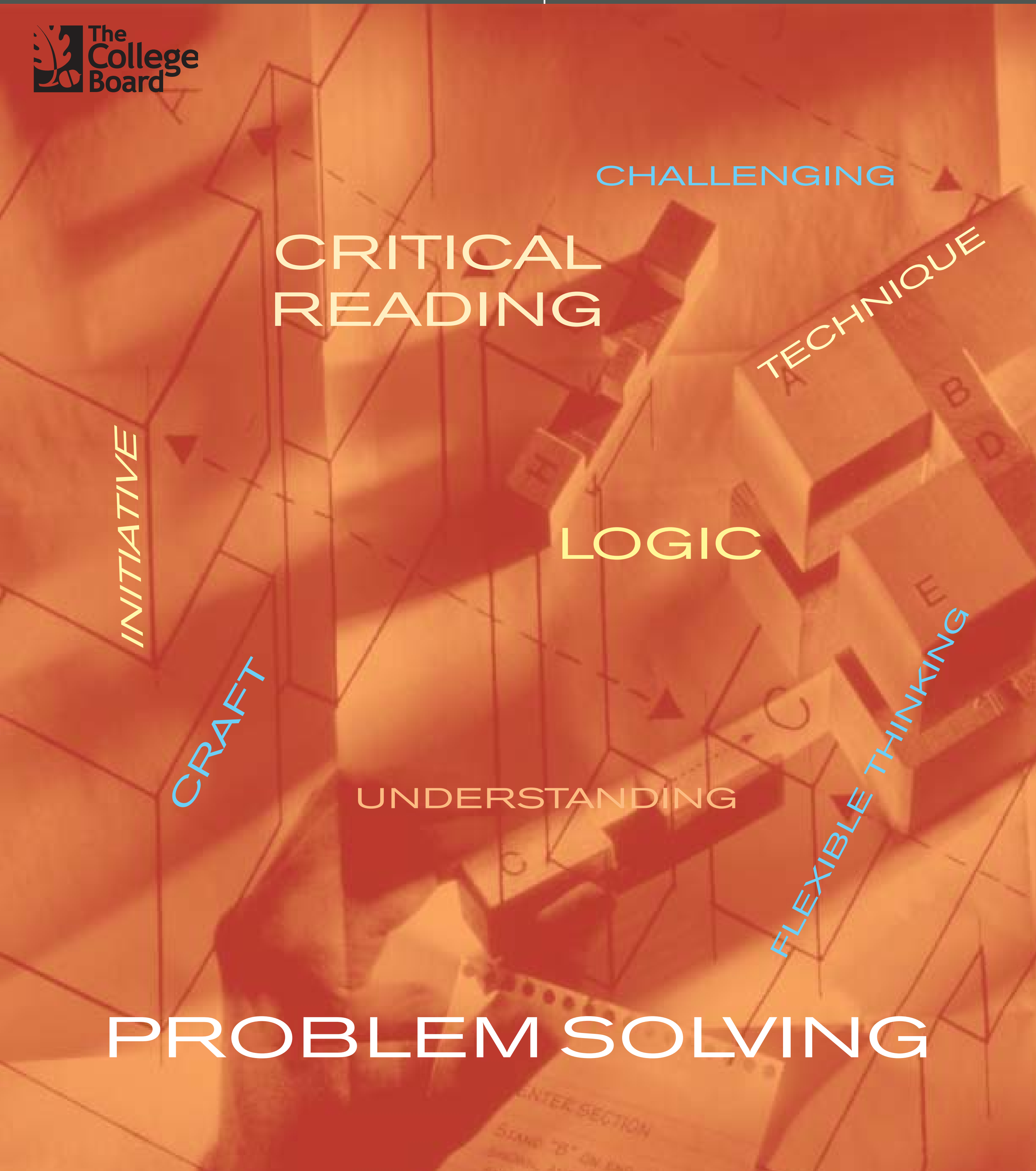
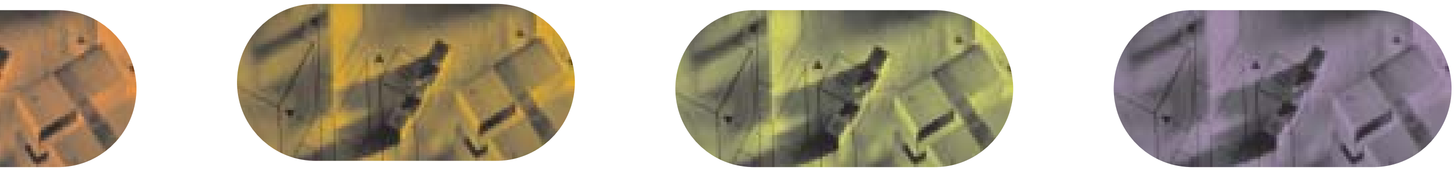
WHAT DOES THE SAT® MEASURE
AND WHY DOES IT MATTER?

