College Board

Assessment Framework for the **Digital SAT® Suite**

Assessment Framework for the Digital SAT® Suite

Version 3.01, August 2024

About College Board

College Board reaches more than 7 million students a year, helping them navigate the path from high school to college and career. Our not-for-profit membership organization was founded more than 120 years ago. We pioneered programs like the SAT® and AP® to expand opportunities for students and help them develop the skills they need. Our BigFuture® program helps students plan for college, pay for college, and explore careers. Learn more at **cb.org**.

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CHANGE LOG

v1.0 (June 2022)	Initial release
v1.01 (July 2022)	Corrected table in appendix E (now F) to accurately reflect the distribution of Math questions by content domain on the paper-based SAT Suite assessments
v1.1 (December 2022)	Added appendix (B) presenting in tabular form the skill/knowledge testing points assessed in the Reading and Writing and Math sections; re-lettered existing appendices and renumbered existing tables correspondingly
v2.0 (August 2023)	Made updates and minor revisions/corrections throughout the document
v3.0 (July 2024)	• Archived section 1.2, The Educational Environment: Four Challenges, retaining the content for historical purposes only • Expanded section 2.2.3, Multistage Adaptive Testing, to directly address issues related to the fairness of the adaptive testing algorithm • Expanded section 2.2.7.1, Universal Design, point 3, to include additional information about College Board's independent, external reviews of digital SAT Suite test materials • Expanded section 2.2.8.1, Scores, to indicate how individual digital-suite test questions are scored • Added section 5.1.15, Usability and Accessibility Testing, which discusses user experience and accessibility testing of digital SAT Suite response formats and the tests as a whole • Revised section 5.3.1, Use of Short Passages in the Reading and Writing section, to augment and better contextualize the research evidence base previously presented • Revised appendix B, Digital SAT Suite Detailed Skill/Knowledge Testing Points, to further delineate the skills and knowledge assessed by Standard English Conventions questions in Reading and Writing and to clarify the Math content domain descriptions • Revised appendix C, Digital SAT Suite Test Development Process Overview, to include more details about question development • In Appendix E, Linear Test Specifications, added table (A40) displaying the distribution of operational test questions by content domain in both digital adaptive and linear modes • Corrected table in Appendix F, Test Specifications Comparison of the Paper-Based and Digital SAT Suites, to accurately reflect the distribution of Math questions by content domain on the paper-based SAT Suite assessments • Made other updates and minor revisions/corrections throughout the document, many of which reflect the now-completed transition to the digital suite
v3.01 (August 2024)	• In Appendix D: Digital SAT Suite Test Directions, added missing information inadvertently left off of the reproduction of the reference sheet of common math formulas available to students during testing

Contents

Tables

Figures

Foreword

For more than one hundred years, the SAT has provided students the opportunity to show colleges what they know and can do. The test has changed significantly over time to better meet the evolving needs of students from all backgrounds and the changing landscape of postsecondary education. The paper-based SAT Suite of Assessments—completely redesigned most recently in 2015 and launched together with free, world-class tailored practice for all students—measures the knowledge and skills that students are learning in high school and that matter most for college and career readiness.

The next major change to the SAT Suite is a fully digital testing experience. College Board's goal is to provide a less stressful, more accessible experience for all students and educators while retaining the value, rigor, and predictive power of the paper-based SAT Suite tests. To achieve this goal, we assembled a team of experts in math and literacy content development, assessment design, psychometrics, technology, and product development and rigorously tested and piloted these new digital assessments with students and educators around the world. In close consultation with College Board's K–12 and Higher Education members as well as experts in the field, this team has produced an all-digital suite of assessments that is easier to take, easier to give, more secure, and more relevant.

The assessment framework laid out in the following pages reflects the care and precision that has gone into creating the digital SAT Suite. Readers will find in this document the context behind the changes and the strong research foundation on which the digital assessments are built. They will also find that the content domains, constructs, and score scales remain consistent even while the tests use an adaptive digital design that allows for shorter, more secure, and more flexible assessments than the paper-and-pencil versions. Sample questions will illustrate the breadth of topics and voices that students will encounter during digital testing as well as the continued rigor of the assessments.

Most of all, this assessment framework demonstrates how a digital SAT Suite of Assessments gives every student a better opportunity to be recognized, show what they know and can do, and connect to college and career opportunities and scholarships.

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CHAPTER 1

Introduction

1.1 The Digital SAT Suite

The *digital SAT® Suite of Assessments* is College Board's collective term for its flagship suite of college and career readiness testing programs and services: the SAT, PSAT/NMSQT® and PSAT™ 10, and PSAT™ 8/9. The digital suite represents an evolution of the SAT Suite that debuted in the 2015–2016 academic year. While continuing to measure the skills and knowledge assessed by the paper-based SAT Suite it replaces, the digital suite is responsive to the changing educational landscape as well as the emerging needs of students and their families, teachers, state and district users, higher education officials, and policymakers. Over the several years that the SAT Suite was available in its paper-based form, College Board listened closely to feedback and input from a wide range of stakeholders, carefully assessed the needs of the suite's users, and evaluated how best to respond. The result is the digital SAT Suite.

The digital SAT was first administered at international test centers in spring 2023. Starting in fall 2023, all PSAT-related testing, both domestic and international, moved to digital. Beginning in spring 2024, all students, except for those few requiring a paper-based test form (e.g., as an accommodation), took the SAT digitally, signaling the retirement of the paper-and-pencil (and linear digital[1]) SAT Suite.

The digital suite continues and expands on the paper-based suite's core commitments to access and opportunity for all students. These commitments include

- **offering valid, reliable, fair, and objective assessments** of students' academic achievement;

[1] Beginning in 2018, College Board made linear (fixed-form, nonadaptive) digital versions of several of the paper-based SAT Suite tests available to state and district users who wanted to administer the exams via computer. Those versions of the SAT Suite assessments were digitized versions of the paper-based tests, with small modifications to improve the user experience, and have been retired alongside the paper-based suite. This document's references to the "paper-and-pencil SAT Suite" or "paper-based SAT Suite" include these linear digital versions as well.

Preview

In this chapter, you will find

- a definition and discussion of the digital SAT Suite of Assessments.
- an analysis of four challenges in the educational environment that have contributed to the design of the digital SAT Suite.
- the four guiding principles undergirding the suite.
- an overview of what has stayed the same and what has changed in the transition to the digital suite.
- a preview of subsequent chapters and appendices.

- **providing actionable information to students and educators** about evidence-based ways to build on academic strengths and to address skill and knowledge shortcomings relevant to college and career readiness;
- **connecting students to opportunities** they have earned through their hard work in school, such as admission to postsecondary institutions well suited to their achievement and interests as well as scholarships and recognitions;
- **helping state users meet federal accountability requirements** through industry-leading assessments, services, and documentation; and
- **helping higher education institutions to find and enroll prospective students and then to support those students** so that they can be successful on their campuses.

At the same time, the digital SAT Suite is responsive to the changing and often challenging educational environment in which students, families, educators, and institutions find themselves in the third decade of the twenty-first century.

1.2 The Educational Environment: Four Challenges

Note: Section 1.2 was authored in 2021 and updated in 2022 and 2023. Although it will not continue to be updated, it is being retained to provide useful background information about the motivations behind the transition to the digital SAT Suite.

Among the welter of challenges that have emerged or become more prominent in the educational landscape in recent years, four interrelated ones have had a particularly important role in motivating College Board to design and implement the digital SAT Suite:

- widespread, persistent concerns about the amount of time U.S. students spend taking tests
- continued and growing threats to test security
- ongoing concerns about the value and affordability of higher education
- the continued lack of college and career readiness attainment by a large proportion of students, especially those from underserved populations

The following subsections discuss each of these challenges in turn and indicate how the digital SAT Suite is responsive to those challenges.

1.2.1. TIME SPENT TESTING

Since at least the No Child Left Behind Act of 2001 was signed into law, critics of standardized testing as well as many families, educators, and policymakers have raised concerns about the extent to which U.S. students are tested as part of K–12 education. Polling has suggested that the public's doubts about the value of standardized testing in schools have grown over time, and the necessary relaxation of federal testing requirements under the successor Every Student Succeeds Act during the 2019–2020 and, to a lesser extent, 2020–2021 pandemic years has further contributed to those doubts. (See Bruno and Goldhaber 2021 for a brief recent overview.)

A Living Document

This release of the *Assessment Framework for the Digital SAT Suite* includes authoritative, up-to-date information about the digital suite. As College Board continues to research and implement the tests, updates will be made to this document (and disseminated through other means, such as our website, **sat.org/digital**) to ensure that readers have as complete and accurate a picture as possible. A change log at the head of this document calls out important additions or alterations to the framework as they are incorporated.

The digital SAT Suite is responsive to these concerns in two main ways. First, the digital-suite tests, like their paper-and-pencil predecessors, are useful and meaningful to students. The SAT Suite tests offer students the opportunity to evaluate their attainment of or progress toward achieving college and career readiness, and, as discussed in section 1.2.3, they open doors and connect students to opportunities that they have earned through their hard work in school. Second, the digital SAT Suite exams are substantially shorter than their paper-based predecessors—about two hours in length rather than nearly three—and the move to digital testing affords schools and students more flexibility in when the tests are given and taken.

1.2.2. TEST SECURITY

Although the SAT Suite tests can open doors for students and connect them to opportunities they might otherwise miss, it can only do so if the tests themselves are secure and the results are accurate reflections of students' own efforts. Test security challenges, which are infrequent but highly consequential, threaten the integrity of the tests and the confidence that test takers and data users have in them. Over the long term, these threats, if unmet, erode trust in the tests; in the nearer term, they risk curtailing students' access to testing when scores and whole administrations have to be canceled due to security compromises.

A key motivation behind College Board's introduction of the digital SAT Suite is to meet these security challenges head-on and to do so in a way that actually expands, rather than restricts, access to the tests. The digital-suite tests reduce test security risks in a number of important ways, notably by eliminating the need to physically deliver, handle, store, distribute, collect, and reship paper test materials around the world and by ensuring that each student who takes one of the digital tests is administered a highly comparable but unique version of the test.

1.2.3. HIGHER EDUCATION AFFORDABILITY AND VALUE

In a further development in no small way attributable to the pandemic but indicative of wider concerns about the cost and value of higher education, enrollment in postsecondary education has been on the decline in recent years (National Student Clearinghouse Research Center 2022, 2023). Although College Board (2022b, 7) has observed "the average published tuition and fees in all three major higher education sectors declin[e] year-over-year in both 2021–22 and 2022–23" after adjusting for inflation, higher education affordability remains a major concern for current and prospective students (Klebs et al. 2021) and for adults generally (Fishman et al. 2021). Indeed, respondents in both prepandemic surveys (e.g., Gallup and Lumina Foundation 2015; Kaplan 2015) and more recent ones (e.g., Citizens Financial Group 2021; Fishman et al. 2021; Snyder 2022) have cited college affordability as a major concern and stressor.

An obvious contributor to concerns about college affordability and value is worry about student debt. Statistics compiled by Hanson (2022) indicate that the average federal student loan debt balance is $37,113 and may, in fact, be closer to $40,100 once private loan debt is incorporated. As with many things in education, this

Companion Resources for Educators

College Board provides numerous resources to help secondary-level teachers (and others) learn more about the digital SAT Suite and its connections to college and career readiness for all students. Among the most notable are the following free publications:

- Our *Teacher Implementation Guide* (**satsuite.org/digital-teacher-implementation-guide**) helps educators unpack the digital SAT Suite tests and connect test content with instruction.
- Our *Classroom Practice Guides* for English language arts/literacy (**satsuite.org/digital-classroom-practice-english**) and math (**satsuite.org/digital-classroom-practice-math**) focus on illuminating key aspects of college and career readiness (e.g., text complexity in literacy; problem-solving and data analysis in math). They provide reader-friendly summaries of research supporting the importance of each topic covered to college and career readiness for all students as well as expert advice on how to incorporate these instructional priorities throughout the academic year.

burden is not borne equally by all. Hanson notes, among many other sobering findings, that 58 percent of all student loan debt belongs to women; that Black/African American holders of bachelor's degrees owe an average of $52,000 in student loan debt; and that American Indian/Alaska Native student borrowers have the highest monthly loan payments.

Negative perceptions of higher education affordability and value, and the troubling realities behind them, are important because they threaten the historic upward trend of college enrollment, which, in turn, is significant because, even with affordability being a concern, higher education retains tremendous value for both individuals and society. Reporting the results of College Board–led research, Ma, Pender, and Welch (2019, 4–5) reached four main conclusions about the benefits of higher levels of education:

- Individuals with higher levels of education tend to earn more, pay more taxes, and are more likely than others to be employed.
- Median earnings increase with level of education, though there is considerable variation in earnings at each level of educational attainment.
- College education increases the chance that adults will move up the socioeconomic ladder and reduces the chance that adults will rely on public assistance.
- Having a college degree is associated with a healthier lifestyle, potentially reducing health care costs. Adults with higher levels of education are also more likely to be active citizens than others and more involved in their children's activities.

The digital SAT Suite helps promote these benefits by connecting students more easily and effectively than ever before to the opportunities they have earned. Among the most critical connections fostered by the suite are the following:

- College Board's BigFuture® resources (https://bigfuture.collegeboard.org/) help students search for colleges and careers that fit their interests; find scholarships, grants, and loans that they qualify for; and plan for their post–high school academic undertakings.
- Taking the PSAT/NMSQT test in the fall of their junior year can qualify students for hundreds of millions of dollars in scholarships from the National Merit® Scholarship Program and other partner organizations.

1.2.4. COLLEGE AND CAREER READINESS GAPS

College and career readiness for all students by no later than the end of high school remains an essential but elusive goal, particularly for members of historically underserved population groups. The achievement picture has remained frustratingly steady, unacceptably low, and reflective of differential impact across the student population as well as societal and educational inequities. Among high school graduates in the class of 2022 who took the SAT, only 43 percent were considered college and career ready by meeting both of the empirically established College and Career Readiness Benchmarks (a reading and writing section score of 480 and a math section score of 530); 32 percent of these same graduates met neither benchmark. What is more, although 75 percent of Asian American students, 53 percent of White students, and 52 percent of students identifying as two or more races met both benchmarks, only 26 percent of Hispanic/Latino students, 24 percent of Native Hawaiian/Other Pacific Islander students, 22 percent of American Indian/Alaska Native students, and 19 percent of Black/African American students did the same; among these latter groups, between 47 percent and 54 percent of students met neither benchmark (College Board 2022a, n.p.; SAT Participation and Performance: Total and Race/Ethnicity tables).

Although college and career readiness testing cannot by itself eliminate these inequities, it plays a critical role in calling attention to and measuring progress toward closing these gaps. Given how significant, persistent, and consequential these gaps are, it would be unwise to turn away from the instruments that inform us about them. This is not to say, however, that those instruments cannot be improved. Better tests—ones that are easier to take, easier to give, more secure, and more relevant to all students—can improve the test-taking experience; yield valid, reliable, actionable data; and clear pathways to opportunities. These features of better tests are hallmarks of the digital SAT Suite and are discussed in detail in the next section.

1.2.5. SECTION CONCLUSION

The brief, selective survey of challenges facing students and their families, educators, policymakers, and other stakeholders paints a daunting picture. Rather than shrink from these challenges, however, College Board remains committed to doing all it can to clear paths so that all students can own their futures and gain access to the opportunities they have earned through their hard work in school.

Indeed, every program and service College Board offers is intended to further the goals of access and opportunity. From valid, reliable, and fair college admission and placement testing via the SAT Suite to BigFuture college and career planning tools to Student Search Service™ to College Board National Recognition Programs to high-quality curriculum and instruction materials via the Advanced Placement® and Pre-AP® programs—and more—we at College Board have dedicated ourselves to helping students attain their post–high school aspirations.

1.3 Digital SAT Suite Guiding Principles

The digital SAT Suite is part and parcel of College Board's larger mission to promote access and opportunity. The digital SAT Suite built on the firm foundations of the paper-and-pencil SAT Suite to make the digital-suite exams

- easier to take;
- easier to give;
- more secure; and
- more relevant.

Each of these guiding principles is discussed in turn in the following subsections.

1.3.1. EASIER TO TAKE

In a number of important ways, the digital SAT Suite tests are easier to take than their paper-and-pencil predecessors. The digital tests themselves are roughly an hour shorter, and pre- and posttest activities and administrative time have been significantly reduced, meaning that test day is a much more streamlined experience for all involved. Students can take the digital tests on a wide range of devices, including personal or school-managed Windows laptops or tablets, Mac laptops, iPads, and school-managed Chromebooks. Because not all students will have ready access to a digital device on which to test, College Board is committed to lending a device to any student testing on the weekend who needs one. (For more information, please visit **https://satsuite.collegeboard.org/digital/device-lending**.)

Digital-suite test questions, while preserving the rigor of the paper-and-pencil SAT Suite tests, are concise and focused, facilitating their delivery on digital devices. Bluebook™, College Board's custom-built test delivery application, renders these questions and the tests themselves in a fluid, intuitive way based on principles of universal design; features numerous tools, such as the built-in Desmos® Graphing Calculator as well as the ability to annotate and to flag questions, that all students may opt to use; and makes available a wide range of accommodations and supports for those students who require them to access the tests and their content.

Data College Board collected from participants throughout 2023, the first year of operational digital administrations, strongly support the claim that the digital SAT Suite tests are easier to take:

- 76 percent of surveyed test takers (n=170,385) reported an excellent or good experience taking a digital SAT Suite test.
- 84 percent of students who had previously taken a paper-based SAT (n=4,957) reported a better test-taking experience with the digital SAT.
- 80 percent of students who had previously taken a paper-based SAT (n=888) stated they felt less overwhelmed by the digital SAT.
- 89 percent of students who had taken other digital assessments (n=62,239) reported a better experience (48 percent) or the same quality of experience (41 percent) taking the digital SAT.
- 95 percent of students (n=120,790) felt Bluebook was easy to use.

1.3.2. EASIER TO GIVE

In their digital form, the SAT Suite assessments are also easier to give than ever before. Gone are the days of shipping, securing, unpacking, distributing, collecting, and repacking test materials, all of which carried with them attendant operational and security risks. The tests themselves have fewer separately timed sections, thereby easing administration, and exam timing is handled by Bluebook itself, not the proctor. The Test Day Toolkit app created by College Board makes the remaining test administration tasks much easier for proctors and test center coordinators as well. Having significantly shorter tests means it is easier for schools administering digital SAT Suite tests as part of the school day to give those exams on their schedule, not College Board's, and the various innovations College Board has introduced by the move to digital mean that more test administrations and wider, more flexible school day testing windows can be introduced, furthering the goal of test access.

With the digital suite, College Board has also taken seriously the concern that not all schools or other test centers have sufficient, or sufficiently reliable, internet access to support large numbers of students simultaneously and continuously accessing Wi-Fi or other networks during testing. And, of course, device batteries can fully drain at inconvenient times. That is why College Board designed Bluebook to be tolerant of momentary interruptions in connectivity (whether network or battery related) without losing students' work or time. Should students experience brief interruptions in their connectivity, they can quickly resume with no loss of testing time; should their device battery fully drain during testing, they can simply plug in, restart, and resume testing without loss of either testing time or their work, as Bluebook automatically saves their responses.

Data College Board collected from participants throughout 2023 back up the claim that the digital-suite tests are easier to give:

- 75 percent of test center coordinators (n=13,461) and 80 percent of staff (n=39,944) rated their experience with the digital SAT as good or excellent.
- 87 percent of test center coordinators and staff (n=46,166) believe students experienced minimal distraction while taking the digital SAT.
- 91 percent of test center coordinators and staff (n=46,162) felt their test center was able to provide assistance to students who needed it.
- 92 percent of test center coordinators and staff (n=46,208) think students understood the expectations of a digital SAT.
- 93 percent of test center coordinators and staff (n=45,605) stated they felt very or somewhat prepared to administer the digital SAT.

1.3.3. MORE SECURE

The tests of the digital SAT Suite are also more secure than the paper-and-pencil tests they have replaced. As mentioned above, the switch to digital has eliminated the paper handling that not only places burdens on test administrators but also creates security risks. Bluebook also displays only one test question at a time, making it much more difficult for bad actors to surreptitiously photograph or otherwise copy test content. Most critically, though, the digital SAT Suite assessments have been designed and developed such that each student is administered a highly comparable but unique version of the test. This innovation greatly diminishes any value in students copying from their test-taking neighbors or scouring the internet for leaked test forms.

1.3.4. MORE RELEVANT

The digital SAT Suite tests are also more relevant for all students than ever before. College Board has always sought to reflect in its test materials the widest possible range of information, ideas, and perspectives, and, to a large extent, the paper-and-pencil versions of the SAT Suite achieved those goals. However, the use on the paper-based suite of a relatively few extended (multiparagraph) passages as the basis for many test questions placed a hard limit on the range of texts that could be presented.

With the digital tests, the number and variety of contexts serving as the basis for test questions have been greatly increased. This means that there are many more opportunities for the tests to represent the diversity of people, experiences, and interests in the United States and around the world. This, in turn, greatly increases the chances that students on test day will encounter passages that they find meaningful and personally interesting, as College Board's early research on student perceptions of the digital tests has suggested. College Board believes the end result will be more engaged test takers whose scores reflect their best efforts.

Data College Board collected from participants throughout 2023 support the claim that the digital-suite tests are more relevant:

- 85 percent of surveyed students (n=868) said the Reading and Writing passages were less stressful than their paper-based counterparts.
- 80 percent of surveyed students (n=853) said the digital passages were more relatable than paper-based SAT passages.
- 80 percent of surveyed students (n=887) said the digital passages were more engaging than the passages found in the paper-based SAT.

1.4 Continuity and Change

The digital SAT Suite represents both continuity and change with respect to the SAT Suite first administered in the 2015–2016 academic year. In essence, the digital SAT Suite is a refined evolution of the paper-based SAT Suite. At the domain level, the digital-suite assessments address content highly comparable to that found in the paper-and-pencil tests and retain strong alignment to essential college and career readiness prerequisites and, consequently, to state college and career readiness standards.

Change between the suites is primarily reflected in the move to digital and adaptive test delivery; substantially reduced test length; and modifications in test question format, particularly evident in the assessment of reading and writing skills and knowledge. The result is a set of assessments preserving the strong foundations of the paper-based suite while introducing innovations in flexibility, efficiency, focus, relevance, and security that make the digital-suite tests responsive to the educational moment and the needs of users.

This section begins with a discussion of the elements that have carried over to the digital suite from the paper-and-pencil suite and then continues with an overview of the changes introduced into the SAT Suite by the shift to digital testing.

1.4.1. WHAT HAS STAYED THE SAME

The digital SAT Suite retains and builds on many of the key emphases of the paper-based SAT Suite. The digital SAT Suite continues to

- measure the skills and knowledge that students are learning in school and that matter most for college and career readiness;
- be scored on the same scales as the paper-and-pencil tests they have replaced, meaning that, for example, the SAT continues to be scored on the familiar 400–1600 scale;
- allow students and educators to track growth via an integrated, vertically scaled suite of assessments from grade 8 through high school and a series of empirically derived benchmark scores aligned with college and career readiness requirements;
- be administered in schools and test centers with a proctor;
- support students' readiness for test day and their development of relevant knowledge and skills through free, world-class practice resources, including Official Digital SAT Prep on Khan Academy®;
- connect students to scholarships;
- recognize the strong academic performance of underrepresented students through the College Board National Recognition Program; and
- support all students who need accommodations and/or supports to access the tests and their content.

The two sections of the digital SAT Suite tests—(1) Reading and Writing and (2) Math—also demonstrate strong continuity with their paper-and-pencil predecessors. Key elements carried over from the paper-based suite include

- the use of reading/writing passages across a range of academic disciplines and text complexities;
- required demonstrations of command of evidence, both textual and quantitative;
- an emphasis on high-utility academic (tier two) words and phrases in context;
- a focus on the revision and editing of writing to improve the effectiveness of expression, achieve specified rhetorical goals, and demonstrate command of core conventions of Standard English sentence structure, usage, and punctuation;
- continued stress on the math that matters most for college and career readiness and success;
- math problems in context as well as without context; and
- the use of both multiple-choice and student-produced response question formats in the Math section.

Both because of this strong similarity in the content being measured and the fact that the two suites are grounded in the best available evidence about critical prerequisites for college and career readiness, the digital SAT Suite, like the paper-and-pencil suite, is strongly aligned to both postsecondary entry requirements and to state academic standards. The digital assessments also retain the key psychometric properties of the paper-based exams that users have come to expect and rely on from College Board.

Rigor is one of those properties. Although College Board has taken pains to make the experience of taking the digital SAT Suite tests easier than taking their paper-and-pencil predecessors, these efforts should *not* be confused with making the tests themselves easier. The tests continue to measure students' mastery of the knowledge and skills required to be ready for college and workforce training. As these requirements are challenging to attain, so must be the tests that assess their attainment.

The digital-suite tests, in other words, maintain the same level of challenge that the SAT Suite assessments have long been known for. Efforts to ensure comparable levels of rigor have taken a number of forms. Among the most notable are the following:

- College Board has aligned the digital-suite tests, like their paper-based predecessors, with the best available evidence about essential college and career readiness prerequisites.
- College Board continues to work closely with a range of independent experts, including subject matter experts at the secondary and postsecondary levels, to ensure that the tests and their questions are sufficiently challenging to assess the knowledge and higher-order skills students need to be ready for college and careers.
- College Board employs robust content development and psychometric processes to verify that digital-suite test questions are comparable in difficulty to those used on the paper-and-pencil versions of the tests.

In sum, while the digital SAT Suite assessments greatly simplify the test-taking process and give students better opportunities to show what they know and can do, the standards to which students are being held have not changed.

1.4.2. WHAT HAS CHANGED

While preserving the best of the paper-and-pencil SAT Suite assessments, College Board seized the opportunity the transition to digital testing offered to reconsider and refine what was tested and how, all in the service of better meeting the needs of students and their families, educators, policymakers, and other stakeholders. These changes are reflected both at the suite level and in the two test sections that compose the suite's assessments.

At the suite level:

- The digital SAT Suite assessments are **substantially shorter** than their paper-and-pencil predecessors—about two hours instead of three.
- Test takers have **more time, on average, to answer each question**, meaning that, more so than ever before, the digital SAT Suite exams are measures of students' skills and knowledge, not test-taking speed.
- Students and educators **receive scores faster** than was possible with the predecessor paper-and-pencil SAT Suite.

- In addition to the many ways that the paper-based SAT Suite connected students to opportunities they had earned through their hard work, digital SAT Suite score reports include **Career Insights Snapshot, a list of growing careers in the student's state that connect to their scores.** Career Insights Snapshot helps students consider career options and the postsecondary pathways needed to reach their goals. These careers are presented as examples and are neither formal recommendations nor the only career options that students should consider.
- The tests are **more secure**. Instead of large groups of students taking the same paper-and-pencil test form at the same time, each student taking one of the digital SAT Suite assessments is administered a highly comparable but unique version of the test. (How we achieve this is discussed more fully in appendix C.)
- As a result of the increase in test security, states, schools, and districts have **much more flexibility in terms of when they give the SAT Suite tests**, including wider testing windows for the PSAT/NMSQT and SAT School Day.

At the test section level:

Reading and Writing

- The digital-suite assessments have a **single Reading and Writing section** instead of separate Reading and Writing and Language Tests. This shift serves to make English language arts/literacy assessment on the digital SAT Suite tests more efficient while also acknowledging the reciprocal, mutually reinforcing nature of reading and writing skills and knowledge.
- The Reading and Writing section's **passages are significantly shorter and more numerous**, giving students more, and more varied, opportunities to demonstrate what they know and can do and to encounter information, ideas, and perspectives they find interesting and relevant. At the same time, these shorter passages **maintain the level of rigor of longer reading passages** with respect to text complexity and grounding in academic disciplines. (For more information on the rigor of Reading and Writing test passages, see section 5.3.1.)
- A **single (discrete) question is associated with each passage (or passage pair)** instead of having several questions associated with a small number of longer passages, as was the case in the paper-and-pencil SAT Suite tests. (For information on how the switch to discrete questions benefits both students and the quality of the assessments, see section 2.2.5.)

Math

- **Calculators are allowed throughout the Math section**. A single Math section has replaced the separately timed no-calculator and calculator-allowed portions of the paper-and-pencil SAT Suite Math Tests. This change allows the Math section to more accurately reflect how the tool of the calculator is used in schools and in the real world. It also eases test administration by eliminating separately timed test portions with different rules. Students may **continue to use their own approved calculator on test day or take advantage of the**

Desmos Graphing Calculator, which is built directly into Bluebook. (For more information about the rationale for allowing calculators throughout the Math section, see section 5.3.2.)

- The **average length, in words, of in-context questions ("word problems") has been reduced**. In-context questions still serve a valuable role in the Math section, as they assess whether students can apply their math skills and knowledge to both academic and real-world situations. However, College Board listened to feedback that longer contexts posed barriers that could inhibit some students, often but not only English learners, from demonstrating their core math achievement.

1.5 Document Preview

This chapter offered a broad overview of the digital SAT Suite, including its place in the evolving educational environment and its design principles as well as in what ways the digital-suite assessments have stayed the same as their paper-and-pencil predecessors and in what ways the tests have changed to better meet the needs of students and their families, educators, state and district users, policymakers, and other stakeholders.

Subsequent chapters describe the digital SAT Suite tests and their design in more detail. Chapter 2 offers a high-level overview of the specifications and key features of the digital-suite tests. Chapter 3 and chapter 4 provide detailed overviews of the digital SAT Suite's Reading and Writing and Math sections, respectively, including numerous sample questions and answer explanations. Chapter 5 discusses the wide-ranging evidence collected by College Board that supports decisions shaping the design of the assessments. A brief conclusion to the body of this document is provided in chapter 6. A full list of referenced works appears next, followed by appendices that summarize aspects of the digital design, display the Reading and Writing and Math sections' skill/knowledge testing points, detail the test development process, provide the test and section directions, present the specifications for the linear (nonadaptive) versions of the digital SAT Suite tests used by students who need such an accommodation to access the tests and their content, and compare specifications between the paper-and-pencil and digital SAT Suites.

CHAPTER 2

The Digital SAT Suite: An Overview

2.1 The Digital SAT Suite

The digital SAT Suite is a series of testing programs and related services designed to measure students' attainment of what the best available evidence has identified as essential college and career readiness outcomes in English language arts/literacy and math.

