call evocation, in which students' curiosity is aroused, their questions elicited, and their reasons for inquiring established. It proceeds to an evocation of meaning stage, in which they are encouraged to inquire, and in some cases, taught to do so. It culminates in a reflection phase, in which students are asked to summarize their knowledge, compare what they have learned to what they knew before, assess to what extent their questions were answered (and formulate new questions, as necessary), apply what they have learned to greater concerns, construct, debate, and defend interpretations of what they have learned. Is the Evocation/Realization of Meaning/Reflection model similar to the models for teaching and learning science we have just reviewed? Clearly it is. The similarities are summarized in the chart on the next page.

Comparing RWCT at the Elementary and Secondary Level

RWCT CATEGORIES:	Evocation	Realization of Meaning	Reflection
Elementary Teaching Model	Exploration	Explanation	Expansion
Secondary Teaching Model	Arousing Interest	Investigating to Answer Questions	Drawing Conclusions and Reflecting on the Results

The model for teaching and learning science at the elementary level and also the model for teaching science in a laboratory at the secondary level begin with a phase of exploration. The goals of this phase are substantially the same in both science models: to arouse curiosity, to help the students raise questions, and to guide the students in setting purposes for learning. The goals of the evocation phase in the RWCT model are virtually identical.

The model for teaching elementary science next has an explanation phase. The purpose here is to have the students draw conclusions and articulate concepts that are implicit in the phenomena they have been exploring. The corresponding phase in the secondary laboratory model is somewhat more formal: in the phase of investigating to answer questions students are expected to design experiments that will, for example, test competing hypotheses and carefully note the results. Again the goals of the realization of meaning phase in the RWCT model are essentially the same. Having set their own purposes for learning, students now are expected to find out what they set out to know, and the emphasis is placed on learning and using inquiry strategies that not only will shed light on the present question, but will have continuing utility as tools for future learning about other questions.

The final phase of the RWCT model is reflection, in which students assess the adequacy of the conclusions they reached as answers to the questions they raised at the outset. They explore the import of the meaning, examine it, apply it, consider its implications and its limitations, and decide what further investigation should be done. This phase also is paralleled in the other two models: the elementary-level science teaching model culminates in a phase of expansion, in which students are encouraged to relate their findings back to their original questions, and

also to make connections to their own lives or to other issues they know and care about. In the secondary teaching model, the culminating stage of drawing conclusions and reflecting on results has similar aims.

Teaching Science With Texts

No matter how active we would like our science curriculum to be, there is far more material to be learned than students can ever discover by direct experience. The work of thousands of scientists working over hundreds of years has given us a body of knowledge that we can learn about through lectures, books, films, and computers and the Internet. For much of this necessarily "received" knowledge, a process of inquiry learning still can be used. But now the procedures are the same as those that have been promoted in the RWCT workshops: The know/want to know/learn strategy, the enhanced lecture method, and the various co-operative learning and write-to-learn activities.

APPENDIX B

Texts for Use in Workshop Activities

As Best She Could

Donald Jones

Old widow crazed with hunger, you came in crippled,
your back country eyes bright and furtive, your voice
careening between a whimper and wild thin laughter.
I saw you take the edge of the chair and cower
as the social worker cut through your explanations,
your patches of self-respect, with her curt queries.
Terrible your smile when asked about your holdings
in bonds, in bank accounts, in property,
your look when reminded of life insurance lapsed.
She wouldn't believe you lived as best you could
on the meager uncertain amount your daughters sent you
and paid no rent to an old and kindly landlord.
She took your naked terror of death for greed
and probable fraud, denied you, sent you off
for written proofs from daughters out of state.
Their misspelt notes came in some three weeks later,
your card for medical care went out, but soon
came back from Public Health a cancellation.
No blame attached, the regulation followed,
your death quite likely in any case, but still
I see you rise and quiver away, your stiff heart
pounding with baffled rage, with stifled pride.

Marco Polo, Adventurer

In 1298 a Venetian adventurer named Marco Polo wrote a fascinating book about his travels in the Far East. Men read his accounts of Oriental riches and became eager to find sea routes to China, Japan, and the East Indies. Even Columbus, nearly 200 years later, often consulted his copy of *The Book of Ser Marco Polo*.

In Marco's day the book was translated and copied by hand in several languages. After printing was introduced in the 1440s, the book was circulated even more widely. Many people thought that the book was a fable or a gross exaggeration. A few learned men believed that Marco wrote truly, however, and they spread Marco's stories of faraway places and unknown peoples. Today geographers agree that Marco's book is amazingly accurate.

Marco Polo was born in the city-republic of Venice in 1254. His father and uncles were merchants who traveled to distant lands to trade. In 1269 Marco's father, Nicolo, and his uncle Maffeo returned to Venice after being away many years. On a trading expedition they had traveled overland as far as Cathay (China). Kublai Khan, the great Mongol emperor of China, asked them to return with teachers and missionaries for his people. So they set out again in 1271, and this time they took Marco.

