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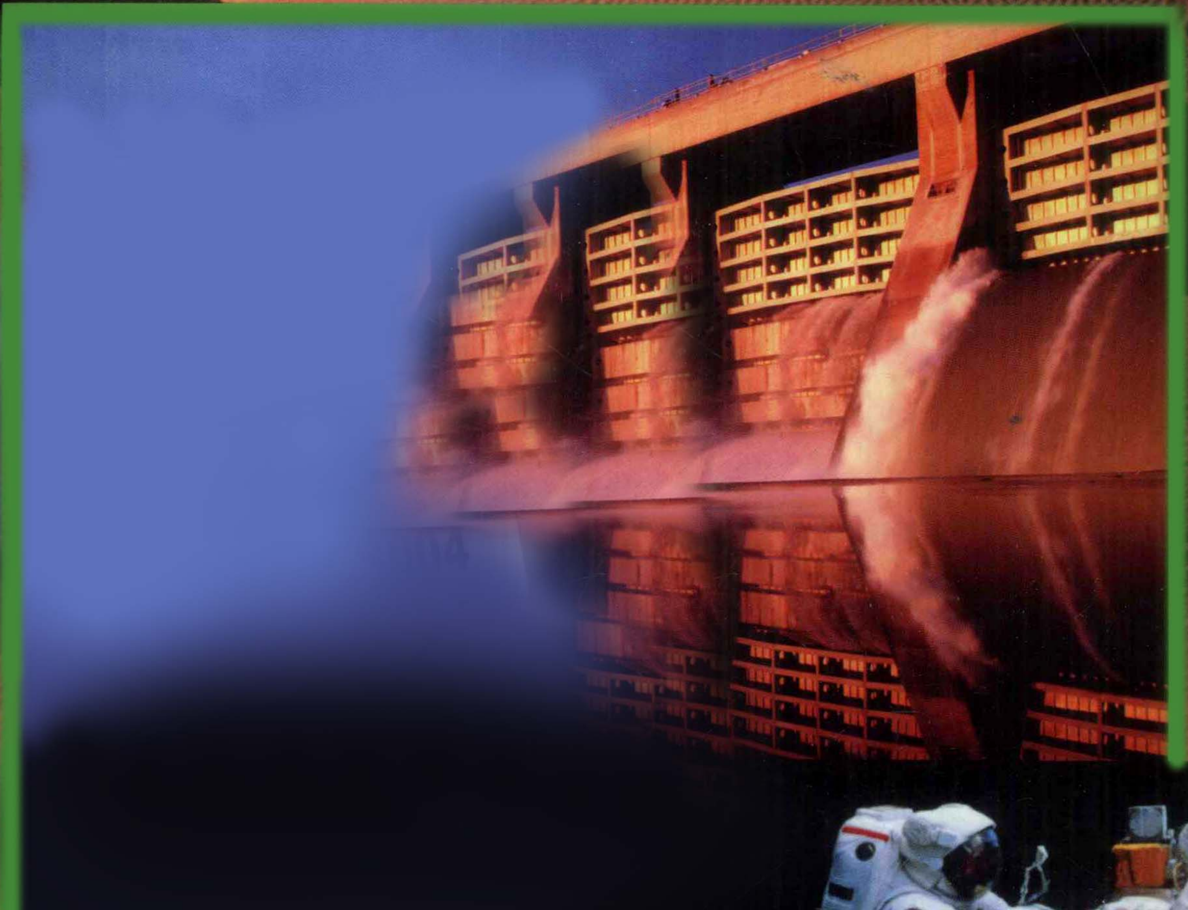
SCIENCE PROBE I

