

# Teaching Secondary School Science

*Strategies for Developing Scientific Literacy*

Ninth Edition



**Rodger W. Bybee   Janet Carlson Powell   Leslie W. Trowbridge**



**NINTH EDITION**

# **TEACHING SECONDARY SCHOOL SCIENCE**

**STRATEGIES FOR DEVELOPING  
SCIENTIFIC LITERACY**

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# Teacher Preparation Classroom

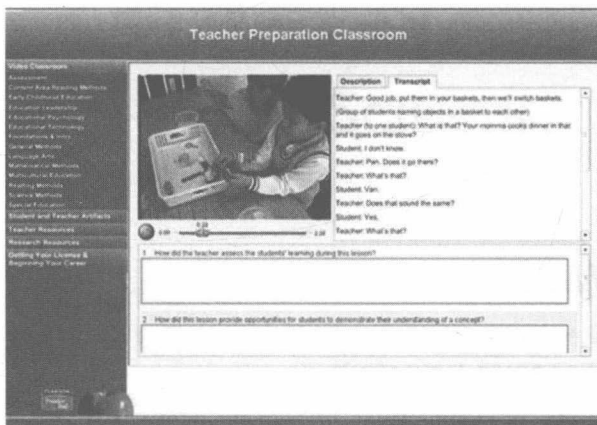
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# PREFACE

*Teaching Secondary School Science: Strategies for Developing Scientific Literacy*, 9th Edition, addresses the needs of undergraduate preservice teachers of science. The text provides information and suggestions for teaching physical, biological, and earth sciences in the middle school and high school grades. It is also useful for graduate students whose undergraduate majors were outside the field of education, but for whom teaching middle and secondary school science is now a primary career goal. This book is also an important resource for graduate students and experienced teachers in courses concerned with assessment in science classes, curriculum development and reform, instructional problems, and current trends in science teaching. It is also a useful guide and reference in workshops and institutes for teachers emphasizing strategies for inquiry teaching. The current emphases on science education standards and inquiry are fully explained and brought to the foreground for science programs.

The ninth edition retains the strong features of previous editions: emphasis on active pupil involvement in learning, use of inquiry and investigative teaching strategies to provide experiences in gathering data to support hypotheses, discussion of advances in our understanding of how students learn science, and use of research-based instructional strategies. Based on the extensive science teaching experience of the authors, many practical examples of successful teaching strategies are provided.

The theme of developing scientific literacy among science students is stressed throughout. Suggestions for fostering the effective reading of science materials, developing the vocabulary of science, and raising the level of awareness of the interrelationships among science, technology, and society are included.

## ORGANIZATION

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The ninth edition encompasses eight units:

- ◆ Introduction
- ◆ Historical and Contemporary Perspectives
- ◆ Goals, Objectives, and Assessments
- ◆ Understanding the Science Curriculum
- ◆ Planning Effective Science Teaching and Programs
- ◆ Strategies for Science Teaching
- ◆ Understanding Students
- ◆ Student Teaching

These units have been reorganized not only to provide prospective secondary science teachers with the tools and resources they need to teach science effectively on a day-to-day basis, but also to develop a holistic view of science teaching, and promote enthusiasm and a desire to succeed at the tasks they encounter.

## NEW AND UNIQUE FEATURES IN THIS EDITION

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- ◆ **Investigating Science Teaching** activities are located at the end of each chapter and provide students an opportunity to examine various aspects of science teaching.
- ◆ **Icons highlight new integrated technology resources.** Discussions of technology have been updated and woven throughout the text, including technology margin notes that encourage students to visit the text's new website at [www.prenhall.com/teacherprep](http://www.prenhall.com/teacherprep) for further research and supplemental science activities.

- ◆ **Guest Editorials** that showcase actual preservice and inservice science teachers illustrate concepts and provide real-world context for students.
- ◆ **Two resources on the Teacher Prep Website** provide additional *Teaching Science Activities* in biology, chemistry, earth sciences, physics, problem solving, science fair projects, technology, and mathematics, as well as activities for gifted students. Further, the website provides sample daily lesson plans that offer practice in using an instructional model for inquiry teaching and learning.

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Special recognition is given to the late Dr. Robert B. Sund, whose foresight regarding the philosophy and teaching methods in the first three editions of this text have strongly influenced subsequent editions, including this one. In particular, the current emphasis on inquiry teaching, recommended by the National Research Council in its publication, “National Science Education Standards,” reflects a teaching strategy that was embodied in all of Dr. Sund’s teaching and subsequently became a fundamental part of the philosophy of this book.



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## UNIT 1

# INTRODUCTION

As she worked late into the night on her first lesson, Maria Romero wondered about her effectiveness as a science teacher. The next day, Ms. Romero began her lesson by asking the students to describe the genetic concepts *genes*, *chromosomes*, and *mutations*. Because Ms. Romero assumed students had learned these concepts in elementary school, she was surprised when they expressed a range of responses, mostly incorrect. She recognized that most students identified the terms as scientific, even biological, but that they consistently responded incorrectly. For example, students indicated that genes were different layers of skin, something in one's blood, things that indicate one's age, and a reproductive part of the body. They also thought chromosomes were either things that clogged one's arteries or plant-eating animals. Finally, they had the idea that mutations were changes that occurred as one got older, sicknesses caused by bacteria, or structures in plants.

Maria knew that elementary teachers had taught biology and even introduced some of these same ideas about genetics, but the students had little understanding of the information, and the terms had no meaning or importance to them. Maria wondered about her role in helping students develop scientific literacy, especially in connection with teaching secondary school science.

After a little research on the Internet, Ms. Romero discovered that the students displayed what contemporary learning theorists referred to as *prior conceptions* or *naive theories*. As she investigated further, she found that psychologists had proposed explanations for students' prior conceptions and the learning process. Ms. Romero discovered that the model of learning was referred to as *constructivism*, a term that expresses a dynamic and interactive view of learning. In the

constructivist view of learning, students continually revise, redefine, and reorganize concepts through interactions among themselves, natural phenomena, science lessons, discussions with other individuals, and the introduction of information from other sources, such as textbooks and science teachers. Students first interpret objects and events in terms of their prior experiences, which, from the perspective of the science teacher, may be incorrect or a prior conception. In order to change the prior conceptions, someone (e.g., a teacher or another student) or an experience (e.g., observations of natural phenomena, textbooks, or laboratory experiences) has to challenge the students' prior conceptions by showing them that their current ideas are inadequate. Further, students must have time and additional experiences to reconstruct a more adequate and scientifically accurate conception.

The results of this brief review of research provided Maria with insights about teaching secondary school science and strategies for developing scientific literacy. When science teachers discover new and better ways to teach, they experience the excitement of education, and the extension of these insights to students learning science can be the most exhilarating of a teacher's career.

A life in science teaching can entail frustrations and disappointments; but it also involves satisfactions and achievements that promise to outweigh the problems. This unit introduces ideas and issues that you will have to consider as a science teacher. Ms. Romero's story about the connections between student learning and science teaching is only one of many that could be told, but more importantly, the stories reflect ones you will experience as you become a science teacher and pursue the goal of developing scientific literacy for your students.