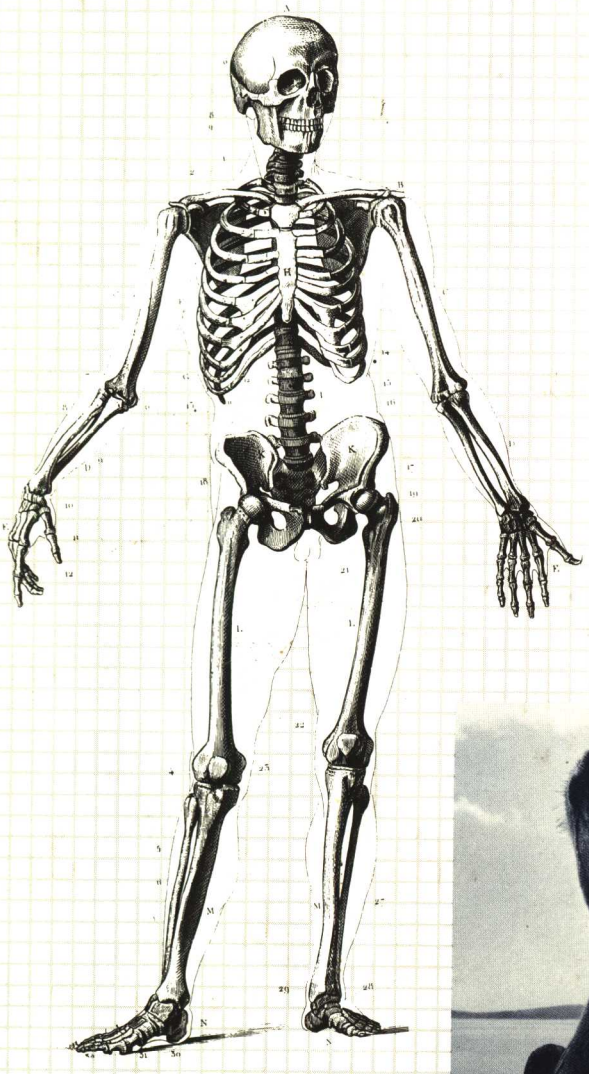
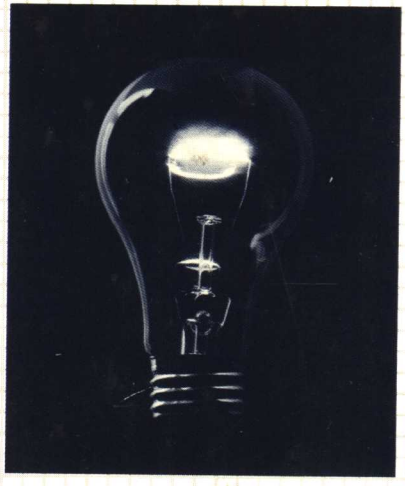
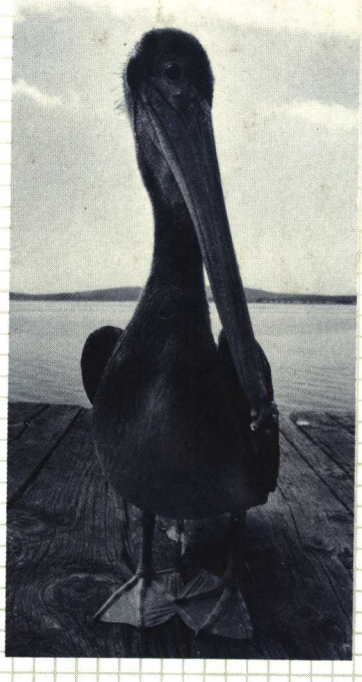
TEACHING ELEMENTARY SCIENCE

Fourth Edition ■ William K. Esler and Mary K. Esler







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Fourth Edition

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TO THE READER

This fourth edition of *Teaching Elementary Science* is dedicated to the same purpose as the original text. That purpose is helping preservice and inservice elementary school teachers acquire the skill, knowledge, and attitudes that will enable them to teach "good" science in their classrooms. As science educators, we are fully aware of the conditions existing in many of our elementary schools that work against the implementation of quality science instruction. We are confident, however, that many of these problems disappear when confronted by a determined and properly prepared teacher.