The College Board





Dear Colleague:

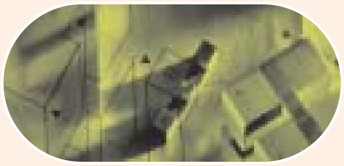
It’s hard to imagine anyone in the United States who doesn’t know what the SAT® is. But the truth is that few people really know what’s in the test. And even though we’ve published literally millions and millions of copies of sample SATs, the rumor persists that the SAT measures something mysterious. Nothing could be farther from the truth.

This publication not only describes exactly what the SAT measures, but it also discusses why it matters in the context of secondary school programs and students’ preparation and readiness for college. It is extraordinary how closely aligned the content of the SAT is with so many of our current state and national curriculum standards. Although the SAT has been revised numerous times over its 75-year history, it has had at its core, for many years, critical reading and problem solving—skills that are considered essential for both high school and college-level academic study.

The SAT provides relevant and objective information to help institutions make informed admission decisions. I am proud of the SAT and the role it plays in helping students and institutions manage the admission process.

Gaston Caperton





While there is a lot of discussion of the SAT® I: Reasoning Test, this discussion rarely addresses in any detail what the test examines. This document opens up the exam so that we can take a careful look at its contents. What we find is a demanding test that examines fundamental math and reading abilities that are crucial to success in college and adult life.

The SAT verbal test focuses above all on critical reading. Students are asked to read passages from the sciences, the social sciences, and the humanities, and to discuss the author's point of view, technique, and logic.

In math, the SAT focuses on problem solving. The test does not measure advanced math skills such as trigonometry or calculus. But it does challenge students to apply strong problem-solving techniques and use the math they do know in flexible ways. The math sections of the SAT ask that students go beyond applying rules and formulas to think through problems they haven't solved before.

This emphasis on problem solving in mathematics mirrors the higher academic standards that are in effect in virtually every state. The National Council of Teachers of Mathematics and other bodies have argued for a long time that mathematics education should not merely inculcate students with a knowledge of facts and algorithms, but should aim to create flexible thinkers who are comfortable handling nonroutine problems. Similarly, critical reading skills have gained increasing importance for success in high school. The majority of high school exit exams in English focus on critical reading of challenging nonfiction.

The reason that both the standards and the SAT focus on critical reading and problem solving is that these are the very skills required for full access to the academic life of college. The SAT is sometimes seen as a means of securing access to college; but access to college doesn't mean just getting in. Access to college in its deepest sense means participating fully in the range of intellectual life that college offers.

The Verbal Test

At first glance, the SAT verbal test can seem like a random assortment of verbal puzzles, ranging from analogies, to sentence completions, to questions about reading passages. However, these sections of the exam are actually concerned with ideas, using language as the tool for exploring them. Language is used at three levels here: analogies focus on the relationship between *words*, sentence completions explore patterns in *sentences*, and reading passages address the meaning of entire *paragraphs*. In short, the SAT measures students' ability to understand ideas as they are expressed through words, sentences, and paragraphs. In what follows, we will take a look at what is involved in each of these three levels; and then we will get down to details, by walking through a typical SAT critical reading section.