TEACHER'S GUIDE



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SCIENCE PROBE I

TEACHER'S GUIDE

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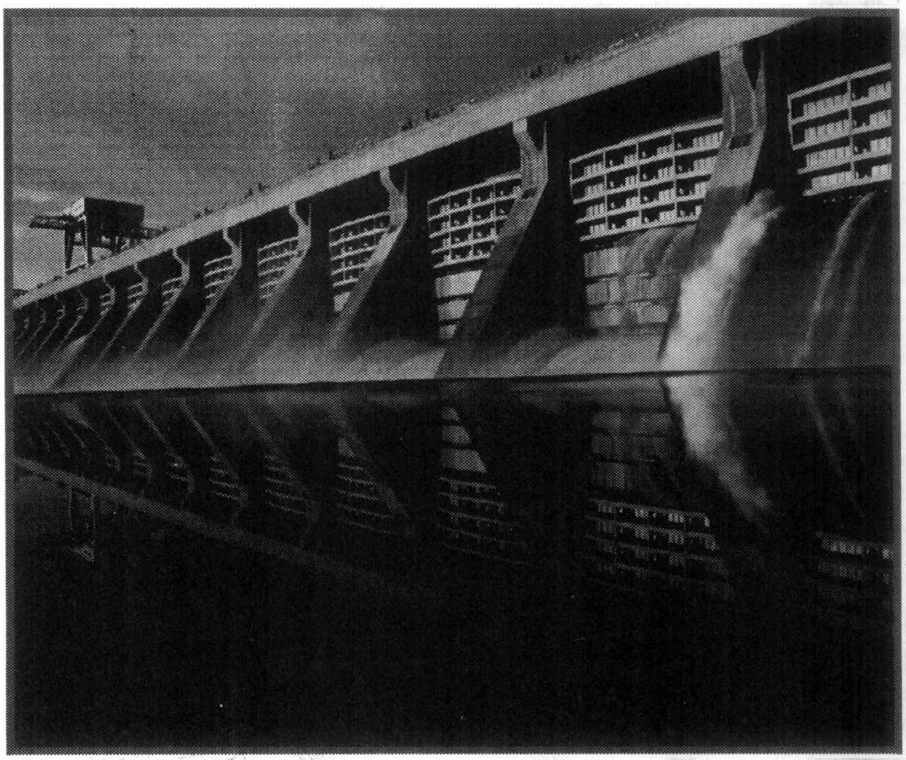

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A Letter from the Authors on Science Reform

REFORM HISTORY

Many organizations have been calling for reform of science education since the United States was embarrassed and shocked with the launching of the Soviet Union's *Sputnik* in 1957. We knew, as a nation, that if we were to compete in the race for space, we would have to make science education a priority. In the mid-1980s the American Association for the Advancement of Science (AAAS) established Project 2061 and published *Science for All Americans.* The AAAS established scientific literacy in learning outcomes for all students, called Benchmarks. In 1969 the Stanford Research Institute International suggested that the National Science Foundation (NSF) support an educational model that would bring a larger population into science careers, objectively "broadening the pool" of scientists rather than "skimming the cream." The NSF urged educators to focus on science education for the general public, concentrating resources on the majority rather than on the advantaged few. Motivating the average student to take more science courses would lead to a totally different mix among outstanding scientists, which is much needed in our nation.

SCOPE, SEQUENCE, AND COORDINATION

An initial report written in 1989 by the National Science Teachers Association (NSTA) Executive Director, Bill Aidridge, called "Essential Changes in the Scope, Sequence, and Coordination of Secondary School Science," gave direction to the reform movement. The report states, "The fundamental problem with high school biology, chemistry, and physics courses is that they are not coordinated, are highly abstract and theoretical, do not spend enough time on each subject, and do not use correct pedagogy; in short, we never give students the chance to understand science." The proposed models suggested that students be taught science in such a way that they would be able to understand and apply it, whether as scientists or citizens. The proposed scenarios for redesigning high school science curriculua are modeled after secondary school science curricula used in Japan, Russia, China, and most European nations. Rather than the traditional "layer cake" curriculum composed of three separate and discrete science courses of biology, chemistry, and physics, taught over three years, the curriculum would teach each subject, as well as earth/space science, concurrently each year.