Since a great variety of science programs and materials exists in elementary classrooms today, this book does not emphasize one curriculum. A program that prepares a teacher to teach one or two curricula is of no use to the teacher who is not fortunate enough to be in a school that has the appropriate materials. The alternative to this approach is to identify the skills, knowledge, and attitudes that enable a teacher to operate in many situations. Good science teachers, in whatever type of program, have certain common characteristics.

1. You should be able to relate science instruction to the cognitive and affective development of children. When students are continuously assigned tasks that are inappropriate, too easy, or too hard, the result is boredom and frustration for both teachers and students. Understanding your students' intellectual structure and development can help you to formulate learning tasks that match their abilities. Understanding the wide range of your students' cognitive skills and being aware of those tasks that can strengthen each skill can also help you formulate procedures that will keep children challenged. The nature of the learner is introduced in Chapters 1 and 2, and the reader is reminded throughout Section One of the relationships of that nature to the learning process.

The child's attitudes toward the teacher and the subject matter are closely related to the nature of the learning activities. Thus, you should understand the nature of the child's involvement as he is engaged in learning tasks. This will help you to structure classroom activities to provide maximum attitudinal changes. Present research indi-

cates that children of diverse cultural backgrounds develop intellectually in much the same way. Therefore, the teaching techniques demonstrated in this book should serve you well, whatever your students' socioeconomic and cultural differences.

2. *You should be able to understand and implement inquiry techniques.* To operate well with the inquiry mode of teaching, you should clearly understand the procedures and possible outcomes of each inquiry technique. Chapter 3 summarizes and describes three basic inquiry techniques and lists four common procedures for introducing an inquiry lesson. Examples of teaching episodes are presented in dialogue form in this chapter and elsewhere. This method of presenting inquiry lessons is intended to help you understand the nature of inquiry as well as to apply inquiry techniques in your classroom. The treatment of inquiry teaching and classroom questioning techniques has been reinforced in this fourth edition of *Teaching Elementary Science*.

Learning Centers and other means of individualizing instruction are commonplace in today's elementary schools. In Chapter 7, you will find an extensive treatment of techniques for adapting individualizing procedures to teach inquiry science in the elementary school classroom.

3. *You should be able to implement didactic teaching techniques in your teaching.* Didactic or direct teaching procedures are used by most teachers to teach science content. Chapter 4 contains a detailed discussion of didactic teaching procedures that due to familiarity are often neglected. Skills for didactic teaching, just as those of inquiry, must be developed with study and practice to achieve optimum results.

4. *You should be able to plan instruction to include both the process and the content of science.* Herein lies the greatest challenge and perhaps the greatest contribution this book has to offer. Inquiry and process are too often presented to science teachers as an either/or proposition. You teach either a textbook or an inquiry program; you teach either the process or the content of science.

This separation of process and product is unnecessary. There is no reason why you cannot teach by employing techniques of inquiry, even in a textbook-based program. By involving children with inquiry activities, you can also help them develop the skills of science; this is true regardless of the nature of their curriculum materials.

The three inquiry techniques discussed in Chapter 3 include the basic teaching procedures prescribed by the activity-oriented laboratory science programs. If you master these procedures, you can easily adapt to any of the new curricula. With some direction you should also be able to reorganize noninquiry programs to include sizable elements of inquiry.

Procedures for helping you implement one or more of the inquiry techniques in a content-oriented textbook program are presented in Chapters 4 and 5. In these chapters you will find a description of the sequence of *inquiry, concepts,* and *information* that will ensure that children understand the science processes even as they experience science lessons based upon a textbook.

There is no evidence to indicate that one technique is preferable to the others. After experimenting with the several inquiry techniques, you may gravitate toward one that complies with your philosophy and suits your style of operation. You may then choose to emphasize that technique, or even to use it to the exclusion of the others.

The very nature of inquiry learning activities causes the learner to develop process skills. The learning activities in Section Two are structured to conform generally to one or another of the three basic inquiry techniques. If you employ one of the activities suggested in Section Two to introduce a concept to children, you may be sure

that it will give them the opportunity to develop one or more of the skills of doing science. This fourth edition of *Teaching Elementary Science* attempts to provide additional information and rationale for the use of a recommended implementation sequence of *inquiry teaching* to develop *scientific concepts* followed by *information-gathering* learning activities.

