The SAT and the Science Teacher

With its traditional focus on assessing general reading, writing, language, and math skills, the SAT, frankly, hasn't had much relevance for science teachers. That situation, however, has changed significantly with the redesign of the SAT.

An important feature of the test—one based on extensive evidence and reflective of best instructional practices—is its emphasis on students applying their literacy and math knowledge and skills in a wide range of subjects. This across-the-curriculum focus means that teachers in many fields, including science, have a critical and specific role to play in helping students get ready for the SAT and, more importantly, acquire the knowledge and skills they'll need to succeed in college and career training programs.

This guide is intended to help you, the science teacher, get more familiar with the SAT, better understand its relationship to the teaching and learning already going on in your classroom, and identify ways to enhance your students' college and career readiness.

Though many of the suggestions in this guide have broad applicability, the information and advice are tailored specifically to science teachers such as you. We do want to note at the outset that our goal here is *not* to try to convert you into an English language arts or math teacher. Instead, our intent is to show how fostering your students' ability to handle the special challenges of reading, writing, language, and quantitative analysis in your field contributes in a unique way to the literacy and numeracy work going on in your school.

Disciplinary Literacy and Numeracy on the SAT

One hallmark of the SAT is its emphasis on disciplinary literacy and numeracy. Rather than simply ask students to demonstrate generic reading, writing, language, and math knowledge and skills in ways that lack real-world relevance, the SAT makes extensive use of texts, tasks, and scenarios similar to those students already encounter in their high school classes and to those they'll have to deal with in college and career training programs.

In recent years, numerous educators and researchers have affirmed the value of subject-based approaches to teaching literacy and numeracy. Writing in the *Journal of Literacy Research*, Cynthia Shanahan, Timothy Shanahan, and Cynthia Misischia make a persuasive case that students' literacy education should extend beyond generic communication skills to include the differing demands of particular fields of study: "In addition to the 'domain knowledge' of the disciplines . . . each discipline possesses specialized genre, vocabulary, traditions of communication, and standards of quality and precision, and each requires specific kinds of reading and writing to an extent greater than has been recognized by teachers or teacher preparation programs." Similarly, Kathleen W. Craver, in *Developing Quantitative Literacy Skills in History and the Social Sciences*, argues for a broad-based, cross-curricular approach to numeracy: "Being charged with the responsibility that our students become quantitatively literate has long been the sole domain of those teaching mathematics. In the data-drenched world of the current century, however, it has now become the responsibility of not only history and social science educators but also STEM (science, technology, engineering, and mathematics) coordinators and curriculum development specialists to integrate quantitative literacy skills into all aspects of the school curriculum, including the humanities."

As a teacher, you're already familiar with the multifaceted role these researchers describe. In addition to helping students obtain essential knowledge in your field, you work closely with them to ensure that they understand how to read, write, analyze data, and, more generally, *think* in ways appropriate to the subject you're teaching. In so doing, you initiate students into the science discipline. By continually asking students to work with texts, tasks, and scenarios in science (as well as other subjects), the SAT supports you in this vital mission.

Science on the SAT

Science contexts and questions can be found throughout the SAT's Reading, Writing and Language, and Math Tests. Selected questions on all three exams contribute to an **Analysis in Science cross-test score**, which gives an indication of how effectively your students can apply their reading, writing, language, and quantitative analysis knowledge and skills in the science area.

Let's begin this section with an overview of the science-related materials on the SAT and then turn to a discussion of the knowledge and skills that are routinely assessed in the course of determining the Analysis in Science score.

Science Contexts and Questions

The field of science is represented in various ways on the three required tests of the SAT. We'll now take a brief look at each test and its science content in turn.

Reading Test

Two of the SAT Reading Test's five sets of multiple-choice questions are science related. Passages associated with these questions are drawn from high-quality, previously published sources and may range in complexity from early high school level to postsecondary-entry level (comparable to that of texts required in common college-entry, credit-bearing courses). Science passages cover foundational and applied topics in the fields of biology, chemistry, Earth science, and physics (and their subfields). Science passages frequently introduce a concept; present descriptive, observational, or experimental data related to that concept; discuss findings; and consider implications. Science passages may be accompanied by one or more informational graphics related to the topic under study and about which students must answer questions involving locating and interpreting data as well as relating data to the information and ideas in the passage. Topically related texts in this category may be paired on the SAT, with some questions asking students to make thoughtful connections between the two texts.