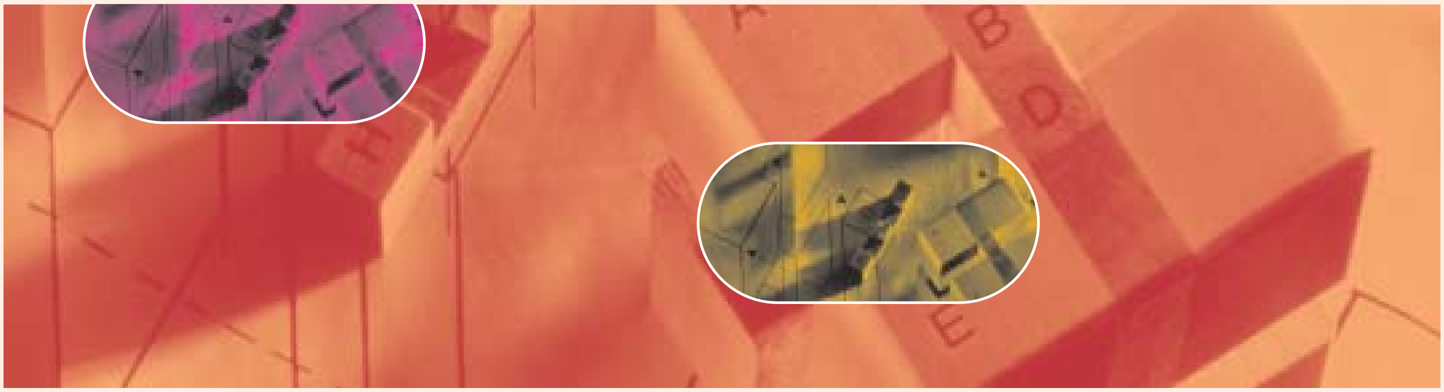
CRITICAL READING — *Grasping the logic and language that authors use to express their ideas*

Critical reading is at the core of the SAT verbal test, accounting for 50 percent of the questions. More than 80 percent of the passages examined are nonfiction: selections from essays or other writings in the sciences, social sciences, and humanities. Recent SAT exams have featured such texts as an analysis of Aristotle's distinction between plants and animals, an essay on the clash between bourgeois and bohemian ethics, and extracts from *The Federalist Papers*.

The SAT requires students to move confidently through these challenging passages, to summarize them, to assess the author's point of view, and to identify the argument's reasonable implications. Moreover, students must be able to think about the author's argument in terms of its logic and technique, and be able to determine the meaning of words and phrases in context. Being prepared for these tasks requires extensive experience in reading difficult nonfiction texts, as well as a solid understanding of how arguments themselves are structured.

If this seems a high bar, it is worth remembering that this is precisely the kind of reading that students will be expected to do on their own in college courses. That is why the College Board believes it is so important that aspiring college students master the skills of reading, summarizing, and interpreting texts from all disciplines. In order to have full access to the range of courses and ideas that college offers, students need the underlying reading skills to access these subjects.

Reading nonfiction well is as important to being an informed citizen as it is for college. People with SAT-level reading skills can read the works of experts for themselves, rather than having someone else summarize them. If we want voters to be able to read a court decision to make up their own minds, without relying on the media, they need to be able to analyze arguments. And in college, more than in any other time of a student's life, it is crucial to experience ideas directly, rather than through the filter of someone else's version.



ANALOGIES — *Understanding the meanings of words and the relationships between them*

Analogies make up 25 percent of the SAT verbal test. Analogies explore the most relevant comparison between two sets of words. The key to answering these questions correctly is a rich vocabulary combined with a sharp understanding of the different kinds of relationships between words and the concepts they signify.

While some people think analogies are only found on exams, in fact such questions are fundamental to thinking throughout the sciences as well as the arts. Historians constantly ask how a particular war or peace is similar to and different from all the others they've learned about. In modern physics there are many concepts, such as the orbit of an electron within an atom, that can't even be visualized. Analogies are the only way we can talk or even think about them. Indeed, the very word "orbit" in this example is part of an analogy ("electron is to nucleus as planet is to sun"). Students in college physics courses spend a great deal of time discussing the appropriateness of this particular analogy.

Analogies operate at the heart of invention and discovery; after all, understanding something new so often begins with recognizing a relationship that has been seen before. Thus, Rutherford, the discoverer of the atomic nucleus, was probably the first person to reach for the planetary analogy to explain the structure of atoms. And analogical reasoning is not only crucial for exploring within a discipline, but also for exploration across disciplines. Economists and ecologists alike have based recent work in understanding large systems on similar mathematical models.