The funding supplied by NSF and the Department of Education supported seven national centers for the Scope, Sequence, and Coordination reform project; the first group, the NSTA in Washington, D.C., provided national coordinating. The other piloting centers were in California, Texas, North Carolina, Puerto Rico, Iowa, and Alaska. The task of bringing together all this preliminary work in science reform is now underway at the National Research Council, in a project leading to National Science Education Standards K–12.

NEED FOR REFORM

There have been many studies supporting the need to reform science education in the United States. These studies have indicated that we as a nation are failing to educate students to compete in a world market. The demand for scientists and engineers is not being met, nor are students prepared to be citizens of the 21st century. Schools need to educate students to live day to day in a world that is increasingly dependent on sophisticated and rapidly changing science and technology. More and more students are leaving schools without a basic understanding of reading comprehension, science, mathematics, or technology. Students leave school with the minimum requirements in science because they perceive science as boring, irrelevant, or too difficult for them. While many students are dropping out of science, only a small elite group of students enroll in upper-level science courses. These students are usually tracked from a very early age. Many of these students "burnout" in high school science. Many go on to major in other areas in college. So not only do we lose many advanced students, we lose many of the average students as well. Our nation needs everyone if we expect to remain competitive in a world market.

Students can no longer compete by memorizing information, because the data base is multiplying exponentially. Students must be able to access, apply, and critically analyze information in today's world. An integration of the studies on reforming science indicates that if all students are really to learn science, then our science framework must change. A reformed science framework is designed around three fundamental questions: What do we mean? How do we know? and Why do we believe? Then students, according to the Aldridge paper, ". . . will know how and when to ask questions, how to think critically, and how to make important decisions based on reason rather than emotion or superstition." Meaning will come from experience. Understanding of how we know will come from examining the results of investigations. Why we believe is based on students constructing their own knowledge by creating their own models, decisions, hypotheses, or theories. The new curriculum design gives students the opportunity to understand science. The traditional approach to measuring success in science will no longer be based on how well students memorize theoretical and abstract information and facts that they cannot apply nor understand.

SCIENCE REFORM

The National Science Teachers Association (NSTA) initiated the Scope Sequence and Coordination Project (SS&C) in early 1989 to implement both the past and current research and development efforts at the high school and middle school levels. Research on the spacing effect by Dempster (1980) showed that students should be taught science a few hours a week over several years instead of concentrated into one year.

Scope in the SS&C project is provided for by spacing and spreading out the study of each science discipline over several years. A coordinated or integrated approach can accomplish the spacing effect. In the coordinated approach, each of the four disciplines of biology, chemistry, physics, and earth/space science are connected within units, each discipline being addressed individually and equitably within the school year. In successive years, the four disciplines are continually addressed with greater and greater depth. This is the approach *Science Probe* has taken. An integrated science curriculum is one in which the lines between the disciplines are not seen. The course, written around themes, refers to all the disciplines continually. For example, a lesson titled "Burning and Bonding" includes chemical reactions, cellular respiration, rock formation, and the earth's stratification in one unit of study.

Sequencing refers to the continuity and progression of instruction. This involves decisions about when to introduce science concepts and processes and how to revisit and enrich them over time. SS&C emphasizes taking into account a student's prior knowledge and how each student learns. First hands-on experiences and concrete descriptions lay a foundation of learning. Abstract symbolism and quantitative expressions complete the sequence of learning. Arons and Karplus (1976) and Bruner (1960) all support the importance of sequencing. Piaget (1973), in *To Understand Is to Invent: The Future of Education,* also suggested the importance of experience with hands-on science phenomena preceding terminology. Students will learn in steps. First, students learn a concept from more than one experiment, with an experience in as many different contexts as possible. This is where 40% hands-on laboratory experiences are so critical to science reform. Once concepts are established, they should be symbolized, and those symbols related to each other. Science requires language to explain it. Finally, more complex relationships can be established over time.