This section describes the four digital SAT Suite testing programs, their purposes, and the uses and interpretations intended for them and their data, with the goal of informing readers about the place of the digital SAT Suite and its assessments in the broader educational landscape.

2.1.1. TESTING PROGRAMS

The digital SAT Suite consists of four testing programs, each with its own purposes and target population:

- The **SAT** is typically administered to high school juniors and seniors. The test measures essential prerequisites for postsecondary readiness and success as determined through an extensive, ongoing research process and is used in college admissions around the world.
- **PSAT/NMSQT** and **PSAT 10** are typically administered to high school sophomores and juniors. PSAT/NMSQT is administered in the fall of each academic year, while PSAT 10 is administered in the spring. The PSAT/NMSQT and PSAT 10 tests are identical in format and content, but only PSAT/NMSQT serves as a qualifying test for the National Merit Scholarship Corporation's annual scholarship program. PSAT/NMSQT and PSAT 10 serve as opportunities to check in on students' progress toward postsecondary readiness, focus students' preparation for post–high school study, connect students to scholarship opportunities, and inform them of College Board's National Recognition Program.

Preview

In this chapter, you will find

- descriptions of the digital SAT Suite testing programs and the purposes and intended uses for each program.
- discussion of the digital suite's key design features.
- high-level specifications for the digital SAT Suite tests.
- information about concordance between the digital and paper-based versions of the SAT Suite.

- **PSAT 8/9** is typically administered to eighth and ninth graders and serves as a baseline for assessing students' readiness for college and career.

The four tests measure the same broad knowledge domains and skills, with slight modifications reflecting differences in the age and attainment of students across the secondary grades, allowing students, families, and educators to monitor student progress and address any areas in need of improvement.

2.1.2. PURPOSES AND INTENDED USES AND INTERPRETATIONS

The primary purpose of the digital SAT Suite is to determine the degree to which students are prepared to succeed both in college and careers. All assessment content, which has been developed based on high-quality research identifying the knowledge and skills most essential to college and career readiness and success (see chapter 5), aligns with this core purpose. Each test within the digital SAT Suite is designed to collect evidence from student performance in support of a set of broad claims about what students know and can do, and each claim is aligned to the primary purpose of assessing college and career readiness. The resulting scores provide meaningful information about a student's likelihood of succeeding in college and workforce training—information that, used in conjunction with other data (such as high school grades) and in the context of where a student lives and learns, can contribute to decisions about higher education admission and placement.

Although the core purpose of the digital SAT Suite is college and career readiness assessment, the suite's data are employed for many purposes by a range of users, notably higher education officials, K–12 educators, and students. In keeping with best practices and professional standards (AERA, APA, and NCME 2014), the digital SAT Suite's intended uses and interpretations are discussed in the following paragraphs, with a rationale presented for each use.

Evaluating and monitoring students' college and career readiness (For use by K–12 educators and students). The SAT's empirically derived College and Career Readiness Benchmarks ("SAT benchmarks") serve as challenging, meaningful, and actionable indicators of students' college and career readiness. States, districts, and schools use the SAT benchmarks to monitor and determine what proportion of their student body has a high likelihood of success in college-entry coursework. Benchmark information is also provided to individual students. The SAT benchmarks are not intended for high-stakes decisions such as restricting student access to challenging coursework or discouraging aspirations of attaining higher education. Grade-level benchmarks are also provided through the PSAT-related assessments. The grade-level benchmarks indicate whether students are on track for college and career readiness and are based on expected student growth toward the SAT benchmarks at each grade. For more details on the benchmarks, see section 2.2.8.3. Additionally, the PSAT 8/9 and SAT are used to satisfy federal accountability requirements in eighth and eleventh grades in several states.

Monitoring student progress through a vertically scaled suite of assessments (For use by K–12 educators and students). Every test in the digital SAT Suite is reported on the same vertical scale, with the SAT as the capstone measure. The scales for the digital SAT have been established through concordance studies using samples of U.S. and non-U.S.-based students, and the scales for the PSAT/NMSQT, PSAT 10, and PSAT 8/9 tests have been linked to the SAT scale through vertical scaling studies using U.S.-based students. Establishing the scales in this manner allows for appropriate inferences regarding a student's academic growth and their progress toward college and career readiness from year to year prior to them taking the SAT. One is then able to make statements about a student's level of preparedness for college and careers based on SAT performance. Students can track their own progress by using information provided in their score report to identify instructional areas needing improvement and then engage in practice and learning opportunities that will help them become more prepared for college-level work. For details on scores, score interpretation, and student score reports, see sections 2.2.8 and 2.2.9; for details on practice opportunities, see section 2.2.10.

Contributing to high school course placement decisions (For use by K–12 educators and students). All assessments across the digital SAT Suite provide information about a student's readiness for particular Advanced Placement (AP) courses. AP Potential™ is a free, online tool that allows schools to generate rosters of students who are likely to score a 3 or higher on a given AP Exam based on their performance on the PSAT 8/9, PSAT/NMSQT, PSAT 10, or SAT. SAT Suite scores are stronger predictors of students' AP Exam scores than are more traditional factors such as high school grades and grades in same-discipline coursework. AP Potential should never be used to discourage a motivated student from registering for an AP course. The AP Program encourages schools to use a variety of factors, including grades, student motivation, and teacher recommendations, when registering students for AP courses.

Connecting students to career possibilities (For use by students). Discovering career options is a driving force as students make decisions about their future. Every career requires a set of skills, the attainment of which can be measured. College Board has worked with experts in occupations and labor market data to map the reading, writing, and math skills and knowledge measured on the SAT and the PSAT-related assessments to the literacy and numeracy requirements of a thousand different careers. To help all students consider the full range of vocational options open to them, digital SAT Suite score reports include Career Insights Snapshot, which lists careers in a student's state that are connected to the student's assessment performance. Each listed career has a bright outlook, pays a living wage in the state, and requires some form and level of postsecondary education. These careers are presented as examples and are neither formal recommendations nor the only career options that students should consider.

Connecting students to postsecondary educational opportunities (For use by K–12 educators and students). Connections™ is free and exclusively for students (thirteen and older) who take the PSAT/NMSQT, PSAT 10, or SAT on a school day. With Connections, students receive messages from nonprofit accredited colleges and universities (domestic and international), nonprofit scholarship providers, and government agencies administering educational programs. College Board delivers relevant messages via the BigFuture School app and by mail on behalf of organizations interested in students based on information that students, schools, districts, or states provide as a part of in-school assessments, score ranges on SAT, PSAT/NMSQT, PSAT 10, and AP Exams, as well as student interests and preferences they may choose to share in BigFuture School. Districts and schools may opt not to provide access to Connections. With Connections, no personal information is shared with institutions unless a student chooses to connect and share directly with them outside of the app. This gives students and their families more control over when, or whether, they raise their hands to be seen. The goal is to create more opportunities for students as they consider their options after high school. With input from students, families, and education professionals, BigFuture School and Connections will expand and improve to help every student chart their path.

Helping underrepresented students be seen by colleges (for use by higher education). The College Board National Recognition Program awards academic honors to high-performing underrepresented students. The five national recognition programs include the National First-Generation Recognition Program, the National African American Recognition Program, the National Hispanic Recognition Program, the National Indigenous Recognition Program, and the National Rural and Small Town Recognition Program. Students who take eligible administrations of the PSAT/NMSQT, PSAT 10, or AP Exams and meet the score requirements are considered for the awards, which are a tangible way to help students be seen by colleges and support colleges' recruitment strategies.

Making college admission, advising, and college course placement decisions (For use by higher education). In conjunction with other sources of data, such as high school grades, as well as contextual information about where students live and learn, as provided through College Board's Landscape® tool (**https://professionals.collegeboard.org/landscape**), the SAT is intended for use in college admission, advising, and course placement decisions. The SAT provides information on a student's level of preparedness for college-level work, which helps admissions professionals make more informed selection decisions. This usefulness extends to informing early academic advising conversations in college as well as academic preparedness or possible academic supports needed for success in different college majors.

Contributing to scholarship decisions and other awards (For use by higher education and nonprofit organizations). Scores from the digital SAT Suite are often used to inform the decisions that colleges and nonprofit programs make in relation to academic awards, scholarships, and other forms of aid.

All students have the option to join Student Search Service® so that interested nonprofit colleges and scholarship programs can reach out to them directly. When students join Student Search Service, their PSAT/NMSQT, PSAT 10, SAT, and/or AP score bands, along with other information about them and their interests, are used and shared with participating nonprofit accredited colleges and universities (domestic and international), nonprofit scholarship providers, and government agencies administering educational programs that are looking for students who are a good match for them. These organizations may send students (and their parent/guardian, if they have opted in) email and postal mail with information about educational, financial aid, and scholarship opportunities.

2.1.3. LIMITS ON USES AND INTERPRETATIONS

The digital SAT Suite is intended to open doors for students and to help them gain access to opportunities that they have earned through their hard work. It is therefore inappropriate to use digital SAT Suite scores as a veto on students' educational or vocational aspirations. When interpreted properly, data from tests such as those of the digital SAT Suite can make valuable contributions to helping students meet their academic and career goals, but test scores should never be the sole basis for highly consequential decisions about students' futures. Digital SAT Suite scores, therefore, should be considered alongside other factors, including high school grades and where students live and learn, when evaluating students' achievement or potential.

Digital SAT Suite scores should also not be used as the single measure to rank or rate teachers, educational institutions, districts, or states. Users should exercise care when attempting to interpret test results for a purpose other than the intended purposes described above. College Board is not aware of any compelling validation evidence to support the use of any of the digital SAT Suite assessments, or other educational achievement measures, as the principal source of evidence for teacher or school leader evaluation. Assessment data, when subjected to several constraints, can, however, be used in conjunction with other educational outcome measures to make inferences about school and educational quality, including teaching and learning.

For further examples of uses of College Board test scores that should be avoided, see appendix B of *Guidelines on the Uses of College Board Test Scores and Related Data* (College Board 2018).

2.2 Key Design Features

A number of key design elements characterize the tests of the digital SAT Suite. These include

- **digital testing** as the primary test delivery method (with paper-based and other accommodations and supports for students who require them);
- **Bluebook, College Board's digital testing application** built to administer the digital SAT Suite in an intuitive, accessible manner;
- **multistage adaptive testing,** which permits shorter tests that nonetheless yield scores as precise and reliable as those from the paper-based SAT Suite tests;
- **embedded pretesting**, which ensures that College Board can securely obtain high-quality question performance statistics and maintain the digital SAT Suite indefinitely while limiting the burden on students of answering pretest (nonoperational) questions on which they are not scored;
- the use of **discrete questions** to assess skills and knowledge in English language arts/literacy and math in an efficient, valid, and fair way;
- the implementation of a broad-based **test fairness** agenda that continues College Board's practice of ensuring that the SAT Suite is a valid and fair assessment of all students' skills and knowledge;

- the implementation of a wide-ranging **test accessibility** agenda that includes Bluebook's adherence to universal design principles, the provision of universal tools to all students during testing, and the availability of accommodations and supports for students who require them to access and respond to the test content;
- **scores and score interpretation tools** that provide clear, actionable information to students and their families, teachers, and other stakeholders;
- **score reports** that link students to both useful test data and a range of college and career opportunities and next steps; and
- **free, world-class practice opportunities** that familiarize students with Bluebook, prepare them to answer test questions successfully, and help them develop durable skills and knowledge needed for college and career readiness.

The following subsections provide an overview of each of these central elements.

2.2.1. DIGITAL TESTING

The digital SAT Suite represents College Board's full shift to digitally based testing for its flagship college and career readiness assessments. All students—with the important exception of those requiring paper-based materials for fair access to the tests—now take SAT Suite tests digitally.

This embrace of digital testing for the SAT Suite offers several critical benefits to those who take the tests, administer the tests, and use the tests' data.

First, the shift recognizes that today's students live much of their lives digitally, including how they learn in school, connect with friends and family, find information to answer their own or assigned questions, and spend their leisure time. The SAT Suite should not be the exception to this. By moving the tests to a digital format, College Board sought to meet students where they are, using a modality (digital delivery) that is increasingly familiar and comfortable to students.

Second, digital testing using the multistage adaptive testing process discussed in detail in section 2.2.3 allows College Board to give much shorter versions of the SAT Suite tests relative to their paper-and-pencil predecessors while maintaining scoring precision (accuracy) and reliability. Students and schools benefit when the same quality of college and career readiness testing that College Board is well known for is compacted into a reduced time frame.

Third, digital testing greatly streamlines the test administration process. Schools and other test centers giving the digital SAT Suite tests no longer have to receive, sort, securely store, re-collect, and ship back test booklets. Thanks to College Board's Test Day Toolkit app, test proctors' work has also been significantly simplified. Notably, the critical function of test timing has been turned over to Bluebook, ensuring that all test takers have exactly the same amount of time to test and are able to track precisely the time they have left via a built-in timer (which can, at students' discretion, be hidden until the five-minute mark in each test module).

Fairness, Equity, and the Digital Divide

College Board recognizes that the availability and use of digital devices and the robust connectivity required to enable them are not uniform across the United States or the world and that the digital divide disproportionately impacts some groups of students, particularly students from lower-income families. To help address these inequities as they affect SAT Suite testing, College Board is committed to lending a digital device to any student testing on the weekend who requires one to take one of the SAT Suite assessments. For more information, please visit **https://satsuite.collegeboard.org/digital/device-lending**. Moreover, Bluebook, the digital SAT Suite test delivery platform (section 2.2.2), has been designed to be tolerant of momentary connectivity drops or loss of battery power. Students can simply resume testing without losing time or effort.

Fourth, the shift to digital testing facilitates the expansion of test administrations and the enlargement of testing windows as part of school day testing. The innovations implemented by the digital SAT Suite will allow for more testing opportunities for individual students as well as much greater flexibility on the part of state and district SAT Suite users in scheduling testing to fit the needs of their schools. Critically, this expansion of testing opportunities does not come at the cost of test security, as the digital SAT Suite administers highly comparable but unique test forms to every student.

Fifth, the move to digital testing will, soon after the initial operational administrations, enable faster score reporting than was possible with paper-based testing. Users will get the data they need to inform decisions in days rather than the weeks required for the paper-and-pencil SAT Suite.

2.2.2. CUSTOMIZED TEST DELIVERY APPLICATION

College Board administers the digital SAT Suite on Bluebook, a proprietary digital testing application customized for the SAT Suite assessments. This app is a modified version of the one used highly successfully to deliver AP Exams. Having a customized and well-vetted test delivery application allows College Board to fully meet SAT Suite users' needs and to respond in an agile manner by quickly making updates and refinements as needed.

Bluebook has been designed to conform to the principles of Universal Design for Assessment (UDA; Thompson, Johnstone, and Thurlow 2002). UDA is a set of principles grounded in prior work on universal design for accessibility in other fields—notably architecture, where the concept originated. The overriding goal of UDA is to purposefully make tests as accessible as possible to the largest number of people so that the maximum number of test takers have full, unimpeded access to the tests and their content. Where the application of universal design principles and the offering of universal test-taking tools is insufficient to allow some test takers that level of access, accommodations and supports are provided to level the playing field in ways that welcome students into the tests without compromising the constructs (concepts) the tests are designed to measure, simplifying the assessment tasks, or inadvertently providing the answers to questions. The digital SAT Suite continues to offer the same range of accommodations and supports available in the suite's paper-and-pencil format, with the caveat that some tools previously available only as accommodations in paper-based and linear digital testing, such as the ability to zoom in and adjust contrast, are available to all test takers as universal tools, which students may elect to use or not use.

Another benefit of Bluebook is that students are able to take full-length, adaptive practice tests for free in the same application in which the vast majority of them will take operational SAT Suite tests. This feature enhances the value of practice by allowing students not only to assess the current state of their skills and knowledge but also to gain experience and comfort with the exact way in which they will be assessed on test day. Students with accommodations can also practice with accessibility features enabled on their testing devices and select extended time and breaks in accordance with their approved accommodations. In addition, the small number of students who will take digital SAT Suite tests in a linear (nonadaptive) format have access to linear practice forms, which provide them with practice opportunities identical to what they will encounter on the actual test.

For more information about accessibility on and practice for the digital SAT Suite, see sections 2.2.7 and 2.2.10, respectively.

2.2.3. MULTISTAGE ADAPTIVE TESTING

For the digital SAT Suite, College Board has shifted from a linear testing model as the primary mode of administration to an adaptive one. In linear testing—the traditional approach for the SAT Suite—a student is given a test form whose array of questions has been set prior to test day and does not change based on the student's performance during the test. Linear tests of this sort are attractive to test makers in part because they allow for fine control of the content presented to students, but they have notable drawbacks as well. In addition to being vulnerable from a test security standpoint, linear test forms are fairly lengthy. This is because the test developers devising such a form cannot make any assumptions about students' achievement levels and therefore must include questions across the full range of the test's specified difficulty to measure accurately any one student's achievement. A linear test form is, in a real sense, a "one-size-fits-all" testing model—functional, time tested, but inefficient both at scale and for individual students.

In an adaptive test model, by contrast, the digital testing application adjusts the difficulty of the questions given to a student during the test based on the student's test-taking performance. These adjustments help ensure that any given student on test day is being administered questions of difficulty levels appropriate to their level of achievement. In contrast to linear testing, in which students (particularly those at the high and low ends of the score distribution) often end up being given questions that are either too easy or too hard for them, adaptive testing adjusts question delivery according to what the digital testing application "learns" about a given student during the exam. Because of this more precise targeting to student achievement level, adaptive testing allows for shorter tests than their linear counterparts and, critically, does so without loss of measurement precision or test reliability. Adaptive testing for the digital SAT Suite is a win for students (and many others) because it means shorter tests that are just as accurate as longer ones.

Adaptivity in digital testing typically occurs in one of two forms. In a question-by-question adaptive model, the test delivery platform adjusts the difficulty of questions given to students on a per-question basis as the student is taking the exam. The second form, and the one being used for the digital SAT Suite, is multistage adaptive testing (MST).

An MST model segments the testing experience into distinct *stages*, with each stage composed of a *module* of test questions. The first module in an MST test such as those of the digital SAT Suite typically consists of questions across a broad span of difficulty (i.e., easy, medium-difficulty, and hard questions) so that a robust if provisional assessment of test taker achievement can be obtained. The

Digital SAT Suite MST Terminology

Stage: One of two separately timed portions of a digital SAT Suite test section

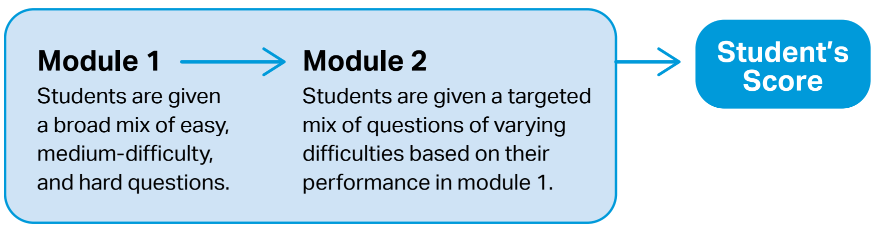
Module: The set of questions composing a given stage; characterized by average question difficulty

Form: A student testing experience; consists of two modules—a given initial (routing) module and a second module of targeted average question difficulty

Panel: A set of three modules—a given initial (routing) module and its pair of second-stage modules, one of which consists of, on average, higher-difficulty questions and the other of which consists of, on average, lower-difficulty questions app then uses this information to select the next module to administer. This module consists of questions targeted to the test taker's performance up to that point by being either, on average, more or less difficult than the questions in the first module. This process continues throughout a given test's stages until a final measure of the student's achievement is obtained. The set of a given initial-stage module and its associated subsequent-stage modules is known as a *panel*. (See also the terminology sidebar to the right.)

For the digital SAT Suite, College Board employs a simple two-stage MST model, depicted schematically in figure 1.

Figure 1. Digital SAT Suite Multistage Adaptive Testing (MST) Model.



On all digital SAT Suite tests, students begin each test section (Reading and Writing; Math) by answering questions in the first module of a given panel. This initial (routing) module comprises half the questions of each test section and consists of a broad mix of easy, medium-difficulty, and hard questions. These questions are sufficiently numerous and diverse to obtain an accurate if provisional measure of a given student's achievement level on the test section. Questions from all four Reading and Writing and Math content domains are included in each section's modules; this helps ensure that students are sampled fairly on all domains in the first module prior to being routed to the second in each section.

Based on student performance on the initial module, Bluebook selects one of two potential second-stage modules to administer. One such module consists of a targeted mix of questions that are, on average, of higher difficulty than those in the first module, while the other consists of a targeted mix of questions that are, on average, of lower difficulty than those in the first module, although both options include easy, medium-difficulty, and hard questions, albeit in differing proportions. Once students have answered the questions in the second module, testing on that section is complete, and a section score can be calculated based on student performance across all the questions given in the section.

MST testing benefits students in two main ways. First, it results in shorter tests that retain the precision and reliability of longer (linear) tests. Second, unlike in most question-by-question adaptive testing models, students taking one of the digital SAT Suite tests can navigate freely through a given module's questions, previewing upcoming questions or marking earlier questions to return to should time permit. This flexibility enables students to approach the modules' questions the way they want, using the test-taking strategies most comfortable to them.

A question students and their families, educators, policymakers, and other stakeholders may have about the multistage adaptive tests of the digital SAT Suite is how College Board ensures that test takers are properly routed through the exams. Recall that in the multistage adaptive tests of the suite, students begin testing in each section with an initial (routing) module of questions of, on average, medium difficulty and then, based on their performance on those questions, are routed to a second module that consists of questions that are, on average, either of higher or lower difficulty than those in the first module. Because of this adaptive "branching," stakeholders may wonder whether test takers are consistently given the second-stage module that matches their true achievement level (*routing accuracy*), whether they would be routed the same way irrespective of which test panel they are administered (*routing consistency*), and to what extent any "misrouting" would affect their section-level performance.

To examine these matters, College Board researchers turned to simulation studies of the digital suite's adaptive algorithm. Such studies, which, broadly speaking, involve simulating the responses of a large number of hypothetical test takers with known "true" achievement levels across the test's (or test section's) score scale, have an essential role in the development and delivery of adaptive tests, allowing for the study of an adaptive algorithm to assess its fairness and to evaluate various types of consistency and error likely to be observed in scores.

These College Board simulation studies reached three main conclusions with respect to the fairness of the digital suite's multistage adaptive algorithm:

- Routing accuracy in both the Reading and Writing and Math sections was very high, with over 93 percent of simulated examinees being routed as expected.
- Routing consistency in both sections was also very high, with over 90 percent of simulated examinees routed in the same way (i.e., to either the higher- or lower-difficulty second-stage module) in two separate test panels.
- When observed in the simulation studies, routing errors (i.e., lack of accuracy and/or consistency) had no appreciable effect on the simulated examinees' scores.

To fully grasp the last point, it is important to understand key design features of the digital suite's adaptive algorithm. The "break point," in terms of performance, between test takers who receive the higher-difficulty second-stage module and those who receive the lower-difficulty second-stage module is set around the median Reading and Writing and Math section scores. In practical terms, this means that roughly half of all test takers are routed to the higher-difficulty module and half to the lower-difficulty module. For students who perform particularly well or poorly on the first module's questions, little chance of routing error exists; routing errors would therefore likely only affect middle-performing test takers, about whom some question exists as to which of the two paths is better suited for them. Even here, however, which particular path these test takers are given is largely a matter of indifference. First, both second-stage modules contain a mix of easy, medium-difficulty, and hard questions (albeit in differing proportions), so middle-performing test takers have a full opportunity, regardless of which second-stage module they receive, to demonstrate their true achievement. Second, many midlevel section scores are, by design, obtainable from either path, meaning that middle-performing test takers can earn their proper score regardless of whether they receive the higher- or lower-difficulty second-stage module. (It should also be noted that this region of section score overlap contains the College and Career Readiness Benchmarks, which means that test takers on either path have the opportunity to demonstrate performance at college and career readiness levels.)

As part of the simulation studies, College Board researchers also analyzed whether there would be any benefit to all or some students to "game" the test's routing decision. The most likely scenario considered was one in which a high-achieving student intentionally answers just enough questions incorrectly in the initial (routing) module to be routed to the lower-difficulty second-stage module, whose questions the student would then answer correctly to maximize their section score. Simulation study results indicate that this student would likely earn a lower score than they would have had they answered each question to the best of their ability—in no small part because intentionally answering numerous first-module questions incorrectly would sharply limit their highest possible section score.

Taken together, these results establish that the adaptive aspect of the digital SAT Suite tests is fair to all students and that students are best served by answering each digital SAT Suite test question to the best of their ability.

2.2.4. EMBEDDED PRETESTING

The digital SAT Suite incorporates embedded pretesting into its design. In embedded pretesting, a small number of pretest (unscored) questions are included, or *embedded*, among the operational (scored) questions. Although they are not administered for a score, these pretest questions are otherwise indistinguishable to students from the operational questions on which their scores are based. This ensures that students give maximum attention and effort to these questions, which enhances the predictive power of the pretest statistics yielded. The number of pretest questions in each test form is kept intentionally low so that students are not unduly burdened with answering questions that do not contribute to their score but is still high enough that College Board can continue to offer students the same high-quality digital SAT Suite testing experience indefinitely.

2.2.5. DISCRETE QUESTIONS

All questions on the digital SAT Suite are in a discrete (standalone) format, meaning that students are able to answer each question independently, without reference to a common stimulus such as an extended passage. This represents a departure from the paper-and-pencil SAT Suite, which used a combination of discrete questions and question sets.

The decision to use discrete questions exclusively on the digital SAT Suite was prompted partly by the nature of College Board's digital testing model. An adaptive test model, such as the multistage model employed for the digital suite, operates more efficiently when choices about what test content to deliver are made in small rather than larger units. Moreover, these small units can be flexibly combined to create large numbers of highly comparable but nonetheless unique test forms, thereby enhancing test security.

At the same time, the shift to exclusively using discrete questions offers several key benefits for students and for the assessments themselves, particularly with respect to the digital SAT Suite Reading and Writing section. First, the shift reduces the amount of cognitively low-level skimming and scanning required to answer reading and writing test questions, since all the information needed to answer each question is contained within a brief passage or pair of passages. Test takers can instead focus on demonstrating higher-order reading, writing, analysis, and reasoning skills, such as inferring, rather than spending time searching for relevant information in a longer passage. Second, students who might have struggled to connect with the subject matter of a long passage and then answer up to eleven questions about it in the paper-and-pencil Reading and Writing and Language Tests can, on the digital tests, simply give their best answer to each question and move on, knowing that one wrong answer will not negatively impact their scores materially. Conversely, the inclusion of more passages and, therefore, more topics dramatically increases the likelihood that students will find subjects of interest to them on the tests, which will keep them more engaged during testing. Third, the use of discrete questions eliminates the possibility, however remote, that questions within a set linked to a common stimulus may interact with one another, such as one question inadvertently cluing the answer to another question. Finally, the use of discrete reading and writing questions linked in passage-dependent ways to brief stimulus texts obviates the value of certain test preparation strategies intended to short-circuit the intended rigor of tasks, such as not closely reading the entire stimulus and instead attending only to those portions directly relevant to answering particular questions.

Importantly, the shift to discrete questions has not entailed a reduction of test rigor. Though shorter, passages on the Reading and Writing section of the digital SAT Suite tests are still selected to represent the same range of text complexities correlated with college and career readiness requirements as in the paper-and-pencil tests, and they continue to sample from and represent the norms and conventions of texts produced in a wide range of academic subject areas, including literature, history/social studies, the humanities, and science. Moreover, pretesting of digital SAT Suite questions in both Reading and Writing and Math has consistently demonstrated that digital-suite and paper-suite questions are of highly comparable difficulty, and both suites' tests emphasize higher-order thinking skills over low-level recognition, recall, and rote application of rules and algorithms. Furthermore, in 2023 College Board undertook a rigorous qualitative study of students' thinking processes while taking the tests (College Board 2024), which confirmed that, as was the case with the paper-based SAT (College Board and HumRRO 2020), digital SAT Suite tests elicit the kinds of higher-order reading, writing, and math skills and knowledge required for college and career readiness. For more details on this study, see section 5.1.12.

See also section 5.3.1 for research evidence indicating that shorter test passages are as viable and appropriate as longer ones for an assessment of reading comprehension.

2.2.6. FAIRNESS

College Board is strongly committed to the indivisibility of the concepts of test validity (i.e., that a test is measuring what it is intended to measure) and test fairness (i.e., that a test affords an equal opportunity to all test takers to perform up to their level of achievement without hindrance). To put the matter simply, a test must be fair to be valid. As with the paper-based suite, test fairness considerations permeate the design, development, and administration of the digital SAT Suite.

Conceptually, *fairness* can be defined in terms of both equitable treatment of all test takers during a test administration and equal measurement quality across subgroups and populations. Best practices as well as standards 3.1–3.5 of the 2014 edition of the *Standards for Educational and Psychological Testing*, jointly produced by the American Educational Research Association (AERA), the American Psychological Association (APA), and the National Council on Measurement in Education (NCME), call for test publishers to "minimize barriers to valid score interpretations for the widest possible range of individuals and relevant subgroups" (AERA, APA, and NCME 2014, 63). An assessment should be built in such a way that the constructs (concepts) being assessed are measured equally for all intended test takers and test-taking subgroups, and it should be administered in a manner that is fair and equitable for all test takers, regardless of gender, race/ethnicity, and other personal characteristics.

To accomplish these goals, four aspects of fairness, identified by the *Standards* (AERA, APA, and NCME 2014), are addressed as part of the development and administration of the digital SAT Suite.

1. **Fairness in treatment during the testing process.** Fairness in treatment involves "maximiz[ing], to the extent possible, the opportunity for test takers to demonstrate their standing on the construct(s) the test is intended to measure" (51). The *Standards* note that test makers have traditionally tried to meet this goal through standardization of the testing process—that is, by ensuring that all students are given the same instructions, testing time, and the like—but that test makers also increasingly recognize that "sometimes flexibility is needed to provide essentially equivalent opportunities for some test takers" (51) when accommodations and supports in testing do not compromise the construct (e.g., reading comprehension) being measured.
2. **Fairness as lack of measurement bias.** Per the *Standards*, bias in a measurement itself or in the predictions made from it may occur when "characteristics of the test itself that are not related to the construct being measured, or the manner in which the test is used," lead to "different meanings for scores earned by members of different identifiable subgroups" (51). Bias in this sense can play out as differential performance on questions and/or tests by identified subgroups equally matched on the characteristic of interest (e.g., math achievement) and/or in differential predictions (inferences) about such subgroups. It is the responsibility of test makers to identify and root out such construct-irrelevant factors when these factors advantage or disadvantage defined subgroups of test takers.