The fact that so many students are taught analogies by practicing lists of words does not mean that analogies are superficial, or that they should be taught superficially. In a public school district in Ridgewood, New Jersey, teachers use analogies from the second grade onwards to help students learn new things in science and history, as well to help improve students' vocabulary and enable students to read literature.[1]

Of course, students will not be equipped to think about the range of relationships between words if they do not know what the words in question mean. The vocabulary on the SAT is fairly demanding; it is the vocabulary students will need to access the realms of knowledge in literature, science, and the arts. On the other hand, this vocabulary is not so thorny as it is sometimes made out to be. One never finds words like

"pastinaceous" on the SAT ("of the nature of or relating to the parsnip"). Indeed, some of the most difficult words on recent SATs have been words such as "congeal," "sycophant," and "collusion." These are exactly the kinds of words one needs to know in order to express ideas vividly, forcefully, and precisely.

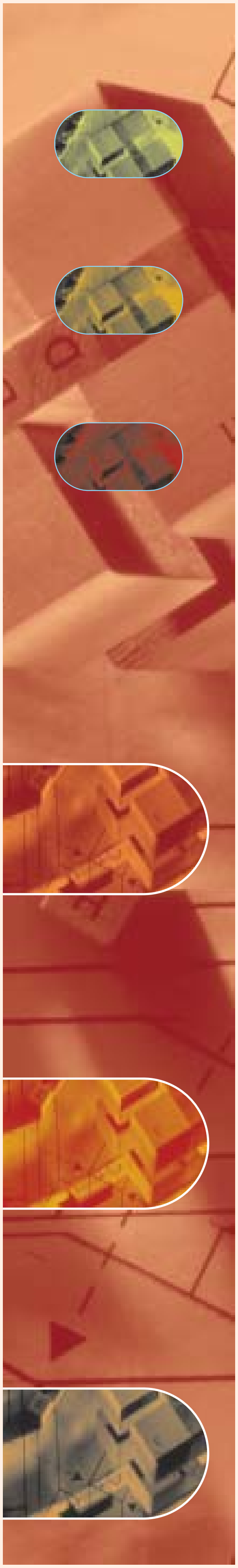
A great deal of research has underscored the importance of vocabulary development to learning and growth in reading power. A review of the findings concludes: "The enduring effects of the vocabulary limitations of students with diverse learning needs are becoming increasingly apparent. Nothing less than learning itself depends on language."[2]

SENTENCE COMPLETIONS — *Following the author's train of thought*

Sentence completions make up the remaining 25 percent of the SAT verbal questions. The format of these questions is familiar: students are given a single sentence containing one or two blanks, and asked to choose the word or combination of words that best fits the sentence. Just as analogies examine relationships between "elemental" ideas (as represented by single words), sentence completions hinge on the relationships between the parts of a broader thought (as represented by a full sentence).

For example, a sentence completion from a past SAT runs as follows: "Interest in the origin of life is _____; all cultures and societies have narratives about creation." The missing word in this case is "universal." However, it is interesting to look at one of the *incorrect* answer choices: "superficial." "Superficial" is a poor choice not because it is absurd, in itself, to claim that an interest in the origin of life is superficial. Rather, "superficial" is a poor choice because it is absurd to claim *in one breath* that an interest in the origin of life is superficial, while proceeding *in the next breath* to amplify this assertion with the statement that all cultures and societies have narratives about creation.

A rich sentence is like an essay in minature. It has a thesis, a point of view, and implications. And, just as essayists use standard techniques to communicate their points and make their arguments, so do writers of rich sentences. Sentence completions turn on the ability to recognize and appreciate these techniques. Is the author using one part of a sentence to define a term or to amplify a more concise thought appearing in some other part of the sentence? Is he or she setting up a contrast of some kind? Is he or she appealing to a cause-and-effect relationship?



Patterns like these are the hallmark of vibrant writing—writing that goes beyond a series of mere declarations. And, no less than in a conversation, where we might say "Yes, I see where you are going with this," recognizing these patterns is essential to following along with an author's train of thought.

A CLOSER LOOK AT SOME NONFICTION APPEARING ON THE SAT®

To see how the SAT works in practice, let's turn to the exam administered in May 2000.[3] Opening the exam, we find at one point a pair of passages side by side, both concerned with the New England town meetings that began in the 1600s as a means for free individuals to govern themselves through discussion.

