Introduction

Clearly relating assessment tasks and products of student work to the valued goals of science education is integral to assessment plans.
—National Research Council [NRC], 1996, p. 91

New models of teaching and learning have evolved from brain research and the wisdom of professionals in the field that cause us to question our beliefs and assumptions about what is worth knowing and how students learn. Educational goals are linked to instruction and assessments in more authentic ways in standards-based classrooms than they are in text-driven classrooms. Instructional strategies are more accurately viewed as the means to the end rather than as an end in themselves, and assessments are regarded as diagnostic tools for monitoring student progress and guiding instruction toward successful learning.

STUDENT-CENTERED INSTRUCTION AND ASSESSMENT

Although teachers have always been held accountable for what students learn in the classroom, science teaching and assessment often take the form of reading from textbooks and recalling information on forced choice tests. Even when laboratory investigations requiring higher-order thinking and problem solving are included in the instructional plan, the measures of student learning are often limited to recalling factual information, restating a definition, or applying a mathematical formula.

The National Science Education Standards endorsed an inquiry-based approach to instruction through which teachers select teaching and assessment strategies that guide and facilitate learning of important concepts and skills, orchestrate discourse about scientific ideas, respond to diversity, and use multiple methods to gather data about students' understanding and abilities (NRC, 1996).

> . . . the measures of student learning are often limited to recalling factual information . . .

The shift from teacher-centered to student-centered instruction and assessment puts more emphasis on developing understanding and responding to student needs and interests. Changing the teacher's role from one of provider of information to one of facilitator of learning

requires them to have a strong commitment to teaching and learning that includes

- an understanding of the nature and content of the disciplines
- knowledge of and ability to implement skills and strategies for effective instruction
- an understanding of and respect for formative assessment as a powerful tool for promoting, enhancing, recognizing, and celebrating achievement (Black and Wiliam, 1998)

CHANGING PRACTICE TO IMPROVE LEARNING

Effective teaching mirrors effective learning. Thus, when students aren't learning, it is time to question the beliefs and policies that guide goal setting and the teaching and assessment practices that reflect them in the classroom. There is now a strong research base to support new approaches to classroom practice that promote higher standards and increase student achievement.

The journey toward more effective instruction and assessment is both bitter and sweet. On one hand, it requires administrators and teachers to invest time, effort, and resources in an ongoing process of professional development and change, but on the other hand, the rewards are great in terms of providing accountability for what students know and are able to do, as well as in increasing student motivation and achievement.

AN OVERVIEW OF CHAPTERS

The chapters that follow provide a research base and rationale for formative assessment and identify and operationally define strategies for embedding formative assessment into the science curriculum.

Chapter 1 operationally defines formative assessment and provides a way to reflect on current beliefs and practices related to assessment. A research-based rationale is provided for use in developing a vision for formative assessment to guide successful standards-based teaching and learning in standards-based science and technology education for the twenty-first century.

In Chapter 2, rubrics are described and shown as ways to identify the important indicators of learning for the development of scientific literacy and to communicate student strengths and weaknesses in reaching learning goals. Rubrics are powerful tools for enabling students to self-assess and take responsibility for learning.

Chapters 3–6 focus on the tools and strategies for enhancing instruction and gathering information about student learning from which to make informed decisions. Descriptions and standards-related models are provided in the context of K–8 science.

Chapter 7 provides a framework for planning and implementing high-quality instruction and formative assessment. The chapter includes a review of assessment strategies, planning guides with examples, and suggestions for differentiating instruction.

Figure 0.1 provides an overview of the chapters for reference.

Figure 0.1 Formative Assessment Strategies for Enhanced Learning in Science

Chapter 1 Formative Assessment and Science	Chapter 2 Using Rubrics to Guide Learning	Chapter 3 Observation Checklists and Effective Questioning	Chapter 4 Notebooks, Reports, Graphic Organizers
• New Ways of Thinking About Assessment • Goal-Centered Assessment • Research Support for Formative Assessment • Creating a Vision for Formative Assessment • Examining Beliefs and Practices • Traditional Versus Student-Centered Views of Assessment • Formative Assessment as "Authentic" Assessment • Clear Targets for Instruction and Assessment	• The What and Why of Rubrics • Holistic Rubrics • Holistic Rubric for a Science Report • Limitations to Holistic Scoring • Designing Holistic Rubrics • Generalized Rubrics • Examples of Generalized Rubrics • Analytic Rubrics • Assessment Tasks With Analytic Rubrics • Designing Analytic Rubrics • Rubrics for Self-Assessment and Peer Assessment • Design a Rubric	• Observation Checklists • Sample Observation Checklists • Effective Questioning • Questions for Thinking and Problem Solving • Questions for Instruction and Assessment	• Notebooks • Notebooks as Assessment Tools • Rubric for a Science Notebook • Lab Reports • Lab Reports for Learning and Assessment • Rubric for a Lab Report • Graphic Organizers • Descriptive Organizers • Sequential Organizers • Process-Causal Organizers • Categorical Organizers • Comparison-Relational Organizers • Problem-Solution Organizers

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Figure 0.1 (Continued)

Chapter 5 Projects and Presentations	Chapter 6 Performance Tasks and Embedded Assessments	Chapter 7 Planning and Implementing Formative Assessment
• Learning Through Projects • Assessing Projects • Rubric for a Project • Learning Through Presentations • Assessing Presentations	• Performance Assessment • Performance Tasks • A Generalized Rubric for a Performance Task • Embedded Assessments • A Model for Embedded Assessment • Sample Embedded Performance Task • Designing Embedded Performance Assessments • Performance Assessments Following Instruction• Sample Performance Assessments • Performance Assessment as Benchmark Assessment • Characteristics of Benchmark Assessments • Sample Benchmark Assessment	• Characteristics of High-Quality Instruction and Assessment • Planning Formative Assessment • A Planning Guide for Formative Assessment • A Planning Guide for a Unit on Cells • Using Assessment Data to Modify Instruction • Project Choices • Adjusting Assignments • Stations for Active Learning• DifferentiatingInstruction Through Centers • Creating Contracts • Formative Assessment and Accountability