3. **Fairness in access to the construct(s) being measured.** The *Standards* define accessible testing situations as those that "enable all test takers in the intended population, to the extent feasible, to show their status on the target construct(s) without being unduly advantaged or disadvantaged by individual characteristics (e.g., characteristics related to age, disability, race/ethnicity, gender, or language) that are irrelevant to the construct(s) the test is intended to measure" (52). Accommodations and supports may take such forms as providing students who have visual impairments with access to large-print versions of text (when visual acuity is not the construct being measured) and avoiding the use of regional expressions in test questions intended for a national or international audience.
4. **Fairness as validity of individual test score interpretations for the intended uses.** The *Standards* indicate that test makers and users should attend to differences among individuals when interpreting test data and should not generalize about individuals from the performance of subgroups to which they belong. Given those considerations, "adaptation to individual characteristics and recognition of the heterogeneity within subgroups may be important to the validity of individual interpretations of test results in situations where the intent is to understand and respond to individual performance," but test makers also have to consider whether such adaptations may, for particular purposes, "be inappropriate because they change the construct being measured, compromise the comparability of scores or use of norms, and/or unfairly advantage some individuals" (53–54).

College Board embraces the fairness expectations articulated by the AERA/APA/NCME *Standards* and the overarching goal of ensuring the maximal inclusiveness, representativeness, and accessibility of its digital SAT Suite test materials consistent with the constructs, purposes, and uses of the tests. Through its fairness-related documentation, processes, procedures, trainings, and other support materials, College Board strives to ensure that the tests of the digital SAT Suite

- are appropriate for and accessible to a national and international test-taking population of secondary students, and defined subgroups of that population, taking a medium- to high-stakes assessment of college and career readiness;
- neither advantage nor disadvantage individual test takers or defined population subgroups of test takers due to factors not related to the constructs being measured;
- are free of content or contexts likely to give offense, provoke a highly distracting emotional response, or otherwise inhibit test takers from demonstrating their best work on the tests;
- accurately and fairly portray the diverse peoples of the United States and the world and convey the widest possible range of ideas, perspectives, and experiences consistent with the tests' design;
- make test content as fully and as widely accessible to as many test takers as possible through universal design and through a range of accommodations and supports for test takers with particular needs while, to the fullest extent possible, remaining faithful to the constructs being measured; and

- have clearly articulated purposes and uses for which they and their data should and should not be used and have clearly indicated populations for whom the tests are designed.

2.2.7. ACCESSIBILITY

As indicated above, accessibility is a critical aspect of test fairness. The following subsections detail how the digital SAT Suite assessments advance the goal of maximal accessibility for all students through the application of universal design principles, the provision of universal tools, and the availability of accommodations and supports for those students who require them.

2.2.7.1. *UNIVERSAL DESIGN*

In designing and developing the digital SAT Suite, College Board adhered closely to the tenets of universal design generally and to the ways in which researchers and practitioners have recommended that these tenets be applied to the design, development, and administration of large-scale standardized tests. The concept of universal design (UD), which originated in the field of architecture, is intended to promote "the design of products and environments [so that they are] usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Center for Universal Design 1997). Universal Design for Learning (Rose et al. 2002) applies UD principles to education. It promotes providing multiple means of engagement, representation, and action and expression to students in order to reduce, if not eliminate, barriers to equitable educational access. Universal Design for Assessment (UDA; Thompson, Johnstone, and Thurlow 2002) extends UD principles specifically to large-scale assessment.

Table 1 displays the seven core principles of UDA, defines each briefly using language from Thompson, Johnstone, and Thurlow (2002), and indicates how the digital SAT Suite implements each principle, a topic that is expanded on in the subsequent discussion.

Table 1. Digital SAT Suite Implementation of Universal Design for Assessment (UDA) Principles (Adapted from Thompson, Johnstone, and Thurlow [2002]).

UDA Principle	Key Requirement(s)	Digital SAT Suite Implementation
Inclusive assessment population	"Opportunities for the participation of all students, no matter . . . their cognitive abilities, cultural backgrounds, or linguistic backgrounds"	Universal tools available to all students Wide range of accommodations and supports available Pretesting and studies that include English learners (ELs) and students with disabilities (SWD) Quantitative data-gathering with special-needs populations
Precisely defined test constructs	"Remov[ing] all non-construct-oriented cognitive, sensory, emotional, and physical barriers" to assessment	Carefully defined test specifications with construct definitions Evaluation of potential accommodations and supports to confirm that they do not affect the constructs intended to be measured

UDA Principle	Key Requirement(s)	Digital SAT Suite Implementation
Accessible, nonbiased test questions	"Incorporating accessibility as a primary dimension of test specifications"; verifying lack of bias in items	Strong commitment to accessibility-as-validity from day one Staff training in content and fairness criteria and appropriate language selection External, independent reviews including race/ethnicity, gender, EL, and SWD representatives Differential item functioning (DIF) analyses
Amenable to accommodations	Ready provision of accommodations for SWD and supports for ELs that do not weaken the intended constructs	Carefully defined test construct descriptions Availability of a wide range of accommodations and supports for those students who require them
Simple, clear, intuitive instructions and procedures	"Instructions . . . in simple, clear, consistent, and understandable language"; practice materials; standardized administration	Focus group evaluations of Math student-produced response (SPR) directions by test takers, including test takers using accommodations Official Digital SAT Prep and other test familiarization opportunities, most of which are offered at no cost Test Day Toolkit to support administration ease and consistency
Maximum readability and comprehensibility	Managing text complexity and "[using] plain language when vocabulary level is not part of the construct being tested"	Mechanisms for evaluating Reading and Writing text complexity and determining which vocabulary words/ phrases are tested Staff training in appropriate language selection
Maximum legibility	Legible texts; legible graphics; legible response formats	Careful selection of font and point size, with the ability to adjust via magnification Well-articulated content and editorial parameters for graphics Alt text for graphics as well as other accommodations Straightforward response entry (with alternatives for students with disabilities needing accommodations)

1. **Inclusive assessment population.** UDA-compliant tests must offer "opportunities for the participation of all students, no matter what their cognitive abilities, cultural backgrounds, or linguistic backgrounds" and "need to measure the performance of students with a wide range of abilities and skill repertories, ensuring that students with diverse learning needs receive opportunities to demonstrate competence on the same content" (Thompson, Johnstone, and Thurlow 2002, 6). The digital SAT Suite meets these goals, in part, by making universal accessibility tools, such as the abilities to zoom in and to adjust contrast, available in Bluebook for all students to use or not use at their discretion; by offering a wide range of accommodations and supports to those students who require them; by including members from special-needs populations, such as English learners (ELs) and students with disabilities (SWD), in pretesting and other studies; and by engaging directly with special-needs populations via studies targeted at better understanding their requirements and preferences.

2. **Precisely defined test constructs.** Carefully articulating constructs—definitions of the concepts (e.g., reading comprehension, math achievement) a given test is intended to assess—promotes fairness and accessibility by differentiating between the skills and knowledge that are appropriate to assess (i.e., *construct relevant*) and confounding elements that may impair an accurate assessment of those skills and knowledge (i.e., *construct-irrelevant factors*). Such construct-irrelevant factors for the digital SAT Suite include, but are not limited to, students' race/ethnicity, gender and sexual identities, home region and home culture, and whether students live in rural/small-town, suburban, or urban areas.

   As Thompson, Johnstone, and Thurlow (2002, 8) put it, "Just as universally designed architecture removes physical, sensory, and cognitive barriers to all types of people in public and private structures, universally designed assessments remove all non-construct-oriented cognitive, sensory, emotional, and physical barriers." The digital SAT Suite meets these goals, in part, by developing and publishing such constructs (see section 3.2.1 for Reading and Writing and section 4.2.1 for Math), by routinely engaging both internal and independent subject matter and fairness experts in assessing test content for construct relevance, and by evaluating potential accommodations and supports to confirm their efficacy and that their use does not compromise the constructs intended to be measured.

3. **Accessible, nonbiased test questions.** For tests to be UDA compliant, test makers must "[incorporate] accessibility as a primary dimension of test specifications" (Thompson, Johnstone, and Thurlow 2002, 9, citing Kopriva 2000) and verify that test questions are free from bias (i.e., construct-irrelevant factors that may influence test performance in unintended ways).

   College Board test development staff are carefully trained on exacting content and fairness requirements, to which they refer when developing and reviewing test materials. (See appendix C for more information on the test development process.)

   Questions on the digital SAT Suite are also routinely subjected to external review for content soundness and fairness by independent educators at the secondary and postsecondary levels, who themselves follow the same content and fairness criteria that College Board staff make use of. These external reviews take two main forms: (1) semiannual reviews of representative test forms and panels and (2) fairness evaluations of individual questions. The main focus of the former is to gather feedback on the high-level suitability of the digital SAT Suite tests to fairly and accurately assess college and career readiness outcomes, while the main focus of the latter is on ensuring lack of bias and sensitivity concerns in particular test questions, although both processes yield feedback about both aspects of test and question design and development.

   In addition, College Board measurement experts perform differential item functioning (DIF) analyses on pretested questions. This statistical method, in brief, involves comparing samples of test taker performance to investigate whether certain defined population subgroups (e.g., males and females) seem to perform differently on given test questions. Assuming the premise that two student samples of equivalent achievement should have an equal probability of answering a given question correctly, DIF analysis seeks to uncover cases where the performance of one sample (e.g., a group of students identifying as female) differs from that of another sample (e.g., a group of students identifying as male) to an extent unlikely to have occurred purely by chance. When questions pretested for the digital SAT Suite exhibit high levels of DIF, those questions are either discarded or revised and re-pretested.

4. **Amenable to accommodations.** According to Thompson, Johnstone, and Thurlow (2002), UDA-compliant tests must make ready provision of testing accommodations that allow students who need them to participate fully in the testing experience. This notion can also be extended to students whose first or best language is not English and who require supports to fully access the test content.

   To these ends, the digital SAT Suite programs offer a wide range of accommodations and supports for students who require them. These offerings have been carefully evaluated to make sure that they aid the students making use of them and do not undermine the constructs the tests are intended to measure. For example, magnification devices are acceptable accommodations on the digital SAT Suite because visual acuity is not a construct being measured; however, because English language proficiency is a requirement throughout the tests' design, students are not permitted access to conventional dictionaries to look up the meaning of words and phrases used on the test, although, in some circumstances, English learners are able to use approved word-by-word bilingual glossaries as an accessibility support. The score reports of students who make use of accommodations and supports are not differentiated from those of students not using them because such assistance serves only to level the playing field between these two groups and to give students with disabilities as well as English learners equivalent opportunities to demonstrate their achievement through the tests.

5. **Simple, clear, intuitive instructions and procedures.** Thompson, Johnstone, and Thurlow (2002, 13) call for test instructions and procedures that are "easy to understand, regardless of a student's experience, knowledge, language skills, or current concentration level." The authors also signal the value of providing students with practice opportunities prior to testing and making sure that test administration conditions are well documented so that they can be standardized and consistently replicated.

   The digital SAT Suite furthers these goals in several ways. First, test instructions and procedures have been kept to a clarifying minimum and are available to students in advance of testing via official practice tests produced by College Board and other test familiarization opportunities (see also section 2.2.10). Procedures for responding to digital SAT Suite questions are also straightforward: students must either select the best option among four for multiple-choice questions (the format used for the vast majority of digital-suite questions) or, for select questions in Math, generate and enter their own answers in a format referred to as student-produced response, or SPR.

Math SPR directions have been crafted carefully by both content and user experience experts to emphasize clarity and minimize the likelihood of student entry error. Student entries in these fields are automatically validated by Bluebook to preclude certain kinds of errors (e.g., entry of too many digits; use of nonnumerical characters other than the negative sign and the slash for fractional answers), and Bluebook previews entries for test takers, allowing them to confirm that the answers they enter are the ones they intend to provide. College Board has also conducted focus groups with test takers, including those using accommodations, on their perceptions and level of understanding of the SPR directions and used this feedback to inform refinements. This research is discussed in section 5.1.15. Finally, the Math SPR instructions, like all digital SAT Suite test directions, are available to students at any time during testing.

Second, as is detailed in section 2.2.10, College Board makes numerous opportunities available to students, most of them at no cost, to practice productively for the digital SAT Suite tests.

Third, the digital SAT Suite represents a significant enhancement of test administration ease over its paper-and-pencil predecessor, thereby improving standardization of test delivery. Test Day Toolkit, College Board's test administration app, vastly simplifies the task of giving the digital SAT Suite tests by guiding proctors through every step of the process. In addition, test timing—formerly a key responsibility of test proctors—has been transferred to Bluebook, thereby ensuring that all students have the exact time allotted for testing and have ready access to accurate information about how much time is left for a given test module. These innovations make it even more likely that every student taking one of the digital SAT Suite assessments does so under precisely the same conditions (with the important exception that approved accommodations and/or supports may intentionally alter testing circumstances as a means to promote test equity).

6. **Maximum readability and comprehensibility.** Thompson, Johnstone, and Thurlow (2002) advocate that test makers control the linguistic demands of test questions to ensure that texts are no more complex than they need to be to satisfy the demands of the construct being measured and that questions "use plain language when vocabulary level is not part of the construct being tested" (15).

   The digital SAT Suite approaches these requirements in two main ways. First, because text complexity is an important aspect of the reading and writing construct being assessed, College Board staff use a mixture of both quantitative and qualitative measures of text complexity to ensure that the passages used as stimuli in test questions represent appropriate levels of challenge consistent with college and career readiness requirements. On the quantitative side of the equation, College Board has developed a custom text complexity measurement tool that is more suitable than off-the-shelf products for assessing accurately the difficulty of the brief Reading and Writing passages used on the tests. Because no quantitative tool, no matter how well designed, can consider all the factors that contribute to text complexity, College Board requires staff trained on text complexity requirements to also weigh in on judgments about which of the digital suite's three text complexity bands—grades 6–8, grades 9–11, and grades 12–14—a given text is most appropriate for.

Second, digital SAT Suite test development staff have been trained on principles of linguistic modification (Abedi and Sato 2008), a set of practices designed to ensure that the language used in test materials is as broadly accessible as possible and is only as complicated as it needs to be to assess the constructs being measured. This training and these approaches are particularly important for the Math section, for which text complexity is not a formal requirement and for which maximal transparency in and clarity of linguistic expression is therefore necessary to prevent extraneous elements of language difficulty from impeding students' performance on the construct.

7. **Maximum legibility.** Finally, Thompson, Johnstone, and Thurlow (2002) set forth the expectations that text and any graphics presented to students be clear and legible and that response formats be designed with the needs of all test takers, including those with visual impairments or issues with fine motor skills, in mind.

   For the digital SAT Suite, College Board has selected a typeface—Noto Serif 15/24—that displays text clearly on a range of digital devices and screen sizes. Via a universal tool (i.e., one not requiring an approved testing accommodation), all students can use built-in magnification to increase display size. Well-articulated content and editorial standards govern the development and presentation of informational graphics, such as tables and graphs, needed as stimuli for select questions; for students requiring verbal descriptions of graphics to respond to test questions, alt text has been created that allows students to access the test content in ways that do not disclose the intended answer to a given graphics-based question. More generally, alternate test formats and response modes, both digital and paper based, are also available for students who require them to participate fully in the tests. (See section 2.2.7.3 for more details about accommodations and supports available for the digital SAT Suite.) For all other students, the universally designed response formats—multiple-choice and student-produced response modes—have, as discussed previously, been carefully vetted for ease of use and minimization of student entry error.

2.2.7.2. *UNIVERSAL TOOLS*

Bluebook supports a number of universal tools that all students, at their discretion and preference, may use or not use to improve their test-taking experience. These tools include a built-in version of the Desmos Graphing Calculator, an annotation tool, an answer choice elimination tool, and a method of marking questions to be reviewed before time elapses. Some of these universal tools, such as those for zooming in and out, were previously offered only as accommodations (e.g., large print); their universal availability in the digital SAT Suite serves to increase the accessibility of the tests for all students.

2.2.7.3. *ACCOMMODATIONS AND SUPPORTS*

Accommodations for Students with Disabilities

To ensure that a fair testing environment is available to all test takers, College Board provides students with disabilities taking the digital SAT Suite assessments with the accommodations that they need. This practice ensures that when appropriate and possible, College Board, via approved accommodations, removes or minimizes construct-irrelevant barriers that can interfere with a test taker accurately demonstrating their true standing on a construct (AERA, APA, and NCME 2014).

The accommodations offered by College Board serve to remove unfair disadvantages for those students with disabilities who have been approved to use accommodations on College Board assessments. In keeping with the AERA/APA/NCME *Standards* and industry best practices, accommodations are intended to "respond to specific individual characteristics, but [do] so in a way that does not change the construct the test is measuring or the meaning of scores" (AERA, APA, and NCME 2014, 67). To this end, all accommodated test forms and testing conditions are designed to be comparable, in that even though test forms or testing conditions might be modified based on the needs of a particular test taker, the constructs being tested and the meaning of the scores obtained remain unchanged.

Although numerous accommodations are possible, students with disabilities must submit a request for approval by College Board. The vast majority of students who are approved for and using testing accommodations at their school through a current Individualized Education Program (IEP) or 504 Plan have those same accommodations approved for taking College Board assessments. Most private school students with a current, formal school-based plan that meets College Board criteria also have their current accommodations approved for College Board assessments.

In those instances in which a student does not qualify for automatic approval through the school verification process, the request and documentation are reviewed by College Board's Services for Students with Disabilities (SSD) department. In general, students approved by SSD to receive College Board testing accommodations meet the following criteria:

The student has a documented disability. Examples of disabilities include, but are not limited to, visual impairments, learning disorders, physical and medical impairments, and motor impairments. Students must have documentation of their disability, such as a current psychoeducational evaluation or a report from a doctor. The type of documentation needed depends on the student's disability and the accommodation(s) being requested.

Participation in a College Board assessment is impacted. The disability must result in a relevant functional limitation that impacts the student's ability to participate in College Board assessments. For example, students whose disabilities result in functional limitations in reading, writing, and sitting for extended periods may need accommodations on College Board assessments, given the components of many of the tests and the manner in which assessments are generally administered.

The requested accommodation is needed. The student must demonstrate the need for the specific accommodation requested. For example, students requesting extended time should have documentation showing that they have difficulty performing timed tasks, such as testing under timed conditions.

Approved accommodations remain in effect until one year after high school graduation (with some limited exceptions) and can be used on the digital SAT Suite and AP Exams. Students **do not need** to request accommodations from College Board for subsequent assessments taken during this eligibility period unless their accommodations needs change. More information about the availability of accommodations and the procedures for requesting them prior to testing can be found at College Board's SSD website, https://collegeboard.org/ssd.

Commonly Offered Accommodations

The following is a list of accommodations commonly offered as part of the digital SAT Suite. Accommodations are not limited to those listed, as College Board considers any reasonable accommodation for any documented disability as long as a student qualifies for testing accommodations.

Timing and Scheduling

- Extended time: Time and one-half (+50%), double time (+100%), more than double time (>+100%)
- Extra/extended breaks

Reading/Seeing Text

- Text to speech
- Magnification device (electronic or nonelectronic)
- Color contrast
- Braille with raised line drawings (Unified English Braille [UEB] Contracted and Nemeth Braille Code)
- Raised line drawings
- Braille device for written responses
- Other: Reading/seeing text

Recording Answers

- Writer/scribe to record responses
- Braille writer
- Dictation / speech to text
- Other: Recording answers

Modified Setting

- Small-group setting
- Preferential seating
- Wheelchair accessibility

- School-based setting
- One-to-one setting
- Other: Modified setting

Other

- Food/drink/medication
- Permission to test blood sugar
- Sign language interpreter for oral instructions (only)
- Printed copy of verbal instructions
- Assistive technology
- Auditory amplification / FM system
- Other: Other

Supports for English Learners (ELs)

To better serve students who are acquiring English, College Board offers testing supports for English learners (ELs) during SAT School Day, PSAT 10, and PSAT 8/9 administrations. Supports are not currently available for weekend SAT administrations. EL supports will be available for PSAT/NMSQT starting fall 2024. Any student who currently uses the supports for PSAT/NMSQT will receive guidance purpose–only scores.

Testing supports include the following:

- **Translated test directions.** Directions are available in English and fourteen other languages for the digital SAT, PSAT 10, and PSAT 8/9.
- **Use of bilingual word-to-word dictionaries.** The bilingual word-to-word dictionaries students use on test day must be from a College Board–approved list. Schools will provide the dictionaries to students on test day, collecting them when testing is complete.
- **Time and one-half (+50%) extended testing time.** When EL students use extended time on test day, they are given time and one-half (+50%) on each test section. Students using time and one-half (+50%) for EL purposes may test in the same room(s) as other students using time and one-half (+50%) for the full test. Extended time for EL students can only be used on the test date indicated; unlike accommodations for students with disabilities, EL supports are temporary.

EL students who use one or more of the above supports during the digital SAT will receive scores they can send to colleges.

Students who meet the following criteria at the time of testing can use EL supports:

- They are enrolled in an elementary or secondary school in the United States or U.S. territories.
- They are an English learner as defined by their state or by federal policy.
- They use the same supports in class or for other assessments.

More information about the availability of supports and the procedures for requesting them prior to testing can be found at College Board's SSD website, https://collegeboard.org/ssd.

2.2.8. SCORES AND SCORE INTERPRETATION

The digital SAT Suite tests yield three scores—a total score and two section scores—accompanied by test interpretation tools that allow test takers and their families, educators, and other stakeholders to make informed, data-based decisions about students' educational futures. Scores for all the assessments are on the same vertical scale, allowing meaningful interpretations about students' academic growth as they move between testing programs within the suite. Student score reports not only provide easy access to performance information and interpretation aids but also facilitate connections to educational opportunities, such as information and resources about local two-year colleges, workforce training programs, and career options.

2.2.8.1. *SCORES*

For each of the tests of the digital SAT Suite, three scores are reported:

- A **Reading and Writing section score**
- A **Math section score**
- A **total score**, which is the arithmetic sum of the two section scores

The scales for these scores use the same ranges as those for the paper-based SAT Suite, meaning, for example, that the digital SAT total score is on the familiar 400–1600 scale. Table 2 summarizes the score scales of the digital SAT Suite testing programs.

Table 2. Digital SAT Suite Total Score and Section Score Scales.

Testing Program	Total Score Scale	Section Score Scales
PSAT 8/9	240–1440, in 10-point intervals	120–720, in 10-point intervals
PSAT/NMSQT / PSAT 10	320–1520, in 10-point intervals	160–760, in 10-point intervals
SAT	400–1600, in 10-point intervals	200–800, in 10-point intervals

Test questions on the digital SAT Suite require students to provide their responses in one of two[1] ways in Bluebook. The first, for **multiple-choice questions** (which constitute the bulk of the assessments), requires students to select their answer from one of four given options. Students may select their answer using a mouse, touchscreen, keypad, stylus (iPad, Chromebook, or Windows device), keyboard shortcuts, trackpad, or other approved technology. The second, for **student-produced response (SPR) questions** in the Math section, requires students to enter their answer into a designated field that follows the question prompt. The student is presented with a preview of their typed response so that they can verify that the

[1] A third response format is not discussed here: that for the digital SAT Essay, which is currently administered only as part of select U.S. school day administrations.

answer they entered was what they had intended to enter. SPR entry directions appear alongside each question that uses that format. Students who require paper testing can record or mark their responses in the test booklet or dictate their answers when that accommodation is necessary.

Bluebook is designed to prevent loss of a student's work and to efficiently use testing time. If a student loses Wi-Fi connectivity during testing, their answers will be encrypted and saved to the device they tested on, with no loss of testing time. If students do not have a connection when testing time runs out, they will be instructed to use the same device they tested on to sign into Bluebook when they are back online and to click/tap the Submit Answers button on their home page.

College Board's scoring system evaluates student responses for each multiple-choice and SPR test question in the following ways:

- For each multiple-choice question, the system compares the student-selected response to the encrypted answer key, scoring the item as 1 (one) if the student response matches the key and 0 (zero) otherwise.
- For each SPR question, the system "cleanses" the student response (e.g., removes double fractional slashes or decimals) and compares it to the keyed response(s). If a match is found, the system scores the item as 1 (one), and no additional comparisons are performed. If no match is found, the item is scored as 0 (zero).

College Board undertakes numerous manual and automated quality control procedures to ensure that scoring of both multiple-choice and SPR questions is accurate prior to making scoring information available to students.

The digital SAT Suite assessments are developed according to an item response theory (IRT) statistical framework. Under the framework used for the suite, scoring is a function of three main factors: (1) whether a student answers questions correctly or incorrectly, (2) attributes of the questions, such as difficulty level, that a student answers correctly or incorrectly, and (3) whether a student's response pattern across questions suggests guessing (see also the sidebar "Guessing on Digital SAT Suite Questions" on this page). Therefore, two students may obtain the same number of correct responses on two different test forms but still have different reported scale scores.

2.2.8.2. *VERTICAL SCALING*

All tests in the digital SAT Suite are on the same vertical scale. Being on a vertical scale allows for student growth to be meaningfully tracked across assessments in the suite because any given score carries the same meaning with respect to achievement regardless of from which test it was obtained. A 530 on the PSAT 8/9 Math section, for example, represents the same level of achievement as would a 530 on the Math sections of the PSAT/NMSQT or PSAT 10 or the SAT. Vertical scaling is possible because the various tests of the digital suite assess the same knowledge and skills across testing programs, with relatively minor exceptions reflecting appropriate age/grade attainment expectations across grades 8 through 12.

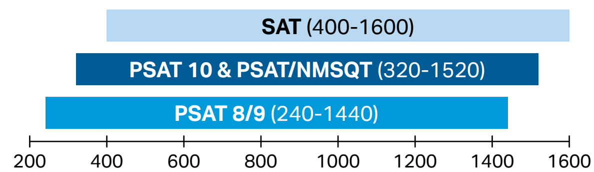
Guessing on Digital SAT Suite Questions

The item response theory (IRT) scoring model used for the digital-suite tests evaluates test taker response patterns to estimate the likelihood that a student answered a given question correctly merely by guessing. This evaluation of scoring patterns is, however, not the same as a "guessing penalty," such as the one imposed on the SAT Suite tests administered prior to the 2015–2016 academic year, which operated on a question-by-question basis.

College Board advises test takers to answer each digital SAT Suite test question to the best of their ability. If they encounter multiple-choice questions to which they are unsure of the answers, they should try to eliminate one or two answer options to improve their odds of making the proper selection. Random guessing or choosing (for example) option A for all multiple-choice questions, on the other hand, is unlikely to benefit their scores.

Figure 2 graphically depicts the total score scales of the digital SAT Suite assessments.

Figure 2. Digital SAT Suite Vertical Scale.



The score scales are somewhat staggered across testing programs. That is, the scale for each subsequent testing program has a higher "floor" (minimum score) and "ceiling" (maximum score). This feature serves to facilitate vertical scaling by offering students in successively higher grades the opportunity to demonstrate higher levels of achievement.

2.2.8.3. *SCORE INTERPRETATION*

Of the array of score interpretation tools available for the digital SAT Suite, two are of particular note here: the College and Career Readiness and grade-level test benchmarks, which set empirically derived thresholds for adequate achievement, and Skills Insight™, which verbally describes the skills and knowledge typically demonstrated by students whose scores fall within particular bands along the test sections' score scales.

Benchmarks. To facilitate meaningful score interpretation and to help both test takers and educators assess student progress toward college and career readiness from year to year, College Board has empirically established benchmark scores for the PSAT 8/9, PSAT/NMSQT and PSAT 10, and the SAT. College and Career Readiness Benchmarks establish the points on the score scale at or above which students are considered college and career ready (i.e., have a high likelihood of succeeding in common entry-level credit-bearing postsecondary courses), while grade-level benchmarks help students and their families, teachers, and others track progress toward college and career readiness.

Table 3 lists the Reading and Writing (RW) and Math benchmark scores according to the testing program(s) to which they are most relevant given the age and attainment of the typical test-taking population. Because the digital SAT has been directly linked to the paper-based SAT, the benchmarks for the SAT remain the same. However, the benchmarks for the digital PSAT/NMSQT / PSAT 10 and PSAT 8/9 may be slightly revised based on vertical scaling studies (described in section 5.1.8). College Board plans to reanalyze all benchmarks when college performance data are available for one or more cohorts of students who have taken the digital SAT operationally. Therefore, the grade-level benchmarks should be considered provisional at the present time.

Table 3. Digital SAT Suite Benchmarks, by Test Section and Testing Program.

	Digital SAT Suite Testing Program					
	SAT		PSAT/NMSQT and PSAT 10		PSAT 8/9	
Benchmark Score	**RW**	**Math**	**RW**	**Math**	**RW**	**Math**
College and Career Readiness	480	530				
Eleventh grade			460	510		
Tenth grade			430	480		
Ninth grade					410	450
Eighth grade					390	430

Note: PSAT/NMSQT / PSAT 10 and PSAT 8/9 benchmarks are subject to further study and potential minor revision.

Skills Insight. Skills Insight is a tool developed by College Board to help digital SAT Suite test users better understand the meaning of scores by describing the skill and knowledge attainment that these scores typically represent. Skills Insight descriptors have been developed from careful examination by College Board subject matter experts of large pools of test questions that exemplify performance in various score bands in each test section across the digital-suite assessments. These descriptors generalize the skills and knowledge typically demonstrated by students scoring in particular score bands; accompanying exemplar questions make these descriptors more concrete. The Skills Insight descriptors are vertically articulated so that they illustrate progression in skill and knowledge attainment across successively higher score bands. Collectively, these descriptors render more transparent the meaning of scores in a way different from that afforded by quantitative interpretation aids, such as benchmark scores and percentile ranks. Skills Insight information is included in student score reports and as a standalone framework (**https://satsuite.collegeboard.org/media/pdf/skills-insight-digital-sat-suite.pdf**) so that students, educators, and others can better understand how skill and knowledge demonstrations increase in sophistication with higher test section scores.