As soon as the student begins reading the questions following these two passages, he or she is immediately led into a dramatically unfolding discussion. For starters, the student is asked to summarize the first passage: to understand its scope and tone, and, next, to report its key idea (namely, that the town meeting's "most significant innovation" was "collective decision making by ordinary citizens"). The third and fourth questions move deeper into the text, assessing the student's ability to infer the author's own opinions and to speculate on the author's chosen rhetorical strategy. None of the answers to these questions are available to a reader who is simply skimming. Nor are these questions tangential or otherwise unrewarding. They are exactly the important questions that a college-level instructor would ask in order to determine whether a student had followed the text's argument. And the texts themselves are of the level of difficulty that one would find in a college history class.

Just as in a good classroom conversation, the exam's discussion then continues with a twist. The questions now turn our attention toward the second passage. Whereas the first author had presented what seemed to be a straightforward, objective view of the town meetings, the second author could hardly be more critical of this "New England mythology." The second author now reminds us that the meetings were closed to "women, Black people, American Indians, and White men who did not own property"; that the meetings were held infrequently, and were dominated by the town selectmen; and that while "Ultimately the power did rest with the townsfolk if they wanted it . . . frequently, they did not."

As the SAT invites us to compare and contrast these two passages, making clear the places where the arguments are compatible and where they conflict, we come to see the New England town meetings as a much more qualified achievement than they had originally appeared. Two profound questions have been opened to us: What is meant by enfranchisement? and What does it mean for someone to be a full member of society and to engage in self-government?

WHAT IS "ACCESS TO COLLEGE"?

No single activity is more central to a student moving through various subjects in college than the reading of difficult nonfiction and the criticism of arguments within it. In this sense, reading through an SAT exam is almost like following along in a day in the life of a college freshman. But imagine how it would feel to enter college unable to analyze difficult nonfiction. Without the ability to read the assigned text with confidence, how could one participate actively in classroom discussions? To a student in this position, almost every assignment is an intimidation. The approach to philosophy, history, and many of the sciences is forbidding. For these students, selecting courses becomes a flight from any subject with weighty reading; as a result, the greatest opportunity these individuals will ever have to stretch themselves is lost.

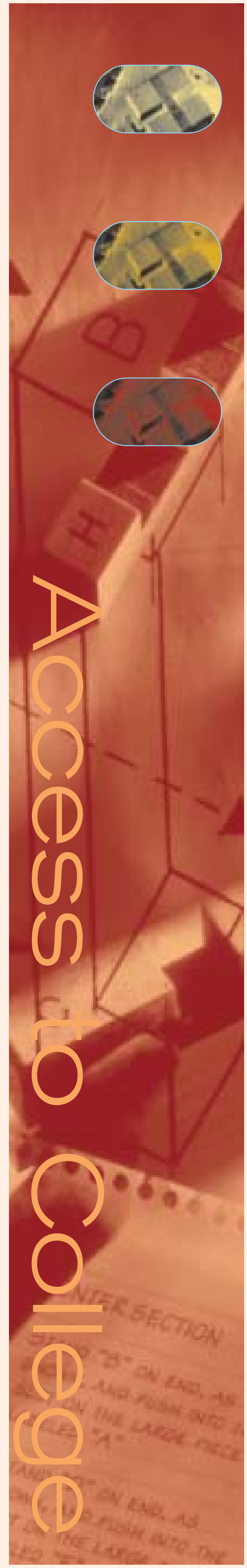
Practiced ease with difficult nonfiction is a requirement for full citizenship in the community of ideas that a college campus should be, and the critical reading portion of the SAT is designed to measure just this kind of fluency.

ACCESS TO PUBLIC DISCOURSE AND DEMOCRACY

There is even more at stake in these critical reading skills, and that is the average citizen's ability to participate authentically and responsibly in the democratic process. Imagine Martin Luther King, Jr., in April of 1963, locked up in Birmingham Jail and writing the famous letter in which he calls for "the kind of tension in society that will help men rise from the dark depths of prejudice and racism to the majestic heights of understanding and brotherhood." Dr. King's letter was intended as a public document — a thoughtful and urgent address to the American people. However, its language, structure, and ideas require close attention to be properly understood. If we as a people cannot comprehend such speech, then our public discourse will itself lack the qualities of thoughtfulness and understanding that are always necessary to resolve divisive issues. Meaningful social criticism requires an audience that can critically evaluate complex ideas.

