Preface

At the national and state levels, reading and writing across the curriculum are being promoted—and in some cases required. As we began this project, we had two questions: Why should reading, writing, and inquiry be included in a secondary science classroom? How can this be done? We each have our own area of interest—inquiry-based science or literacy in secondary classrooms—and have taught corresponding undergraduate and graduate courses. Combined, we have more years in classroom teaching than we wish to count. Yet we both became learners during the development of this book. We talked to classroom teachers and to our colleagues. We explained and clarified our own ideas and challenged each other's assertions. As we worked together, we shared information and blended methods in our effort to present theoretically based, yet practical, ideas that could be used in secondary classrooms. We hope our readers will join us in our learning experience. The role of reading, writing, and literacy in science classrooms is evolving. Many of the ideas in this book come from classroom experiences—our own and those of our colleagues. We encourage readers to try these ideas or develop your own.

According to Chiappetta and Koballa (2002), four elements should be integrated into science lessons:

Science as a Belief

Some beliefs have changed over time with new discoveries. Six characteristics that mold belief include:

- *Curiosity*—Scientists ask questions. Some scientists are so driven to prove their ideas that they may be ridiculed, discriminated against, or persecuted for their beliefs.
- *Imagination*—Scientific and technological knowledge has its roots in imagination.
- *Reasoning*—Looking at patterns in nature and collection of data through observation and experimentation help scientists obtain knowledge.
- *Cause and effect*—Such relationships prompt many "why" questions that scientists seek to answer.
- *Belief and rejection*—How do we know what to believe or not believe?
- *Attitude*—Scientists need to be open minded and objective when seeking facts.

Science Investigation

There are many facets of scientific investigation and no specific format for procedure. However, there are three aspects that need to be included:

- *Hypothesis*—We state an educated guess of what is the cause of or reason for something that will be tested.
- *Experimentation*—Using controls shows relationships among variables that can be changed. One must be careful because data can be manipulated to produce false beliefs.
- *Observation*—The use of senses helps to obtain observations resulting from our experimentation.

Science Knowledge

- *Facts* are based on observations and can be demonstrated at any time.
- *Concepts, principles,* and *laws* must be meaningful to the learner after having opportunities to explore. They tie together facts.
- *Theories* are used as tentative explanations until proven otherwise.
- *Models* are useful to help explain a concept but are not exact.

Science, Technology, and Society

- *Technology* includes highly sophisticated instruments to help solve problems.
- *Society* is impacted by science and supplies support and funds for projects.

If these elements are to be included into a science lesson, how do we combine them with reading, writing, and technology? Richard Preston (1996), in the foreword of his book *First Light*, states:

> Scientific facts are often described in textbooks as if they just sort of exist, like nickels someone picked up on the street. But science at the cutting edge, conducted by sharp minds probing deep into nature, is not about self-evident facts. It is about mystery and not knowing. It is about taking huge risks. It is about wasting time, getting burned, and failing. It is like trying to crack a monstrous safe that has a complicated, secret lock. . . . Sometimes there is a faint clicking sound, and the door pulls wide open, and you walk in. (pp. xiii–xiv)

Is he saying we must take risks to encourage the sharp minds of students—to let them take risks—and hope that the door to science will open for them? Can teachers take risks and incorporate different approaches that encourage students to enjoy the mystery of science and to think like scientists, act like scientists, and gain scientific knowledge which they may be able to understand,

apply, and communicate with others? Inquiry-based science may provide a means to that end.

Inquiry-based science has been promoted by national-level organizations such as the American Association for the Advancement of Science (AAAS) and the National Science Teachers Association. According to the *National Science Education Standards* (National Research Council, 1996), there are five elements of science inquiry:

- Scientifically oriented questions
- Priority of evidence
- Formulation of explanations from evidence
- Connecting explanations to scientific knowledge
- Communicating and justifying conclusions

Conversations with preservice and practicing teachers suggest that of the five essential elements, those that appear to be the most difficult to implement in lessons are developing questions, connecting explanations to scientific knowledge, and communicating and justifying conclusions. We searched through literature by and about scientists; we were particularly interested in how scientists defined literacy. The above elements are related to science literacy.

Jennifer Cartier and Jim Stewart (2000) provide an overview of a high school genetics inquiry-based unit in an article you can find in *Science and Education*. In that article, they state that those who are scientifically literate "possess familiarity with key scientific concepts and an ability to relate those concepts to their everyday lives in decision-making or problem-solving situations" (p. 249). Cartier and Stewart reference reading materials that can be used to understand how ideas have historically developed and give examples of materials that students are required to read, such as a revised version of Mendel's work. They also give examples of writing students must do in the unit, including keeping a notebook of their ideas and experiences and journaling. Articles such as this support our assumptions that reading and writing could be effectively included.

Chapter 1 begins our exploration by addressing foundational assumptions about the meaning of literacy, specifically science literacy, and the meaning of inquiry-based science. The chapter describes lesson designs that are models for inquiry.

Chapter 2 introduces reading as it relates to science education and addresses the relationship of textbooks to inquiry-based instruction. Strategies that are presented that support student comprehension of written material are ones that may be adopted for many types of reading materials.

Chapter 3 continues the discussion of reading through the use of non-textbook materials. These two chapters support the fourth element of inquiry as presented above—students seek to verify or confirm their conclusions by comparing their results to what they have encountered in literature and to existing scientific knowledge.

Chapter 4 addresses the fifth element, communication, by presenting strategies for writing in the science classroom. It discusses the specifics of scientific writing compared and contrasted to other types of writing. We present the

Science Writing Heuristic, which is intended to guide students as they construct knowledge through inquiry, thus using writing to learn.

Chapter 5 shows how technology can be used to enhance students' science knowledge as they define problems, collect and analyze data, and communicate their knowledge to others. The chapter connects technological literacy to reading, writing, and inquiry. We discuss how students can be encouraged to use and evaluate resources available to them over the Internet and show similarities to strategies used when reading. We also provide resources available for teachers to use.

Our goal was to develop material that will aid teachers who are beginning to use inquiry-based methods and those who have already begun to use inquiry and wish to expand or refine their teaching methods. We hope to meet the needs of secondary classroom teachers who are being encouraged to incorporate more reading and writing in their lessons. Because students in classrooms are becoming more diverse and teachers are being asked to work with students with many different needs, we have included ideas that can be used with struggling students and students who need enrichment. We encourage readers to use the materials we present as a catalyst for developing their own strategies and as a vehicle for conversation with others.