Preface

The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.

—Ausubel, Novak, & Hanesian (1978)

FORMATIVE ASSESSMENT IN SCIENCE

Science educators agree that good assessment practices are integral to informing teaching and learning, as well as measuring and documenting student achievement. When I began writing the first edition of this book in 2006, the balance of time, resources, and emphasis on assessment was tilted considerably toward the summative side. This imbalance led to a cycle of even more standardized testing of students, test-taking practice, and "mile wide, inch deep" instruction, often with only marginal gains in achievement. When science test scores failed to improve significantly, the knee-jerk reaction was to increase the cycle of testing and test preparation, covering large amounts of content in a superficial way. This reduced the amount of time teachers spent on really understanding what their students were thinking prior to and throughout instruction and using that information to design learning opportunities that help students develop deeper conceptual understanding. Fast forward to almost 10 years later, and I am happy to say that in science much of that weight has been shifted to the formative side so that assessment is truly a balance between diagnostic/formative assessment and summative assessment. I like to think, and maybe I'm not too far off, that the first edition of this book, combined with the National Science Teachers Association's *Uncovering Student Ideas in Science* and the extensive professional development that was provided to districts, contributed to this shift. Today, I am pleased to see a huge interest in science formative assessment, particularly as it relates to uncovering student thinking and using that information to make better informed instructional decisions.

This revised edition continues to address the need to balance opportunity to learn, which includes assessment *for* learning (Black, Harrison, Lee,

Marshall, & Wiliam, 2003), with assessment *of* learning. Optimal opportunities to learn exist when science teachers are aware of the variety of different ideas students are likely to bring to their learning, see the connections between students' thinking and the specific ideas targeted by state and national standards, and provide learning experiences that build a bridge between their students' thinking and the accepted scientific ideas. What is effective for one purpose—external accountability—may not effectively serve the purpose of informing instructional planning and decision making, which is what ultimately affects student learning. A rich repertoire of formative assessment techniques provides the ongoing feedback and stimulus for deep thinking that a high-stakes test once or twice a year cannot provide in time to inform instruction and improve learning.

Teachers are the most important link in the chain that connects assessment, instruction, and learning. The need for a varied repertoire of purposeful techniques that weave assessment throughout instruction and learning is what led to this book. I hope you can turn the insights and ideas gleaned from this book into practical actions that will transform teaching and learning in your classroom.

PURPOSE AND NEED

A substantive body of research indicates that formative assessment can significantly improve student learning. Yet this same research shows that the features of formative assessment that affect student achievement are, sadly, missing from many classrooms (Black et al., 2003). Formative assessment is research rich, yet practice poor. The purpose of this book is to provide teachers with guidance, suggestions, and techniques for using formative assessment to improve teaching and learning in the science classroom. A wide variety of assessment books and resources available to educators provide the theoretical rationale for formative assessment, its implications for teaching and learning, and general strategies. What makes this book different is that it is focused on the discipline of science. Science, through which we seek to understand the natural world, has nuances that are very different from other subject areas. That is why science educators need a resource that is specifically focused on the discipline of science. This book expands on the current literature by identifying and describing practical techniques science teachers can use to build a rich repertoire of formative assessment strategies for the science classroom that help them uncover students' ways of thinking about phenomena and concepts in science.

The acronym, FACT, is used to label the 75 techniques included in this book. FACT stands for **f**ormative **a**ssessment **c**lassroom **t**echnique. Through the varied use of FACTs, explicitly tied to a purpose for gathering information about or promoting students' thinking and learning, teachers can focus on what works best for learning and design or modify lessons to

fit the needs of their students. The FACTs are easily integrated into existing science curriculum materials

AUDIENCE

The primary audience for this book is K–12 science teachers. However, many of the formative assessment techniques described can be used in other disciplines such as mathematics, social studies, language arts, visual and performing arts, health, and foreign language. The FACTs can also be used in teacher preservice education, general undergraduate science classes, and teacher professional development.

ORGANIZATION

Chapter 1 provides an introduction to formative assessment in the science classroom. It describes the inextricable link between assessment, instruction, and learning. It describes what a FACT is and the research on learning that supports the use of FACTs. It describes the learning environments that support assessment, instruction, and learning. It examines the relationship between teaching and learning and describes new roles and implications for a formative assessment-centered classroom. It also addresses misunderstandings about misconceptions, connections to the new vision for science standards, and ways the FACTs enhance literacy capacities.

Chapter 2 focuses on the use of FACTs to integrate assessment, instruction, and learning. It examines the connection between assessment and instruction and describes a learning cycle model in science (SAIL cycle) that integrates assessment with instruction and learning and provides a framework for using FACTs. It describes how formative assessment promotes learning in the science classroom, including the role of metacognition, self-assessment, and reflection. It provides suggestions for strengthening the link between assessment, instruction, and learning.

Chapter 3 addresses considerations for selecting, implementing, and using the data from science formative assessment. It includes a chart that highlights examples of FACTs used throughout the book and their link to the disciplinary core ideas in *A Framework for K–12 Science Education* (National Research Council [NRC], 2012). It also includes a chart to show how the FACTs support use of the scientific practices. It includes a matrix for matching FACTs with their primary purposes in teaching and learning.

Chapter 4 is the heart of the book. It includes a collection of 75 different FACTs. The FACTs are arranged in alphabetical order so that teachers can locate them by name. Each FACT uses a common format that provides a description, how it promotes student learning, how it informs instruction, considerations for design and administration, connection to *A Framework*

for K–12 Science Education (NRC, 2012), general attributes, modifications that can be made to a FACT for different types of students or purposes, caveats for using a particular technique, and uses in other disciplines besides science including a brief example. Each FACT includes an example related to a disciplinary core idea that shows or describes how the FACT is used in science. Space is provided at the end of each FACT description to record your notes on how it worked in your classroom and any modifications or suggestions for further use.

The Appendix contains annotated resources referenced in Chapter 4. It also contains additional resources that a science educator would find useful for expanding his or her knowledge of formative assessment and building a repertoire of strategies.

WHAT IS DIFFERENT ABOUT THIS EDITION?

About 80% of the material in this revised edition is the same as the first edition (Keeley, 2008). Since the first edition was released, thousands of teachers have been using the FACTs and have shared with me various ways they have used them. I have included several new suggestions, thanks to all the teachers who enthusiastically provide me with feedback! I have also changed the examples in several FACTs to reflect core disciplinary ideas and scientific practices in *A Framework for K–12 Science Education*. These core ideas and practices also make up the *Next Generation Science Standards* (NGSS Lead States, 2013). Since several states are adopting the NGSS or are using the *Framework* to revise their state standards, I have included a description of the connection to the *Framework* in each of the FACT descriptions. Additionally, there are two charts included in Chapter 3 that link each FACT to the grade level disciplinary core idea in the example provided as well as provide links to the scientific practices.

I also learned that many schools and districts purchased this book for use with teachers of all subject areas so they could be using common formative assessment strategies. As a result, I included a brief example for each FACT that shows how it can be used in a subject area other than science.