Prior knowledge of the passages' topics isn't assessed; all of the information needed to answer the associated questions is either in the passages (and graphics) themselves or, occasionally, in accompanying explanatory notes (such as an advance organizer or footnotes).

Writing and Language Test

One of the SAT Writing and Language Test's four sets of multiple-choice questions is science related. The passage associated with these questions is a high-quality, carefully crafted piece written specifically for the test and has a complexity within a range spanning from early high school to postsecondary-entry levels. Science passages on the Writing and Language Test cover foundational and applied topics in the fields of biology, chemistry, Earth science, and physics (and their subfields). Like their Reading counterparts, Writing and Language science passages discuss concepts, data, findings, and implications drawn from research and may be accompanied by one or more informational graphics related to the topic under discussion and about which students must answer questions involving revising (or choosing not to revise) a passage in light of the data displayed visually.

Math Test

A key feature of the SAT's Math Test is its emphasis on students' ability to apply their math knowledge and skills to solve problems and analyze data grounded in authentic, meaningful contexts, including science contexts. Test takers can expect to see questions calling on them to consider scenarios, analyze data, and solve problems reflecting real-world tasks in the sciences. As with the tests discussed previously, prior knowledge of specific science topics is not assessed on the Math Test; the questions themselves provide students with enough background information to answer the questions using their math knowledge and skills.

The Analysis in Science Score

Overview

To offer greater insight into students' achievement and to aid teachers, parents, and others in directing and supporting future learning, the SAT reports out a number of scores in addition to the familiar total and section scores. Part of this array is the Analysis in Science cross-test score. It's called a "cross-test score" because selected questions drawn from the Reading, Writing and Language, and Math Tests contribute to the score, giving a rounded picture of students' strengths and weaknesses.

Analysis in Science Score: Contributions by SAT Test

Test	Contribution to Analysis in History/Social Studies Score
Reading	21 questions; all questions associated with the two science passages (or one science passage and one science pair)
Writing and Language	6 questions; all Expression of Ideas (Development, Organization, Effective Language Use) questions associated with the science passage (questions about sentence structure, usage, and punctuation *not* included)
Math	8 questions; based in science contexts

It's important to recognize that the Analysis in Science score does *not* represent the level of students' background knowledge in science. (As noted earlier, all of the science information needed to answer questions is provided in the tests themselves.) What the score *does* indicate, however, is the extent to which students can apply their literacy and numeracy knowledge and skills to science texts, tasks, and scenarios. Understood this way, the Analysis in Science score offers students, teachers, parents, and others useful, actionable information about student achievement.

Key Knowledge and Skills Commonly Represented in the Score

While the exact makeup of questions contributing to the Analysis in Science score varies to some extent from one administration of the SAT to another, several recurring themes emerge from the kinds of questions that students are frequently asked and from the sorts of knowledge and skills that students are routinely expected to demonstrate:

- Command of evidence (Reading; Writing and Language)
- Words in context (Reading; Writing and Language)
- Informational graphics (Reading; Writing and Language; Math)
- Multiple texts (Reading)
- Relationships (Reading); logical sequence, transitions, syntax (Writing and Language)
- Problem solving and data analysis (Math)

These themes, discussed next, are suggestive of some of the approaches you can take with your students to prepare them better for the test and for the challenges of college and career training programs. (Several such approaches are talked about later in this guide.)

Command of Evidence (Reading; Writing and Language)

Science texts (e.g., textbooks, journal articles) make extensive use of a wide variety of evidence—facts, data, quotations, and the like. To be proficient readers of these texts, students must understand what counts as evidence in science and be able to evaluate how—and how effectively—particular authors use (or fail to use) evidence to support their claims and points. As fledgling scientists themselves, students must also learn how to gather and analyze high-quality, relevant, sufficient evidence and how to marshal that evidence effectively in their writing, speaking, and presenting.