2.2.9. STUDENT SCORE REPORTS

The student score report and online score insights are used by students, parents, and educators to better understand student scores on a digital SAT Suite test. The score report is not merely a vehicle for retrieving scores but rather is designed to provide a comprehensive understanding as to what scores mean as they relate to a student's demonstrated knowledge and skills in the context of other test takers' performance, college and career readiness requirements, and the student's own goals. In addition to the PDF score report that may be provided to students by their school, students with a College Board account can gain further score insights using the online scores portal. In general, students seek to answer the following questions when viewing their score report:

- What are my scores?
- Am I on track to achieve my goals?
- How did I do compared to others?
- What do I need to do to get a better score?

At their core, the digital SAT Suite score report and online score insights

- give a student access to their scores, including explanatory information such as score scales and score ranges;
- identify a student's performance growth from one test in the digital SAT Suite to another;
- allow a student to contextualize their score performance relative to that of other test takers using score comparisons and percentile rankings involving a variety of test populations, including test takers from the student's school, district, state, and country as well as all test takers;
- provide information on a student's college and career readiness relative to established section score benchmarks;
- give a high school junior who has taken the PSAT/NMSQT information about their eligibility for entry into the National Merit Scholarship Program; and
- give a student information regarding the skills and knowledge that their test scores indicate they are likely able to demonstrate and suggest actionable next steps concerning knowledge domains and skills the student can focus on to improve their scores, including tools, tips, and other resources to get them started.

For more detailed information about digital SAT Suite scores and the uses to which they may be put, see College Board's *Understanding Scores for Students and Families* guides for digital SAT school day testing (**https://satsuite.collegeboard.org/media/pdf/sat-sd-understanding-scores.pdf**), PSAT/NMSQT (**https://satsuite.collegeboard.org/media/pdf/psat-nmsqt-understanding-scores.pdf**), PSAT 10 (**https://satsuite.collegeboard.org/media/pdf/psat-10-understanding-scores.pdf**), and PSAT 8/9 (**https://satsuite.collegeboard.org/media/pdf/psat-8-9-understanding-scores.pdf**).

2.2.10. PRACTICE

Productive practice for the digital SAT Suite is supported by a number of high-quality resources created or supported by College Board and available to all students, most of them at no cost. To be productive, practice must familiarize students with the test itself, its response formats, and its delivery method as well as help students build on what they are already good at and address weaknesses where they exist. Bluebook onboarding, full-length and question-level practice, and skill/knowledge building support are designed to facilitate students' readiness for test day and to meet College Board's professional and ethical obligation to level the playing field so that all test takers have an equal chance to demonstrate their achievement on the digital SAT Suite.

College Board conceptualizes *practice* for the digital SAT Suite as operating at three main levels:

- **digital assessment readiness**, which is intended to make students familiar and comfortable with Bluebook and the manner in which answer responses are entered
- **test wisdom**, which is intended to acquaint students with the types of questions they will encounter on the tests, determine whether they can or cannot answer such questions correctly, and offer insights into ways students can improve their future test performance
- **skill/knowledge building**, which is intended to help students gain durable academic abilities useful for college, career, and life

Conceiving of practice in these ways serves students far more effectively than do traditional forms of "test prep" focused only on the middle layer in the above scheme. To be clear, providing all students with practice test questions is a critically important element of ensuring fairness and equity in testing, but overfocusing on repetitive test- or question-level practice risks narrowing students' attention and the secondary curriculum itself to only those skills and knowledge elements directly measured by an assessment and to the ways and manner these elements are sampled on a given test. In a real sense, practice focused mainly on such test preparation runs the risk of conflating a proxy of the desired skills and knowledge—that is, performance on an assessment—with the goal of developing students' durable skills and knowledge through a rich, diverse educational experience.

Table 4 provides a synoptic look at the several layers of practice opportunities available for the digital SAT Suite, each of which is discussed in more detail below.

Table 4. Digital SAT Suite Practice Opportunities.

Form of Practice	Focus	Digital SAT Suite Implementation
Digital assessment readiness	Prepare students to test on Bluebook	• Digital Test Preview
Test wisdom	Prepare students to answer test questions productively and offer insight into students' academic strengths and weaknesses	• Sample test questions (with answer explanations) • Official full-length practice test forms • Official Digital SAT Prep on Khan Academy • *Official Digital SAT Study Guide* (print book) • SAT Suite question banks • Score reports • Skills Insight score interpretation • Test implementation guide
Skill/knowledge building	Build durable skills and knowledge needed for college, career, and life	• Official Digital SAT Prep on Khan Academy • Classroom practice guides • High-quality instructional materials

Digital assessment readiness. Students preparing for one of the digital SAT Suite tests have access to Digital Test Preview, which acquaints them with the central features of Bluebook and the assessments and presents them with a small number of sample Reading and Writing and Math questions. These sample questions serve primarily to familiarize test takers with the kinds of questions they will be administered on test day and how to properly enter their answers rather than assess students' readiness to answer such questions successfully.

Test wisdom. Students taking one of the digital SAT Suite tests have ready access to a wide range of high-quality test wisdom resources, all of them provided at no cost with the exception of the print book. Table 5 provides an overview of these resources.

Table 5. Digital SAT Suite Test Wisdom Resources.

Test Wisdom Resource	Description
Sample test questions (with answer explanations)	These questions (**satsuite.collegeboard.org/media/pdf/digital-sat-sample-questions.pdf**) serve to illustrate the range of skills and knowledge sampled on the digital SAT (and other tests in the suite) as well as the response formats used (multiple-choice and, for select Math questions, student-produced response).
Official full-length practice forms	Digital adaptive test forms are available through Bluebook, College Board's exam app, allowing students to practice using the same interface and format most of them will use on test day. Linear (nonadaptive) test forms, with directions for determining scores, are also available in Bluebook or from College Board as downloadable PDFs. The PDF versions of practice test forms are recommended only for students who will test with paper-based accommodations on test day. Because these forms are nonadaptive, they must be somewhat longer to achieve the same level of measurement precision as their digital adaptive counterparts. Students can visit **satsuite.collegeboard.org/digital/digital-practice-preparation/practice-tests** (digital SAT), **https://satsuite.collegeboard.org/psat-nmsqt/preparing/practice-tests** (digital PSAT/NMSQT), **https://satsuite.collegeboard.org/psat-10/preparing/practice-tests** (digital PSAT 10), or **https://satsuite.collegeboard.org/psat-8-9/preparing/practice-tests** (digital PSAT 8/9) to get started. (See appendix E for a comparison between the digital adaptive and linear test specifications.)
Official Digital SAT Prep on Khan Academy	Khan Academy (**khanacademy.org/digital-sat**) offers students the opportunity to practice on sequences of test questions and receive feedback, including answer explanations.
***Official Digital SAT Study Guide* (print book)**	*The Official Digital SAT Study Guide*™ offers authoritative insights and advice regarding taking the digital SAT (information that applies generally across all the suite's exams) as well as paper-based test forms with which students can practice (although, as noted earlier, practice in Bluebook is recommended for most test takers).

Test Wisdom Resource	Description
SAT Suite Question Banks	These free digital resources allow users to search through a repository of released digital SAT Suite test questions. The banks' contents are filterable along many dimensions, making it easy for users to find exactly the questions they want. Both educator- and student-facing versions are available. Students can use their bank to select and download questions for practice, test familiarization, and question-level review, while educators can use theirs for those purposes as well or for instructional planning and quiz and formative assessment development. The educator bank can be found at **satsuitequestionbank.collegeboard.org/**. The student bank is available as part of My Practice, which can be reached via Bluebook or directly (**https://mypractice.collegeboard.org/login**).
Score reports	Score reports provide students with their scores, information about what their scores mean, and suggestions for next steps, such as additional practice and links to college and workforce training opportunities. For additional information, see section 2.2.9.
Skills Insight score interpretation	Skills Insight verbally describes the skills and knowledge in reading and writing and in math that test takers scoring in particular ranges are likely to know and to be able to demonstrate. The descriptions at each score band are empirically derived from an analysis of student performance on digital SAT Suite test questions. Exemplar questions by test section and score range help concretize the verbal descriptors. An overview of Skills Insight is available at **satsuite.org/digital-skills-insight**.
Test implementation guide	This resource (**satsuite.org/digital-teacher-implementation-guide**), developed primarily for teachers, details the design of the digital SAT Suite and offer suggestions to educators looking to incorporate test preparation as part of their classroom instruction.

Skill/knowledge building. College Board, in partnership with Khan Academy and others, makes a range of skill-/knowledge-building resources available for free. These resources are aimed at developing students' durable knowledge and skills rather than directly at preparing students for test day. Table 6 provides an overview of these resources.

Table 6. Digital SAT Suite Skill-/Knowledge-Building Resources.

Skill-/Knowledge-Building Resource	Description
Official Digital SAT Prep on Khan Academy	In addition to providing test preparation activities, Khan Academy (**khanacademy.org/digital-sat**) offers students a range of high-quality skill-/knowledge-building activities, including numerous videos and articles that target specific areas where students might need additional support.
Classroom practice guides	These guides, designed primarily for teachers, are collections of essays on select topics written by experts in English language arts/literacy (**satsuite.org/digital-classroom-practice-english**) and math (**satsuite.org/digital-classroom-practice-math**). The essays discuss critical college and career readiness requirements and how instruction can be designed to support all secondary students obtaining those competencies. Sidebars draw links between the essays' topics and how those topics are addressed on the digital SAT Suite tests.

Skill-/Knowledge-Building Resource	Description
High-quality instructional materials	College Board offers a wide range of high-quality instructional materials through its Pre-AP and AP programs. These programs support all students' attainment of critical college and career readiness prerequisites.

2.3 Overall Digital SAT Suite Specifications

Each digital SAT Suite test is composed of two sections: a Reading and Writing section and a Math section. The questions in both sections focus on the skills and knowledge most essential for college and career readiness and success, and the test domains are highly correlated with those of the paper-and-pencil SAT Suite assessments. All the testing programs within the digital SAT Suite—the SAT, PSAT/NMSQT and PSAT 10, and PSAT 8/9—have similar designs, with appropriate allowances for differences in students' age and attainment across grades, promoting system cohesion and making the taking of one test a form of preparation for taking all subsequent tests in the suite. These benefits are possible because each test in the suite measures essentially the same thing: acquisition of critical college and career readiness prerequisites in reading and writing and in math.

Table 7 summarizes the basic characteristics of the two digital SAT Suite sections, which are detailed afterward.

Table 7. Digital SAT Suite: Overall Test Specifications.

Characteristic	Reading and Writing Section	Math Section
Administration	Two-stage adaptive test design: one Reading and Writing section administered via two separately timed modules	Two-stage adaptive test design: one Math section administered via two separately timed modules
Test length (number of operational and pretest questions)	1st module: 25 operational questions and 2 pretest questions 2nd module: 25 operational questions and 2 pretest questions	1st module: 20 operational questions and 2 pretest questions 2nd module: 20 operational questions and 2 pretest questions
Time per module	1st module: 32 minutes 2nd module: 32 minutes	1st module: 35 minutes 2nd module: 35 minutes
Total number of questions	54 questions	44 questions
Total time allotted	64 minutes	70 minutes
Average time per question	1.19 minutes	1.59 minutes
Scores reported	Total score Section scores (Reading and Writing; Math)	
Question type(s) used	Discrete; four-option multiple-choice	Discrete; four-option multiple-choice (≈75%) and student-produced response (SPR) (≈25%)
Stimulus subject areas	Literature, history/social studies, the humanities, science	Science, social studies, real-world topics

Characteristic	Reading and Writing Section	Math Section
Word count	25–150 (6-character) words per stimulus text (or pair of texts)	Approximately 30% of questions in context; a majority of in-context questions have 50 (6-character) words or fewer
Informational graphics	Tables, bar graphs, line graphs	A wide range of data displays, geometric figures, and *xy*-plane graphs
Text complexity bands	Grades 6–8, grades 9–11, grades 12–14 (Grades 12–14 excluded from PSAT 8/9)	N/A (see section 2.3.12)

2.3.1. ADMINISTRATION

Each assessment of the digital SAT Suite is composed of two sections: a Reading and Writing section and a Math section. For individual students, each section is, in turn, composed of two equal-length *stages* consisting of *modules* of test questions: an initial (routing) module consisting of a broad mix of easy, medium-difficulty, and hard questions and, depending on student performance on the first module, a second-stage module containing questions that are of either higher or lower average difficulty. Because the tests are designed according to a two-stage adaptive model (see section 2.2.3), each module is separately timed, and while students may navigate freely within each module, they may not return to the first module's questions once having transitioned to the second module's nor return to the first section (Reading and Writing) after moving to the second (Math). Up-to-date administration procedures can be found on the digital SAT Suite website, **https://satsuite.collegeboard.org/digital**.

2.3.2. TEST LENGTH

Each Reading and Writing module consists of twenty-seven questions. Of the questions in each module, twenty-five are operational, the answers to which contribute to students' scores; an additional two questions per module are pretest questions, performance on which does not affect students' scores and whose inclusion is designed to help determine the suitability of using these questions in future tests. In total, the Reading and Writing section is made up of fifty-four questions, fifty of which are operational and four of which are unscored pretest questions. Each Math module consists of twenty operational questions and two pretest questions, for a total of forty-four questions (forty operational, four pretest) across each test form. Note that the same second-stage pretest questions are presented to students taking either the higher- or lower-difficulty module, ensuring that these questions are evaluated relative to the full range of student achievement. (For more details on embedded pretesting in the digital SAT Suite, see section 2.2.4.)

2.3.3. TIME PER MODULE

Each Reading and Writing module is thirty-two minutes in length, while each Math module is thirty-five minutes. As noted above, each module is separately timed. When time runs out on the first module of each section, Bluebook automatically moves students to the second-stage module, where they are administered either the lower- or higher-difficulty module associated with the routing module. When students complete the Reading and Writing section, they are automatically moved to the Math section after a short break between the sections.

2.3.4. TOTAL NUMBER OF QUESTIONS

Each Reading and Writing test form consists of fifty-four questions (four of which are pretest), while each Math test form consists of forty-four questions (four of which are, again, pretest questions).

2.3.5. TOTAL TIME ALLOTTED

Students have sixty-four minutes to complete the Reading and Writing section and seventy minutes to complete the Math section.

2.3.6. AVERAGE TIME PER QUESTION

Students have, on average, 1.19 minutes to answer each Reading and Writing question and 1.59 minutes to answer each Math question.

2.3.7. SCORES REPORTED

Each digital SAT Suite assessment yields three scores: a total score and two section scores. The *total score* is based on students' performance on the entire assessment and is the arithmetic sum of the two section scores. Two *section scores*, one for Reading and Writing and the other for Math, are based on students' performance on each section. (For more details on digital SAT Suite scores, see section 2.2.8.1.)

2.3.8. QUESTION FORMAT(S) USED

The Reading and Writing section exclusively uses four-option multiple-choice questions, with each question having a single best answer (known as the *keyed response* or *key*). Approximately 75 percent of questions in the Math section use the same four-option multiple-choice format, while the remainder use the student-produced response (SPR) format. As the name implies, students answering the latter type of Math question must generate their own response and enter it into a field in Bluebook. These questions assess students' ability to solve math problems with greater independence and with less structure and support than that provided in the multiple-choice format. SPR questions may have more than one correct response, although students are directed to supply only one answer.

2.3.9. STIMULUS SUBJECT AREAS

The digital SAT Suite assessments ground all Reading and Writing and some Math questions in authentic contexts based in academic disciplines or real-world scenarios. In Reading and Writing, each of these contexts includes a brief passage or pair of passages as well as a single (discrete) question based on the passage(s). Reading and Writing passages are drawn from and reflect the norms and conventions of the subject areas of literature, history/social studies, the humanities, and science. Students do not need topic-specific prior knowledge to answer Reading and Writing questions; all the information needed to answer each question is provided in the passage or passages themselves. To help confirm that passage contexts are appropriate for the target test-taking population, test development staff consult various external sources, such as the Next Generation Science Standards (NGSS), to help determine what those students are likely to know and be able to do in various subject areas. However, because the passages and questions are designed to emulate those in the sampled subject areas, students with greater experience in and facility with these disciplines and how they structure and communicate knowledge textually are likely, on average, to perform better than those who lack that exposure.

In Math, about 30 percent of test questions are set in academic (science or social studies) or real-world contexts, while the rest are “pure” math questions outside of context. Math contexts are brief: sufficient in length to establish a scenario but clear, direct, and concise enough not to impose undue linguistic burdens on students. Contexts set in science or social studies emulate the kinds of problems, reasoning, and solving strategies commonly encountered in those fields, adding to the tests’ verisimilitude. Again, topic-specific prior knowledge is not required to answer these sorts of questions.

2.3.10. WORD COUNT BY QUESTION

Passages (or pairs of passages) used in Reading and Writing questions range in length from 25 to 150 words. In this technical context, a *word* is considered a set of six characters of any sort (i.e., any combination of letters, numbers, spaces, or symbols, including punctuation) so that word counts are standardized across passages and thus not affected by an abundance of especially short or long words in any one passage. This character count is then divided by six to obtain a word count. In-context Math questions are typically fifty (six-character) words or fewer.

2.3.11. INFORMATIONAL GRAPHICS

In accordance with evidence about essential college and career readiness requirements, both the Reading and Writing and Math sections include informational graphics with select questions. For Reading and Writing, these informational graphics are restricted to tables, bar graphs, and line graphs, as these are the most commonly used types in academic and real-world texts; for Math, the range is wider and includes several types of data displays (e.g., scatterplots) as well as geometric figures and *xy*-plane graphs.

2.3.12. TEXT COMPLEXITY

An abundance of evidence, summarized briefly in section 5.2.1.1, supports the conclusion that the complexity of texts students are able to read is closely associated with their degree of college and career readiness. In accordance with that evidence, text complexity plays an important role in the design and development of the digital SAT Suite Reading and Writing section. Texts in that section are assigned to one of three complexity bands (grades 6–8, grades 9–11, and grades 12–14) aligned with the growing text complexity demands across successively higher grades of schooling and with college and career readiness requirements. Complexity of passages is determined using a combination of a sophisticated quantitative measure and expert, trained human judgment. Math contexts are not formally rated for complexity. However, Math test development staff review each context qualitatively to ensure that its linguistic load and demands are consistent with the requirements of the question being posed, and Math (and Reading and Writing) staff have been trained in linguistic modification principles (Abedi and Sato 2008), which seek to relieve students of unnecessary linguistic burdens during test taking through clear and concise word choice in stimuli and questions.

Assembly parameters for the Reading and Writing section of the SAT, PSAT/NMSQT, and PSAT 10 tests do not constrain for text complexity. This means that texts in any of the three bands may appear on any of these tests. Texts from the highest complexity band (grades 12–14) are, however, excluded from PSAT 8/9, as these complex to highly complex texts are not generally appropriate for use in assessing the literacy knowledge and skills of eighth and ninth graders.

2.4 Concordance between the Digital and Paper-Based SATs

To facilitate the transition to digital, scores from the digital SAT have been directly linked to scores from the paper-based SAT, so there is no need for concordance tables or score conversions.

College Board confirmed this statistical linking through a series of studies conducted in 2022. The underlying linking methodology is essentially the same as that used in most assessment programs to equate alternate test forms over time.

The digital and paper-based SATs measure very similar, but not identical, content, so while a score on the digital test is not a perfect predictor of how a student will perform on the paper-and-pencil test (and vice versa), directly linking the digital SAT to the paper-based SAT enables users to easily compare digital SAT scores and paper-based SAT scores without any conversions. For example, colleges can assume the same relationships between scores and college readiness from both digital and paper-and-pencil SAT scores.

We use the term *linking* instead of *equating* because what the digital SAT measures is similar but not identical to what is measured on the paper-based SAT, and therefore the process falls short of meeting the psychometric criteria for equating. This is to be expected when shifting from a linear paper-and-pencil format to a digital adaptive format.

When using digital SAT scores, counselors, educators, and higher education professionals should keep the following considerations in mind:

- Because of the direct linking between the digital SAT and the paper-based SAT, colleges and other organizations can still use the existing ACT/SAT concordance tables with digital SAT scores. College Board will continue to review the relationship between SAT and ACT scores over time.
- Linking relationships are sample dependent. The samples used to determine the relationships between digital and paper-based SAT scores were paper-based SAT test takers participating in two separate studies in 2022. College Board will continue to review these relationships over time.

Results of the two studies conducted in 2022 to establish the linking relationships between the digital SAT and the paper-based SAT are available on request.

For more on College Board's two concordance studies involving the digital SAT, see section 5.1.7.

CHAPTER 3

The Reading and Writing Section

The Reading and Writing section of the digital SAT Suite assessments is designed to measure students' attainment of critical college and career readiness prerequisites in literacy in English language arts as well as in various academic disciplines, including literature, history/social studies, the humanities, and science. The Reading and Writing section focuses on key elements of comprehension, rhetoric, and language use that the best available evidence identifies as necessary for postsecondary readiness and success. Over the course of a Reading and Writing section of one of the digital SAT Suite assessments, students answer multiple-choice questions requiring them to read, comprehend, and use information and ideas in texts; analyze the craft and structure of texts; revise texts to improve the rhetorical expression of ideas; and edit texts to conform to core conventions of Standard English.

3.1 The Reading and Writing Section at a Glance

Table 8 summarizes many of the key features of the Reading and Writing section. These features are discussed throughout the remainder of this section.

Table 8. Digital SAT Suite Reading and Writing Section High-Level Specifications.

Characteristic	Digital SAT Suite Reading and Writing Section
Administration	Two-stage adaptive test design: one Reading and Writing section administered via two separately timed modules
Test length (number of operational and pretest questions)	1st module: 25 operational questions and 2 pretest questions 2nd module: 25 operational questions and 2 pretest questions **Total:** 54 questions

Preview

In this chapter, you will find

- an overview and discussion of key features of the Reading and Writing section of the digital SAT Suite assessments.
- sample Reading and Writing questions with answer explanations.

Characteristic	Digital SAT Suite Reading and Writing Section
Time per module	1st module: 32 minutes 2nd module: 32 minutes **Total:** 64 minutes
Average time per question	1.19 minutes
Score reported	Section score (constitutes half of total score) SAT: 200–800 PSAT/NMSQT and PSAT 10: 160–760 PSAT 8/9: 120–720
Question format used	Discrete; four-option multiple-choice
Passage subject areas	Literature, history/social studies, the humanities, science
Word count	25–150 (6-character) words per stimulus text (or pair of texts)
Informational graphics	Tables, bar graphs, line graphs
Text complexity bands	Grades 6–8, grades 9–11, grades 12–14 (Grades 12–14 excluded from PSAT 8/9)

The features identified above are discussed briefly in this section of the chapter and in more detail throughout the chapter and document.

3.1.1. ADMINISTRATION

As described in section 2.2.3, the digital SAT Suite Reading and Writing section is administered in two equal-length and separately timed portions, or *stages*. Each stage consists of a *module* of test questions. The first (*routing*) module in each test form consists of a broad mix of easy, medium-difficulty, and hard questions. The second module also contains a mix of easy, medium-difficulty, and hard questions, but the average question difficulty is targeted to the test taker's performance on the questions in the first module. Specifically, a test taker receives a second module that consists of questions that, on average, are either of higher or lower difficulty than those in the first module. Student performance on all operational (i.e., non-pretest) questions across both modules is used to calculate the section score.

Questions from all four content domains appear in each test module in the sequence depicted in table 9.

Table 9. Reading and Writing Section Question Sequence.

Reading and Writing Module	Content Domain Sequence
Module 1	Craft and Structure questions Information and Ideas questions Standard English Conventions questions Expression of Ideas questions
Module 2	Craft and Structure questions Information and Ideas questions Standard English Conventions questions Expression of Ideas questions

Within each content domain except Standard English Conventions, questions are ordered first by skill/knowledge element and then by question difficulty from easiest to hardest. Standard English Conventions questions are ordered from easiest to hardest irrespective of skill/knowledge element tested. Placing questions testing similar skills and knowledge together reduces task switching and makes it easier for students to budget their time, while the ordering of questions from easiest to hardest (within the placement restriction noted above) means that students can build confidence as they move from relatively straightforward to more demanding assessment tasks. Embedded pretest questions appear alongside questions testing the same skill/knowledge element (or, in the case of Standard English Conventions pretest questions, among the operational questions in that content domain).

Students may navigate freely through a given module of questions; this allows them to preview upcoming questions within the module or flag others to return to should time permit. However, once Bluebook has moved them to the second module in the Reading and Writing section, students may not return to the questions in the first module, nor may students return to the Reading and Writing section once Bluebook has moved them to the Math section.

3.1.2. TEST LENGTH BY NUMBER OF QUESTIONS

The Reading and Writing section consists of fifty-four questions, which are divided into two equal-length modules, one for each of the section's two stages. Of each module's twenty-seven questions, twenty-five are *operational*, meaning that students' performance on them contributes to their section score, and two questions are *pretest*. Answers to pretest questions do not contribute in any way to students' Reading and Writing section score; rather, their purpose is to collect student performance data that will be used by College Board to help assess whether these questions are suitable for operational use at a future time. To students, pretest questions appear the same as operational questions, thereby ensuring students' maximal effort on the former. The number of pretest questions embedded in the Reading and Writing section is minimized to limit the impact of answering nonoperational questions on students' test taking.

3.1.3. TIME PER SECTION AND MODULE

Students have a total of sixty-four minutes to complete the Reading and Writing section. This time is divided equally between the two modules, meaning that students have thirty-two minutes to answer the questions in a given module. Once time has expired for the first module, students are automatically advanced to the appropriate (higher- or lower-difficulty) second module and may not return to the questions in the first module.

3.1.4. AVERAGE TIME PER QUESTION

Students have, on average, 1.19 minutes to answer each Reading and Writing test question.

3.1.5. SCORE REPORTED

Students receive a section score based on their overall performance on the Reading and Writing section. This score is scaled from 200–800 for the SAT, 160–760 for the PSAT/NMSQT and PSAT 10, and 120–720 for the PSAT 8/9, each in 10-point intervals. This section score is added to the Math section score to determine students' total score for the assessment.

3.1.6. QUESTION FORMAT USED

All Reading and Writing test questions are in the four-option multiple-choice format with a single best answer known as the *keyed response* or simply the *key*. These questions are considered *discrete* because each has its own passage (or passage pair) serving as a stimulus and because no question is linked to any other question in the section. See section 2.2.5 for more details.

3.1.7. PASSAGE SUBJECT AREAS

Passages on the Reading and Writing section, which serve as the basis for answering test questions, represent the subject areas of literature, history/social studies, the humanities, and science. Topic-specific prior knowledge is not assessed. See section 3.4 for more details.

3.1.8. WORD COUNT

The passage (or passage pair) accompanying each Reading and Writing test question ranges from 25 to 150 words. To ensure that this word count is not unduly influenced by the presence of many long or short words in a given passage (or passage pair), a *word* in this sense is considered six characters, with characters including letters, numbers, spaces, and symbols (including punctuation). A standardized word count is thus calculated by dividing the passage's total character count by six. When a single test question uses a pair of short passages as the stimulus, the total word count for both passages must fall within the specified range.

3.1.9. INFORMATIONAL GRAPHICS

Select passages in the Reading and Writing section are accompanied by an informational graphic. The goal of the inclusion of such graphics is to authentically assess students' ability to locate and interpret data and to use these data effectively to answer an associated question. For the Reading and Writing section, informational graphics are limited to tables, bar graphs, and line graphs, as these are the most common ways to display data in the subject areas sampled by the section. Questions on the section associated with informational graphics do not require students to perform calculations (and calculators are not permitted on the section). Instead, students must use their quantitative and disciplinary literacy skills and knowledge to find relevant data in graphics, make reasonable interpretations of those data, and use those data along with information and ideas in associated passages to reach supportable conclusions.

3.1.10. TEXT COMPLEXITY

Consistent with the evidence presented in chapter 5, the overall text complexity of Reading and Writing passages is aligned with college and career readiness requirements, with individual passages (or passage pairs) representing one of three complexity levels: grades 6–8, grades 9–11, or grades 12–14. As noted in section 2.3.12, passages of the highest text complexity band are excluded from PSAT 8/9, as these texts are generally too challenging to contribute materially to an assessment of eighth and ninth graders' literacy achievement. Bands rather than grades are used to conceptualize text complexity for two main reasons. First, text complexity expectations at the secondary level are relatively compressed across grades, resulting in significant overlap between and among grade-specific expectations. Second, even minor changes to the wording of passages as short as those used in the Reading and Writing section can significantly influence the results yielded by quantitative text complexity measures, so the use of bands permits some necessary flexibility in passage development while maintaining an appropriate and easily understood range of text complexities across the section.

Reading and Writing passages' complexity is determined using both quantitative and qualitative measures. College Board has developed its own robust quantitative text complexity tool better suited than off-the-shelf options to assess accurately the difficulty of the brief texts that appear in the section. Test development staff are also guided by a custom qualitative text complexity rubric calibrated to the various grade bands represented in the section. See also section 5.2.1.1 for more details about the quantitative measure College Board uses.

Although some Reading and Writing passages can be highly complex, Reading and Writing questions themselves are as clear and direct as possible. The challenge of answering a given question is rooted in the cognitive demands of the question, not inflated by unnecessarily challenging language.

3.2 Definitions

3.2.1. CONSTRUCT

A crucial foundation of assessment validity, or ensuring that a test measures what it is intended to measure and nothing else, is a clear definition of the test's construct. A *construct*, in this sense, is "the concept or characteristic that a test is designed to measure" (AERA, APA, and NCME 2014, 11). Clearly defining the construct—in the case of the digital SAT Suite, at the test section level—serves two main purposes. First, such a definition establishes the basis for and guides the development of test specifications, both content and statistical, which, in turn, set the parameters for what will be measured and how by the assessment. Second, the construct definition helps identify what should *not* be measured by the assessment. Such elements are considered *construct irrelevant*—that is, they should not have an impact on test performance, and any effects they might have should be minimized when they cannot be eliminated. In the case of the digital SAT Suite, such construct-irrelevant factors include, but are not necessarily limited to, students' race/ethnicity, gender and sexual identities, home region, home culture, family income, and physical ability.

It should be clear, then, that construct definition is not merely a technical matter but is, in fact, a cornerstone of both test validity and test fairness. By defining what should and should not be measured, developers can help ensure that a given test measures what it is intended to measure and minimize the possibility that other factors not intended to be assessed have impacts on performance. Indeed, "the central idea of fairness in testing is to identify and remove construct-irrelevant barriers to maximal performance for any examinee," and "removing these barriers allows for the comparable and valid interpretation of test scores for all examinees" (AERA, APA, and NCME 2014, 63).