From Venice the Polos sailed to Acre, in Palestine. There two monks, missionaries to China, joined them. Fearing the hard journey ahead, however, the monks soon turned back. The Polos crossed the deserts of Persia (Iran) and Afghanistan. They mounted the heights of the Pamirs, the "roof of the world," descending to the trading cities of Kashgar (Shufu) and Yarkand (Soche). They crossed the dry stretches of the Gobi. Early in 1275 they arrived at Kublai Khan's court at Cambaluc (Peking). At that time Marco was 21 years old.

At the Court of the Great Khan

Marco quickly became a favorite of Kublai Khan. For 3 years he governed busy Yangchow, a city of more than 250,000 people. He was sent on missions to far places in the empire: to Indochina, Tibet, Yunnan, and Burma. From these lands Marco brought back stories of the people and their lives.

The Polos became wealthy in Cathay. But they began to fear that jealous men in the court would destroy them when the khan died. They asked to return to Venice. Kublai Khan refused. Then came an envoy from the khan of Persia. He asked Kublai Khan for a young Mongol princess for a bride. The Polos said that the princess' journey should be guarded by men of experience and rank. They added that the mission would enable them to make the long-desired visit to Venice. The khan reluctantly agreed.

Because there was danger from robbers and enemies of the khan along the overland trade routes, a great fleet of ships was built for a journey by sea. In 1292 the fleet sailed, bearing the Polos, the princess, and

600 noblemen of Cathay. They traveled southward along Indochina and the Malay Peninsula to Sumatra. Here the voyage was delayed many months.

The ships then turned westward and visited Ceylon and India. They touched the East African coast. The voyage was hazardous, and of the 600 noblemen only 18 lived to reach Persia. The Polos and the princess were safe. When the Polos landed in Venice, they had been gone 24 years. The precious stones they brought from Cathay amazed all Venice.

Later Marco served as gentleman-captain of a ship. It was captured by forces of the rival trading city of Genoa, and he was thrown into a Genoese prison. There he wrote his book with help from another prisoner. Marco was released by the Genoese in 1299. He returned to Venice and engaged in trade. His name appears in the court records of his time in many lawsuits over property and money. He married and had three daughters. He died about 1323.

Pollution of the Air

John H. Thomas and Paul J. Allen

Efforts to improve the standard of living for humans through the control of nature and the development of new products have also resulted in the pollution, or contamination, of the environment. Much of the world's air, water, and land is now partially poisoned by chemical wastes. Some places have become uninhabitable. This pollution exposes people all around the globe to new risks from disease. Many species of plants and animals have become endangered or are now extinct. As a result of these developments, governments have passed laws to limit or reverse the threat of environmental pollution. Let's look specifically at air pollution.

Factories and transportation depend on huge amounts of fuel, and billions of tons of coal and oil are consumed around the world every year. When these fuels burn they introduce smoke and other, less visible, by-products into the atmosphere. Although wind and rain occasionally wash away the smoke given off by power plants and automobiles, the cumulative effect of air pollution poses a grave threat to humans and the environment.

In many places, smoke from factories and cars combines with naturally occurring fog to form smog. For centuries, London, England, has been subjected to the danger of smog, long recognized as a potential

cause of death, especially for elderly persons and those with severe respiratory ailments. Air pollution in London originally resulted from large-scale use of heating fuels.

A widespread awareness of air pollution dates to about 1950. It was initially associated with the area of Los Angeles, California, in the United States. The Los Angeles Basin is ringed for the most part by high mountains. As air sinks from these mountains it is heated until it accumulates as a warm layer that rises above the cooler air from the Pacific Ocean. This results in a temperature inversion, with the heavier cool air confined to the surface. Pollutants also become trapped at surface levels. Because of air-circulation patterns in the Los Angeles Basin, polluted air merely moves from one part of the basin to another part.

Scientists believe that all cities with populations exceeding 50,000 have some degree of air pollution. Burning garbage in open dumps causes air pollution. Other sources include emissions of sulfur dioxide and other noxious gases by electric power plants that burn high-sulfur coal or oil. Industrial boilers at factories also send large quantities of smoke into the air. The process of making steel and plastic generates large amounts of smoke containing metal dust or microscopic particles of complex and sometimes even deadly chemicals.

The single major cause of air pollution is the internal-combustion engine of automobiles. Gasoline is never completely burned in the engine of a car, just as coal is never completely burned in the furnace of a steel mill. Once they are released into the air, the products of incomplete combustion particulate matter (soot, ash, and other solids), unburned hydrocarbons, carbon monoxide, sulfur dioxide, various nitrogen oxides, ozone, and lead undergo a series of chemical reactions in the presence of sunlight. The result is the dense haze characteristic of smog. Smog may appear brownish in color when it contains high concentrations of nitrogen dioxide, or it may look blue-gray when it contains large amounts of ozone. In either case, prolonged exposure will damage lung tissue.

The costs of air pollution are enormous. The American Lung Association cites sulfur-dioxide exposure as the third leading cause of lung disease after active and passive smoking. Contaminants in the air also have been implicated in the rising incidence of asthma, bronchitis, and emphysema, a serious and debilitating disease of the lung's air sacs.