Coordination is the degree to which the physical sciences, life sciences, and earth/space sciences are connected within and among topics and processes they all have in common. This leads students to an awareness of the interdependence of the sciences as a part of a larger body of knowledge. *Science Probe* coordinates all science disciplines, as well as providing students with opportunities to integrate other subject areas with science learning in cross-curricular activities.

The ultimate goal of both the SS&C reform project and the authors of *Science Probe* is to space learning over several years and move from experience, to concepts, to abstraction in a well-planned sequence and coordination, helping students construct their own knowledge using the constructivist approach. Harms and Yager (1981) stress the importance of students constructing their own knowledge of science by formulating and testing solutions to problems that occur in their daily lives or in society. The reports of Resnick (1967) and Driver (1989) indicate the difficulty teachers have teaching elementary science concepts due to students' preconceived explanations for natural phenomena, which persist even after students are correctly taught. To address this issue, students write in their journals what they already know about the topic being studied. Finally, students compare how their response has changed at the end of the chapter. *Science Probe* also provides many activities for students to experience, experiment, role-play, debate, research and write about ethical issues, and design their own experiments in authentic assessment activities. This gives *all* students the opportunity and motivation to examine issues and challenge preconceptions. Many times students learn more from each other and from a teacher who is facilitating instruction rather than controlling instruction through a traditional lecture. As an educational tool, *Science Probe* endeavors to help fulfill the goals and learning outcomes of the new reformed science curriculum for both the teacher and student. The features of the teacher's resource guide will elaborate specifically how material in each unit will meet these needs for both student and teacher.

Susan Thee
Gary Sokolis

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Features of the *Teacher's Guide*

The *Teacher's Guide* (TG) has been designed to meet the needs of both novice and experienced science teachers.

The Introduction features five sections that cover the pedagogical content and context of the student book. These sections are:

- Teaching Science
- Learning in Science
- Public Issues and Science Teaching
- Basic Skills Assessment
- Remediation Activities

The Introduction also contains a Content Matrix, a yearly Time Line, and a National Science Education Standards Matrix. Following the Introduction is TG material pertaining specifically to each unit and chapter. An explanation of their organization follows.

HOW UNIT MATERIALS ARE ORGANIZED

- **Unit Interest Catcher** supplies suggestions for piquing student interest in the unit with a Story Line and demonstration. Included are suggested questions to help stimulate student thinking.
- **Intended Learning Outcomes** outlines what students should be able to do after completing the unit in regard to Attitudes, Skills and Processes, Scientific Knowledge, and Thinking Abilities.
- **Unit at a Glance** lists the corresponding student text page of all sections, subsections, activities, features, and reviews (questions) within the unit.
- **Advance Planning** alerts teachers to any preparation they might consider before beginning the unit and, in some cases, supplies pedagogical suggestions on the teaching of the unit. Further suggestions are included in the **Advance Planning** section at the beginning of each chapter.
- **Authentic Assessment** provides an end-of-unit assessment that reflects the instructional strategies of the unit and accommodates diverse learning methods. This feature includes a Unit Story Line, Performance Assessment, Teacher Background Information, and Performance Standards.
- **Suggested List of Resources** categorizes supplementary resources available for the unit under the headings Audiovisuals, Books, Magazines and Periodicals, and Computer Programs, as appropriate.
- **Blackline Masters** can be photocopied for distribution to students. The last section of some units contains additional activities, important drawings, and charts or other original masters.

HOW CHAPTER MATERIALS ARE ORGANIZED

- **Advance Planning** suggests steps to have materials on hand when needed and a Time Line for the chapter.
- **Materials at a Glance** lists essential materials needed for each activity within individual chapters. This list does not include materials for authentic assessments and optional activities.

