Preface

Since we wrote the first edition of this book, the assessment of students has continued to be a major focus of education, and assessment has become an increasingly important part of teachers' professional practice. Educators have extended responsibilities for not only setting educational goals and objectives but also for instructing and assessing in ways that help students meet these goals and objectives. State assessments bring additional pressures for students to perform well, and this also is a driver for teachers to ensure that their students are prepared. Stiggins (1994) noted that teachers make decisions about how to interact with their students at the rate of 1 out of every 2 to 3 minutes, and they base those decisions on their own assessments of student learning. Preparing students to do well in the classroom and on the measures used to make this determination are keys to making valid and reliable decisions about how to instruct and what and how to assess.

Instruction and assessment should be planned together and interconnected. Assessment practices have often focused on the use of set questions that have provided a limited number of options for student responses. While this assessment approach may be representative of some tests, teachers of science realize that students should develop deeper science understandings. Continued emphases on assessments at local, state, and national levels mean that educators must persist in changing and refining the assessments that are implemented in classrooms. Assessment can be viewed as a pathway to address the following questions:

- Should assessments tell us what students cannot do or what each student can do?
- Should assessments set targets for learning or merely sample the present curriculum?
- Should students be evaluated only on their individual work or also on their abilities to work together for the benefit of a larger group?
- How can assessments encourage and recognize inventive, imaginative responses that, although unexpected, are constructive and appropriate?
- To what extent can students evaluate data, understand concepts, demonstrate process mastery, and apply what has been learned to new situations?

Table 1.1 What Characterizes Each of the Six Domains?

Science Domain	*Domain Foci*
I. Concepts (knowing and understanding)	Scientific information—facts, concepts, laws, hypotheses, and theories accepted by the scientific community
II. Processes (exploring and discovering)	Processes of science, how scientists work and think
III. Applications (using and applying)	Applications of what is learned to do science, connections to everyday life; informed decision making
IV. Attitudes (feeling and valuing)	Attitudes, sensitivity, societal issues and impacts
V. Creativity (imagining and creating)	Idea generation, designing, problem solving
VI. Nature of Science (the scientific endeavor)	History and philosophy of science; how science progresses and science knowledge and understanding develop

I. CONCEPTUAL DOMAIN

What Research Says About the Conceptual Domain

Science concepts are central to science instruction, and students' understanding of these concepts is crucial to successful teaching and learning. Millar (1989) noted that without an understanding of science concepts it would be nearly impossible for students to follow much of the public discussion of scientific results or public policy issues pertaining to science and technology. According to Thagard (1992), conceptual systems are primarily structured via either *kind* (or *is-a*) hierarchies (e.g., Tweety is a canary, which is a kind of bird, which is a kind of animal, which is a kind of organism) or *part-whole* hierarchies (e.g., a toe is part of a foot, which is part of a leg, which is part of a body). If a basic goal of science education is to help students construct an understanding of the natural world, then students' prior knowledge should be the starting point for instruction.

Assessment enters the field of view to help make determinations on where students are with respect to conceptual understanding. Students should have concrete experience with concepts before moving to abstractions, and they need opportunities to try and to do, not just to read about science. The evidence that science concepts have been learned can be seen most clearly when students can use concepts in a real-life or real-world situation (National Science Teachers Association [NSTA], 1982).

Science in the classroom has been viewed and practiced for decades as a body of knowledge or facts to be learned or absorbed by students. Classically,

IMPLEMENTING ASSESSMENT GUIDELINES

In this section, some considerations for how to implement assessment guidelines in a classroom will be addressed. The ways described are by no means exhaustive, but rather, they represent an attempt to draw more attention for consideration of potential applications. Teachers hold the best position to make assessment decisions and most of the responsibilities for implementing assessment standards in the context of teaching.

