

Educational Curriculum Standards & Standardized Educational Tests: Comparing Apples & Oranges?

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ABSTRACT

Mandated biology curriculum standards and standardized tests may vary widely from one state to another, making academic-performance comparisons among the states problematic. This report outlines the effects of the “No Child Left Behind” law and uses California as a test case against which teachers in other states may make comparisons of their own biology curriculum standards and tests. Several sources are cited that offer sample multiple-choice questions that have appeared on previous California standardized tests for sciences/life sciences/biology. These examples, and critique thereof, may help teachers better prepare their own tests to improve student performance in meeting the state’s curriculum standards in individual science classes and in mandated statewide tests.

Key Words: California’s STAR program; national vs. state educational curriculum standards; No Child Left Behind Act of 2001; standardized educational tests; student proficiency rates.

In 2002, the “No Child Left Behind” (NCLB) legislation was enacted, requiring every K–12 pupil to attain the seemingly impossible goal of becoming “proficient” in reading and mathematics by 2014. Each state was expected to establish its own standards and develop its own set of standardized tests to accomplish the national goal if it was to receive federal educational grants. The *National Science Education Standards* (National Research Council, 1996) served as a guide for each state to develop its own standards. The NCLB law also allowed each state to define its own concept of “proficiency.” Could the legislators not have foreseen that individual states might be tempted to adjust the rigor of their standards or tests, thereby increasing the average state test scores and the percentage of students acquiring “proficiency”? Without mandated national educational curriculum standards and national standardized tests, making comparisons between different states’ educational performance tests is like trying to compare apples and

Without mandated national educational curriculum standards and national standardized tests, making comparisons between different states’ educational performance tests is like trying to compare apples and oranges.

oranges. We often read about how poorly some states are performing on statewide educational tests, but these comparisons may be meaningless unless all states use the same curriculum standards and standardized tests. Comparisons between schools in different counties of a state, however, should be more meaningful because they are being evaluated on a more even playing field.

The NCLB law also allowed the establishment of charter schools (privately managed “public” schools financially supported by government funds) in expectation that such deregulation would increase student performance on test scores. However:

Despite the recent expansion of charter schools, test results did not generally improve – either there or in the regular public schools, which increasingly enrolled more disadvantaged pupils, special education students, and the troublesome and inattentive, all unlikely to lift scores. “No Child” only required testing in mathematics and English, so art, music, history, social studies, and science classes were cut in many school systems. Teachers taught a narrower range of topics even within the tested subjects, undermining learning. Without any evident improvement in test scores, the curriculum narrowed and teaching to the test on the truncated basics became more prevalent. (Reese, 2010)

The lack of mandated national science educational standards and tests makes comparisons between U.S. schools and those of other nations even more problematic than comparisons between states. The 2006 Programme for International Student Assessment reports that

15-year-old students ranked 21st among the 30 developed nations in science. It is of interest to note that almost all of these competitive countries have national science-education standards and score much higher on international science-achievement assessments. Would the United States perform better in international comparisons if it had its own national educational standards that differed from those adopted by other nations? “Efforts are now under way that can move the United States toward what are often referred to as ‘common, internationally benchmarked, state-approved standards’” (Leshner et al., 2010). If uniform standards and tests were adopted by all states, then shouldn’t “teaching to the tests” give students the best opportunity to perform well? With class time at such a premium, how can teachers justify devoting class time to subjects not directly related to statewide test questions?

The National Governors Association and the Council of Chief State School Officers released a draft of *Framework for Science Education* containing new standards in March 2010 for public comment until 2 August 2010; the final version will be publicly available sometime in 2011. The draft *Framework* consists of two documents: Common Core State Standards for Mathematics, and Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science and Technology Subjects. Common core rules allow states to add up to 15% more content standards. So, if adopted, the new standards will still not make all states play by exactly the same rules. Constructing rigorous common core educational standards is no guarantee that they alone will be able to significantly raise test scores. For example, California’s K–12 standards are rigorous, but student proficiency rates are relatively low. If new standards demanding the rigor of California’s standardized tests are adopted by all the states, will they be clearer and more cohesive than the old standards, and will they result in students better prepared to achieve at a higher level? It is not enough to only unify the standards; the assessments (tests) must also be the same. Teachers must also be prepared to use these tools to help students reach the standards.