- **Chapter Interest Catcher** provides suggestions to focus student interest on the intent of the chapter. It includes a Story Line to help show relevance of materials in the chapter and questions to stimulate student thinking.
- **Suggested Teaching/Learning Strategies** are provided for each chapter and include the chapter intent, a chapter vocabulary list; pedagogical and background information regarding each activity and major sections and subsections in the chapter; extension, research projects, enrichment activities, and student materials supplied on blackline masters that can be photocopied for distribution; expected results and answers for all text activities and questions; and additional or alternative activities for teacher consideration. The enrichment activities may also be used as open-ended questions for additional authentic assessment.
- **Chapter Review** includes questions answered and discussed.
- **Chapter Test,** which includes a variety of question types and levels of questions concludes each chapter. The answers to the test are supplied after the chapter test. The enrichment questions may be used as additional open-ended questions.
- **Blackline Masters** can be photocopied for distribution to students. The last section of each chapter of the Teacher's Guide contains additional activities, important drawings, and charts or other original masters.

SAFETY

Every effort has been made to ensure that the activities in the student text and in the Teacher's Guide are as safe as possible. Ultimately, student safety is the responsibility of the teacher in the classroom. You should review the Safety Rules (pages ix–xii in the student text) carefully with your students at the beginning of the year. Emphasize the importance of labelling anything students may make in the laboratory as part of a student experiment. Make sure that all stock chemicals are also carefully labelled and stored.

Emphasize the correct use of hot plates (Safety Rule 31). Remind students to pull the plug of an electrical cord, not the cord itself. Make sure that electrical cords are placed so that no one can trip over them.

Explain clearly that the **"No Crowding Zone"** is an area around equipment in which only the person who is operating the equipment is allowed to stand. Crowding around an equipment space can result in injury should an accident occur, and some students might inadvertently push others into the equipment itself. Instruct students to stay outside the **"No Crowding Zone"** and not to push.

You should be well versed in accident-prevention procedures as outlined by your school or district.

Teaching Science

How we teach depends to a large extent on how we understand the processes involved in learning. If, as science teachers, we are to encourage students to think as scientists, then, like scientists, students need to evolve individual explanations of happenings around them, be required to test these explanations, and be allowed to share these explanations with others. Insights gained from research into science education suggests that learning occurs by the learner actively interacting with the environment and not by responding passively to it. Since people learn in a variety of ways and at different rates, learning becomes both an individual and a social process. With this as a basis, we can construct a view of learning and the learner that might inform science teaching.

The information that follows is divided into three sections. The first will describe a view of learning and the learner. The second will outline a teaching sequence based on this view of learning. The third section will describe various teaching strategies that may be used to assist students in learning science in school.

LEARNING AND THE LEARNER

Given that students must be active in their own learning and that they learn in a variety of different ways, both individually and socially, there are four key points that might be made about the learning process. All of these are interrelated and have only been separated for the purpose of explanation.

Students' prior knowledge and conceptions influence what they learn. Students come to science class with their own ideas about the world and how it works. They have gained these ideas from personal experience of natural phenomena, other science lessons, parents, television, friends, and so on. Because these ideas fit the students' own experience, they are often strongly held. For example, students might believe that a continuous application of force is always necessary to keep something moving. "If you don't keep pedaling, your bike slows down and stops." And humans are not animals, because it is "rude" to call someone an animal. Students will interpret new situations in light of their own ideas, and what they learn may not reflect what was originally intended.

Learning often involves "conceptual change." Learning in science often involves more than simply adding to students' existing ideas. It may often be necessary for students to develop or change ideas they already hold. If a teacher is aware of students' ideas about a particular topic, then experiences may be provided that will challenge these ideas and allow students to alter their existing conceptions. A presentation and discussion of an example from space might challenge students' ideas about the necessity for the constant application of force for continued movement. Consideration of the features that all animals share might help students understand that humans are animals.

Social interaction is important in learning. Learners need to be aware of the ideas of others and learn to collaborate with others, so they can see that there are other possible explanations for events, and how their own ideas compare with those of others. In conversation, a number of things happen. Ideas must be clearly stated in such a way that people can understand what is meant. Some people may agree and reinforce your ideas, or they may disagree and comment in such a way that might cause you to change your ideas. Thus, knowledge is largely socially constructed. The knowledge of science is socially constructed and consists mainly of those conventions the scientific community currently agrees on.