Several questions on both the Reading and the Writing and Language Tests directly address students' command of evidence. One approach used frequently on the Reading Test requires students to determine the best textual evidence for the answer to a previous question. In the most common format, test takers are asked to decide which of four brief quotations from the passage represents the best support for the answer to that earlier question. In completing this task, students make explicit their reasoning as they read and comprehend text. On the Writing and Language Test, students use evidence, such as descriptive details and data from informational graphics, to add or refine central ideas, develop and strengthen claims and points, sharpen focus, and improve precision and accuracy.

These and other questions contribute to a **Command of Evidence subscore**, one of the array of scores the SAT yields. You may find this score useful as an indicator of your students' facility with understanding and using evidence in their reading and writing.

Words in Context (Reading; Writing and Language)

To comprehend challenging texts and to communicate effectively through writing, speaking, and presenting in science classes, students need both a well-developed vocabulary and a range of vocabulary-related skills, including the ability to determine the meaning of words and phrases as they're used in particular contexts; to understand how an author's word choice influences meaning, audience response, and the like; and to use words and phrases effectively to convey information and ideas precisely and concisely, in an appropriate and consistent style and tone, and by means of language structures and patterns that facilitate audience understanding and interest.

As a science teacher, you're already familiar with introducing students to the specialized vocabulary used in your field. It's important to recognize that you also share with other instructors in your school the responsibility of helping students attain mastery of the broadly applicable high-utility academic words and phrases that appear commonly in writings across many subject areas (including science). While it's easy to see that many students need help understanding and using such specialized ("tier three") terms as *isotope*, *meiosis*, *hydrosphere*, and *superconductor*, we have to remember that they also likely need support in acquiring the relatively common general academic ("tier two") words and phrases, such as *association*, *dispute*, and *integrate*, that show up frequently in readings of many sorts (but relatively seldom in conversation). Though knowledge of these high-utility words and phrases has clear value in unlocking the meaning of challenging texts on a wide variety of topics, classroom instruction too often neglects them because, ironically, their very commonness means they're the "property" of no single subject area and hence the responsibility of no single teacher.

Vocabulary knowledge extends beyond an understanding of word and phrase definitions, as important as that is. Students must also appreciate nuances in meaning as well as the connotations that particular words and phrases carry. Such knowledge allows students to assess how language choice can influence an audience's perception of and reaction to claims, results, or implications. Students may consider, for example, how readers' attitudes may be influenced and their opinions shaped when a science writer's account characterizes a researcher's preliminary conclusion as *tentative*, *debatable*, or *suspect*.

Several questions on both the Reading and the Writing and Language Tests assess students' ability to apply their vocabulary knowledge and skills. While specialized, domain-specific terms do appear in passages and questions, the tests' main vocabulary focus is on high-utility academic words and phrases because of their versatility and their great power in aiding comprehension and communication. Vocabulary questions on the Reading Test address the skills of interpreting words and phrases in context and analyzing word choice for its rhetorical effect. On the Writing and Language Test, vocabulary questions deal with precision and concision of expression; appropriateness and consistency of style and tone; and effective arrangement and combination of sentence elements. (A sample of this approach appears later in this guide.)

These sorts of questions contribute to a **Words in Context subscore**, another of the scores the SAT yields. You may find this score useful as an indicator of your students' vocabulary knowledge and their ability to apply that knowledge in meaningful ways.

Informational Graphics (Reading; Writing and Language; Math)

Science materials often use graphics—tables, graphs, charts, and the like—to convey information and ideas visually and to make interpretation and analysis of data easier. A line graph, for example, may depict temperature trends over time more quickly and intuitively than could a list containing the same information; a table displaying pH levels in samples of lake water taken from different locations over several days may organize data far more effectively than could a written description.