5. *You should be able to adapt your science program to individualize instruction for both normal and exceptional children in your classroom, and to integrate science with reading, language arts, mathematics, and social studies.* Information contained in Chapters 6 and 7 will help you to develop the skills and insights necessary to do this.

6. *You should know and understand some of the major concepts of science.* Many elementary school teachers lament that they do not know enough science to teach it. Indeed, some knowledge of the content of science is essential to good teaching. The ideal science teacher would probably be a person who combines a knowledge of the subject matter and skills of science with an understanding of the nature of children.

Section Two of this book is designed to explain both the subject matter and how to present it in the classroom. Each broad topic—such as magnetism or electricity—is organized in terms of the big ideas, or their concepts and subconcepts. This conceptual organization simplifies the presentation of science content, and it provides ideas around which to organize your teaching. A brief overview of each concept and subconcept of science is accompanied by complete lesson plans that can guide you in introducing the concept to elementary school children. Section Two reviews seventeen broad topics of science and contains nearly two hundred lesson plans.

In summary, this book attempts to: (1) show why you should teach science in such a way as to challenge the child intellectually and to help the child to maintain a high level of curiosity and to enjoy what is taught. (2) provide models for inquiry and didactic teaching that you can use in the classroom; (3) present an overview of natural science organized into a conceptual framework; and (4) show you how to use inquiry and didactic techniques to reshape content-oriented programs so that you can develop your students' science skills. Hopefully, this book will help you operate a successful skill-oriented inquiry science program, regardless of the materials with which you must work.

Acknowledgments

We wish to express our appreciation to our friends and colleagues at the University of Central Florida who have offered support and criticism of the first two editions of the book: to Jack Armstrong, Robert Bird, and Pat Manning, who examined its methods and content in the crucible of the classroom; to Michael Hynes, who evaluated the material on integrating mathematics and science; to Richard Thompson, who evaluated the material on integrating reading and science; to Fred Green, who provided materials and suggestions on the integration of social studies and science; and to Jeanice Midgett, for sharing her experience and expertise in the area of exceptional child education.

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And most of all, we express our appreciation to those for whom the book was written. Many students have read and reacted to it, and their suggestions have been invaluable to us in maintaining the timeliness and clarity of its content.

CONTENTS

SECTION ONE

Organizing to Teach Children Science

HOW TO USE SECTION ONE OF THIS BOOK

This book has two parts. Section One is the "how to teach" part; Section Two is the "what to teach" part.

Before starting any chapter of Section One, look over the objectives that precede it. They will tell you what you can expect to gain from that chapter. Each chapter also contains "self-checks," one for each of the stated objectives of the chapter. They will help you to determine how well you understand the material. If you perform the self-checks successfully, go on to the next part of the chapter. If not, review the material upon which the self-check is based. Then repeat the exercise.

At the end of each chapter of Section One, you will find a list of extending activities. These activities are meant to add depth and understanding to previously learned concepts. You can gain a minimal level of understanding without doing the extending activities. They are provided as enrichment exercises. Do them as time and energy permit.

Section One should be read sequentially from beginning to end. The presentation of ideas is accumulative—that is, to understand material in the later chapters, you must sometimes know terms and concepts that were presented in the early chapters. Suggestions for using Section Two will be found in the introductory pages to that section.

We hope you find what follows a helpful preparation for teaching science. Good luck to you as you read the book, and later as you put your ideas into practice in the classroom.