Students' learning is facilitated when they are encouraged to express their ideas and when they are treated with respect in a supportive, risk-taking environment. If a student's ideas are to change as a result of experiences in science class, those ideas need to be made explicit. Then a student may examine and test his or her ideas with the teacher and with peers. Students' ideas might best be viewed not as wrong, but as different, and of varying degrees of usefulness. They should be listened to with interest and questioned for clarification and meaning. Often what sounds like an incorrect idea is actually a difficulty in expressing the idea in words. Students need to be actively involved in learning, but to do so involves the risk of looking foolish in front of others. If students' conceptions are valued and treated with respect, it will be easier, and more enjoyable, for them to articulate and examine their own ideas.

A TEACHING SEQUENCE

Science Probe has been structured to allow for a particular teaching sequence that is based on an understanding that learners construct their own knowledge and ideas as a result of personal experience and through social interaction with adults and peers. It is important to note that *Science Probe* will continue to support other methods of teaching science. Should you have a different way of approaching the teaching of science you will find all that you need in this text. There are some activities that you may wish to leave out, but this will not interfere with the flow of the text or your teaching. This teaching sequence also takes into account the fact that students come to any learning situation with their own ideas and that these ideas may require elaboration or modification as a result of science teaching. A teaching sequence such as this works best, as you have seen above, in a supportive environment.

The following are the five steps of this particular teaching sequence. Perhaps it is best to view these as five components of a model for teaching that facilitates student learning.

Orientation "sets the scene for the work to come" and provides motivation for learning. Each chapter of *Science Probe* provides an introduction designed to accomplish this. You may wish to add activities in the form of class or small group discussion, teacher demonstration, film, video, or newspaper clippings that arouse students' interest in a particular aspect of a topic in science.

Elicitation activities allow students to bring out their own ideas and share them with their classmates and the teacher. In this "exposing event," students make their own ideas explicit, to themselves and to others, and have an opportunity to see the range of ideas in the class and where theirs fit in. Each chapter begins with such an elicitation activity. Its purpose is to allow both students and teacher to become aware of the kinds of ideas students have about the topic to be covered in the chapter. As well, there are opportunities within each chapter for students to state their ideas before encountering experiences that will allow them to examine and test their own ideas.

You may wish to design elicitation activities of your own. Some examples of strategies you may use for this are small group discussion; whole group sharing/reporting back; making posters (that can be posted for the duration of the teaching sequence); concept mapping; mind mapping; answering questions and comparing answers; agreeing/disagreeing with statements individually and in groups; categorizing and predicting; experimenting and investigating; and writing.

Restructuring consists of a series of activities that allow students to modify and extend their own ideas. In this section of the teaching sequence, students are exposed to conflict situations, anomalies, or "discrepant events," and have the opportunities to clarify and exchange ideas with others, to construct new ideas, and finally to evaluate their new ideas. The various activities undertaken during restructuring should promote "conceptual conflict" and allow for evaluation and testing of ideas. Activities, including the readings, in each chapter of *Science Probe* should provide the kind of experiences necessary for students to learn in this way.

Strategies used at this point will present alternate views for students' consideration and testing. Some examples are demonstrations, experiments (especially those designed by students to test their own ideas), POE (predict, observe, explain), readings, teacher presentation of an alternate view, video presentations, small group and whole class discussion, and writing.

Application provides students an opportunity to use newly constructed ideas in different contexts in order to consolidate and reinforce these conceptions. Certain of the activities, as well as optional activities, in each chapter will allow for this application of new ideas. At the end of the chapter, Connections and Explorations questions encourage students to apply new learning in different contexts.

Other strategies you may use at this point will allow students to use their new ideas. Some examples are making posters, problem solving, answering questions, creating questions, small group discussion, projects, and writing (especially creative writing).