For the past 8 years, this legislation [NCLB] has had the unintentional result of reducing or eliminating science from school programs, especially at the elementary level, by not including science test scores as a significant part of the calculation for measuring Adequate Yearly Progress. The current blueprint of the U.S. Department of Education for the reauthorization fails to remedy this situation; the final legislation could and should. (Bybee, 2010)

○ State Achievement Tests

State achievement tests in the United States are standardized tests required in American public schools in order for the schools to receive federal funding, according to the Elementary and Secondary Education Act of 1965, in US Public Law 107-110, and the No Child Left Behind Act of 2001. (<http://www.universitycofc.org/documents/ListofstandardizedtestsinthelUnitedStates.pdf>)

A list of state achievement tests in the United States can be found at http://en.wikipedia.org/wiki/List_of_state_achievement_tests_in_the_United_States.

The National Center for Education Statistics (NCES) is the primary federal entity for collecting and analyzing data related to education (<http://nces.ed.gov/nationsreportcard/>). State profiles can be compared at <http://nces.ed.gov/nationsreportcard/states/>. For example, enter: California, science, year 2005, grade 8. Results: CA average score 136; national average 147; at or above basic 44%, at or above proficient 18%, at advanced 2%.

I will report here on the requirements in my own state of California, emphasizing science and biology as an example. Graduation from high school in California requires passing statewide standardized tests in English and mathematics (http://en.wikipedia.org/wiki/California_High_School_Exit_Exam). California Content Standards Tests are administered as part of the Standard Testing and Reporting (STAR) program (<http://www.cde.ca.gov/ta/tg/sr/>). Each spring, California public school students in grades 2–11 take a STAR test developed by grade and subject, unless a parent or guardian submits a written request exempting them. The STAR Program includes the following four tests; students take the test that’s right for their age and individual needs.

- The California Standards Tests (CSTs) are for California public schools and are aligned to the state content standards. All students in grades 2–11 take the CSTs for the subjects listed for their grade.
- The California Modified Assessment (CMA) is a grade-level assessment for students with disabilities in California public schools who meet the state criteria.
- The California Alternate Performance Assessment (CAPA) is for California public school students who have significant cognitive disabilities and cannot take the CSTs even with accommodations or modifications.
- The Standards-based Tests in Spanish (STS) have been developed for Spanish-speaking English learners in California public schools. These tests measure the achievement of state content standards in reading/language arts and mathematics in Spanish.

The California Department of Education contracts with Educational Testing Service (ETS) for the development, administration, scoring, and reporting of the California Standards Tests, the California Modified Assessment, the California Alternate Performance Assessment, and the Standards-based Tests in Spanish (<http://www.startest.org/>).

There are three kinds of CSTs that are based on California’s content standards. First, there are CSTs based on content standards for a particular grade and subject, such as mathematics for grade 2 and English-language arts for grade 10. Second, there are CSTs administered in the secondary grades that are based on the content standards for specific courses, such as chemistry, world history, and geometry. These often are referred to as the “end-of-course” CSTs. Third, there are CSTs that cover selected content standards for a specific subject but for multiple grades. Two examples are the CST for science (grade 5), which covers science content standards for grades 4 and 5, and the CST for history/social science (grade 8), which covers history/social science content standards for grades 6, 7, and 8.

Mathematics, science, and history/social science are the three subjects that have end-of-course CSTs. There is a total of eight

end-of-course CSTs for science. There are four end-of-course CSTs for science that are based on the content standards for earth sciences, biology/life sciences, chemistry, and physics, respectively. In addition, there are four end-of-course CSTs for integrated/coordinated science that are based on selected combinations of content standards for earth sciences, biology/life sciences, chemistry, and physics. Students in grade 10 are required to take the CST for life science. This test covers selected content standards for middle school life sciences and high school biology. Details of the California Standards Tests and the reporting thereof are available at <http://www.ed-data.k12.ca.us/articles/article.asp?title=Understanding%20the%20STAR>.

○ Science Content Standards & Standardized Tests

In preparing California's science content standards, the California State Board of Education and the Academic Standards Commission reviewed the *National Science Education Standards*, the *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1994), and science standards and frameworks from numerous local school districts in California, from around the country, and from other nations with successful science-education programs. Science content standards for California are outlined in a 52-page document, available at <http://www.cde.ca.gov/be/st/ss/documents/sciencestnd.doc> or <http://www.cde.ca.gov/be/st/ss/documents/sciencestnd.pdf>.