What does it mean for people to be unable to read complicated texts for themselves? Think of the Supreme Court, which issues decisions with far-reaching and fundamental consequences for who we are as a country and how we live as private citizens. Many Americans are unable to read a court opinion firsthand, and this is not due to any government suppression of free speech, but rather to a simple lack of critical reading skills. Are we to rely on the media to summarize and filter the opinions of the courts that interpret our laws? This is already an uneasy prospect, and yet, for many Americans, even such a summary is too difficult to follow and evaluate.

A time when all Americans can read court opinions with confidence may be far away, but this is precisely the sort of capacity we expect from college-bound students in our society. Our democracy will be stronger the more widely the tools of critical reading are available.



The Math Test

THE SAT AND MATHEMATICAL PROBLEM SOLVING

An important and perhaps surprising fact about the SAT math test is that it requires only a limited mathematical background. If you know the basic properties of common geometric figures, if you have some basic familiarity with algebra, and if you have a basic understanding of properties of numbers, then you know enough to take this test. Virtually all students in the United States acquire these skills by the time they reach about the tenth grade.

But if the skills required for the SAT are so basic, then why doesn't everyone get a perfect score? The answer is that the SAT requires more than just the ability to recall the basic facts of geometry, algebra, and arithmetic. It also requires that you be able to combine these mathematical facts in new ways to solve problems you haven't seen before. This ability to solve unfamiliar problems is usually called, simply, "problem-solving ability" — and it's one of the core goals of an education in mathematics.

THE IMPORTANCE OF PROBLEM SOLVING IN MATHEMATICS

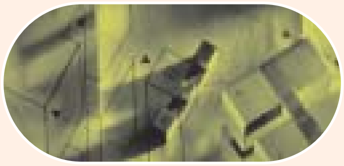
It's easy to get the idea that math is more or less a system of rules and procedures. After all, students in math classes spend a lot of their time memorizing rules. (Think, "negative times negative is positive" or "the area of a rectangle is the length times the width.") In addition to rules like these, students also spend a lot of their time learning routine procedures: how to multiply, how to divide, how to find areas of simple shapes, how to use significant figures, and so on. Even professional mathematicians are constantly learning new techniques — for example, techniques for approximating solutions to interesting classes of equations.

Notwithstanding all of this concern with rules and procedures, the truth is that no list of rules is long enough, and no set of procedures is flexible enough, to solve most of the math problems that come our way throughout the course of a life. Most math problems are one-of-a-kind, and there just isn't a single rulebook that applies to every case.

For this reason, math educators place great emphasis on the need to teach "problem-solving ability," the ability, that is, to solve unfamiliar problems. And most state education departments have highlighted problem solving as one of their basic mathematics standards. In California, for example, problem solving forms one of the five overall goals of the state's mathematics education program:

> "[The goal in mathematics education is for students to] become mathematical problem solvers who can recognize and solve routine problems readily and can find ways to reach a solution or goal where no routine path is apparent."[4]

The idea of "problem-solving ability" is not specific to mathematics. This is because all it really means



is the ability to consistently handle new situations. This is perhaps the defining characteristic of an expert in any field, from the doctor who successfully diagnoses patients with unusual symptoms, to the teacher who somehow finds a way to reach every child, and even to the tennis player who always seems to find a weakness in every new challenger's game. In all these people, we recognize the presence of craft, creativity, and initiative — elements that mark the difference between competence and proficiency.

CRAFT

Craft in mathematics means having a deep understanding of the tools of the trade, and also being able to apply these tools with complete ease. For example, at the high school level, this might mean recognizing without hesitation that the two equations

$$x + y = 2$$
$$3x + 3y = 5$$

have no solution; and moreover, recognizing this from both an algebraic point of view as well as a geometric point of view. (Algebraically speaking, if $x + y$ is 2, then $3(x + y)$ should be 6, not 5. Geometrically speaking, the solution sets of these two equations form parallel lines in the *xy*-plane, and therefore do not cross at any solution point.)