Review in this teaching sequence involves a comparison of newly constructed ideas with those originally held. If students have elicited their own ideas at the beginning of a chapter or a section, then they can look back to see how their ideas have changed, and how this has occurred and why. Note that this is not review in the traditional sense; rather, this kind of review involves students *thinking* about their own thinking and *learning* about their own learning.

Strategies that may be used at this point will allow students to look back at their original ideas and make comparisons with those they now hold. The Reflections section at the end of each chapter provides one or two questions that will stimulate students to examine how their ideas have changed. Some examples of other strategies that may be used for this purpose are concept mapping, mind mapping, redoing posters, small group discussion, and writing.

TEACHING STRATEGIES

The following section elaborates on some of the teaching and learning strategies mentioned above.

Small Group Discussion. In class discussions, few talk and many listen. On the other hand, small groups encourage more students to express their ideas because there is greater opportunity and the situation is less threatening. In a small group discussion around an activity, reading, or question assignment, students elicit, clarify, and refine their own ideas. They also become aware of the conceptions of others, that there are other ways of explaining a given phenomenon, and they have an opportunity to modify their ideas through social interaction. You may wish to look into "Cooperative Learning" (e.g., Johnson, Johnson, and Holubec, 1986) for ideas on how to structure groups for cooperation and positive interdependence.

Reporting Back. You may wish to have small groups report back to the whole class on the results of their discussion. This may be facilitated by the production of a poster or visual representation of their ideas. In reporting back, students have the opportunity to see and hear the ideas of other groups in the class and to ask questions for clarification. Such an activity may be time consuming but will provide groups with the opportunity to clearly express the ideas they have developed. It is usually best if one member of the group is chosen to report for the group.

Writing. Writing is a powerful teaching and learning strategy. When ideas are elicited in writing, students must take pains to be clear about what they mean. Writing to someone else, besides the teacher, helps students clarify their ideas. In restructuring, writing provides a way to explore and reflect on new ideas. Writing can also be used to vary the context of the application of ideas. Writing to a different audience (for example, younger students, parents, a scientist), or writing in an imaginary context will allow students to apply new learning and to think about the ideas of science in a variety of ways. You might consider the use of learning journals with your students. A learning journal is a good place to write about existing ideas, new learning, and thoughts, in a reflective and nonthreatening way. The writing process and whole language initiatives might provide ideas to vary writing assignments in science. You might experiment with posters, writing lab reports in different ways, and creative writing assignments.

Predict, Observe, Explain (POE). This strategy incorporates both elicitation and restructuring. For any of the activities in this text, students can be asked to predict what they think the outcome might be, and to give reasons for their predictions. Thus, students' ideas are elicited. After conducting the activity and observing what actually does occur, students are then asked to explain why they think this is so. The actual occurrence may provide an anomaly or discrepancy, and cause students to change their original ideas. The explanation part of POE will encourage students to make clear to themselves and others how their ideas have changed. Hearing or reading students' predictions will give you an idea of the variety of ways in which they are thinking about the activity, and will provide clues as to how you might wish to structure the activity and what you might wish to emphasize about it to students.

Concept Mapping. Concept mapping has been dealt with extensively in **To the Student** in the text, and in the Learning in Science section of this Teacher's Guide. Concept mapping can be used in a variety of ways. In the text, it is used to encourage students to make connections among new vocabulary terms. You might also wish to use "before and after" concept maps to take into account the elicitation and review components of the teaching strategy elaborated above. Before teaching a lesson, you might give students some of the terms to be introduced and see how they make connections among them. At the end of the lesson or unit, students can construct another concept map and compare this one to their first. For more information on concept mapping you may wish to refer to the book *Learning How to Learn* by Novak and Gowin (1985). Mind mapping is a learning strategy with similar ends but different means from concept mapping. You might like to refer to Buzan (1983) or Lim (1989) for more information on mind mapping.

