



Assessment of Student Learning



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Good science assessment answers the critical question: Have the students mastered the content? The answer is used to guide curriculum and instruction. Science assessments need to cover all the grade-level standards. Although some standards will be readily taught and assessed, others will require intensive and extensive instruction accompanied by matching assessments. Assessments also need to reflect the balance among and emphasis given to the earth, life, and physical sciences and the Investigation and Experimentation strands.

California's Standardized Testing and Reporting (STAR) program currently includes standards-based assessments at the high school level (grades nine through eleven) for students enrolled in physics, chemistry, biology/life sciences, earth sciences, and integrated science courses. In the near future a standards-based science assessment for students in grade five (covering the science standards for grades four and five) will be developed and implemented. The STAR program also includes a nationally norm-referenced science test for all students in grades nine through eleven. STAR program results are important to educators at the state and local levels, parents or guardians, and students.

This chapter supports two key principles of assessment in science:

- All students need and are entitled to assessment at appropriate times during the school year on the science standards they are learning.
- All teachers need and are entitled to receive assessment results in a timely manner that empower them to assist students meaningfully in mastering the content.

These principles apply equally to students in kindergarten through grade eight—all of whom receive science instruction regularly—and high school students who are enrolled in standards-based, laboratory science courses. The challenge to educators and to instructional materials publishers is to fashion valid and reliable assessments that are appropriately integrated in a program of efficient and effective science instruction.

Purposes of Assessment

Assessment may serve many purposes, but three are of particular importance:

- Entry-level assessment measures the extent of students' existing knowledge and skill, helping teachers to determine whether review is needed

for certain content and whether some students are ready for greater challenges.

- Progress-monitoring assessment measures the extent to which students have mastered (or are mastering) science content sufficiently to proceed in the logical sequence of instruction.
- Summative assessment measures the extent to which students have mastered science content, understand the content well, and are able to apply the knowledge meaningfully.

Entry-Level Assessment

Entry-level assessment measures student mastery of preceding sets of content standards that serve as prerequisite building blocks for the content forthcoming. Typically, the prerequisite knowledge was learned in preceding years or in separate courses. Entry-level assessment also helps the teacher determine what (if anything) in the planned course of instruction has already been mastered by students. Basic psychometric principles must be followed for an entry-level assessment to be used reliably and effectively in comparing the performance of students in a classroom (or school) or to establish a baseline by which to measure growth. The principles are as follows:

- The assessment must be administered under the same conditions to all students.
- The assessment must be administered using the same directions to all students.
- The assessment must be scored in scaled increments small enough to detect growth.

Progress-Monitoring Assessment

Assessment to monitor students' progress is critical in standards-based instruction. Adopted science instructional programs have regular assessments embedded in them. Assessment is the means by which teachers can continually adjust instruction so that all students make progress toward content mastery. Every student in need of extra help or a different instructional approach to master content must receive this type of assessment quickly. Similarly, students who are ready to move on must be enabled to do so and not be required to spend time in unnecessary review.

Teachers need to look regularly for indicators of content mastery in homework and classroom learning activities. Short, objective assessments (e.g., weekly or even daily quizzes) may also prove useful. In addition to this regular monitoring of achievement, more formal assessment needs to be conducted at least every six weeks of instruction. In all cases, progress-monitoring assessments must:

- Use uniform administration procedures and tasks.
- Document student performance.
- Reflect current lessons.
- Help teachers make solid instructional decisions and adjustments based on student performance.
- Indicate when direct interventions are needed for students who are struggling to master content standards.

Summative Assessment

Summative assessment is typically conducted at the end of a chapter, unit,

or school year. It measures students' ability to apply the science knowledge and skill they have acquired. Summative assessment requires students to demonstrate understanding of the facts, concepts, principles, and theories in the science standards.

Science Assessment Strategies

Teachers confront a complex array of responsibilities, including the selection and implementation of effective instructional methods and assessment strategies. To help ease teachers' workload in those areas, it is important for publishers of science instructional materials to incorporate multiple measures of assessment that may be used at various points in the school year (or course). The measures need to:

- Reveal the student's knowledge and skill in science and the ability to apply that knowledge and skill as a foundation for future learning.
- Document the student's progress (or lack of progress) toward mastering the content standards.
- Provide information useful to planning and modifying future instruction in ways that will help all students master (or exceed) the content standards.
- Help identify and reinforce effective instructional practices.

The types of assessments are as follows:

Multiple-Choice, Short-Answer, and Essay Responses

Multiple-choice and short-answer tests are familiar, basic assessment in-

struments. They are particularly useful in covering a number of topics quickly and, if appropriately prepared, provide valid and reliable evaluations of student achievement.

Essay responses are useful for exploring in greater depth students' ability to apply the facts, concepts, principles, and theories learned in science. They typically take more time than multiple-choice or short-answer tests in relation to the number of topics covered, and they are also more complex to grade validly and reliably. They are usually graded with a rubric created in advance. In evaluating essay responses in the area of science, teachers need to be careful to differentiate between students' actual lack of knowledge (or misunderstanding) of science content and limited writing ability.

Investigation and Experimentation Assessments

Investigations and experiments typically involve either (1) a clear-cut question and application of an experimental procedure or protocol; or (2) analysis of a problem and student selection of an appropriate procedure or protocol to use in solving it. In either approach relevant data may be collected or analyzed by students, and the results and conclusions communicated orally or in writing.

As with assessment of essay responses, teachers must be careful in assessing students who conduct investigations and experiments. Teachers may have to distinguish between students' actual lack of knowledge (or misunderstanding) of science content and physical or linguistic limitations.

Reasonable measures may need to be taken to accommodate individual students, but the rigor of the learning and assessment challenge must be equivalent for all students.

STAR Program Results

The State Board of Education has adopted five performance standards for reporting student achievement on the STAR program's standards-based tests in science. The performance standards (levels) are Advanced, Proficient, Basic, Below Basic, and Far Below Basic. Over time, student achievement in science in relationship to these performance standards will be incorporated in California's Academic Performance Index (API), a measure of overall student achievement in the California public schools. Through the API, growth targets are established for individual schools each year, and a system of rewards and interventions has been created based on meeting (or failing to meet) those growth targets.

The STAR program includes four standards-based, subject-specific tests for high school science: physics, chemistry, biology/life sciences, and earth sciences. Standards-based tests have

also been created for integrated science courses at the high school level by using various groupings of the same items that appear on the subject-specific tests. All the tests include assessment in the Investigation and Experimentation standards, using items that reflect the science content. These tests are taken only by students enrolled in the respective courses.

Summary

All students need and are entitled to assessment at appropriate times during the school year on the science standards they are learning. Teachers need to receive timely assessment results that inform instruction and curriculum to assist students meaningfully in mastering the content. Three principal types of assessment are important to science instruction: entry-level assessment, progress-monitoring assessment, and summative assessment. Assessments need to reflect the richness of the science standards and, in the elementary and middle grades, to cover all the strands (life, physical, and earth sciences) and the Investigation and Experimentation standards.