The reason craft is so important in problem solving is that when you confront an unfamiliar problem, you need to be thinking creatively — planning strategies, brainstorming — and you also need to be paying attention to whether or not you're getting anyplace in your attempt at a solution. It's difficult to do all of this flexible thinking when you're still having to concentrate on the mechanics of each step of the process. In this, math is really no different from any other discipline. An Olympic wrestler spends years practicing holds and escapes, all so that when the match begins and he is faced with an opponent's unexpected move, he can execute the proper countermove as a matter of reflex. If he has to think about the details of what he's doing in that moment, he's lost.

CREATIVITY AND INITIATIVE

Creativity and initiative are not the first words that come to mind when people think of mathematics. But these factors play a strong role in helping people solve unfamiliar problems, including the kinds of unfamiliar problems one finds on the SAT math test. The best way to see this is to walk through a couple of examples.

> In an election a total of 5,000 votes were cast for three candidates *X*, *Y*, and *Z*. Candidate *Z* received 900 votes. If candidate *Y* received more votes than candidate *Z* and candidate *X* received more votes than candidate *Y*, what is the least number of votes that candidate *X* could have received?

This is a fairly difficult problem. It's easy to go around in circles thinking about it, without making any real progress.

If we aren't getting anywhere with a problem, it sometimes helps to "change the rules." Here, for example, we can see whether the problem becomes any more manageable with smaller numbers inserted in place of the given numbers (5,000 and 900). Thus, we might consider the following problem instead:

> In an election a total of 10 votes were cast for three candidates *X*, *Y*, and *Z*. Candidate *Z* received 1 vote. If candidate *Y* received more votes than candidate *Z* and candidate *X* received more votes than candidate *Y*, what is the <u>least</u> number of votes that candidate *X* could have received?

Since *Z* received 1 vote out of 10, that leaves 9 votes for *X* and *Y* to split. In this version, there just aren't very many possibilities. So we can just write out all the different ways it could have ended up:

Number of votes	
X	**Y**
9	0
8	1
7	2
6	3
5	4
4	5
3	6
2	7
1	8
0	9

But we are told that *X* received more votes than *Y*. This cuts down the possibilities further:

Number of votes	
X	**Y**
9	0
8	1
7	2
6	3
5	4
4	5
3	6
2	7
1	8
0	9

(*X* has more votes than *Y*)

Here we can easily see that the least number of votes *X* could have is 5.

Notice that this possibility is just above the halfway point in the table. Notice also that *X*'s 5 votes are just over half of the 9 votes available to *X* and *Y*. That makes sense, because if *X* has to have more votes than *Y*, but *X* also has to have as few votes as possible, then in fact *X* should be *just* higher than *Y* — in which case, *X* and *Y* will be almost equal. And if *X* and *Y* are almost equal, then *X* will be just about half of what's available to *X* and *Y*.

Returning now to the original problem, *Z* has received 900 out of 5,000 votes. This leaves 4,100 votes for *X* and *Y* to split. Based on the simpler version of the problem, it is not hard to guess that the least number of votes that *X* could have, and still have more votes than *Y*, would be just over half of 4,100, or 2,051 votes. This would leave 2,049 votes for *Y*. (This is indeed more than *Z*'s 900 votes, by the way, as mentioned in the problem.) And this is the correct answer: *X* = 2,051.

Another way to find this answer is to imagine repeating our earlier approach of writing out all the possibilities:

Number of votes	
X	**Y**
4,100	0
4,099	1
4,098	2
2,051	2,049
2,050	2,050
2	4,098
1	4,099
0	4,100

(*X* has more votes than *Y*)

Solution

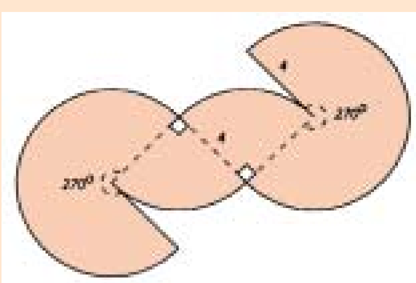
Once again it is easy to see that the least number of votes *X* could have is 2,051.

The important thing to recognize in this example is that our basic approach was to take a difficult problem and *rewrite it* in such a way that it became solvable. Using the insights gained in solving the simpler version, we were then able to return to the original problem and find the solution.

No one told us to replace 5,000 and 900 with smaller numbers. This wasn't in the instructions, and there was no hint suggesting we do so. Instead, when faced with a difficult problem, we simply took the initiative and did something — anything! — on our own.