Assessment Reminders for Educators

Keep in mind the following six points:

1. A given assessment is only one piece of information used to provide evidence for meeting learning targets or objectives. Assessment should be considered a tool in the service of the learner rather than as a teacher-effectiveness measure.
2. The integration of assessment tasks into real-world problem-solving contexts should be a goal of assessment. Multiple assessments are recommended, and an emphasis should be placed on monitoring students' performances throughout the learning process and not just in the culminating assessment.
3. When looking at student outcome measures, questions that should be raised are those of when and where students have had the opportunity to experience and learn the information being assessed. A responsible teacher needs to be aware of and in control of as many factors as possible to reach a fair judgment when a given assessment is used.
4. Assessment standards are typically set by individuals other than students, but the teacher should invite students to participate in the establishment of some criteria for their assessments. Students should have an opportunity to contribute to what they learn and should learn how to assess their own learning.
5. Peer evaluation, group performance, and participation can be considered in determining a final grade.
6. In addition to normative comparisons, personal growth and ability levels should be taken into account in some ways when assessing students. For students to become engaged in learning, the opportunities to experience some level of success seem to be necessary in classroom instruction and assessment.

Embedding Assessment in Teaching Practice

While planning instruction and assessments, guidelines assist in moving ideas into practice. Some of the following strategies can help guide the planning process:

Biology Assessment Task

A Sample Performance Task

The U.S. Surgeon General has selected you and your colleagues to serve on a committee that is responsible for raising public awareness of an environmental issue that has a potential impact on human health. The U.S. Surgeon General would like you to identify an issue and develop a position statement and suggestions for addressing the issue. To assist you with the development of your position statement and recommendations, the following guidelines should help focus your task:

- Identify an environmental issue that has the potential to have an impact on human life.
- Prepare a position paper that addresses this issue and suggest ways to address this issue.
- Research the issue your group has chosen.
- Describe how this issue affects the human body systems.
- Address potential problems if this issue is not addressed or resolved.
- Develop a plan to educate others about your findings.

Table 4.3 Performance Task Rubric

Criteria	*10 (Set your own exemplary standards)*	*8*	*6*	*4*
Issue identified and group position stated		Significance of issue clearly presented, with detail	Significance of issue clearly presented but more detail needed	Issue stated but little said about the significance
Linkage of environmental effects on body systems		Two effects discussed per system; three additional effects identified and discussed	Two effects discussed per system; two additional effects identified and discussed	Two effects discussed per system; two additional effects identified and discussed
Evidence and support		Extensive support data included (What is extensive? Students can discuss this.)	Adequate support data included (What is adequate? Students can discuss this.)	Minimal support data included (What is minimal? Students can discuss this.)
Body systems				
Reproductive				

The teacher should set the stage for the students and could introduce the writing activity like this:

> I am going to ask some questions (or describe some situations) that will give you a chance to see how you are at thinking up new ideas and solving problems. I want you to use all the imagination and thinking ability you have. This is like a game to exercise your brain. You will have a chance to use your imagination in thinking up ideas and putting them into words. Try to think of as many ideas as possible. Try to think of interesting, unusual, and clever ideas. It does not matter if you have the same ideas as others in the class or if you suggest something that no one else thinks up.
>
> Here are two sample questions:

Elementary: "What would the world be like if it rained chocolate drops?"

Secondary: "What would happen if lakes became frozen from the bottom?"

Situation statements should be related to the unit of instruction so that the students can connect the assessments and what they are studying. Care should be taken, however, to ensure that the unit of instruction does not center on the situation statement to such an extent that this measure of creativity becomes a test of knowledge.

Teachers may want to present situations related to concepts being studied and have students write their responses. Sample situation statements could include the following:

First grade: "Bobby woke up and found dinosaurs in his yard."
What would your reactions be?

Third grade: "Suppose we lived in a world without insects."
What would your reactions be?

Fifth grade: "Pretend that there was no more pollution."
What would your reactions be?

Seventh grade: "Suppose there was no more disease in the world."
What would your reactions be?

General: "Jane stopped at the gas station to buy gas for her car."
What would your reactions be?

Scoring This Creativity Task

The rationale behind this measure is to provide a thought-provoking situation appropriate to the ability and experiences of the students to be