Photo by Esler

"Curiosity in children is but an appetite for knowledge." Locke

CHAPTER 1

An Introduction to Elementary School Science

After studying this chapter the student will be able to:

1 *List eight areas in which activity-oriented, inquiry-based elementary science instruction helps children to develop basic skills.*

2 *Describe briefly how oral communication and reading skills may be developed using science activities.*

3 *Write a paragraph that provides justification for the place of science in the elementary school curriculum.*

4 *Order statements of scientific ideas in terms of scope, from the most comprehensive to the most specific.*

5 *Give at least three reasons for organizing science in terms of concepts.*

6 *Describe the nature of science as a dynamic search for truth.*

7 *Explain the two ways in which scientific models aid understanding.*

8 *Trace orally and/or in writing the historical development of the modern emphasis on science processes.*

9 *Describe orally and/or in writing the principal characteristics of the Science—A Process Approach science program.*

10 *Describe orally and/or in writing the principal characteristics of the Science Curriculum Improvement Study science program.*

11 *Describe orally and/or in writing the principal characteristics of the Elementary Science Study science program.*

12 *Describe the nature of contemporary elementary school science programs in terms of objectives, methods, and learning activities.*

13 *List and explain the goals of elementary school science.*

The beginning of science is wondering. A prehistoric man is startled by a shooting star streaking across the sky. An ancient Egyptian stares into a sunlit well. A boy on the beach watches the soaring, twisting flight of a bird. Each of these scenes contains a common element, curiosity. In each instance curiosity is a beginning, a force that may drive a person to seek an explanation of the phenomenon he has witnessed. Curiosity is the same across the barriers of time, race, and geography.

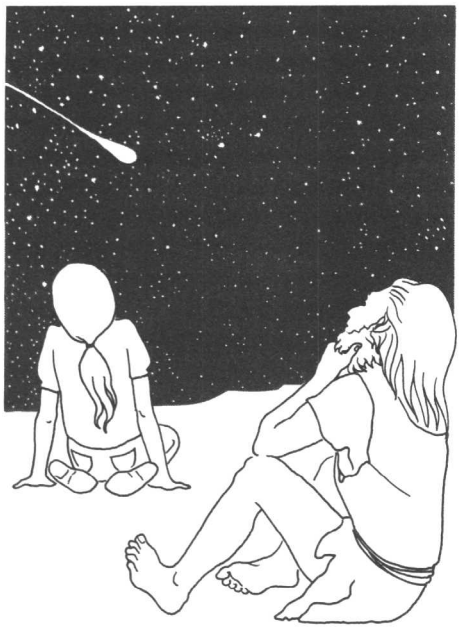

Figure 1–1. Curiosity Is the Starting Point for Science

CURIOSITY OF CHILDREN

Science begins with the individual. Questions like "What is a shooting star?" and "How can birds fly?" have been answered a thousand times with a hundred different answers. Obviously some of these answers were wrong. It is not especially important that any individual was right, but only that he saw and wondered and sought an answer.

Children are naturally curious about their environment. Young children observe and openly seek to understand what they see. Some teachers get their greatest pleasure from helping young children to pursue their enthusiastic involvement with nature. In no other activity are children quite so open and questioning, quite so willing to express their feelings and their thoughts. Science, teachers find, is the near-perfect vehicle to help children develop their thinking skills. This, then, is the pleasant task of the modern elementary science teacher —helping children to acquire the skills and knowledge necessary to *understand* the world around them.

A PLACE FOR SCIENCE IN THE ELEMENTARY SCHOOL

Throughout the history of the United States pressures have been brought to bear on the schools that have caused basic changes in what children have been taught and the way they have been taught. The most notable trend today in the elementary schools is the result of a feverish cry for *accountability*. Accompanied by the slogan "back to the basics," the accountability movement is interpreted in too many elementary schools across the nation as a demand for more reading and more mathematics, often to the exclusion of the other subjects in the curriculum.

These two basic skills areas already consume a large portion of instructional time in today's elementary schools, and yet one of the greatest frustrations of elementary school teachers and principals is the low achievement in these two subjects by large groups of children, particularly children of low socioeconomic status from both rural white and inner-city black communities. Many imaginative programs have been designed and implemented to enhance the ability of elementary school children to communicate verbally and with numbers. Attacks upon the problems of language and mathematic deficiencies have been mostly direct, resulting in the development of learning continuums, diagnostic techniques, and attractive, logical, step-by-step learning activities. Contemporary materials in language arts and mathematics are greatly enhanced by the use of color and an abundance of pictures. However, the effect of all of these efforts to upgrade children's performance in basic skills has been discouragingly modest. *So far, no large-scale solutions to the prob-*