In the case of the digital SAT Suite Reading and Writing section, the construct is literacy achievement relative to core college and career readiness requirements in English language arts as well as in the academic disciplines of literature, history/social studies, the humanities, and science.

3.2.2. CLAIMS

Like constructs, *claims* serve to establish parameters for what is tested and how. "In assessment," Mislevy and Riconsente (2005, 1) write, "we want to make some claim about student knowledge, skills, or abilities (KSAs), and we want our claims to be valid." The purposes of establishing claims, then, are, first, to precisely identify what students should be able to demonstrate to be considered successful on the construct of interest (in this case, literacy achievement) and, second, to build a test (or test section) to collect evidence in support of those claims.

The Reading and Writing section is designed to elicit evidence from student test performance in support of four broad claims about students' literacy achievement. To be successful on the Reading and Writing section, students must be able to

- demonstrate understanding of **information and ideas** in texts across a range of academic disciplines and complexities aligned with college and career readiness requirements;
- effectively evaluate the **craft and structure** of texts, including demonstrating understanding and proficient use of high-utility academic vocabulary in context;
- revise the **expression of ideas** in texts to enhance communicative power in accordance with specified rhetorical goals; and
- edit texts in accordance with **Standard English conventions** in order to meet academic and workplace expectations regarding the use of standardized expression.

3.3 Content Domain Structure

In close correspondence with the claims listed above, questions on the Reading and Writing section represent one of four *content domains*:

- **Information and Ideas**, for which students must use comprehension, analysis, and reasoning skills and knowledge as well as what is stated and implied in texts (including in any accompanying informational graphics) to locate, interpret, evaluate, and integrate information and ideas
- **Craft and Structure**, for which students must use comprehension, vocabulary, analysis, synthesis, and reasoning skills and knowledge to use and determine the meaning of high-utility academic words and phrases in context, evaluate texts rhetorically, and make supportable connections between multiple topically related texts
- **Expression of Ideas**, for which students must use revision skills and knowledge to improve the effectiveness of written expression in accordance with specified rhetorical goals
- **Standard English Conventions**, for which students must use editing skills and knowledge to make text conform to core conventions of Standard English sentence structure, usage, and punctuation

Each question is classified as belonging to a single content domain.

The first two content domains—Information and Ideas and Craft and Structure—primarily address reading-related skills and knowledge, while the second two content domains—Expression of Ideas and Standard English Conventions—primarily address writing-related skills and knowledge. This division into reading- and writing-focused domains is purely heuristic and has no substantive bearing on the test structure or the scores reported. The divisions into "reading" and "writing" are, in fact, somewhat porous, and the test section itself may fairly be thought of as a blended reading and writing assessment.

Within each domain, questions address a number of skill/knowledge testing points, as discussed below.

Questions from all four domains appear in each test module and are sequenced as described in section 3.1.1.

Table 10 displays the content domain structure of the Reading and Writing section. The table includes the domains and their associated claims, the skill/knowledge testing points addressed in each domain, and the distribution of operational (scored) questions by domain on each test form. Subsequent discussion in this chapter describes the skill/knowledge testing points in each domain and provides illustrative samples with answer explanations.

Table 10. Digital SAT Suite Reading and Writing Section Content Domains and Operational Question Distribution.

Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Information and Ideas	Students will use comprehension, analysis, and reasoning skills and knowledge as well as what is stated and implied in texts (including in any accompanying informational graphics) to locate, interpret, evaluate, and integrate information and ideas.	Central Ideas and Details Command of Evidence • Textual • Quantitative Inferences	≈26% / 12–14 questions
Craft and Structure	Students will use comprehension, vocabulary, analysis, synthesis, and reasoning skills and knowledge to use and determine the meaning of high-utility academic words and phrases in context, evaluate texts rhetorically, and make supportable connections between multiple topically related texts.	Words in Context Text Structure and Purpose Cross-Text Connections	≈28% / 13–15 questions
Expression of Ideas	Students will use revision skills and knowledge to improve the effectiveness of written expression in accordance with specified rhetorical goals.	Rhetorical Synthesis Transitions	≈20% / 8–12 questions
Standard English Conventions	Students will use editing skills and knowledge to make text conform to core conventions of Standard English sentence structure, usage, and punctuation.	Boundaries Form, Structure, and Sense	≈26% / 11–15 questions

3.4 Passages and Questions

The passages serving as stimuli for Reading and Writing questions represent a range of academic disciplines and text complexities aligned to college and career readiness requirements. Passages in the literature subject area are excerpted from previously published third-party sources for which permission to use has been obtained if necessary (i.e., not for works in the public domain), while all other Reading and Writing passages are written specifically for the tests in a way that maintains verisimilitude by including factual information and reflecting the norms and conventions (e.g., structure, language patterns, vocabulary, style and tone) of authentic texts in the disciplines. Associated questions pose tasks similar to those assigned in rigorous secondary school classes, entry-level, credit-bearing college courses, and workforce training programs. These tasks include comprehending information and ideas conveyed explicitly and implicitly in texts from various academic disciplines and of varying complexities; demonstrating command of textual and quantitative evidence; determining the meaning of and skillfully using high-utility academic (tier two) words and phrases in context; revising texts to accomplish particular rhetorical purposes; and editing texts so that they conform to core conventions of Standard English sentence structure, usage, and punctuation.

All Reading and Writing questions are four-option multiple-choice in format, with a single best answer to each question. This best answer is known as the *keyed response* or simply the *key*, while the three alternatives are known as *distractors*. Each distractor represents a common error that students might reasonably make in answering the question or common misconception that students might hold, so distractors are intended to be plausible to degrees varying depending on the intended difficulty of the question; however, no distractor is meant to compete with the key as the best response for students with the targeted level of reading and writing achievement.

3.4.1. VARIATIONS BY TESTING PROGRAM

Given that the digital SAT Suite assessments are intended to measure attainment of a fixed target—college and career readiness—and because evidence informing the broader literacy construct tends to suggest only relatively small variations in skill and knowledge requirements across the secondary grades, the Reading and Writing sections across all testing programs (SAT, PSAT/NMSQT and PSAT 10, and PSAT 8/9) are the same in terms of content specifications with one exception: PSAT 8/9 does not include passages from the highest (grades 12–14) text complexity band. Statistical specifications vary by testing program, meaning that the range of difficulty of questions students are administered differs from program to program. This, along with the multistage adaptive nature of testing and the PSAT 8/9 text complexity constraint, ensures that students taking the various tests are given age- and attainment-appropriate questions, with allowances for higher- and lower-achieving students within each test-taking population to demonstrate the full extent of their ability.

3.5 Sample Questions

As previously indicated, questions on the Reading and Writing section correspond to one of four content domains: Information and Ideas, Craft and Structure, Expression of Ideas, and Standard English Conventions. This section provides an overview of each of these domains, identifies the skill/knowledge testing points addressed by each, and presents sample questions (with answer explanations) exemplifying how the various testing points are commonly (but not necessarily exhaustively) addressed in each domain.

Note that the formatting of the sample questions is approximate and does not precisely reflect how these questions are displayed in Bluebook. Moreover, these sample questions are merely illustrative and do not necessarily reflect the full range of question difficulty students may expect to encounter on test day.

3.5.1. INFORMATION AND IDEAS

Table 11. Digital SAT Suite Reading and Writing Section: Information and Ideas Content Domain.

Domain Description (Claim)	Students will use comprehension, analysis, and reasoning skills and knowledge as well as what is stated and implied in texts (including in any accompanying informational graphics) to locate, interpret, evaluate, and integrate information and ideas.
Skill/Knowledge Testing Points	Central Ideas and Details Command of Evidence (Textual, Quantitative) Inferences
Proportion	Approximately 26% of operational questions (12–14 questions)

For questions in the **Information and Ideas** content domain, students must use comprehension, analysis, and reasoning skills and knowledge as well as what is stated or implied in texts, which may include tables and graphs, to locate, interpret, evaluate, and integrate information and ideas.

Three skill/knowledge testing points are addressed in this domain:

- **Central Ideas and Details**, for which students must determine the central idea of a text and/or interpret the key details supporting that idea
- **Command of Evidence**, for which students must use textual evidence (e.g., a fact, detail, or example) or quantitative evidence (i.e., data from an informational graphic) to appropriately support, challenge, or otherwise respond to a specified claim or point
- **Inferences**, for which students must draw a reasonable inference based on explicit and/or implicit information and ideas in a text

3.5.1.1. *SAMPLE INFORMATION AND IDEAS QUESTIONS*

To dye wool, Navajo (Diné) weaver Lillie Taylor uses plants and vegetables from Arizona, where she lives. For example, she achieved the deep reds and browns featured in her 2003 rug *In the Path of the Four Seasons* by using Arizona dock roots, drying and grinding them before mixing the powder with water to create a dye bath. To intensify the appearance of certain colors, Taylor also sometimes mixes in clay obtained from nearby soil.

Which choice best states the main idea of the text?

A) Reds and browns are not commonly featured in most of Taylor's rugs.

B) *In the Path of the Four Seasons* is widely acclaimed for its many colors and innovative weaving techniques.

C) Taylor draws on local resources in the approach she uses to dye wool.

D) Taylor finds it difficult to locate Arizona dock root in the desert.

Key	C
Domain	Information and Ideas
Skill/Knowledge Testing Point	Central Ideas and Details

Key Explanation: Choice C is the best answer. The passage focuses on the idea that the artist Lillie Taylor uses resources such as plants and vegetables from where she lives in Arizona to make dyes for wool.

Distractor Explanations: Choice A is incorrect because the passage offers no evidence that reds and browns are unusual colors in Taylor's rugs; in fact, it offers an example of a rug that does feature those colors. **Choice B** is incorrect because the passage offers no indication of whether *In the Path of the Four Seasons* is widely acclaimed; it also does not mention whether the weaving techniques are innovative. **Choice D** is incorrect because the passage offers no evidence that Taylor has a hard time finding Arizona dock root.

Jan Gimsa, Robert Sleigh, and Ulrike Gimsa have hypothesized that the sail-like structure running down the back of the dinosaur *Spinosaurus aegyptiacus* improved the animal's success in underwater pursuits of prey species capable of making quick, evasive movements. To evaluate their hypothesis, a second team of researchers constructed two battery-powered mechanical models of *S. aegyptiacus*, one with a sail and one without, and subjected the models to a series of identical tests in a water-filled tank.

Which finding from the model tests, if true, would most strongly support Gimsa and colleagues' hypothesis?

A) The model with a sail took significantly longer to travel a specified distance while submerged than the model without a sail did.

B) The model with a sail displaced significantly more water while submerged than the model without a sail did.

C) The model with a sail had significantly less battery power remaining after completing the tests than the model without a sail did.

D) The model with a sail took significantly less time to complete a sharp turn while submerged than the model without a sail did.

Key	D
Domain	Information and Ideas
Skill/Knowledge Testing Point	Command of Evidence (Textual)

Key Explanation: Choice D is the best answer. The passage states that Gimsa and colleagues' hypothesis was that the sail-like structure on the back of *S. aegyptiacus* enhanced the dinosaur's ability to travel underwater to hunt down "prey species capable of making quick, evasive movements." This choice's finding would effectively support the hypothesis because it would indicate that the sail-like structure would enable a dinosaur moving underwater to maneuver more quickly than a dinosaur moving underwater without the structure.

Distractor Explanations: Choice A is incorrect because it would essentially contradict the hypothesis by suggesting that a dinosaur moving underwater with the sail-like structure would move more slowly than a dinosaur moving underwater without the structure. **Choice B** is incorrect because there is no clear passage-based relationship between the amount of water displaced and the hypothesis. **Choice C** is incorrect because there is no clear passage-based relationship between the amount of battery power used and the hypothesis.

"Ghosts of the Old Year" is an early 1900s poem by James Weldon Johnson. In the poem, the speaker describes experiencing an ongoing cycle of anticipation followed by regretful reflection: ______

Which quotation from "Ghosts of the Old Year" most effectively illustrates the claim?

A) "The snow has ceased its fluttering flight, / The wind sunk to a whisper light, / An ominous stillness fills the night, / A pause—a hush."

B) "And so the years go swiftly by, / Each, coming, brings ambitions high, / And each, departing, leaves a sigh / Linked to the past."

C) "What does this brazen tongue declare, / That falling on the midnight air / Brings to my heart a sense of care / Akin to fright?"

D) "It tells of many a squandered day, / Of slighted gems and treasured clay, / Of precious stores not laid away, / Of fields unreaped."

Key	B
Domain	Information and Ideas
Skill/Knowledge Testing Point	Command of Evidence (Textual)

Key Explanation: Choice B is the best answer. The quotation addresses both aspects of the claim: cycles of anticipation ("Each, coming, brings ambitions high") and regretful reflection ("And each, departing, leaves a sigh / Linked to the past").

Distractor Explanations: Choice A is incorrect because the quotation focuses on anticipation ("An ominous stillness fills the night, / A pause—a hush") but not regretful reflection. **Choice C** is incorrect because the quotation focuses on worry and anxiety (". . . a sense of care / Akin to fright?") rather than anticipation and regretful reflection. **Choice D** is incorrect because the quotation focuses on regretful reflection ("It tells of many a squandered day") but not anticipation.

Participants' Evaluation of the Likelihood That Robots Can Work Effectively in Different Occupations

Occupation	Somewhat or very unlikely (%)	Neutral (%)	Somewhat or very likely (%)
television news anchor	24	9	67
teacher	37	16	47
firefighter	62	9	30
surgeon	74	9	16
tour guide	10	8	82

Rows in table may not add up to 100 due to rounding.

Georgia Tech roboticists De'Aira Bryant and Ayanna Howard, along with ethicist Jason Borenstein, were interested in people's perceptions of robots' competence. They recruited participants and asked them how likely they think it is that a robot could do the work required in various occupations. Participants' evaluations varied widely depending on which occupation was being considered; for example, ______

Which choice most effectively uses data from the table to complete the example?

A) 82% of participants believe that it is somewhat or very likely that a robot could work effectively as a tour guide, but only 16% believe that it is somewhat or very likely that a robot could work as a surgeon.

B) 47% of participants believe that it is somewhat or very likely that a robot could work effectively as a teacher, but 37% of respondents believe that it is somewhat or very unlikely that a robot could do so.

C) 9% of participants were neutral about whether a robot could work effectively as a television news anchor, which is the same percent of participants who were neutral when asked about a robot working as a surgeon.

D) 62% of participants believe that it is somewhat or very unlikely that a robot could work effectively as a firefighter.

Key	A
Domain	Information and Ideas
Skill/Knowledge Testing Point	Command of Evidence (Quantitative)

Key Explanation: Choice A is the best answer. This choice supports the claim by contrasting two occupations that survey participants gave widely divergent probabilities of robots working effectively in: tour guide (82 percent) and surgeon (16 percent).

Distractor Explanations: Choice B is incorrect because it focuses on only one occupation—that of teacher—and therefore does not illustrate how survey participants' views of the likelihood of robots working effectively vary widely by occupation. **Choice C** is incorrect because although it does compare survey participants' views of robots working effectively in two occupations, the percentages cited for television news anchor and surgeon are the same, not widely varied. **Choice D** is incorrect because it focuses on only one occupation—that of firefighter—and therefore does not illustrate how survey participants' views of the likelihood of robots working effectively vary widely by occupation.

Many animals, including humans, must sleep, and sleep is known to have a role in everything from healing injuries to encoding information in long-term memory. But some scientists claim that, from an evolutionary standpoint, deep sleep for hours at a time leaves an animal so vulnerable that the known benefits of sleeping seem insufficient to explain why it became so widespread in the animal kingdom. These scientists therefore imply that ______

Which choice most logically completes the text?

A) it is more important to understand how widespread prolonged deep sleep is than to understand its function.

B) prolonged deep sleep is likely advantageous in ways that have yet to be discovered.

C) many traits that provide significant benefits for an animal also likely pose risks to that animal.

D) most traits perform functions that are hard to understand from an evolutionary standpoint.

Key	B
Domain	Information and Ideas
Skill/Knowledge Testing Point	Inferences

Key Explanation: Choice B is the best answer. The passage indicates that although scientists recognize that sleep, which is widespread among animal species, has benefits, some scientists believe that deep, prolonged sleep is so risky from the perspective of animal species' survival and well-being that there must be some so-far-undiscovered advantage(s) to sleep to make it worthwhile from an evolutionary standpoint.

Distractor Explanations: Choice A is incorrect because the passage suggests that the extent of deep, prolonged sleep among animal species is well understood by scientists and that the real question for scientists is why so many animal species engage in deep, prolonged sleep. **Choice C** is incorrect because the passage offers no evidence that any trait other than deep, prolonged sleep poses both benefits and risks for animal species. **Choice D** is incorrect because the passage offers no evidence that any trait other than deep, prolonged sleep has one or more functions that are hard for scientists to understand.

3.5.2. CRAFT AND STRUCTURE

Table 12. Digital SAT Suite Reading and Writing Section: Craft and Structure Content Domain.

Domain Description (Claim)	Students will use comprehension, vocabulary, analysis, synthesis, and reasoning skills and knowledge to use and determine the meaning of high-utility academic words and phrases in context, evaluate texts rhetorically, and make supportable connections between multiple topically related texts.
Skill/Knowledge Testing Points	Words in Context Text Structure and Purpose Cross-Text Connections
Proportion	Approximately 28% of operational questions (13–15 questions)

For questions in the **Craft and Structure** content domain, students must use comprehension, vocabulary, analysis, synthesis, and reasoning skills and knowledge to use and determine the meaning of high-utility academic words and phrases in context, evaluate texts rhetorically, and make supportable connections between multiple texts on the same or similar topics.

Three skill/knowledge testing points are addressed in this domain:

- **Words in Context**, for which students must determine the meaning of a high-utility academic word or phrase in context or use such vocabulary in a precise, contextually appropriate way
- **Text Structure and Purpose**, for which students must analyze the structure of a text or determine the main rhetorical purpose of a text
- **Cross-Text Connections**, for which students must draw a reasonable connection between two topically related texts

3.5.2.1. *SAMPLE CRAFT AND STRUCTURE QUESTIONS*

In recommending Bao Phi's collection *Sông I Sing*, a librarian noted that pieces by the spoken-word poet don't lose their ______ nature when printed: the language has the same pleasant musical quality on the page as it does when performed by Phi.

Which choice completes the text with the most logical and precise word or phrase?

A) jarring
B) scholarly
C) melodic
D) personal

Key	C
Domain	Craft and Structure
Skill/Knowledge Testing Point	Words in Context

Key Explanation: Choice C is the best answer. "Melodic," referring to a pleasant arrangement of sounds, effectively signals the later use in the passage of "pleasant musical quality" to refer to Phi's spoken-word poetry when read rather than heard.

Distractor Explanations: Choice A is incorrect because "jarring," meaning disagreeable or upsetting, suggests the opposite of what the passage says about the "pleasant musical quality" of Phi's spoken-word poetry, whether read or heard. **Choice B** is incorrect because "scholarly" does not effectively signal the later use in the passage of "pleasant musical quality" to refer to Phi's spoken-word poetry. **Choice D** is incorrect because "personal" does not effectively signal the later use in the passage of "pleasant musical quality" to refer to Phi's spoken-word poetry.

The following text is from F. Scott Fitzgerald's 1925 novel *The Great Gatsby*.

[Jay Gatsby] was balancing himself on the dashboard of his car with that resourcefulness of movement that is so peculiarly American—that comes, I suppose, with the absence of lifting work in youth and, even more, with the formless grace of our nervous, sporadic games. This quality was continually breaking through his punctilious manner in the shape of restlessness.

As used in the text, what does the word "quality" most nearly mean?

A) Characteristic

B) Standard

C) Prestige

D) Accomplishment

Key	A
Domain	Craft and Structure
Skill/Knowledge Testing Point	Words in Context

Key Explanation: Choice A is the best answer. As used in the last sentence of the passage, "quality" refers to a trait or attribute ("characteristic")—specifically, Jay Gatsby's "resourcefulness of movement," which manifested as restlessness.

Distractor Explanations: Choice B is incorrect because although Jay Gatsby's "resourcefulness of movement" is a trait or attribute, referring to it as a "standard" implies that he is meeting a requirement or criterion set by others, a conclusion the passage does not support. **Choices C** and **D** are incorrect because neither "prestige" nor "accomplishment" makes sense in this context.

The work of molecular biophysicist Enrique M. De La Cruz is known for ______ traditional boundaries between academic disciplines. The university laboratory that De La Cruz runs includes engineers, biologists, chemists, and physicists, and the research the lab produces makes use of insights and techniques from all those fields.

Which choice completes the text with the most logical and precise word or phrase?

A) reinforcing

B) anticipating

C) epitomizing

D) transcending

Key	D
Domain	Craft and Structure
Skill/Knowledge Testing Point	Words in Context

Key Explanation: Choice D is the best answer. "Transcending," which means rising above or going beyond limits, effectively signals that De La Cruz broke down traditional academic disciplinary boundaries by working with experts, ideas, and methods from numerous fields.

Distractor Explanations: Choice A is incorrect because "reinforcing" suggests the opposite of what the passage says, which is that De La Cruz broke down, rather than made stronger, traditional barriers between academic disciplines. **Choice B** is incorrect because "anticipating," in the sense of expecting or acting in advance of something, does not make sense in this context. **Choice C** is incorrect because "epitomizing," meaning to use something as an ideal example, suggests the opposite of what the passage says, which is that De La Cruz broke down, rather than idealized, traditional barriers between academic disciplines.

Some studies have suggested that posture can influence cognition, but we should not overstate this phenomenon. A case in point: In a 2014 study, Megan O'Brien and Alaa Ahmed had subjects stand or sit while making risky simulated economic decisions. Standing is more physically unstable and cognitively demanding than sitting; accordingly, O'Brien and Ahmed hypothesized that standing subjects would display more risk aversion during the decision-making tasks than sitting subjects did, since they would want to avoid further feelings of discomfort and complicated risk evaluations. But O'Brien and Ahmed actually found no difference in the groups' performance.

Which choice best states the main purpose of the text?

A) It presents the study by O'Brien and Ahmed to critique the methods and results reported in previous studies of the effects of posture on cognition.

B) It argues that research findings about the effects of posture on cognition are often misunderstood, as in the case of O'Brien and Ahmed's study.

C) It explains a significant problem in the emerging understanding of posture's effects on cognition and how O'Brien and Ahmed tried to solve that problem.

D) It discusses the study by O'Brien and Ahmed to illustrate why caution is needed when making claims about the effects of posture on cognition.

Key	D
Domain	Craft and Structure
Skill/Knowledge Testing Point	Text Structure and Purpose

Key Explanation: Choice D is the best answer. The passage asserts that "we should not overstate" the effect of posture on cognition and uses the O'Brien and Ahmed study as a "case in point" in support of that claim.

Distractor Explanations: Choice A is incorrect because although the passage indicates that O'Brien and Ahmed reached different conclusions from those of other researchers, it does not use the O'Brien and Ahmed study to criticize how those earlier studies were conducted or to directly challenge the accuracy of those studies' results. **Choice B** is incorrect because although the passage indicates that the results from studies finding a link between posture and cognition have been overstated, it offers no evidence that the O'Brien and Ahmed study has often been misunderstood. **Choice C** is incorrect because the passage suggests that although

O'Brien and Ahmed were interested in studying the matter of posture and cognition, it does not indicate what these researchers thought before conducting their study or that the researchers set out specifically to solve a problem.

The following text is from Herman Melville's 1854 short story "The Lightning-Rod Man."

The stranger still stood in the exact middle of the cottage, where he had first planted himself. His singularity impelled a closer scrutiny. A lean, gloomy figure. Hair dark and lank, mattedly streaked over his brow. His sunken pitfalls of eyes were ringed by indigo halos, and played with an innocuous sort of lightning: the gleam without the bolt. The whole man was dripping. He stood in a puddle on the bare oak floor: his strange walking-stick vertically resting at his side.

Which choice best states the function of the underlined sentence in the text as a whole?

A) It sets up the character description presented in the sentences that follow.

B) It establishes a contrast with the description in the previous sentence.

C) It elaborates on the previous sentence's description of the character.

D) It introduces the setting that is described in the sentences that follow.

Key	A
Domain	Craft and Structure
Skill/Knowledge Testing Point	Text Structure and Purpose

Key Explanation: Choice A is the best answer. The underlined sentence, which asserts that the uniqueness of the stranger's physical appearance invited careful examination, sets up the following sentences' description of the stranger's distinctive physical features and stance.

Distractor Explanations: Choice B is incorrect because the underlined sentence has no direct logical relationship to the previous sentence. **Choice C** is incorrect because the previous sentence does not describe the stranger, so the underlined sentence cannot build on it in this way. **Choice D** is incorrect because the underlined sentence offers a general sense of the stranger's physical appearance and does not introduce a setting, nor is the main purpose of the following sentences to describe a setting.

Text 1

What factors influence the abundance of species in a given ecological community? Some theorists have argued that historical diversity is a major driver of how diverse an ecological community eventually becomes: differences in community diversity across otherwise similar habitats, in this view, are strongly affected by the number of species living in those habitats at earlier times.

Text 2

In 2010, a group of researchers including biologist Carla Cáceres created artificial pools in a New York forest. They stocked some pools with a diverse mix of zooplankton species and others with a single zooplankton species and allowed the pool communities to develop naturally thereafter. Over the course of four years, Cáceres and colleagues periodically measured the species diversity of the pools, finding—contrary to their expectations—that by the end of the study there was little to no difference in the pools' species diversity.

Based on the texts, how would Cáceres and colleagues (Text 2) most likely describe the view of the theorists presented in Text 1?

A) It is largely correct, but it requires a minor refinement in light of the research team's results.

B) It is not compelling as a theory regardless of any experimental data collected by the research team.

C) It may seem plausible, but it is not supported by the research team's findings.

D) It probably holds true only in conditions like those in the research team's study.

Key	C
Domain	Craft and Structure
Skill/Knowledge Testing Point	Cross-Text Connections

Key Explanation: Choice C is the best answer. Text 2 indicates that Cáceres and colleagues expected to find at the end of their study that the pools they stocked with multiple zooplankton species would have greater diversity than the pools they stocked with a single zooplankton species but that this was not, in fact, the case.

Distractor Explanations: Choice A is incorrect because the findings obtained by Cáceres and colleagues fundamentally challenge the hypothesis in Text 1 rather than largely support it. **Choice B** is incorrect because "contrary to their expectations" (Text 2) indicates that Cáceres and colleagues had assumed the hypothesis in Text 1 was correct prior to conducting their own study. **Choice D** is incorrect because the findings obtained by Cáceres and colleagues undermine, rather than support, the hypothesis in Text 1.

3.5.3. EXPRESSION OF IDEAS

Table 13. Digital SAT Suite Reading and Writing Section: Expression of Ideas Content Domain.

Domain Description (Claim)	Students will use revision skills and knowledge to improve the effectiveness of written expression in accordance with specified rhetorical goals.
Skill/Knowledge Testing Points	Rhetorical Synthesis Transitions
Proportion	Approximately 20% of operational questions (8–12 questions)

For questions in the **Expression of Ideas** content domain, students must use revision skills and knowledge to improve the effectiveness of written expression in accordance with rhetorical goals specified in the questions themselves.

Two skill/knowledge testing points are addressed in the domain:

- **Rhetorical Synthesis**, for which students must strategically integrate provided information and ideas on a topic to form an effective sentence achieving a specified rhetorical aim
- **Transitions**, for which students must determine the most effective transition word or phrase to logically connect information and ideas in a text

3.5.3.1. *SAMPLE EXPRESSION OF IDEAS QUESTIONS*

While researching a topic, a student has taken the following notes:

- Maika'i Tubbs is a Native Hawaiian sculptor and installation artist.
- His work has been shown in the United States, Canada, Japan, and Germany, among other places.
- Many of his sculptures feature discarded objects.
- His work *Erasure* (2008) includes discarded audiocassette tapes and magnets.
- His work *Home Grown* (2009) includes discarded pushpins, plastic plates and forks, and wood.

The student wants to emphasize a similarity between the two works. Which choice most effectively uses relevant information from the notes to accomplish this goal?

A) *Erasure* (2008) uses discarded objects such as audiocassette tapes and magnets; *Home Grown* (2009), however, includes pushpins, plastic plates and forks, and wood.

B) Like many of Tubbs's sculptures, both *Erasure* and *Home Grown* include discarded objects: *Erasure* uses audiocassette tapes, and *Home Grown* uses plastic forks.

C) Tubbs's work, which often features discarded objects, has been shown both within the United States and abroad.

D) Tubbs completed *Erasure* in 2008 and *Home Grown* in 2009.

Key	B
Domain	Expression of Ideas
Skill/Knowledge Testing Point	Rhetorical Synthesis

Key Explanation: Choice B is the best answer. The sentence uses "like many of Tubbs's sculptures" and "both" to emphasize a similarity between *Erasure* and *Home Grown* in terms of their common use of discarded objects, though the specific discarded objects used differed between the two works.

Distractor Explanations: Choice A is incorrect because although the sentence discusses two of Tubbs's works, the use of "however" emphasizes a contrast, rather than a similarity, between the works. **Choice C** is incorrect because the sentence focuses only on Tubbs's work in general and does not mention any specific works. **Choice D** is incorrect because the sentence simply conveys information about two of Tubbs's works—the year in which each was completed—without establishing any sort of logical relationship between the pieces of information.

Iraqi artist Nazik Al-Malaika, celebrated as the first Arabic poet to write in free verse, didn't reject traditional forms entirely; her poem "Elegy for a Woman of No Importance" consists of two ten-line stanzas and a standard number of syllables. Even in this superficially traditional work, ______ Al-Malaika was breaking new ground by memorializing an anonymous woman rather than a famous man.

Which choice completes the text with the most logical transition?

A) in fact,

B) though,

C) therefore,

D) moreover,

Key	B
Domain	Expression of Ideas
Skill/Knowledge Testing Point	Transitions

Key Explanation: Choice B is the best answer. The passage's first sentence establishes that although Al-Malaika is famous for her free verse poetry, she still made some use of traditional poetic forms, as in her work "Elegy for a Woman of No Importance." The passage's last sentence qualifies the point made in the passage's first sentence by indicating that even when Al-Malaika used traditional forms, as in "Elegy," she challenged tradition, in this case by making an "anonymous woman rather than a famous man" the subject of the poem. "Though" is the best transition for the passage's last sentence because, along with "even," it signals that Al-Malaika subverted traditional poetic forms even when she used them by, in this case, using a nontraditional subject for an elegy.