Investigations. Investigations or experiments are an important teaching and learning strategy in science. Investigations in *Science Probe* are designed to allow students to explore an idea or topic. Questions are asked to guide their inquiry. Any such inquiry is an opportunity for students to test their own ideas. At a number of points in the text, students are encouraged to design their own investigations. Sometimes it is necessary for them to be able to test their own or new ideas, and sometimes it is necessary for them to have the experience of designing and carrying out experiments.

Choice. At a number of points in *Science Probe,* you will notice that students have been given a choice of how they might investigate or express an idea.

Because students learn best in different ways, they often have distinct preferences for working and reporting. Choice is an attempt to recognize and respond to the different learning styles of students and to increase their motivation to learn. As you get to know your students, you may discover their individual preferences and respond to these in various ways in your own lessons. Choice in learning is a powerful motivator.

Questions. There are two important ways in which questions can be used as a teaching and learning strategy in science. First, you will notice that students are often encouraged in the text to ask their own questions. Science is all about asking and seeking answers to questions, and the ability to formulate a question is an important skill. Second, the questions asked in *Science Probe* are often higher-level questions. Such questions may appear too difficult for many students, but any student can use what he or she knows or has recently learned to think about difficult questions. Answers will vary in appropriateness and complexity, but all will have involved the use of ideas and the practice of thinking skills. Finally, allow students time to think. When answering questions, each student should be allowed sufficient time to reflect and formulate an answer.

Reading Activities. A teaching and learning strategy that has been used in *Science Probe* is the reading activity. Students learn best when they are actively engaged. Therefore, before reading, it is a good idea for students to think about what they already know about the topic of the reading and to set up some means for making sense of what they read. Students may make two-column notes in their learning journals, where the first column contains what they know before the reading, and the second column contains information and understanding they have gained from the reading. They may construct charts and tables to organize the information presented in the reading. They might make a flow chart of a process described in a reading. They might make notes or draw diagrams. Any of these "reading activities" will help students to make sense of a reading and increase their learning.

Other Strategies. There are many other strategies that may be used to enhance students' learning. You have many strategies of your own that work and that you will continue to use. *Science Probe* has attempted to introduce some possibilities for science teaching and at the same time support more traditional methods.

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Learning in Science

Students come to science class with many ideas about the world and how it works. They have gained these ideas from their personal experiences of that world. Because these ideas fit the students' own experience, they are often strongly held. Learning in science involves more than simply adding to these ideas. It may often be necessary for students to develop or change ideas they already hold.

You may wish to spend some time on **To the Student** (pages xiii–xv in the student text) with your classes. The ideas presented there will help them think about learning, and encourage them to develop strategies that will enhance their learning in science. The following are suggestions you might find useful for each section of **To the Student.**

CONSIDER WHAT YOU ALREADY KNOW

If students are to develop or modify their ideas about the world, both they and you must be aware of them. Therefore, it is suggested that activities be undertaken that allow students to explain the ideas they already have about a particular topic. You will find their ideas interesting. Driver, Guesne, and Tiberghien (1985) and Osbourne and Freyberg (1985) describe research into children's ideas and suggest that these ideas may be common among all students.

WRITE IN YOUR LEARNING JOURNAL

A learning journal is personal. There are some activities in this text where it is suggested that they be done in the students' learning journals. You may or may not wish to do this. What is *important* here is the personal nature of learning and the opportunity for students to continue to think and learn. A journal also stresses the importance of writing as a learning strategy.

READ ACTIVELY

Even when reading, students need to be actively engaged. Thus, activities have been provided for some readings in the text, and you may wish to design your own for other readings. These activities attempt to go beyond note taking to encourage students to think about what they read.

MAKE A CONCEPT MAP

Concept mapping has been included in this text as a means for students to explicitly make connections among concepts they are learning. It is suggested that students construct concept maps using vocabulary words at the end of each chapter, and concept mapping can be used in a variety of places in each chapter as well. This section of **To the Student** tells students how concept maps are constructed. It will take some time for students to gain this skill, but the payoff in terms of learning will be worth it. It is important that they gain some idea of what a concept is and that they make the connections explicit by writing "connecting words" on the lines.