Several questions on the Reading, Writing and Language, and Math Tests ask students to use information and ideas presented in various graphical formats. On the Reading Test, students may be expected to locate or interpret data in a graphic or to make meaningful connections between information in a graphic and in an accompanying passage on the same topic. (A sample of this approach appears later in this guide.) On the Writing and Language Test, students may be asked to draw on data in a graphic to improve the accuracy or precision of a writer's account of the results of an experiment or to substantiate a writer's claim about a phenomenon. Questions about informational graphics on the Reading and the Writing and Language Tests focus on locating, interpreting, and using data, not on computation; students may, for instance, have to compare values represented by the various bars of a graph, but they won't, say, have to calculate percentage differences.

On the Math Test, by contrast, students may be asked to perform such tasks as using the relationship between two variables to investigate key features of a graph or showing an understanding of a nonlinear relationship between two variables by making connections between their algebraic and graphical representations.

Questions making use of quantitative information displayed graphically in science contexts appear in every administration of the Reading Test and may appear in administrations of the Writing and Language and the Math Tests.

Multiple Texts (Reading)

Building knowledge in science (or any subject, really) often involves finding multiple credible, reliable sources on a topic, analyzing and evaluating each source individually, and developing with the aid of the sources a unified, sophisticated understanding of the topic. After reading several texts on a particular scientific theory, for example, students should be able to synthesize information and ideas from the sources into a cohesive account that also acknowledges and examines (rather than ignores) important differences and distinctions, such as the varying assessments by leading researchers of the theory's explanatory strength.

Each administration of the Reading Test includes a pair of related passages on a history/social studies or science topic. In answering the questions accompanying such pairs, students demonstrate that they understand each passage individually and are able to synthesize information and ideas found in the two texts in substantive ways. They may, for instance, be asked to compare the main purposes of the two passages or to describe the reaction that the author of one passage would likely have to an assertion made by the author of the other passage. Paired-text questions are thus not limited to simple factual comparisons but rather extend to such

matters as focus, emphasis, structure, and perspective. (A sample of this approach appears later in this guide.)

Relationships (Reading); Logical Sequence, Transitions, Syntax (Writing and Language)

In science, it's important to be precise about the nature of relationships between and among hypotheses, events, data, phenomena, and the like. Comparisons and contrasts frequently need to be drawn, sequences of events delineated, effects linked to causes, and so on. To be able to trace and establish such relationships in their reading and writing, students must attend closely to various aspects of language and writing—for example, to the order in which information and ideas are presented, the words and phrases used to signal logical connections between sentences and paragraphs, and the arrangement of ideas within sentences.

Various questions on both the Reading and the Writing and Language Tests require students to show an understanding of how information and ideas are or should be connected. On the Reading Test, students may be asked to identify stated or to infer implicit cause-effect, comparison-contrast, sequential, or other kinds of relationships presented in passages, including those on science topics. (A sample of this approach appears later in this guide.) On the Writing and Language Test, students may need to add, delete, or rearrange information within a paragraph to create a more logical order of presentation; insert or revise a transition word or phrase (e.g., *however*, *as a consequence*) or sentence to clarify the relationship between ideas; or restructure one or more sentences to achieve a particular writing goal, such as placing emphasis on a central idea rather than on a less important one.

Problem Solving and Data Analysis (Math)

Students in science classes will often be confronted, in one way or another, with data. Whether those data are observations from a study of the mutation rates of microbes in different environments, statistics from an analysis of the gravitational influence of planets on asteroid orbits, or the outcomes of an experiment on techniques to improve memory, students must find ways to analyze and make meaning from them.

The Math Test includes numerous questions focused on just such analyses. These questions require significant reasoning about ratios, rates, and proportional relationships. As indicated previously, many of these questions are rooted in science (as well as social studies and career-related) contexts, and students answering them must demonstrate that they can interpret and synthesize data and apply core concepts and methods used in the sciences and in other fields. (A sample of this approach based in a science context appears later in this guide.)

These questions contribute to a **Problem Solving and Data Analysis subscore**, another one of the scores yielded by the SAT. You may find this score useful as an indicator of your students' strengths and weaknesses in solving problems and working with and coming to reasonable conclusions about data.