Distractor Explanations: Choice A is incorrect because "in fact" illogically signals that the passage's last sentence stresses or amplifies the truth of the assertion made in the passage's first sentence. **Choice C** is incorrect because "therefore" illogically signals that the passage's last sentence describes a consequence arising from the assertion made in the passage's first sentence. **Choice D** is incorrect because "moreover" illogically signals that the passage's last sentence merely offers additional information about the assertion made in the passage's first sentence.

3.5.4. STANDARD ENGLISH CONVENTIONS

Table 14. Digital SAT Suite Reading and Writing Section: Standard English Conventions Content Domain.

Domain Description (Claim)	Students will use editing skills and knowledge to make text conform to core conventions of Standard English sentence structure, usage, and punctuation.
Skill/Knowledge Testing Points	Boundaries Form, Structure, and Sense
Proportion	Approximately 26% of operational questions (11–15 questions)

For questions in the **Standard English Conventions** content domain, students must use editing skills and knowledge to ensure that text conforms to conventions of Standard English sentence structure, usage, and punctuation.

Two skill/knowledge testing points are addressed in the domain:

- **Boundaries**, for which students must edit text to ensure that sentences are conventionally complete
- **Form, Structure, and Sense**, for which students must edit text to conform to conventional usage (e.g., agreement, verb tense/aspect)

3.5.4.1. *SAMPLE STANDARD ENGLISH CONVENTIONS QUESTIONS*

According to Naomi Nakayama of the University of Edinburgh, the reason seeds from a dying dandelion appear to float in the air while ______ is that their porous plumes enhance drag, allowing the seeds to stay airborne long enough for the wind to disperse them throughout the surrounding area.

Which choice completes the text so that it conforms to the conventions of Standard English?

A) falling,

B) falling:

C) falling;

D) falling

Key	D
Domain	Standard English Conventions
Skill/Knowledge Testing Point	Boundaries

Key Explanation: Choice D is the best answer. No punctuation is needed.

Distractor Explanations: Choices A, B, and **C** are incorrect because each inserts unnecessary punctuation (a comma, colon, and semicolon, respectively) between the sentence's subject ("the reason . . . falling") and the verb "is."

Rabinal Achí is a precolonial Maya dance drama performed annually in Rabinal, a town in the Guatemalan highlands. Based on events that occurred when Rabinal was a city-state ruled by a king, ______ had once been an ally of the king but was later captured while leading an invading force against him.

Which choice completes the text so that it conforms to the conventions of Standard English?

A) *Rabinal Achí* tells the story of K'iche' Achí, a military leader who

B) K'iche' Achí, the military leader in the story of *Rabinal Achí*,

C) there was a military leader, K'iche' Achí, who in *Rabinal Achí*

D) the military leader whose story is told in *Rabinal Achí*, K'iche' Achí,

Key	A
Domain	Standard English Conventions
Skill/Knowledge Testing Point	Form, Structure, and Sense

Key Explanation: Choice A is the best answer. This choice ensures that the introductory participial phrase "Based on events that occurred when Rabinal was a city-state ruled by a king" appears immediately before the noun it modifies, "*Rabinal Achí*."

Distractor Explanations: Choices B, C, and **D** are incorrect because "Based on events that occurred when Rabinal was a city-state ruled by a king" should appear next to the words it modifies, "*Rabinal Achí*," whereas all these choices result in dangling modifiers.

CHAPTER 4

The Math Section

The Math section of the digital SAT Suite assessments is designed to measure students' attainment of critical college and career readiness prerequisites in math. The digital SAT Suite Math section focuses on key elements of algebra, advanced math, problem-solving and data analysis, and geometry and (SAT, PSAT/NMSQT, and PSAT 10 only) trigonometry that the best available evidence identifies as necessary for postsecondary readiness and success. Over the course of the Math section of one of the digital SAT Suite assessments, students answer multiple-choice and student-produced response (SPR) questions that measure their fluency with, understanding of, and ability to apply the math concepts, skills, and practices that are most essential for readiness for entry-level postsecondary work.

4.1 The Math Section at a Glance

Table 15 summarizes many of the key features of the Math section. These features are discussed throughout the remainder of the section.

Table 15. Digital SAT Suite Math Section High-Level Specifications.

Characteristic	Digital SAT Suite Math Section
Administration	Two-stage adaptive test design: one Math section administered via two separately timed modules
Test length (number of operational and pretest questions)	1st module: 20 operational questions and 2 pretest questions 2nd module: 20 operational questions and 2 pretest questions **Total:** 44 questions
Time per module	1st module: 35 minutes 2nd module: 35 minutes **Total:** 70 minutes
Average time per question	1.59 minutes

Preview

In this chapter, you will find

- an overview and discussion of key features of the Math section of the digital SAT Suite assessments.
- sample Math questions with answer explanations.

Characteristic	Digital SAT Suite Math Section
Score reported	Section score (constitutes half of total score) SAT: 200–800 PSAT/NMSQT and PSAT 10: 160–760 PSAT 8/9: 120–720
Question formats used	Discrete; four-option multiple-choice (≈75%) and student-produced response (SPR) (≈25%)
Context topics	Science, social studies, real-world topics
Word count	Approximately 30% of questions in context; a majority of in-context questions have 50 (6-character) words or fewer
Informational graphics	A wide range of data displays, geometric figures, and *xy*-plane graphs
Text complexity bands	N/A (see section 4.1.10)

The features identified above are discussed briefly in this section of the chapter and in more detail throughout the chapter and document.

4.1.1. ADMINISTRATION

As described in section 2.2.3, the digital SAT Suite Math section is administered in two equal-length and separately timed portions, or *stages*. Each stage consists of a *module* of test questions. The first (*routing*) module in each test form consists of a broad mix of easy, medium-difficulty, and hard questions. The second module also contains a mix of easy, medium-difficulty, and hard questions, but the average question difficulty is targeted to the test taker's performance on the questions in the first module. Specifically, a test taker receives a second module that consists of questions that, on average, are either of higher or lower difficulty than those in the first module. Student performance on all operational (i.e., non-pretest) questions across both modules is used to calculate the section score.

Questions from all four content domains appear in each test module. Across each module, questions are arranged from easiest to hardest, allowing each test taker the best opportunity to demonstrate what they know and can do. Embedded pretest questions appear in differing locations throughout the sequence.

Students may navigate freely through a given module of questions; this allows them to preview upcoming questions within the module or flag others to return to should time permit. However, once Bluebook has moved them to the second module in the Math section, students may not return to the questions in the first module, nor may students return to the Reading and Writing section once Bluebook has moved them to the Math section.

4.1.2. TEST LENGTH BY NUMBER OF QUESTIONS

The Math section consists of forty-four questions, which are divided into two equal-length modules, one for each of the section's two stages. Of each module's twenty-two questions, twenty are *operational*, meaning that students' performance on them contributes to their section score, and two questions are *pretest*. Answers to pretest questions do not contribute in any way to students' Math section score;

rather, their purpose is to collect student performance data that will be used by College Board to help assess whether these questions are suitable for operational use at a future time. To students, pretest questions appear the same as operational questions, thereby ensuring students' maximal effort on the former. The number of pretest questions embedded in the Math section is minimized to limit the impact of answering nonoperational questions on students' test taking.

4.1.3. TIME PER SECTION AND MODULE

Students have a total of seventy minutes to complete the Math section. This time is divided equally between the two modules, meaning that students have thirty-five minutes to answer the questions in a given module. Once time has expired for the first module, students are automatically advanced to the appropriate (higher- or lower-difficulty) second module and may not return to the questions in the first module.

4.1.4. AVERAGE TIME PER QUESTION

Students have, on average, 1.59 minutes to answer each Math test question.

4.1.5. SCORE REPORTED

Students receive a section score based on their overall performance on the Math section. This score is scaled from 200–800 for the SAT, 160–760 for the PSAT/NMSQT and PSAT 10, and 120–720 for the PSAT 8/9, each in 10-point intervals. This section score is added to the Reading and Writing section score to determine students' total score for the assessment.

4.1.6. QUESTION FORMATS USED

Approximately three-quarters of the Math questions use the four-option multiple-choice format with a single best answer known as the *keyed response* or simply the *key*. The remaining questions are in the student-produced response, or SPR, format. For this latter format, students must generate their own answers to the questions and then enter their responses in Bluebook. For more details on the nature and entry of these responses, see the SPR test directions in appendix D. Unlike Math multiple-choice questions, for which only one correct response is provided among the answer choices, Math SPR questions may have more than one answer that students could enter and have counted correct, although they are directed to provide only one answer per question.

4.1.7. CONTEXT TOPICS

Approximately 30 percent of Math questions are set in context. These in-context ("word") questions require students to consider a science, social studies, or real-world scenario and apply their math skills and knowledge, along with an understanding of the context, to determine the answer to each. To reduce the impact that topic selection might have on answering these questions, contexts are developed that are either widely familiar or otherwise accessible to all students because of their grounding in common rigorous academic subject matter. Topic-specific prior knowledge is not assessed.

4.1.8. WORD COUNT

A majority of math-in-context questions are fifty standardized (six-character) words or fewer in length. (For an explanation of how word counts are determined, see section 3.1.8.)

4.1.9. INFORMATIONAL GRAPHICS

Select questions in the Math section are accompanied by an informational graphic. The inclusion of such graphics achieves two main goals: first, it authentically reflects the prominence and utility of such data displays in the field of math; second, it realistically assesses students' ability to locate, interpret, and use information from graphics to solve problems. Informational graphics in the Math section can take many forms, including, but not necessarily limited to, graphs of functions in the *xy*-plane, dot plots, scatterplots, bar graphs, line graphs, histograms, and representations of geometric figures.

4.1.10. TEXT COMPLEXITY

Text complexity is not formally measured in the Math section. For the roughly 70 percent of Math questions without a context, text complexity is irrelevant. For those questions in context, the test development goals are to minimize the impact of linguistic factors on students' ability to answer the questions while still presenting scenarios rich enough to support problem-solving in science, social studies, and real-world settings. To these ends, word counts are constrained, and the language used is kept as simple, clear, and direct as possible. Moreover, Math (and Reading and Writing) test development staff have been trained in the principles of linguistic modification (Abedi and Sato 2008), a set of approaches that seeks to reduce language burdens in test questions without altering the construct being measured or reducing intended rigor.

4.2 Definitions

4.2.1. CONSTRUCT

A crucial foundation of assessment validity, or ensuring that a test measures what it is intended to measure and nothing else, is a clear definition of the test's construct. A *construct*, in this sense, is "the concept or characteristic that a test is designed to measure" (AERA, APA, and NCME 2014, 11). Clearly defining the construct—in the case of the digital SAT Suite, at the test section level—serves two main purposes. First, such a definition establishes the basis for and guides the development of test specifications, both content and statistical, which, in turn, set the parameters for what will be measured and how by the assessment. Second, the construct definition helps identify what should *not* be measured by the assessment. Such elements are considered *construct irrelevant*—that is, they should not have an impact on test performance, and any effects they might have should be minimized when they cannot be eliminated. In the case of the digital SAT Suite, such construct-irrelevant factors include, but are not necessarily limited to, students' race/ethnicity, gender and sexual identities, home region, home culture, family income, and physical ability.

It should be clear, then, that construct definition is not merely a technical matter but is, in fact, a cornerstone of both test validity and test fairness. By defining what should and should not be measured, developers can help ensure that a given test measures what it is intended to measure and minimize the possibility that other factors not intended to be assessed have impacts on performance. Indeed, "the central idea of fairness in testing is to identify and remove construct-irrelevant barriers to maximal performance for any examinee," and "removing these barriers allows for the comparable and valid interpretation of test scores for all examinees" (AERA, APA, and NCME 2014, 63).

In the case of the digital SAT Suite Math section, the construct is math achievement relative to core college and career readiness requirements. Although literacy achievement is not directly measured, students are still required to employ such skills and knowledge to a limited, carefully constrained extent when solving math problems set in context.

4.2.2. CLAIMS

Like constructs, *claims* serve to establish parameters for what is tested and how. "In assessment," Mislevy and Riconsente (2005, 1) write, "we want to make some claim about student knowledge, skills, or abilities (KSAs), and we want our claims to be valid." The purposes of establishing claims, then, are, first, to precisely identify what students should be able to demonstrate to be considered successful on the construct of interest (in this case, math achievement) and, second, to build a test (or test section) to collect evidence in support of those claims.

The Math section is designed to elicit evidence from student test performance in support of four broad claims about students' math achievement. To be successful on the Math section, students must be able to do the following:

- analyze, fluently solve, interpret, and create linear equations and inequalities as well as analyze and fluently solve systems of equations using multiple techniques (**Algebra**)
- demonstrate attainment of skills and knowledge central for successful progression to more advanced math courses, including analyzing, fluently solving, interpreting, and creating equations, including absolute value, quadratic, exponential, polynomial, rational, radical, and other nonlinear equations, as well as analyzing and fluently solving systems of linear and nonlinear equations in two variables (**Advanced Math**)
- apply quantitative reasoning about ratios, rates, and proportional relationships; understand and apply unit rate; and analyze and interpret one- and two-variable data (**Problem-Solving and Data Analysis**)
- solve problems that focus on perimeter, area, and volume; angles, triangles, and trigonometry; and circles (**Geometry and Trigonometry** [SAT, PSAT/NMSQT, and PSAT 10] / **Geometry** [PSAT 8/9])

These general suite-level claims are modified to some extent at the individual test program level, as discussed in section 4.4.1.

4.3 Content Domain Structure

In close correspondence with the claims listed above and as appropriate for the age and attainment of the test-taking populations targeted by the various digital SAT Suite assessments, questions on the Math section represent one of four *content domains*:

- **Algebra**, for which students must analyze, fluently solve, and create linear equations and inequalities as well as analyze and fluently solve systems of equations using multiple techniques
- **Advanced Math**, for which students must demonstrate attainment of skills and knowledge central for successful progression to more advanced math courses, including analyzing, fluently solving, interpreting, and creating equations, including absolute value, quadratic, exponential, polynomial, rational, radical, and other nonlinear equations, as well as analyzing and fluently solving systems of linear and nonlinear equations in two variables
- **Problem-Solving and Data Analysis**, for which students must apply quantitative reasoning about ratios, rates, and proportional relationships; understand and apply unit rate; and analyze and interpret one- and two-variable data
- **Geometry and Trigonometry** (SAT, PSAT/NMSQT, and PSAT 10) **/ Geometry** (PSAT 8/9), for which students must solve problems that focus on perimeter, area, and volume; angles, triangles, and trigonometry; and circles

Some notable variations by testing program exist; see section 4.4.1.

Each question is classified as belonging to a single content domain.

Within each domain, questions address a number of skill/knowledge testing points, as described below.

Questions from all four domains appear in each module.

Table 16, table 17, and table 18 display the domain structure of the Math section by test program level, beginning with the SAT. The tables include the domains and their associated claims, the skill/knowledge testing points addressed in each domain, and the distribution of operational (scored) questions by domain on each test form. Subsequent discussion in this chapter describes the skill/knowledge testing points in each domain and provides illustrative samples with answer explanations.

Table 16. Digital SAT Math Section Content Domains and Operational Question Distribution.

Math Section Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Algebra	Students will interpret, create, use, represent, and solve problems using linear representations and make connections between different representations of linear relationships.	Linear equations in one variable Linear equations in two variables Linear functions Systems of two linear equations in two variables Linear inequalities in one or two variables	≈35%/ 13–15 questions
Advanced Math	Students will interpret, rewrite, fluently solve, make strategic use of structure, and create absolute value, quadratic, exponential, polynomial, rational, radical, and other nonlinear equations and make connections between different representations of a nonlinear relationship between two variables.	Equivalent expressions Nonlinear equations in one variable and systems of equations in two variables Nonlinear functions	≈35%/ 13–15 questions
Problem-Solving and Data Analysis	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; fit models to data and compare linear and exponential growth; and calculate, compare, and interpret mean, median, and range, compare distributions with the same and different standard deviation, understand basic study design, and interpret margin of error.	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability Inference from sample statistics and margin of error Evaluating statistical claims: observational studies and experiments	≈15%/ 5–7 questions
Geometry and Trigonometry	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; determine congruence, similarity, and sufficiency using concepts and theorems about vertical angles, triangles, and parallel lines cut by a transversal; solve problems using the Pythagorean theorem, right triangle and unit circle trigonometry, and properties of special right triangles; and use properties and theorems relating to circles to solve problems.	Area and volume Lines, angles, and triangles Right triangles and trigonometry Circles	≈15%/ 5–7 questions

Table 17. Digital PSAT/NMSQT and PSAT 10 Math Section Content Domains and Operational Question Distribution.

Math Section Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Algebra	Students will interpret, create, use, represent, and solve problems using linear representations and make connections between different representations of linear relationships.	Linear equations in one variable Linear equations in two variables Linear functions Systems of two linear equations in two variables Linear inequalities in one or two variables	≈35%/ 13–15 questions
Advanced Math	Students will interpret, rewrite, fluently solve, make strategic use of structure, and create absolute value, quadratic, exponential, polynomial, rational, radical, and other nonlinear equations and make connections between different representations of a nonlinear relationship between two variables.	Equivalent expressions Nonlinear equations in one variable and systems of equations in two variables Nonlinear functions	≈32.5%/ 12–14 questions
Problem-Solving and Data Analysis	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; fit models to data and compare linear and exponential growth; and calculate, compare, and interpret mean, median, and range and compare distributions with the same and different standard deviation.	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability Inference from sample statistics	≈20%/ 7–9 questions
Geometry and Trigonometry	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; determine congruence, similarity, and sufficiency using concepts and theorems about vertical angles, triangles, and parallel lines cut by a transversal; and solve problems using the Pythagorean theorem and right triangle trigonometry.	Area and volume Lines, angles, and triangles Right triangles and right triangle trigonometry	≈12.5%/ 4–6 questions

Table 18. Digital PSAT 8/9 Math Section Content Domains and Operational Question Distribution.

Math Section Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Algebra	Students will interpret, create, use, represent, and solve problems using linear representations and make connections between different representations of linear relationships.	Linear equations in one variable Linear equations in two variables Linear functions Systems of two linear equations in two variables Linear inequalities in one or two variables	≈42.5%/ 16–18 questions
Advanced Math	Students will rewrite, fluently solve, and make strategic use of structure, absolute value, quadratic, exponential, polynomial, and other nonlinear equations and make connections between different representations of a nonlinear relationship between two variables.	Equivalent expressions Nonlinear equations in one variable and systems of equations in two variables Nonlinear functions	≈20%/ 7–9 questions
Problem-Solving and Data Analysis	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; fit models to data; and calculate, compare, and interpret mean, median, and range.	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability	≈25%/ 9–11 questions
Geometry	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; apply theorems such as triangle sum; and solve problems using the Pythagorean theorem.	Area and volume Lines, angles, and triangles, including right triangles	≈12.5%/ 4–6 questions

Table 19 summarizes the digital SAT Suite Math section specifications across testing programs.

Table 19. Digital SAT Suite Math Section Content Specifications Summary, by Testing Program.

Feature	Digital SAT Suite Testing Program: SAT	PSAT/NMSQT and PSAT 10	PSAT 8/9
Operational Questions	40	40	40
Questions by Format (%, #)			
Multiple-Choice (MC)	≈75% / 28–32	≈75% / 28–32	≈75% / 28–32
Student-Produced Response (SPR)	≈25% / 8–12	≈25% / 8–12	≈25% / 8–12
Questions in Context (%, #)	≈30% / 10–14	≈30% / 10–14	≈30% / 10–14
Questions by Content Domain (%, #)			
Algebra	≈35% / 13–15	≈35% / 13–15	≈42.5% / 16–18
Advanced Math	≈35% / 13–15	≈32.5% / 12–14	≈20% / 7–9
Problem-Solving and Data Analysis	≈15% / 5–7	≈20% / 7–9	≈25% / 9–11
Geometry and Trigonometry (SAT, PSAT/NMSQT, PSAT 10) / Geometry (PSAT 8/9)	≈15% / 5–7	≈12.5% / 4–6	≈12.5% / 4–6 (Only geometry for PSAT 8/9)
Embedded Pretest Questions			
Per module	2	2	2
Per test form	4	4	4

4.4 Questions

Math questions come in two formats: four-option multiple-choice questions, each with a single correct response among the answer choices, and student-produced response (SPR) questions, wherein students must generate and enter their own answers to questions and where there may be more than one correct answer (although students are directed to enter only one). The correct answer (potentially more than one for SPR questions) is known as the *keyed response* or simply the *key*, while the three alternative answer options in multiple-choice questions are known as *distractors*. Each multiple-choice distractor represents a common error that students might reasonably make in answering the question or common misconception that students might hold, so distractors are intended to be plausible to degrees varying depending on the intended difficulty of the question; however, no distractor is meant to compete with the key as the correct response for students with the targeted level of math achievement.

The distribution of questions by the two Math question types—multiple-choice (MC) and student-produced response (SPR)—by testing program is summarized in table 20.

Table 20. Digital SAT Suite Math Section: Distribution of MC and SPR Question Formats across Content Domains.

Digital SAT Suite Testing Program	Question Format	Algebra	Advanced Math	Problem-Solving and Data Analysis	Geometry and Trigonometry (SAT, PSAT/NMSQT, PSAT 10)/ Geometry (PSAT 8/9)	Total
SAT	MC	10–11	10–11	4–5	4–5	28–32
	SPR	3–4	3–4	1–2	1–2	8–12
PSAT/ NMSQT and PSAT 10	MC	10–11	10–11	5–6	3–4	28–32
	SPR	3–4	2–3	2–3	1–2	8–12
PSAT 8/9	MC	14–15	5–6	6–7	3–4	28–32
	SPR	2–3	2–3	3–4	1–2	8–12

4.4.1. VARIATIONS BY TESTING PROGRAM

As indicated in the preceding tables and discussion, the content of the Math section varies to some extent by testing program in order to reflect age and attainment differences across the test-taking populations. The following are of particular note:

- Rational and radical equations (Advanced Math) are not represented on PSAT 8/9.
- Trigonometry skills and knowledge are not assessed on PSAT 8/9.
- Skills and knowledge associated with circles (Geometry and Trigonometry) are assessed only on the SAT.
- In terms of number and proportion of questions, Algebra is most prominent in PSAT 8/9 and decreases slightly at higher program levels; the weighting of Advanced Math increases by program level; the weighting of Problem-Solving and Data Analysis decreases slightly by program level; and the weighting of Geometry and Trigonometry/Geometry remains largely consistent by level.

Other small variations by skill/knowledge testing point can be found in the preceding and following tables.

4.5 Sample Questions

As previously indicated, questions on the Math section correspond to one of four content domains: Algebra, Advanced Math, Problem-Solving and Data Analysis, and Geometry and Trigonometry/Geometry. This section provides an overview of each of these domains, identifies the skill/knowledge testing points addressed by each, and presents sample questions (with answer explanations) exemplifying how the various testing points are commonly (but not necessarily exclusively) addressed in each domain.

Note that the formatting of the sample questions is approximate and does not precisely reflect how these questions are displayed in Bluebook. Moreover, these sample questions are merely illustrative and do not necessarily reflect the full range of question difficulty students may expect to encounter on test day.

4.5.1. ALGEBRA

Table 21. Digital SAT Suite Math Section: Algebra Content Domain.

Domain Description (Claim)	SAT, PSAT/NMSQT, PSAT 10	Students will interpret, create, use, represent, and solve problems using linear representations; and make connections between different representations of linear relationships, all from high school algebra courses preparatory for the math aligned with college and career readiness expectations.
	PSAT 8/9	Students will interpret, create, use, represent, and solve problems using linear representations; and make connections between different representations of linear relationships, all from middle school and first-year algebra courses preparatory for the math aligned with college and career readiness expectations.
Skill/Knowledge Testing Points	All programs	Linear equations in one variable Linear equations in two variables Linear functions Systems of two linear equations in two variables Linear inequalities in one or two variables
Proportions	SAT, PSAT/NMSQT, PSAT 10	≈35% / 13–15 questions
	PSAT 8/9	≈42.5% / 16–18 questions

For questions in the Algebra content domain, students must analyze, fluently solve, and create linear equations and inequalities as well as analyze and fluently solve systems of equations using multiple techniques.

Five skill/knowledge testing points are addressed in this domain across all digital SAT Suite testing programs:

- Linear equations in one variable
- Linear equations in two variables
- Linear functions
- Systems of two linear equations in two variables
- Linear inequalities in one or two variables

4.5.1.1. *SAMPLE ALGEBRA QUESTIONS*

If $f(x) = x + 7$ and $g(x) = 7x$, what is the value of $4f(2) - g(2)$?

A) -5

B) 1

C) 22

D) 28

Key	C
Domain	Algebra
Skill/Knowledge Testing Point	*Linear functions* Evaluate a linear function given an input value

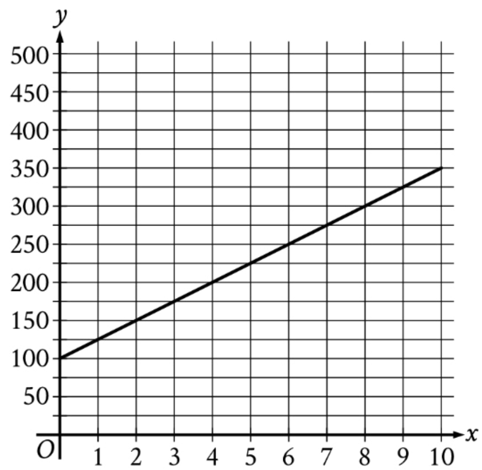
Key Explanation: Choice C is correct. The value of $f(2)$ can be found by substituting 2 for x in the given equation $f(x) = x + 7$, which yields $f(2) = 2 + 7$, or $f(2) = 9$. The value of $g(2)$ can be found by substituting 2 for x in the given equation $g(x) = 7x$, which yields $g(2) = 7(2)$, or $g(2) = 14$. The value of the expression $4f(2) - g(2)$ can be found by substituting the corresponding values into the expression, which gives $4(9) - 14$. This expression is equivalent to $36 - 14$, or 22.

Distractor Explanations: Choice A is incorrect. This is the value of $f(2) - g(2)$, not $4f(2) - g(2)$. **Choice B** is incorrect and may result from calculating $4f(2)$ as $4(2) + 7$, rather than $4(2 + 7)$. **Choice D** is incorrect and may result from conceptual or calculation errors.

The y-intercept of the graph of $y = -6x - 32$ in the xy-plane is $(0, y)$. What is the value of y?

Key	-32
Domain	Algebra
Skill/Knowledge Testing Point	*Linear equations in two variables* Make connections between an algebraic representation and a graph

Key Explanation: The correct answer is -32. It's given that the y-intercept of the graph of $y = -6x - 32$ is $(0, y)$. Substituting 0 for x in this equation yields $y = -6(0) - 32$ or $y = -32$. Therefore, the value of y that corresponds to the y-intercept of the graph of $y = -6x - 32$ in the xy-plane is -32.



The graph of the function f, where $y = f(x)$, models the total cost y, in dollars, for a certain video game system and x games. What is the best interpretation of the slope of the graph in this context?

A) Each game costs \$25.

B) The video game system costs \$100.

C) The video game system costs \$25.

D) Each game costs \$100.

Key	A
Domain	Algebra
Skill/Knowledge Testing Point	*Linear functions* Interpret the graph of a linear function in terms of a context

Key Explanation: Choice A is correct. The given graph is a line, and the slope of a line is defined as the change in the value of *y* for each increase in the value of *x* by 1. It's given that *y* represents the total cost, in dollars, and that *x* represents the number of games. Therefore, the change in the value of *y* for each increase in the value of *x* by 1 represents the change in total cost, in dollars, for each increase in the number of games by 1. In other words, the slope represents the cost, in dollars, per game. The graph shows that when the value of *x* increases from 0 to 1, the value of *y* increases from 100 to 125. It follows that the slope is 25, or the cost per game is \$25. Thus, the best interpretation of the slope of the graph is that each game costs \$25.

Distractor Explanations: Choice B is incorrect. This is an interpretation of the *y*-intercept of the graph rather than the slope of the graph. **Choice C** is incorrect.

The slope of the graph is the cost per game, not the cost of the video game system. **Choice D** is incorrect. Each game costs \$25, not \$100.

$$y < -4x + 4$$

Which point (x, y) is a solution to the given inequality in the xy-plane?

A) $(2, -1)$
B) $(2, 1)$
C) $(0, 5)$
D) $(-4, 0)$

Key	D
Domain	Algebra
Skill/Knowledge Testing Point	*Linear inequalities in one or two variables* For a linear inequality, interpret a point in the *xy*-plane

Key Explanation: Choice D is correct. For a point (x, y) to be a solution to the given inequality in the xy-plane, the value of the point's y-coordinate must be less than the value of $-4x + 4$, where x is the value of the x-coordinate of the point. This is true of the point $(-4, 0)$ because $0 < -4(-4) + 4$, or $0 < 20$. Therefore, the point $(-4, 0)$ is a solution to the given inequality.

Distractor Explanations: Choices A, **B**, and **C** are incorrect. None of these points is a solution to the given inequality because each point's y-coordinate is greater than the value of $-4x + 4$ for the point's x-coordinate.

Figure A and figure B are both regular polygons. The sum of the perimeter of figure A and the perimeter of figure B is 63 inches. The equation $3x + 6y = 63$ represents this situation, where x is the number of sides of figure A and y is the number of sides of figure B. Which statement is the best interpretation of 6 in this context?

A) Each side of figure B has a length of 6 inches.
B) The number of sides of figure B is 6.
C) Each side of figure A has a length of 6 inches.
D) The number of sides of figure A is 6.

Key	A
Domain	Algebra
Skill/Knowledge Testing Point	*Linear equations in two variables* For a linear equation, interpret a solution, constant, variable, factor, or term based on the context

Key Explanation: Choice A is correct. It's given that figure A and figure B (not shown) are both regular polygons and the sum of the perimeters of the two figures is 63 inches. It's also given that x is the number of sides of figure A and y is the number of sides of figure B, and that the equation $3x + 6y = 63$ represents this situation. Thus, $3x$ and $6y$ represent the perimeters, in inches, of figure A and figure B, respectively. Since $6y$ represents the perimeter, in inches, of figure B and y is the number of sides of figure B, it follows that each side of figure B has a length of 6 inches.