The NCLB law

requires states to administer science tests in grade spans 3–5, 6–9, and 10–12. Therefore, all students in grades five, eight, and ten take a science test. CSTs in Biology, Chemistry, Earth Science, Physics, and Integrated/Coordinated Science 1, 2, 3, and 4 are end-of-course tests taken by students in grades 9 through 11. The CSTs in science consist of 60 multiple-choice questions with an additional 6 field-test questions. (<http://www.cde.ca.gov/ta/tg/sr/sciencepreface.asp>)

Each year, 25% of the test questions used in CSTs are released and posted on the Internet for public viewing. None of these released questions will be used on future tests.

There are four disciplines within the Sciences section of STAR: Biology, Chemistry, Earth Sciences, and Physics. Within the Biology discipline, there are five Reporting Clusters. Table 1 shows the number of example (released) test items available and the percentage of all 60 items that are devoted to five Reporting Clusters. This 30-page document contains 90 released test questions for biology that are representative of 60 questions on the exam. Following the questions is a table that gives the correct answer for each question, the content standard that each question is measuring, and the year each question last appeared on the test (2006, 2007, 2008).

If teachers could find out the percentages of questions that will be devoted to each of the reporting clusters before the exams are administered, they could adjust their lesson plans to devote corresponding instructional periods. For example, if 30% of questions will cover genetics, then about 30% of class time would be given to genetics, while only about half that time would be given to cell biology.

Table 1. California Content Standards for Biology (<http://www.cde.ca.gov/TA/TG/sr/documents/cstrtqbiology.pdf>).

Reporting Cluster	Number of Items	Percentage
1. Cell Biology	9	15
2. Genetics	18	30
3. Ecology and Evolution	16	26.67
4. Physiology	11	18.33
5. Investigation/Experimentation	6	10
Totals	60	100

STAR sample questions used on previous exams are available at <http://starsamplequestions.org/starRTQ/search.jsp>. To review any of these questions, teachers and students can make selections by entering the desired grade level (2–11), end-of-course science subject (Biology, Chemistry, Earth Science, Physics), and performance level (All Performance Levels, Advanced, Proficient, Basic, Below Basic).

The following is an example of the content provided by such a search.

- Enter: Grade level = 11; Subject = Biology (End of Course); Performance Level = Advanced. Click on “Submit” tab → Output: 4 questions; Genetics = 2; Cell Biology = 2.
- Example for Cell Biology – Question 01 <<http://starsamplequestions.org/starRTQ/results.jsp?param=CSB00067&count=1>>
- A cell from heart muscle would *probably* have an unusually high proportion of A. lysosomes; B. mitochondria; C. mRNA; D. Golgi bodies
- Results: Percentages of students that give each of the four foils are A. 22; B. 39 (correct response); C. 24; D. 14
- Click on “What This Question Is Testing” tab → Biology Reporting Category – Cell Biology
- The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:
- 1.g. Students should know the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide. See 1.g in Table 2.

A 25-page Parent Guide with 5 sample released STAR questions each for biology, chemistry, earth science, and physics, plus an example of a STAR student report for parents, is available at http://starsamplequestions.org/grades_9_11_sciences.pdf.

A database of 243 sample test questions from National Assessment of Educational Progress (NAEP) can be accessed at <http://nces.ed.gov/nationsreportcard/itmrlsx/search.aspx?subject=science> or <http://nces.ed.gov/nationsreportcard/itmrlsx/> (click on Questions Tool). This database is searchable by grade (4, 8, 12); question type (multiple choice, short constructed response, extended constructed response); difficulty (easy, medium, hard); content classification (physical science, earth science, life science); and knowing and doing science (scientific investigation, practical reasoning, conceptual understanding). Many of these NAEP test questions ask test takers to demonstrate more than just memorization of facts. Descriptions of these kinds of questions contain words such

Table 2. California Content Standards: Biology/Life Sciences (<http://www.cde.ca.gov/ta/tg/sr/documents/biology1105.doc>).

	Number of Items
Cell Biology	9
1. The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:	
a. <i>Students know</i> cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings.	1
b. <i>Students know</i> enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.	1 or 2**
c. <i>Students know</i> how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.	1 or 2**
d. <i>Students know</i> the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.	1
e. <i>Students know</i> the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins.	1
f. <i>Students know</i> usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.	1
g. <i>Students know</i> the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.	1
h. <i>Students know</i> most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.	1
i.* <i>Students know</i> how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.	NA*
j.* <i>Students know</i> how eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both.	NA*
For biology, chemistry, earth science, physics, and integrated/coordinated science 1, 2, 3, and 4, standards that all students <i>should have the opportunity to learn</i> , identified with an asterisk (*), are not tested , though they are important to the comprehension of the strand. In some grades or courses there are standards that, while important, are not assessable in a multiple-choice format. These standards have been identified with the notation NA*. Though these standards are not assessed, they are important to the comprehension of the strand.	

as identify, relate, predict, compare, recognize, explain, describe, use, why, list, design, graph, balance, classify, and interpret. If teachers would make students aware of the URLs for the standards and example tests in this article (or comparable sources in their own state), they and their parents could study these documents anytime at their own speeds.