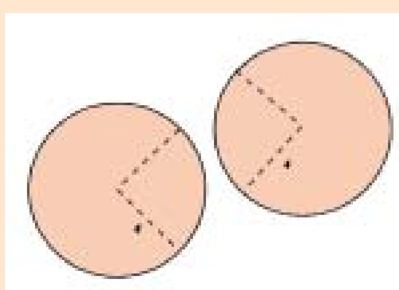
As another example, in the SAT problem shown here, students are asked to find the area of a complicated figure.

SAT Math question



The figure above is partitioned into sectors of circles with radius 4. What is the area of the figure?

Once again, the easiest way to solve this problem is to *change it* — this time by manipulating the figure. The wedges can be rearranged to yield the following figure.



The area is now easy to compute as 32π, using the standard formula πr^2 for the area of a circle.

No one told us we could change the figure. We just did it. We took the initiative, and, by a quite creative act, turned a difficult problem into a simple one.

PROBLEM SOLVING IN COLLEGE

Problem solving is important for a variety of subjects in college, from math, science, and engineering, to social sciences like economics and political science, and even design-oriented disciplines like architecture. College professors in these and other disciplines expect students to take what they know and apply it in new situations all the time. And practitioners in these fields do so for a living.

In college life generally there is a great emphasis on applying what you learn to new and unfamiliar situations. As a result, the transition from high school to college can be very difficult if students are not ready to use tools and ideas creatively.

For example, the reader should attempt both of the problems shown here in order to get a sense of the leaps that are required in mathematics. One problem is typical of a rigorous high school exit exam. The other problem was given as a practice midterm problem for a freshman course at a selective public university. Notice that these two problems involve some very similar calculus skills. The only difference is the degree to which the problems are routine. The first is a common textbook problem, while the second requires creative thinking.

> A model rocket is launched from ground level. Its height, h meters above the ground, is a function of time t seconds after launch and is given by the equation $h = -4.9t^2 + 68.6t$. What would be the maximum height, to the nearest meter, attained by the model?
>
> – *New York State Regents Examination (sample problem)*

> Find the equation of the parabola $y = ax^2 + bx$ so that the tangent line at (1,-1) has the equation $y = -4x + 3$.
>
> – *UC Berkeley freshman-year midterm (practice problem)*

Examples like these are typical, not just within mathematics, but, in their own way, within all disciplines of thought that seek to apply particular methods to diverse problems. This includes not only technical subjects such as physics, chemistry, and engineering, but also many disciplines in the humanities. Even philosophy and literary criticism have specific principles and frameworks, which they then seek to apply to diverse problems and diverse texts. In all these areas, creativity and initiative, as well as craft, are the prerequisites for expertise. No less is true for the kind of basic mathematics skills required for success on the SAT.

THE SAT AS A CALL TO MEANINGFUL LEARNING

Students need strong critical reading and problem-solving skills in order to fully participate in college and to best flourish in, and contribute to, the world that awaits them after graduation. The College Board has here begun to discuss these skills and the ways in which the SAT measures them, so that teachers, parents, and students can recognize their importance and also understand what is expected. We need to be very explicit about the kinds of texts and problem situations that are presented on the test, the kinds of questions that are asked about them, how these questions tie directly to educational standards, and how students can thoughtfully work to reach and exceed these standards.

The College Board, high schools, universities, and students and parents all have more work to do to ensure that more young people are prepared to attend college and are prepared to succeed when they are admitted. This is the hard work of freedom and opportunity: worth doing, and worth doing well.

[1] *Ridgewood Analogies*, Libonate, Jr., Brunner, Burde, Schoenlank, Williams, Wiss, eds. (Cambridge, MA: Educators Publishing Service, Inc., 1996).
[2] *Summer Training Institute: Learning to Read*, Baker, Simmons, and Kame'enui, eds. (Eugene, OR: Institute for The Development of Educational Achievement, College of Education, University of Oregon, Oregon 1997).
[3] *10 Real SATs*, ed. Claman (New York, NY: College Entrance Examination Board, 2000).
[4] *Mathematics Framework for California Public Schools, Kindergarten Through Grade Twelve* (Sacramento, CA: California Department of Education Press, 1999), p. 18.

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