Distractor Explanations: Choice B is incorrect. The number of sides of figure B is y, not 6. **Choice C** is incorrect. Since the perimeter, in inches, of figure A is represented by $3x$, each side of figure A has a length of 3 inches, not 6 inches. **Choice D** is incorrect. The number of sides of figure A is x, not 6.

Store A sells raspberries for $5.50 per pint and blackberries for $3.00 per pint. Store B sells raspberries for $6.50 per pint and blackberries for $8.00 per pint. A certain purchase of raspberries and blackberries would cost $37.00 at store A or $66.00 at store B. How many pints of blackberries are in this purchase?

A) 12
B) 8
C) 5
D) 4

Key	C
Domain	Algebra
Skill/Knowledge Testing Point	*Systems of two linear equations in two variables* Create and use a system of two linear equations

Key Explanation: Choice C is correct. It's given that store A sells raspberries for $5.50 per pint and blackberries for $3.00 per pint, and a certain purchase of raspberries and blackberries at store A would cost $37.00. It's also given that store B sells raspberries for $6.50 per pint and blackberries for $8.00 per pint, and this purchase of raspberries and blackberries at store B would cost $66.00. Let r represent the number of pints of raspberries and b represent the number of pints of blackberries in this purchase. The equation $5.50r + 3.00b = 37.00$ represents this purchase of raspberries and blackberries from store A and the equation $6.50r + 8.00b = 66.00$ represents this purchase of raspberries and blackberries from store B. Solving the system of equations by elimination gives the value of r and the value of b that make the system of equations true. Multiplying both sides of the equation for store A by 6.5 yields $(5.50r)(6.5) + (3.00b)(6.5) = (37.00)(6.5)$, or $35.75r + 19.5b = 240.5$. Multiplying both sides of the equation for store B by 5.5 yields $(6.50r)(5.5) + (8.00b)(5.5) = (66.00)(5.5)$, or $35.75r + 44b = 363$. Subtracting both sides of the equation for store A, $35.75r + 19.5b = 240.5$, from the corresponding sides of the equation for store B, $35.75r + 44b = 363$, yields $(35.75r - 35.75r) + (44b - 19.5b) = (363 - 240.5)$, or $24.5b = 122.5$. Dividing both sides of this equation by 24.5 yields $b = 5$. Thus, 5 pints of blackberries are in this purchase.

Distractor Explanations: Choices A and **B** are incorrect and may result from conceptual or calculation errors. **Choice D** is incorrect. This is the number of pints of raspberries, not blackberries, in the purchase.

4.5.2. ADVANCED MATH

Table 22. Digital SAT Suite Math Section: Advanced Math Content Domain.

Domain Description (Claim)	SAT, PSAT/NMSQT, PSAT 10	Students will interpret, rewrite, fluently solve, make strategic use of structure, and create absolute value, quadratic, exponential, polynomial, rational, radical, and other nonlinear equations and make connections between different representations of a nonlinear relationship between two variables, all from high school courses preparatory for the math aligned with college and career readiness expectations.
	PSAT 8/9	Students will rewrite, fluently solve, and make strategic use of structure, absolute value, quadratic, exponential, polynomial, and other non-linear equations and make connections between different representations of a nonlinear relationship between two variables, all from middle school and first-year algebra courses preparatory for the math aligned with college and career readiness expectations.
Skill/Knowledge Testing Points	All programs	Equivalent expressions Nonlinear equations in one variable and systems of equations in two variables Nonlinear functions
Proportions	SAT	≈35% / 13–15 questions
	PSAT/NMSQT, PSAT 10	≈32.5% / 12–14 questions
	PSAT 8/9	≈20% / 7–9 questions

For questions in the Advanced Math content domain, students must skillfully address topics central for successful progress to more advanced math courses, including demonstrating an understanding of absolute value, quadratic, exponential, polynomial, rational, radical, and other nonlinear equations.

Three skill/knowledge testing points are addressed in this domain across all digital SAT Suite testing programs:

- Equivalent expressions
- Nonlinear equations in one variable and systems of equations in two variables
- Nonlinear functions

4.5.2.1. *SAMPLE ADVANCED MATH QUESTIONS*

$$g(x) = x^2 + 55$$

What is the minimum value of the given function?

A) 3,025

B) 110

C) 55

D) 0

Key	C
Domain	Advanced Math
Skill/Knowledge Testing Point	*Nonlinear functions* Determine the most suitable form of a function to display key features

Key Explanation: Choice C is correct. A quadratic function in the form $g(x) = a(x - h)^2 + k$, where a, h, and k are constants, has a minimum value of k at $x = h$ when $a > 0$. The given quadratic function can be rewritten as $g(x) = 1(x - 0)^2 + 55$, where $h = 0$ and $k = 55$. Therefore, the minimum value of the given function is 55.

Distractor Explanations: Choice A is incorrect and may result from squaring the minimum value. **Choice B** is incorrect and may result from multiplying the minimum value by 2. **Choice D** is incorrect. This is the x-value at which the minimum value of $g(x)$ occurs.

The function h is defined by $h(x) = a^x + b$, where a and b are positive constants. The graph of $y = h(x)$ in the xy-plane passes through the points $(0, 10)$ and $\left(-2, \frac{325}{36}\right)$. What is the value of ab?

A) $\frac{1}{4}$

B) $\frac{1}{2}$

C) 54

D) 60

Key	C
Domain	Advanced Math
Skill/Knowledge Testing Point	*Nonlinear functions* Make connections between algebraic representations and a graph

Key Explanation: Choice C is correct. It's given that the function h is defined by $h(x) = a^x + b$ and that the graph of $y = h(x)$ in the xy-plane passes through the points $(0, 10)$ and $\left(-2, \frac{325}{36}\right)$. Substituting 0 for x and 10 for $h(x)$ in the equation $h(x) = a^x + b$ yields $10 = a^0 + b$, or $10 = 1 + b$. Subtracting 1 from both sides of this equation yields $9 = b$. Substituting -2 for x and $\frac{325}{36}$ for $h(x)$ in the equation $h(x) = a^x + 9$ yields $\frac{325}{36} = a^{-2} + 9$. Subtracting 9 from both sides of this equation yields $\frac{1}{36} = a^{-2}$, which can be rewritten as $\frac{1}{36} = \frac{1}{a^2}$, or $a^2 = 36$. Taking the square root of both sides of this equation yields $a = 6$ and $a = -6$, but because it's given that a is a positive constant, a must equal 6. Because the value of a is 6 and the value of b is 9, the value of ab is $(6)(9)$, or 54.

Distractor Explanations: Choice A is incorrect and may result from finding the value of $a^{-2}b$ rather than the value of ab. **Choice B** is incorrect and may result from conceptual or calculation errors. **Choice D** is incorrect and may result from correctly finding the value of a as 6, but multiplying it by the y-value in the first ordered pair rather than by the value of b.

$$(x - 1)^2 = -4$$

How many distinct real solutions does the given equation have?

A) Exactly one

B) Exactly two

C) Infinitely many

D) Zero

Key	D
Domain	Advanced Math
Skill/Knowledge Testing Point	*Nonlinear equations in one variable and systems of equations in two variables* Determine the conditions under which a quadratic equation has zero, one, two, or infinitely many real solutions

Key Explanation: Choice D is correct. Any quantity that is positive or negative in value has a positive value when squared. Therefore, the left-hand side of the given equation is either positive or zero for any value of x. Since the right-hand side of the given equation is negative, there is no value of x for which the given equation is true. Thus, the number of distinct real solutions for the given equation is zero.

Distractor Explanations: Choices A, **B**, and **C** are incorrect and may result from conceptual errors.

Which expression is equivalent to $\frac{4}{4x-5} - \frac{1}{x+1}$?

A) $\frac{9}{(x+1)(4x-5)}$

B) $\frac{3}{3x-6}$

C) $\frac{1}{(x+1)(4x-5)}$

D) $-\frac{1}{(x+1)(4x-5)}$

Key	A
Domain	Advanced Math
Skill/Knowledge Testing Point	*Equivalent expressions* Rewrite a rational expression

Key Explanation: Choice A is correct. To subtract one rational expression from another, the denominators of the expressions must be the same. Since $4x - 5$ and $x + 1$ do not have any common factors, each rational expression should be rewritten with a denominator of $(x + 1)(4x - 5)$. Multiplying $\frac{4}{(4x-5)}$ by $\frac{x+1}{x+1}$ and multiplying $\frac{1}{(x+1)}$ by $\frac{4x-5}{4x-5}$ yields $\frac{4(x+1)}{(x+1)(4x-5)} - \frac{4x-5}{(x+1)(4x-5)}$. This expression can be rewritten using the distributive property, which yields $\frac{4x+4}{(x+1)(4x-5)} - \frac{4x-5}{(x+1)(4x-5)}$. Since the denominators are the same, this expression is equivalent to $\frac{4x+4-4x+5}{(x+1)(4x-5)}$, or $\frac{9}{(x+1)(4x-5)}$.

Distractor Explanations: Choices B, **C**, and **D** are incorrect and may result from conceptual or calculation errors.

For the function f, $f(0) = 86$, and for each increase in x by 1, the value of $f(x)$ decreases by 80%. What is the value of $f(2)$?

Keys	3.44, 86/25
Domain	Advanced Math
Skill/Knowledge Testing Point	*Nonlinear functions* Create and use quadratic or exponential functions

Key Explanation: The correct answer is 3.44. It's given that $f(0) = 86$ and that for each increase in x by 1, the value of $f(x)$ decreases by 80%. Because the output of the function decreases by a constant percentage for each 1-unit increase in the value of x, this relationship can be represented by an exponential function of the form $f(x) = a(b)^x$, where a represents the initial value of the function and b represents the rate of decay, expressed as a decimal. Because $f(0) = 86$, the value of a must be 86. Because the value of $f(x)$ decreases by 80% for each 1-unit increase in x, the value of b must be $(1 - 0.80)$, or 0.2. Therefore, the function f can be defined by $f(x) = 86(0.2)^x$. Substituting 2 for x in this function yields $f(2) = 86(0.2)^2$, which is equivalent to $f(2) = 86(0.04)$, or $f(2) = 3.44$. Either 3.44 or 86/25 may be entered as the correct answer.

Alternate approach: It's given that $f(0) = 86$ and that for each increase in x by 1, the value of $f(x)$ decreases by 80%. Therefore, when $x = 1$, the value of $f(x)$ is $(100 - 80)\%$, or 20%, of 86, which can be expressed as $(0.20)(86)$. Since $(0.20)(86) = 17.2$, the value of $f(1)$ is 17.2. Similarly, when $x = 2$, the value of $f(x)$ is 20% of 17.2, which can be expressed as $(0.20)(17.2)$. Since $(0.20)(17.2) = 3.44$, the value of $f(2)$ is 3.44. Either 3.44 or 86/25 may be entered as the correct answer.

In the xy-plane, a line with equation $2y = 4.5$ intersects a parabola at exactly one point. If the parabola has equation $y = -4x^2 + bx$, where b is a positive constant, what is the value of b?

Key	6
Domain	Advanced Math
Skill/Knowledge Testing Point	*Nonlinear equations in one variable and systems of equations in two variables* Solve systems of linear and nonlinear equations in two variables

Key Explanation: The correct answer is 6. It's given that a line with equation $2y = 4.5$ intersects a parabola with equation $y = -4x^2 + bx$, where b is a positive constant, at exactly one point in the xy-plane. It follows that the system of equations consisting of $2y = 4.5$ and $y = -4x^2 + bx$ has exactly one solution. Dividing both sides of the equation of the line by 2 yields $y = 2.25$. Substituting 2.25 for y in the equation of the parabola yields $2.25 = -4x^2 + bx$. Adding $4x^2$ and subtracting bx from both sides of this equation yields $4x^2 - bx + 2.25 = 0$. A quadratic equation in the form of $ax^2 + bx + c = 0$, where a, b, and c are constants, has exactly one solution when the discriminant, $b^2 - 4ac$, is equal to zero. Substituting 4 for a and 2.25 for c in the expression $b^2 - 4ac$ and setting this expression equal to 0 yields $b^2 - 4(4)(2.25) = 0$, or $b^2 - 36 = 0$. Adding 36 to each side of this equation yields $b^2 = 36$. Taking the square root of each side of this equation yields $b = \pm 6$. It's given that b is positive, so the value of b is 6.

4.5.3. PROBLEM-SOLVING AND DATA ANALYSIS

Table 23. Digital SAT Suite Math Section: Problem-Solving and Data Analysis Content Domain.

Domain Description (Claim)	SAT	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; fit models to data and compare linear and exponential growth; and calculate, compare, and interpret mean, median, range and standard deviation, understand basic study design, and interpret margin of error, all from high school courses preparatory for the math aligned with college and career readiness expectations.
	PSAT/NMSQT, PSAT 10	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; fit models to data and compare linear and exponential growth; and calculate, compare, and interpret mean, median, range, and compare distributions with the same and different standard deviation, all from high school courses preparatory for the math aligned with college and career readiness expectations.
	PSAT 8/9	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; and fit models to data; and calculate, compare, and interpret mean, median, and range, all from middle school and first-year algebra courses preparatory for the math aligned with college and career readiness expectations.
Skill/Knowledge Testing Points	SAT	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability Inference from sample statistics and margin of error Evaluating statistical claims: observational studies and experiments
	PSAT/NMSQT, PSAT 10	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability Inference from sample statistics
	PSAT 8/9	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability

Proportions	SAT	≈15% / 5–7 questions
	PSAT/NMSQT, PSAT 10	≈20% / 7–9 questions
	PSAT 8/9	≈25% / 9–11 questions

For questions in the Problem-Solving and Data Analysis content domain, students must apply quantitative reasoning about ratios, rates, and proportional relationships; understand and apply unit rate; and analyze and interpret one- and two-variable data.

Up to seven skill/knowledge testing points are addressed in this domain, depending on the digital SAT Suite testing program:

SAT

- Ratios, rates, proportional relationships, and units
- Percentages
- One-variable data: distributions and measures of center and spread
- Two-variable data: models and scatterplots
- Probability and conditional probability
- Inference from sample statistics and margin of error
- Evaluating statistical claims: observational studies and experiments

PSAT/NMSQT and PSAT 10

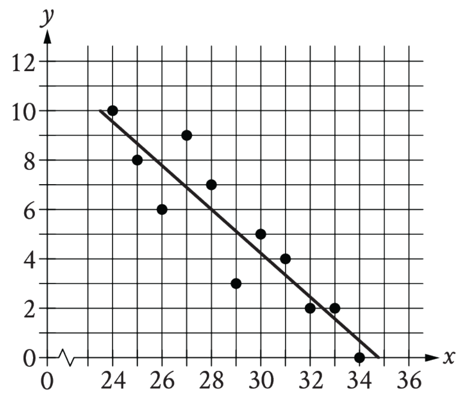
- Ratios, rates, proportional relationships, and units
- Percentages
- One-variable data: distributions and measures of center and spread
- Two-variable data: models and scatterplots
- Probability and conditional probability
- Inference from sample statistics

PSAT 8/9

- Ratios, rates, proportional relationships, and units
- Percentages
- One-variable data: distributions and measures of center and spread
- Two-variable data: models and scatterplots
- Probability and conditional probability

4.5.3.1. *SAMPLE PROBLEM-SOLVING AND DATA ANALYSIS QUESTIONS*

The scatterplot shows the relationship between two variables, x and y. A line of best fit for the data is also shown.



At $x = 32$, which of the following is closest to the y-value predicted by the line of best fit?

A) 0.4

B) 1.5

C) 2.4

D) 3.3

Key	C
Domain	Problem-Solving and Data Analysis
Skill/Knowledge Testing Point	*Two-variable data: Models and scatterplots* Analyze and interpret data in a scatterplot

Key Explanation: Choice C is correct. At $x = 32$, the line of best fit has a y-value between 2 and 3. The only choice with a value between 2 and 3 is choice C.

Distractor Explanations: Choice A is incorrect. This is the difference between the y-value predicted by the line of best fit and the actual y-value at $x = 32$ rather than the y-value predicted by the line of best fit at $x = 32$. **Choice B** is incorrect. This is the y-value predicted by the line of best fit at $x = 31$ rather than at $x = 32$. **Choice D** is incorrect. This is the y-value predicted by the line of best fit at $x = 33$ rather than at $x = 32$.

In a group, 40% of the items are red. Of all the red items in the group, 30% also have stripes. What percentage of the items in the group are red and have stripes?

A) 10%
B) 12%
C) 70%
D) 75%

Key	B
Domain	Problem-Solving and Data Analysis
Skill/Knowledge Testing Point	*Percentages* Use percentages to solve problems

Key Explanation: Choice B is correct. It's given that in a group, 40% of the items are red. It follows that the number of red items in the group can be represented by $0.4x$, where x represents the total number of items in the group. It's also given that of all the red items in the group, 30% also have stripes. It follows that the number of items in the group that are red and have stripes can be represented by $0.3(0.4x)$, or $0.12x$. The expression $0.12x$ represents 12% of x. Since x represents the total number of items in the group, it follows that 12% of the items in the group are red and have stripes.

Distractor Explanations: Choice A is incorrect and may result from subtracting 30% from 40% rather than calculating 30% of 40%. **Choice C** is incorrect and may result from adding 30% and 40% rather than calculating 30% of 40%. **Choice D** is incorrect and may result from calculating the percentage that 30% is of 40% rather than calculating 30% of 40%.

The density of a certain type of wood is 353 kilograms per cubic meter. A sample of this type of wood is in the shape of a cube and has a mass of 345 kilograms. To the nearest hundredth of a meter, what is the length of one edge of this sample?

A) 0.98

B) 0.99

C) 1.01

D) 1.02

Key	B
Domain	Problem-Solving and Data Analysis
Skill/Knowledge Testing Point	*Ratios, rates, proportional relationships, and units* Solve problems involving derived units

Key Explanation: Choice B is correct. It's given that the density of a certain type of wood is 353 kilograms per cubic meter (kg/m^3), and a sample of this type of wood has a mass of 345 kg. Let x represent the volume, in m^3, of the sample. It follows that the relationship between the density, mass, and volume of this sample can be written as $\frac{353\text{kg}}{1\text{ m}^3} = \frac{345\text{kg}}{x\text{m}^3}$, or $353 = \frac{345}{x}$. Multiplying both sides of this equation by x yields $353x = 345$. Dividing both sides of this equation by 353 yields $x = \frac{345}{353}$. Therefore, the volume of this sample is $\frac{345}{353}$ m^3. Since it's given that the sample of this type of wood is a cube, it follows that the length of one edge of this sample can be found using the volume formula for a cube, $V = s^3$, where V represents the volume, in m^3, and s represents the length, in m, of one edge of the cube. Substituting $\frac{345}{353}$ for V in this formula yields $\frac{345}{353} = s^3$. Taking the cube root of both sides of this equation yields $\sqrt[3]{\frac{345}{353}} = s$, or $s \approx 0.99$. Therefore, the length of one edge of this sample to the nearest hundredth of a meter is 0.99.

Distractor Explanations: Choices A, **C**, and **D** are incorrect and may result from conceptual or calculation errors.

4.5.4. GEOMETRY AND TRIGONOMETRY (SAT, PSAT/NMSQT, PSAT 10) / GEOMETRY (PSAT 8/9)

Table 24. Digital SAT Suite Math Section: Geometry and Trigonometry/ Geometry Content Domain.

Domain Description (Claim)	SAT (Geometry and Trigonometry)	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; determine congruence, similarity, and sufficiency using concepts and theorems about vertical angles, triangles, and parallel lines cut by a transversal; solve problems using the Pythagorean theorem, right triangle and unit circle trigonometry, and properties of special right triangles; and use properties and theorems relating to circles to solve problems, all from high school courses preparatory for the math aligned with college and career readiness expectations.
	PSAT/NMSQT, PSAT 10 (Geometry and Trigonometry)	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; determine congruence, similarity, and sufficiency using concepts and theorems about vertical angles, triangles, and parallel lines cut by a transversal; and solve problems using the Pythagorean theorem and right triangle trigonometry, all from high school courses preparatory for the math aligned with college and career readiness expectations.
	PSAT 8/9 (Geometry)	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; apply theorems such as triangle sum; and solve problems using the Pythagorean theorem, all from middle school and first-year algebra courses preparatory for the math aligned with college and career readiness expectations.
Skill/Knowledge Testing Points	SAT (Geometry and Trigonometry)	Area and volume Lines, angles, and triangles Right triangles and trigonometry Circles
	PSAT/NMSQT, PSAT 10 (Geometry and Trigonometry)	Area and volume Lines, angles, and triangles Right triangles and right triangle trigonometry
	PSAT 8/9 (Geometry)	Area and volume Lines, angles, and triangles, including right triangles
Proportions	SAT (Geometry and Trigonometry)	≈15%/ 5–7 questions
	PSAT/NMSQT, PSAT 10 (Geometry and Trigonometry); PSAT 8/9 (Geometry)	≈12.5%/ 4–6 questions

For questions in the Geometry and Trigonometry/Geometry content domain, students must address problems focused on area and volume; angles, triangles, and trigonometry; and circles.

Up to four skill/knowledge testing points are addressed in this domain, depending on the digital SAT Suite assessment program:

SAT

- Area and volume
- Lines, angles, and triangles
- Right triangles and trigonometry
- Circles

PSAT/NMSQT and PSAT 10

- Area and volume
- Lines, angles, and triangles
- Right triangles and right triangle trigonometry

PSAT 8/9

- Area and volume
- Lines, angles, and triangles, including right triangles

4.5.4.1. *SAMPLE GEOMETRY AND TRIGONOMETRY / GEOMETRY QUESTIONS*

Two nearby trees are perpendicular to the ground, which is flat. One of these trees is 10 feet tall and has a shadow that is 5 feet long. At the same time, the shadow of the other tree is 2 feet long. How tall, in feet, is the other tree?

A) 3

B) 4

C) 8

D) 27

Key	B
Domain	Geometry and Trigonometry
Skill/Knowledge Testing Point	*Lines, angles, and triangles* Use concepts of congruence and similarity of triangles to solve problems

Key Explanation: Choice B is correct. Each tree and its shadow can be modeled using a right triangle, where the height of the tree and the length of its shadow are the legs of the triangle. At a given point in time, the right triangles formed by two nearby trees and their respective shadows will be similar. Therefore, if the height of the other tree is x, in feet, the value of x can be calculated by solving the proportional relationship $\frac{\text{10 feet tall}}{\text{5 feet long}} = \frac{x \text{ feet tall}}{\text{2 feet long}}$. This equation is equivalent to $\frac{10}{5} = \frac{x}{2}$, or $2 = \frac{x}{2}$. Multiplying each side of the equation $2 = \frac{x}{2}$ by 2 yields $4 = x$. Therefore, the other tree is 4 feet tall.

Distractor Explanations: Choice A is incorrect and may result from calculating the difference between the lengths of the shadows, rather than the height of the other tree. **Choice C** is incorrect and may result from calculating the difference between the height of the 10-foot-tall tree and the length of the shadow of the other tree, rather than calculating the height of the other tree. **Choice D** is incorrect and may result from a conceptual or calculation error.

The length of a rectangle's diagonal is $5\sqrt{17}$, and the length of the rectangle's shorter side is 5. What is the length of the rectangle's longer side?

A) $\sqrt{17}$

B) 20

C) $15\sqrt{2}$

D) 400

Key	B
Domain	Geometry and Trigonometry
Skill/Knowledge Testing Point	*Right triangles and trigonometry* Use the Pythagorean theorem to solve problems

Key Explanation: Choice B is correct. A rectangle's diagonal divides a rectangle into two congruent right triangles, where the diagonal is the hypotenuse of both triangles. It's given that the length of the diagonal is $5\sqrt{17}$ and the length of the rectangle's shorter side is 5. Therefore, each of the two right triangles formed by the rectangle's diagonal has a hypotenuse with length $5\sqrt{17}$, and a shorter leg with length 5. To calculate the length of the longer leg of each right triangle, the Pythagorean theorem, $a^2 + b^2 = c^2$, can be used, where a and b are the lengths of the legs and c is the length of the hypotenuse of the triangle. Substituting 5 for a and $5\sqrt{17}$ for c in the equation $a^2 + b^2 = c^2$ yields $5^2 + b^2 = \left(5\sqrt{17}\right)^2$, which is equivalent to $25 + b^2 = 25(17)$, or $25 + b^2 = 425$. Subtracting 25 from each side of this equation yields $b^2 = 400$. Taking the positive square root of each side of this equation yields $b = 20$. Therefore, the length of the longer leg of each right triangle formed by the diagonal of the rectangle is 20. It follows that the length of the rectangle's longer side is 20.

Distractor Explanations: Choice A is incorrect and may result from dividing the length of the rectangle's diagonal by the length of the rectangle's shorter side, rather than substituting these values into the Pythagorean theorem. **Choice C** is incorrect and may result from using the length of the rectangle's diagonal as the length of a leg of the right triangle, rather than the length of the hypotenuse. **Choice D** is incorrect. This is the square of the length of the rectangle's longer side.

A circle has center O, and points A and B lie on the circle. The measure of arc AB is 45° and the length of arc AB is 3 inches. What is the circumference, in inches, of the circle?

A) 3

B) 6

C) 9

D) 24

Key	D
Domain	Geometry and Trigonometry
Skill/Knowledge Testing Point	*Circles* Use definitions, properties, and theorems relating to circles to solve problems

Key Explanation: Choice D is correct. It's given that the measure of arc *AB* is 45° and the length of arc *AB* is 3 inches. The arc measure of the full circle is 360°. If x represents the circumference, in inches, of the circle, it follows that $\frac{45°}{360°} = \frac{3 \text{ inches}}{x \text{ inches}}$. This equation is equivalent to $\frac{45}{360} = \frac{3}{x}$, or $\frac{1}{8} = \frac{3}{x}$. Multiplying both sides of this equation by $8x$ yields $1(x) = 3(8)$, or $x = 24$. Therefore, the circumference of the circle is 24 inches.

Distractor Explanations: Choice A is incorrect. This is the length of arc *AB*. **Choice B** is incorrect and may result from multiplying the length of arc *AB* by 2. **Choice C** is incorrect and may result from squaring the length of arc *AB*.

CHAPTER 5

Evidentiary Foundations

This chapter summarizes the evidentiary foundations undergirding the design and development of the digital SAT Suite. The material in this chapter is grouped into four main sections:

- research conducted or planned on the design of the digital SAT Suite itself, which includes an extensive series of one-time and ongoing studies intended to gather evidence in support of design features of the suite
- construct and content validity evidence, which affirms the choices College Board has made in determining what skills and knowledge should be assessed by the digital SAT Suite
- subject area evidence, which confirms important content emphases in English language arts/literacy and math assessment on the digital SAT Suite
- evidence on select additional topics of likely interest to educators, researchers, and policymakers

5.1 Research on the Digital SAT Suite

The process of conducting research undergirding key design decisions for the digital SAT Suite continues College Board's tradition of exhaustively examining every aspect of its tests to ensure that they meet or exceed the highest standards for large-scale standardized assessment. The following section highlights the key one-time and ongoing studies that have already been undertaken or are (as of June 2022) planned for the near future. A full account of these studies will be included in the forthcoming digital SAT Suite technical manual, which will be released sometime after the tests have been in use sufficiently long to collect necessary data on student performance under operational test-taking conditions.

Preview

In this chapter, you will find a discussion of a wide range of College Board and third-party research in support of the design of the digital SAT Suite. References for all works cited can be found at the end of the body of this document.

5.1.1. CURRICULUM SURVEY DATA

Status: Completed

College Board content and measurement staff made extensive use of curriculum survey data to inform decisions about which skills and knowledge should be tested on the digital SAT Suite. College Board's most recent curriculum survey data (College Board 2019) were collected from (1) a nationally representative sample (n=1,645) of postsecondary faculty at two- and four-year institutions who teach courses in English, math, social science, and science and (2) a nationally representative sample (n=2,686) of middle school/junior high school math teachers and high school English language arts and math teachers.

College Board analyzed the collected data to answer two main questions:

1. To what extent are the English language arts/literacy and math skills and knowledge measured on the SAT Suite deemed important for incoming students to have attained in order to be ready for and successful in entry-level, credit-bearing two- and four-year postsecondary English, math, social science, and science courses?
2. To what extent are the skills and knowledge measured on the SAT Suite being taught in middle school/junior high school math, high school math, and high school English language arts classrooms?

For the present purpose, the answer to question 1 is more central because it relates directly to the core purpose of the SAT Suite: measuring students' attainment of essential college and career readiness prerequisites.

Although this curriculum survey study was framed with the paper-based SAT Suite and its specifications in mind, its data nonetheless support the conclusion that the digital SAT Suite, which, by design, measures a highly similar range of skills and knowledge, also addresses critical college and career prerequisites in English language arts/literacy and math.

Table 25 and table 26 summarize the key findings relevant to the digital suite in English language arts/literacy and math, respectively. The mean importance rating for each skill/knowledge element included in the surveys is an average of respondents' individual importance ratings on a four-point scale, with 4 meaning very important, 3 meaning important, 2 meaning somewhat important, and 1 meaning not important. For analytical purposes, mean importance ratings of 2.50 and above identify skills and knowledge deemed important for incoming postsecondary students already to have mastered, while mean importance ratings of below 2.50 suggest skills and knowledge not important for incoming students already to have mastered. For the Standard English Conventions test section content domain, only the grand mean importance rating (the average of mean importance ratings across twenty-five skill/knowledge elements) is included due to the extensive number of testing points in this area.

Table 25. Key Postsecondary Curriculum Survey Findings: Reading and Writing (RW), All Surveyed Faculty (College Board 2019).