○ Critique

Students are required to take the California standardized tests, but the results of these tests are not used by teachers to assign course grades. "The tests evaluate the schools, not the students taking the tests. We are measuring the wrong criterion (i.e., knowledge instead of ability) and we are doing so in a fundamentally flawed manner" (Kliewer, 2010). Furthermore, the STAR Program test results do not go on a student's high school transcript. What, therefore, is the motivation for students to do well on these standardized tests? Teachers are encouraged to explain to students how important their performance will be to the school in terms of statewide prestige and potential funding from various governmental agencies. Perhaps if the scores a student earns on each of these standardized tests could be accumulated by the school and made available to the student on his school transcript, the student could use this information upon graduation when applying for a job, for a scholarship, or for credit, placement, or admission into a college or university. Parents, guardians, and teachers should review CST results, grades, classroom work, and results from other classroom and standardized tests for a more complete picture of each student's academic progress.

If states develop their own standardized educational curriculum and standardized tests, differences are bound to exist, and some of these differences may not be trivial. A case in point is the 2009 revision of the science standards developed by the State Board of Education (SBOE) for the Texas Essential Knowledge and Skills (TEKS). Given that in a recent Harris poll ~40% of respondents stated that they believe in creationism, it is not surprising that the boards of education in some states might contain creationists. In the Texas case, the 15-member SBOE contained at least seven biblical literalists and creationists. This SBOE approved several antiscience amendments to the TEKS.

The outcome of the process was that the scientific method standard and many of the standards that concern the cosmic and biological evolution in the biology and earth and space science (ESS) standards were compromised... Their end of course biology exams may contain questions focused on alleged problems with evolution and the history of life, not test whether the students have accurate and reliable knowledge of this field. Teachers and students will be forced to prepare for this pseudoscientific nonsense if they want to pass the exam. (Schafersman, 2009)

The companies that develop the standardized tests for each state do so in accordance with the desires of the SBOE. The rigor of a multiple-choice test for any given standard can be made relatively easy or difficult. The test question for California cell biology standard 1g, cited above, requires the student to understand that mitochondria are involved in making chemical energy available to cells by completing the breakdown of glucose to carbon dioxide. Furthermore, it requires the student to make the inference that (of the four choices given) the heart muscle should logically need to contain an unusually high proportion of mitochondria to power contractions of this energy-hungry tissue. If a less rigorous question is desired, the same standard could be tested by (for example) the following kind of question:

The most general role of mitochondria in the cell is to A. store lipids; B. activate enzymes; C. synthesize ATP; D. mark proteins for secretion from the cell.

The instructions from the SBOE to the test maker regarding the need to increase or decrease the rigor of various parts of the test is not transparent to the general public and, hence, may be open to political manipulation. For example, if the SBOE wishes to show a 2–3% increase in test scores from year to year, the test makers might be directed to decrease the rigor of test questions by a corresponding amount. The necessity of maintaining secrecy about these standardized tests is understandable, as is the political pressure placed upon elected or appointed superintendents and other officials at the highest levels of state public education to show progressive improvement each year in these test scores. Voters should thus recognize the need for moral integrity and honesty when they choose their elected educational representatives or the people who appoint them.

There are at least three main functions that any standardized test of educational performance can supply. (1) How well does each student perform with respect to others in the same grade or same class? (2) Ideally, as a result of class results, teachers should be able to identify and correct their own teaching methods regarding certain aspects of the curriculum. (3) Students should be able to review their test results and profit by learning the correct answers to questions

they missed. In this respect, the results of the STAR program offer no chance for students to learn from their mistakes because the standardized test questions, the student's answers, and the correct answers are not made available to students, teachers, or parents.

The best way to prepare students for the tests in the STAR Program is to provide classroom instruction and assessments that are aligned to California content standards. Teachers are encouraged to talk with their student's parents and guardians about what the school district, school, and teachers are doing to make sure the content standards are being taught and tested. (Understanding 2009 STAR Program tests; <http://www.cde.ca.gov/ta/tg/sr/resources.asp>)

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