In the mid-1970s, people became aware of the phenomenon called acid rain. When sulfur dioxide emissions from electric power plants combine with particles of water in the atmosphere, they fall to ground

as acid rain or snow. The acidity or basicity of liquids, including rainfall and snow, is measured by a special scale, called the pH scale. Developed in 1909 by the Danish biochemist S.P.L. Sorensen, the pH scale is used to describe the concentration of electrically charged hydrogen atoms in a water solution. A pH of 7.0 means that the solution is neutral. A pH above 7.0 means the solution is basic; below 7.0 means the solution is acidic. Normal rainwater has a pH of 5.5. The National Center for Atmospheric Research has recorded storms in the northeastern United States with a pH of 2.1, which is the acidity of lemon juice or vinegar. In Canada, Scandinavia, and the northeastern United States, acid rain is blamed for the deaths of thousands of lakes and streams. These lakes have absorbed so much acid rain that they can no longer support the algae, plankton, and other aquatic life that provide food and nutrients for fish. Acid rain also damages buildings and monuments. Scientists are concerned that the deaths of thousands of trees in the forests of Europe, Canada, and the United States may be the result of acid rain.

Another new and troubling form of air pollution comes from a variety of chemicals called chlorofluorocarbons, also known as CFCs. These chemicals are used for many industrial purposes, ranging from solvents used to clean computer chips to the refrigerant gases found in air conditioners and ice boxes. CFCs combine with other molecules in the Earth's upper atmosphere and then, by attaching themselves to molecules of ozone, transform and destroy the protective ozone layer. The result has been a sharp decline in the amount of ozone in the stratosphere. At ground level, ozone is a threat to our lungs, but in the upper atmosphere ozone works as a shield to protect against ultraviolet radiation from the sun. If the ozone shield gets too thin or disappears, exposure to ultraviolet radiation can cause crop failures and the spread of epidemic diseases, skin cancer, and other disasters. In late 1987, more than 20 nations signed an agreement to limit the production of CFCs and to work toward their eventual elimination.

Air pollution has been the target of some of the most complicated and far-reaching legislation ever enacted. In 1970, the United States Congress passed legislation aimed at curbing sources of air pollution and setting standards for air quality. A few years later, Congress passed laws designed to phase out the use of lead as an additive in gasoline. Since 1975, the level of lead in the average American's bloodstream has declined. Further action against the causes of acid rain is continually debated in North America and throughout Europe.

Although the release of toxic chemicals into the atmosphere is against the law in most countries, accidents can happen, often with tragic results. In 1984, in Bhopal, India, a pesticide manufacturing plant released a toxic gas into the air that within a few hours caused the deaths of more than 2,000 people.

Acid Rain

When fossil fuels such as coal, gasoline, and fuel oils are burned, they emit oxides of sulfur, carbon, and nitrogen into the air. These oxides combine with moisture in the air to form sulfuric acid, carbonic acid, and nitric acid. When it rains or snows, these acids are brought to Earth in what is called acid rain.

During the course of the 20th century, the acidity of the air and acid rain have come to be recognized as a leading threat to the stability and quality of the Earth's environment. Most of this acidity is produced in the industrialized nations of the Northern Hemisphere: the United States, Canada, Japan, and most of the countries of Eastern and Western Europe.

The effects of acid rain can be devastating to many forms of life, including human life. Its effects can be most vividly seen, however, in lakes, rivers, and streams and on vegetation. Acidity in water kills virtually all life forms. By the early 1990s tens of thousands of lakes had been destroyed by acid rain. The problem has been most severe in Norway, Sweden, and Canada.

The threat posed by acid rain is not limited by geographic boundaries, for prevailing winds carry the pollutants around the globe. For example, much research supports the conclusion that pollution from coal-powered electric generating stations in the midwestern United States is the ultimate cause of the severe acid-rain problem in eastern Canada and the northeastern United States. Nor are the destructive effects of acid rain limited to the natural environment. Structures made of stone, metal, and cement have also been damaged or destroyed. Some of the world's great monuments, including the cathedrals of Europe and the Colosseum in Rome, have shown signs of deterioration caused by acid rain.

Scientists use what is called the pH factor to measure the acidity or alkalinity of liquid solutions. On a scale from 0 to 14, the number 0 represents the highest level of acid and 14 the most basic or alkaline. A solution of distilled water containing neither acids nor alkalis, or bases, is designated 7, or neutral. If the pH level of rain falls below 5.5, the rain

is considered acidic. Rainfalls in the eastern United States and in Europe often range from 4.5 to 4.0.

Although the cost of such antipollution equipment as burners, filters, and chemical and washing devices is great, the cost in damage to the environment and human life is estimated to be much greater because the damage may be irreversible. Although preventative measures are being taken, up to 500,000 lakes in North America and more than 4 billion cubic feet (118 million cubic meters) of timber in Europe may be destroyed before the end of the 20th century by acid rain.