RW Section Content Domain	Skill/Knowledge Element	Mean Importance Rating, Standard Deviation
Information and Ideas	Read closely to . . .	
	. . . identify information and ideas stated explicitly in a text	3.77, 0.46
	. . . draw reasonable inferences and conclusions from a text	3.74, 0.48
	Cite the textual evidence that best supports a given claim or point	3.36, 0.83
	Analyze data displays to . . .	
	. . . understand the information the graphic conveys	3.27, 0.68
	. . . synthesize information in the graphic with information conveyed in words	3.22, 0.72
	Determine central ideas in a text	3.57, 0.65
	Understand cause-effect, compare-contrast, and sequential relationships in text	3.57, 0.62
Craft and Structure	Determine the meaning of words and phrases used frequently in a wide range of academic texts (“tier two” words and phrases)	2.99, 0.81
	Analyze the purpose of part of a text or the text as a whole	3.17, 0.83
	Describe the overall structure of a text	2.79, 0.90
	Determine the point of view or perspective from which a text is related	2.96, 0.88
	Analyze the influence of point of view or perspective on a text’s content or style	2.77, 0.92
	Synthesize information and ideas from multiple texts	3.25, 0.86
Expression of Ideas	Produce writing that . . .	
	. . . develops a logical argument by supporting a claim with cogent reasoning and relevant and sufficient evidence	3.49, 0.73
	. . . informs the reader or explains a concept, process, or the like	3.40, 0.76
	Create effective transitions (words, phrases, sentence) between and among information and ideas	3.11, 0.85
	Ensure precision of language for clarity and appropriateness to task, purpose, and audience	3.40, 0.79
	Use various sentence structures to achieve various rhetorical purposes (e.g., emphasis)	2.75, 0.91
Standard English Conventions	*25 skill/knowledge elements*	3.01, 0.73 (grand mean importance rating)

Source: College Board 2019, 38–41 (appendix A.1), 44–46 (appendix A.4)

Table 26. Key Postsecondary Curriculum Survey Findings: Math, Postsecondary Math Faculty (College Board 2019).

Math Section Content Domain	Skill/Knowledge Element	Mean Importance Rating, Standard Deviation
Algebra	Represent contexts using a . . .	3.67, 0.66
	. . . linear expression or equation in one variable	3.67, 0.66
	. . . linear equation in two variables	3.26, 0.91
	. . . linear inequality in one or two variables	2.82, 0.95
	. . . system of linear equations	2.93, 0.96
	. . . system of linear inequalities	2.39, 0.92
	Interpret variables, constants, and/or terms in a linear equation	3.73, 0.59
	Evaluate a linear expression	3.71, 0.61
	Solve a . . .	
	. . . linear equation	3.77, 0.54
	. . . system of two linear equations	2.96, 0.98
	Graph a . . .	
	. . . linear equation	3.71, 0.63
	. . . linear inequality	3.06, 0.95
	. . . system of two linear equations	2.86, 0.99
	. . . system of two linear inequalities	2.30, 1.00

Math Section Content Domain	Skill/Knowledge Element	Mean Importance Rating, Standard Deviation
Advanced Math	Understand numbers and number systems, including radicals and exponents and their qualities	3.48, 0.74
	Represent contexts using a(n) . . .	
	. . . quadratic equation in two variables	2.56, 1.02
	. . . exponential equation in two variables	2.27, 1.02
	Interpret variables, constants, and/or terms in a(n) . . .	
	. . . quadratic equation	3.33, 0.91
	. . . exponential equation	2.90, 0.99
	Use properties of variables to . . .	
	. . . add, subtract, and multiply polynomials	3.55, 0.78
	. . . divide polynomials	2.86, 0.96
	. . . factor polynomials	3.32, 0.93
	Evaluate a(n) . . .	
	. . . polynomial expression	3.45, 0.76
	. . . rational or radical expression	3.12, 0.99
	. . . exponential expression	3.04, 0.98
	Solve a(n) . . .	
	. . . quadratic equation	3.31, 0.91
	. . . polynomial (degree three or higher) equation in one variable	2.48, 0.96
	. . . rational or radical equation in one variable	2.79, 0.95
	. . . system of one linear equation and one nonlinear equation	2.28, 1.01
	Choose and produce equivalent forms of a quadratic or exponential equation	2.66, 0.94
	Isolate one variable in terms of other variables of an equation	3.59, 0.71
	Graph a(n) . . .	
	. . . quadratic equation	3.22, 0.98
	. . . polynomial (degree three or higher) equation in one variable	2.50, 0.99
	. . . exponential equation in one variable	2.63, 1.03
	Use and interpret function notation	3.34, 0.93

Math Section Content Domain	Skill/Knowledge Element	Mean Importance Rating, Standard Deviation
Problem-Solving and Data Analysis	Understand numbers and number systems, including . . .	
	. . . absolute value of real numbers	3.38, 0.75
	. . . elementary number theory (primes, prime factorization, divisibility, number of divisors, odd/even)	3.26, 0.87
	Solve problems with rates, ratios, and percents	3.49, 0.76
	Use units and unit analysis to solve problems	3.20, 0.88
	Identify and distinguish linear and exponential growth	2.74, 0.98
	Given a scatterplot, model statistical data with a(n) . . .	
	. . . linear function	2.65, 1.12
	. . . quadratic function	2.09, 1.02
	. . . exponential function	2.03, 0.97
	Solve problems using . . .	
	. . . measures of center, including mean, median, and mode	2.60, 1.04
	. . . measures of spread, including range and standard deviation	2.24, 1.05
	. . . sample statistics and population parameters	2.09, 1.05
	. . . probability	2.18, 1.03
	Understand the characteristics of well-designed studies, including the role of randomization in surveys and experiments	2.06, 1.01
	Read and interpret statistical graphs	2.48, 1.08
Geometry and Trigonometry	Solve problems using . . .	
	. . . area and volume formulas	3.35, 0.75
	. . . special right triangles	2.99, 1.01
	. . . the Pythagorean theorem	3.39, 0.92
	. . . theorems of triangle similarity and congruence	2.69, 1.05
	. . . circle theorems	2.52, 1.01
	. . . logical reasoning and mathematical proofs	2.62, 1.00
	. . . trigonometry relationships, including sine, cosine, and tangent	2.50, 1.19

Source: College Board 2019, 58–59 (appendix B.1), 61–62 (appendix B.4)

Note: Mean importance ratings from postsecondary math faculty (only) were considered for this analysis, rather than ratings from the full postsecondary respondent sample (as was used for English language arts/literacy) because the math skill/knowledge elements are most prerequisite for readiness for college-level math courses. Ratings from social science and science faculty to the math skills/knowledge elements listed above were generally lower, particularly in social science.

The data in table 25 and table 26 broadly confirm the validity of the selection of skills and knowledge being tested on the digital SAT Suite. In table 25 (English language arts/literacy), all skill/knowledge elements (including the twenty-five elements in the Standard English Conventions content domain considered together) are rated at or above 2.50, the threshold at which an element was considered important in the analysis. In table 26 (math), most skill/knowledge elements have a mean importance rating of 2.50 or higher, with the relatively small number that do not meet or exceed this threshold being included in the design for the sake of coherence and comprehensiveness of math domain testing. In 2024, College Board will again undertake a national curriculum survey, this time tuned to the specifications of the digital SAT Suite, to assess the continued importance of the skills and knowledge tested in the suite to college and career readiness.

5.1.2. READING AND WRITING DOMAIN MAPPING

Status: Completed in 2021

Early in the digital SAT Suite design phase, College Board content and measurement experts determined that to meet the aims for the digital tests, English language arts/literacy assessment would have to change significantly in format relative to how it has been conducted in the paper-and-pencil version of the suite. Critically, reading and writing assessment, previously separate, would need to be blended to obtain shorter testing instruments, and alternatives to the extended, multiparagraph passages used in the paper-based suite would have to be found if the test content were to be readily accessible on a range of digital devices without extensive scrolling. At the same time, to foster comparability between the digital Reading and Writing section and the paper-based Evidence-Based Reading and Writing section and to facilitate concordance between the paper-based and digital SAT Suite assessments, the digital Reading and Writing section would need to sample robustly from the same skill and knowledge domains as addressed in the corresponding paper-and-pencil section.

College Board staff thus began the design process for the digital SAT Suite Reading and Writing section by determining which Evidence-Based Reading and Writing skills and knowledge were most important to continue to test in the digital suite. Preference was given, first, to those skill/knowledge testing points for which evidence was the strongest as to their centrality to college and career readiness; second, to those testing points whose questions contributed the most psychometric value to the digital tests; and, third, to those testing points whose questions contributed most positively to concordance between the paper-and-pencil and digital SAT Suite English language arts/literacy sections.

This process resulted in a domain mapping that established which skills and knowledge would be tested and how, at what cognitive complexities and question difficulties, and in what proportions on the digital SAT Suite exams. This mapping yielded a preliminary set of Reading and Writing test specifications that would be evaluated and refined throughout the rest of the design process.

As part of this process, a small number of elements tested as part of the paper-based SAT Suite Evidence-Based Reading and Writing section were not carried over to the digital section. Passages in the U.S. founding documents/Great Global Conversation subject area were not made a formal requirement of the digital design. This was in part due to the reduction of passage length, as passages from these historical documents typically require an extended length to make a cohesive argument. More importantly, though, was the fact that evidence collected after the paper-based tests' design was complete indicates that students' ability to read and analyze these texts is not an essential prerequisite for college and career readiness (College Board 2019). In addition, two testing points in Standard English

Conventions—frequently confused words and conventional expression—were also not carried over to the digital section. These points were deemed to be conflated with spelling, which is not part of the section's construct, and feedback from independent subject matter experts suggested the possibility that questions about these points could disadvantage English learners who, in other respects, would be able to demonstrate mastery of Standard English conventions.

5.1.3. PRETESTING

Status: Ongoing; begun in 2020

In 2020, beginning with the Math section, College Board started pretesting digital SAT Suite questions on samples of the student testing population. In addition to collecting performance statistics on these new questions, pretesting in this early phase also substantiated the hypothesis that the digital SAT Suite Reading and Writing questions were as capable as their paper-and-pencil counterparts of eliciting from students a range of performance consistent with college and career readiness testing. The similarity in performance of paper-based and digital English language arts/literacy questions enhanced College Board's confidence that the questions in the digital-suite Reading and Writing section would have the same psychometrically desirable properties (e.g., adequate difficulty, sufficient ability to differentiate between lower- and higher-achieving students, absence of substantial differential performance among population subgroups) as questions in the paper-and-pencil Evidence-Based Reading and Writing section. This, in turn, increased College Board's confidence that the digital and paper-based SATs could be directly linked without a conversion table.

5.1.4. READING AND WRITING SECTION PILOTING

Status: Completed in 2021

The initial design for the Reading and Writing section of the digital SAT test was piloted using prototype test questions in February 2021. This study focused solely on the Reading and Writing section due to the number of changes introduced relative to the Math section, which is more similar in format to its paper-and-pencil counterpart. Student volunteers, each of whom had prior SAT Suite test scores, took either a test form simulating a digital SAT Reading and Writing section or participated in a control condition consisting of a portion of the paper-and-pencil Evidence-Based Reading and Writing section translated into digital form and truncated for length. After participation, students were requested to complete a postexperience survey describing their impressions of the test conditions. Performance data as well as results from this survey largely validated the preliminary Reading and Writing section design.

5.1.5. STUDENT POSTEXPERIENCE SURVEYS AND FOCUS GROUPS

Status: Ongoing; begun in 2021

For all 2023 weekend and in-school administrations of the digital SAT and PSAT-related assessments, College Board has systematically collected feedback from student test takers on various aspects of the digital-suite experience, including students' perceptions of the comprehensibility and ease/difficulty of the test questions, the quality of the opportunity offered to demonstrate their skills and knowledge, their academic preparedness for and comfort with answering the test questions, the tests' timing conditions, and their experiences with early versions of the digital test delivery interface. College Board has also inaugurated a series of ad hoc student focus groups to obtain more systematic feedback on the digital-suite tests. These focus groups to date have included both broad cross sections of the SAT Suite test-taking population as well as groups composed of members of specific test-taking subpopulations, including English learners and international students. Input from these surveys and focus groups has been correlated with student performance data to help evaluate the test design and to identify potential refinements to the tests. College Board will continue to conduct surveys and meet with focus groups as College Board continues to roll out domestic SAT weekend testing in order to collect feedback directly from the tests' most important users: students themselves.

5.1.6. TIMING STUDY

Status: Completed in 2021

The timing study conducted in the fall of 2021 was designed to ascertain whether the time initially budgeted for students to complete the digital SAT Suite Reading and Writing and Math sections was sufficient to allow the vast majority of them to finish the test sections without rushing. "Speededness" is an undesirable test characteristic in assessments such as those in the digital SAT Suite because the constructs being tested pertain to English language arts/literacy and math achievement, not test-taking speed.

To assess timing conditions, comparable samples of student volunteers were given otherwise identical digital SAT Suite test sections under different timing conditions, and both performance and self-reported experience data were collected. Although the data suggested that the overwhelming majority of students had enough time to complete both sections without rushing and that therefore the digital SAT Suite tests were not speeded, College Board psychometricians determined that adding a few minutes to the Reading and Writing section would help an additional segment of the test-taking population finish the section without rushing. Based on a thorough analysis of the findings, College Board leadership decided to slightly increase the amount of time students had in Reading and Writing (from the initially proposed sixty minutes to sixty-four minutes) and slightly decrease the number of questions asked (from fifty-six to fifty-four). The Math section saw an identical decrease in the total number of questions administered in the section (from forty-six to forty-four) but no change in the amount of time allotted, as the study data indicated that there was no solid basis for increasing the time to complete that section.

5.1.7. SAT CONCORDANCE STUDIES

Status: Completed in 2023; monitoring ongoing

Two concordance studies, conducted in the spring and fall of 2022, provided data to establish the direct relationship between paper-based and digital SAT scores.

Direct relationship in this sense means that scores on the two versions of the SAT are comparable for the students and test forms included in the studies—that is, scores of 540 on either test would be comparable, and scores from both tests could be fairly evaluated side by side without a concordance table. These studies' results support the hypothesis of a direct one-to-one relationship between the two versions of the assessment. Students participating in these studies received college-reportable SAT scores, which, among other benefits, ensured maximal motivation on the part of test takers. Note that this study process only concorded the two versions of the SAT; concordance between the two versions of the PSAT-related assessments will occur subsequently and may require conversion tables.

5.1.8. VERTICAL SCALING STUDIES

Status: Conducted in 2022; monitoring ongoing

These two studies, conducted in the spring and fall of 2022, were designed, in conjunction with the concordance studies described above, to establish the reporting scale for the entire digital SAT Suite by collecting student performance data on full-length exams under typical administration conditions, with the exception that some students may have taken an "off-grade-level" exam. (For example, a ninth grader may have taken either the PSAT 8/9 or the PSAT 10 exam.) The results of the study confirmed the expected relationships to grade-level performance. For example, high school juniors performed, on average, better than high school sophomores irrespective of whether they took the SAT or PSAT 10. The study also supported the conclusion that the specific version of digital SAT Suite assessment has little impact on scores. For example, high school sophomores performed about the same on all three assessments (SAT, PSAT 10, PSAT 8/9), with variations due mainly to differences in content. For more information on the value of the digital SAT Suite's vertical scale in tracking student growth in meaningful ways, see section 2.2.8.2.

5.1.9. ALIGNMENT TO STATE COLLEGE AND CAREER READINESS STANDARDS

Status: Ongoing

Although the digital SAT Suite has not been designed to measure any particular set of state college and career readiness standards for K–12 students, alignment studies undertaken by College Board indicate strong alignment to these standards generally. This is no accident, as the digital SAT Suite and these standards documents are derived from the same sorts of evidence about essential prerequisites for college and career readiness.

College Board will issue alignment reports for each set of state standards and will update these documents as states revise their expectations. These reports, focused on clarity and usability, will summarize the degree of alignment in reading, writing, language, and math as well as provide detailed tables showing the match between specific standards and skill/knowledge elements tested on the digital SAT Suite and vice versa.

5.1.10. INDEPENDENT STATE STANDARDS ALIGNMENT STUDIES

Status: Completed in 2023 (SAT) and to be completed in 2024 (PSAT-related assessments)

To supplement and validate the internally produced alignment studies discussed above, College Board has contracted with an independent, third-party firm with extensive experience in alignment work to evaluate the degree of match between the digital SAT and the Common Core State Standards (CCSS).

Note: The CCSS were chosen as the basis for this alignment study because of their wide use in the U.S. educational system and because, like the digital SAT Suite, the CCSS are grounded in high-quality evidence regarding essential college and career readiness outcomes. The tests of the digital SAT Suite were not designed to measure CCSS outcomes specifically, and College Board's internally developed alignments (mentioned above) document strong alignment to academic standards in both Common Core and non–Common Core states. Moreover, College Board is assisting and will continue to assist states that wish to conduct independent, third-party alignments to their own specific sets of standards.

The digital SAT-to-CCSS alignment study, completed in 2023, reached the following conclusions:

1. The overall purposes, content domains, and emphases of the digital SAT correspond to the overall purposes, content domains, and emphases of the CCSS.
2. A content analysis of four digital SAT forms as well as a stratified sample of items from the digital-suite item pool demonstrated that
   a. all Reading and Writing and Math items aligned to at least one CCSS standard;
   b. all CCSS content domains, with the intentional exclusion of Speaking and Listening, were represented by items in the digital-suite item pool; and
   c. the digital-suite items demonstrated the full range of cognitive complexity expected by the CCSS.
3. The test forms overall were considered acceptably aligned to the CCSS.

Additional research studies for the PSAT-related assessments are underway and expected to be completed in 2024.

5.1.11. PILOT SAT PREDICTIVE VALIDITY AND CONVERGENT VALIDITY STUDIES

Status: Complete

College Board's pilot predictive validity study examined relationships between digital SAT scores and key college and career readiness outcomes, while the convergent validity study examined whether digital SAT scores relate to (i.e., "agree" with) other established educational measures, such as high school GPA (HSGPA) and AP Exam scores, to the same degree that paper-based SAT scores do.

Findings from the pilot predictive validity study, which focused on first-year college performance, showed that digital SAT scores are as predictive of students' college performance as are paper-and-pencil SAT scores. Moreover, the study found that the accuracy of predictions of students' college performance notably improved when digital SAT scores were considered in combination with HSGPA relative to when HSGPA was used alone—a 22 percent improvement for the overall student sample and a 38 percent improvement for those students majoring in STEM (science, technology, engineering, and math) fields.

Strong positive digital SAT score relationships with first-year college GPA (FSGPA) were also observed for population subgroups such as underrepresented minority students, first-generation college students, and students who identified their best language(s) as being a language other than English or as English and another language.

When performance in specific first-year college coursework domains was examined, strong positive relationships were seen between digital SAT Math section scores and both math and STEM course grades. Digital SAT Reading and Writing section scores were also able to differentiate among levels of postsecondary course performance in all non-math coursework.

These findings mirror those found from studying digital SAT score relationships with first-semester college performance, reported on in 2023.

College Board's convergent validity study examined relationships between digital SAT scores and other relevant educational achievement measures, such as HSGPA, PSAT/NMSQT total score, and average AP Exam score, and compared those relationships to their paper-and-pencil SAT equivalents. Results indicated that students' digital SAT scores were strongly positively related to their scores on the paper-based SAT. Moreover, the strength of the relationships of the digital SAT with other measures of academic achievement—HSGPA, PSAT/NMSQT total score, and average AP Exam score—paralleled the strength of the relationships found between the paper-based SAT and these same measures. Given this, relationships between digital SAT scores and other student outcomes such as first-year GPA are expected to parallel those found with the paper-based SAT, which should give paper-based SAT score users confidence in the value of digital SAT scores for understanding student readiness for college, predicting students' college outcomes, making course placement and scholarship decisions, and identifying students needing academic support.

5.1.12. COGNITIVE LABS

Status: Ongoing; one report released in 2024, with others to follow in 2024–2025

In 2023, College Board undertook a cognitive lab study to confirm that, as with the paper-and-pencil SAT (College Board and HumRRO 2020), questions on the digital SAT Suite are capable of eliciting from students the sorts of higher-order, cognitively complex thinking required for college and career readiness. The methodology of this study made use of think-aloud protocols to gain insight into students' thinking processes as they read and answer select digital SAT Suite test questions. Such evidence is important, first, because it serves to confirm that the digital SAT Suite is an appropriately challenging set of assessments aligned with college and career readiness requirements and, second, because federal peer review of state accountability systems using the digital SAT Suite requires such evidence for the states' systems to meet expectations.

For the 2023 study (College Board 2024), twenty-six high school juniors and seniors volunteered to think aloud as they answered a set of twenty Reading and Writing section questions, while another twenty-three students participated in thinking aloud through a set of twenty Math section questions. Questions from both sections were chosen to be broadly representative of the sections' designs, including key skill/knowledge elements, question difficulty levels, subject areas, question formats (for Math), and text complexity levels (for Reading and Writing). Each participant engaged in a one-on-one interview session conducted via Zoom, wherein students were briefed on the task by a trained interviewer, experienced modeling of thinking aloud by the interviewer, had one or more opportunities to practice thinking aloud themselves, and then conveyed as much as possible about their concurrent thoughts as they worked through and attempted to answer a set of digital SAT Suite test questions.

Transcripts were produced from these interview sessions and analyzed qualitatively and quantitatively by College Board assessment and subject matter experts.

Qualitatively, each student's response to each test question was coded against a set of required (Reading and Writing) or expected (Math) behaviors. These behaviors, predefined by the College Board research team, described the aspects of cognitively complex thinking various question types are intended to elicit. Each student participant was judged by the researchers to have or have not demonstrated each of these behaviors in their response to the questions, and their responses were coded correspondingly. Vignette candidates of students exhibiting these behaviors and, in the process, demonstrating exemplary (if not necessarily perfect) thinking through a given question were also identified during the coding stage.

In quantitative terms, the College Board researchers tabulated several statistics from the coding. The most important metric for each Reading and Writing and Math question is referred to in this report as the *differential*. This differential is the arithmetic difference between (1) the number of students who answered a given test question correctly and (2) the number of students who both answered the question correctly and also demonstrated all required (Reading and Writing) or at least one expected (Math) behavior. A low differential—one of 5 or lower—was deemed evidence of a given test question having performed as intended, as the majority of students would've demonstrated requisite elements of cognitively complex thinking in line with the question type's intended construct (i.e., the academic concept the question type is trying to assess students' attainment of). A higher differential, by contrast, was suggestive that a given question wasn't performing as intended, though mitigating factors may have led the researchers to conclude that the question was still capable of eliciting aspects of cognitively complex thinking.

All examined Reading and Writing questions and the vast majority (85 percent) of examined Math questions performed as intended, with differentials from 0 to 5. Two Math questions had differentials greater than 5, but the qualitative evidence suggests that students were still exhibiting aspects of cognitively complex mathematical reasoning. A third Math question was answered correctly by no student, so although it technically had a differential of 0, it was considered an outlier. Vignettes of student performance associated with each of the forty questions supply additional evidence that the questions elicited cognitively complex thinking from student participants.

The key finding of this study is strong confirmation of the hypothesis that the digital SAT Suite assessments are capable of eliciting cognitively complex thinking from student test takers. This is important because, first, a large body of evidence supports the conclusion that students need to be able to engage in such thinking to be college and career ready (i.e., prepared to succeed in college or workforce training programs without remediation) and, second, because the U.S. Department of Education requires states using the digital-suite tests (or other off-the-shelf large-scale standardized assessments) as part of their education accountability systems to supply evidence that the tests are capable of eliciting such thinking. Based on the findings reported here, policymakers should have high confidence that the tests of the digital SAT Suite of Assessments satisfy these criteria. In addition, the results and the methodology laid out in this report may be useful to researchers interested in evaluating the cognitive demands of large-scale standardized assessments.

The full report can be downloaded from College Board's website at **https://satsuite.collegeboard.org/media/pdf/digital-sat-cognitive-lab-report.pdf**.

Beginning in 2024, College Board will conduct additional cognitive labs with members of select test-taking population subgroups, including English learners, students with dyslexia, and students with ADHD, to examine these students' thought processes as they take portions of the tests. The two main goals here are, first, to learn more about how students in these population subgroups engage with test materials and, second, to see whether changes in test design introduced by the digital SAT Suite contribute to more accurate assessment of these students' knowledge and skills via the elimination or reduction of construct-irrelevant barriers. Findings from these studies will be shared in 2025 and will feed into future test design and development.

5.1.13. CURRICULUM SURVEY

Status: To be completed in 2024

Section 5.1.1 describes in broad terms College Board's curriculum survey process, the results of the organization's most recent survey, and how curriculum survey data were used in designing the digital SAT Suite. In 2024, College Board will undertake a new survey to confirm or update its findings on college and career readiness requirements as well as secondary-level teaching emphases.

5.1.14. SAT PREDICTIVE VALIDITY STUDY

Status: Timing to be determined; approximately 2026–2027

A full predictive validity study evaluating the digital SAT's ability to predict outcomes in common first-year, entry-level, credit-bearing college courses will be conducted subsequent to the availability of sufficient data from operational testing to meet the goals of the study.

5.1.15. USABILITY/ACCESSIBILITY RESEARCH

The following subsections discuss two studies conducted by College Board to evaluate and improve on the more complex of the two response formats used for digital SAT Suite test questions as well as the Bluebook testing platform itself.

Student-Produced Response (SPR) Question Format (Math section only)

College Board has extensively examined how best to implement the student-produced response (SPR) question format in the digital SAT Suite's Math sections. This matter is of particular concern as the format requires more complex answer entry and verification steps on students' part than are required with selecting multiple-choice answer options.

The SPR format, which is used for roughly twenty-five percent of Math section questions on any given digital-suite test form, is intended to complement the four-option, single-select multiple-choice format used for the remainder of the questions (as well as for all Reading and Writing questions). While both question formats are suitable for assessing a wide range of skills and knowledge in math, SPR questions differ from multiple-choice questions in that students must derive and enter their own answers rather than select from a predefined option set. The use of the SPR format thus serves to assess whether students can apply their math skills and knowledge to a variety of math problems without the scaffolding and support of multiple-choice answers.

Math SPR questions require students to enter answers of up to six characters, the first of which may be a negative sign. For answers exceeding this limit, students are instructed to either round or truncate their results and are given examples of how to perform each. Students are also advised on how to properly enter fractional and decimal answers (as well as integer answers).

Over a lengthy period of development, feedback collection, and iterative improvement, College Board solicited input from content, measurement, and user experience stakeholders and students on a range of issues related to the SPR format. Across four phases of study (involving samples of 451, 796, 847, and 1,166 high school juniors and seniors), College Board researchers tested a range of SPR formats and features, including whether a single entry field or separate fields for each character should be supplied; whether students should be asked to fill in boxes or blanks; whether students preferred and had better success with dropdowns (for individual-character fields), onscreen keypads, and/or keyboards; whether the directions should be open by default or closed; how the directions themselves should appear; and what sorts of validation and error messaging would be most beneficial.

These studies concluded that having a single entry field for answers (rather than separate fields for each character) and the directions open by default provided the best results and experience. Bluebook, the digital testing application, also previews entered answers for students to help ensure that what they actually entered was what they had intended to enter (which is particularly important for the entry of mixed numbers), and error messages are presented when students make clear entry errors (e.g., a negative sign in a position other than as the first character).

Bluebook Usability and Accessibility for Students Who are Blind or Visually Impaired

The Services for Students with Disabilities (SSD) and the Accessibility Compliance Office (ACO), with support from other College Board members, conducted usability and accessibility testing at the 2022 National Federation of the Blind (NFB) convention on July 6–7, 2022. The NFB is the oldest and largest advocacy organization in the United States for blind and visually impaired people. The purpose of the test was to assess the usability and accessibility of the Bluebook application and sample test content. Because this study was conducted in 2022, this sample content consisted of the AP World History preview test, which uses the Bluebook platform and includes complex graphics, such as maps.

Eleven conference attendees participated on day 1 (July 6), and twenty-three participated on day 2 (July 7). In addition, a total of nine virtual conference attendees participated across the two days.

According to the survey responses, NFB participants found the testing experience to be 75 percent excellent/good, with 79 percent indicating that they were comfortable testing on their device. Respondents rated the alternate text descriptions highly for appropriateness (76 percent) and for providing enough information (86 percent).

Common observations included the following:

- Most participants liked the question navigator and the mark for review feature, finding these tools to be highly usable, intuitive, easy to navigate, and readable.
- Most users wanted the keyboard shortcuts for navigating the exam, entering responses, and using the exam features to be more discernable.
- Participants reported being overwhelmed with verbose alt text descriptions and indicated a desire for tactile graphics for complex images.
- Participants noted that test directions should be relevant for screen reader users. For example, the directions included information about using scratch paper, which is not of any use to a blind student, and to the countdown timer turning red when five minutes of testing remain. (Screen reader users can instead use the annotate tool to take notes during testing and set a notification for the five-minute warning.)
- Low vision users found that test graphics did not scale while zooming.

College Board continues to make iterative improvements to the Bluebook platform to better address the needs and preferences of blind and low vision test takers as well as users in general. For instance, since this study was conducted, College

Board staff have devoted considerable attention to codifying and refining alt text style to make these verbal descriptions of visual images more concise, more precise, and easier to use. (It should also be noted that the digital SAT Suite tests do not use graphics as complex as those from the sample AP content tested in the 2022 NFB study.) College Board develops its alt text descriptions in partnership with content experts and in accordance with various professional standards, including the DIAGRAM Center's Image Description Guidelines (**http://diagramcenter.org/table-of-contents-2.html**), NWEA's Image Description Guidelines for Assessments (IDGA; **https://www.nwea.org/accommodations-accessibility/**), and the Web Content Accessibility Guidelines (WCAG) produced by WC3 Web Accessibility Initiative (**https://www.w3.org/WAI/standards-guidelines/wcag/**). College Board also now strongly recommends that blind and low vision students using screen readers request supplemental raised line drawings.

5.2 Subject Area Evidence

In an ongoing fashion, College Board collects and assesses high-quality evidence about what matters most for college and career readiness in the subject areas sampled by the tests. This evidence helps inform both high-level design decisions as well as which particular skill and knowledge elements are assessed and how.

The following sections summarize the highlights of this evidence in both English language arts/literacy and math. These evidence précis have been consolidated from essay-length pieces commissioned by College Board and written by experts in the various topics addressed; following each précis is a brief discussion of the topic's links to the digital SAT Suite. Full treatments of the evidence, including instructional implications and classroom implementation advice, can be found in forthcoming College Board publications in English language arts/literacy and math.

5.2.1. ENGLISH LANGUAGE ARTS/LITERACY

Six topics are addressed in the following subsections: (1) text complexity, (2) close reading and the use of textual evidence, (3) inferences, (4) vocabulary and knowledge, (5) Standard English conventions, and (6) disciplinary literacy. Each subsection discusses why the given topic is important for college and career readiness for all students and how the topic is addressed on the digital SAT Suite tests.

5.2.1.1. *TEXT COMPLEXITY*

Why Text Complexity Is Important

Every U.S. state and dominion now has college and career readiness standards requiring that students be given access to grade-appropriate complex text, an emphasis that began with the Common Core State Standards (NGA Center for Best Practices and CCSSO 2010a). Despite this requirement, the majority of instruction in classrooms fails to provide all students with the opportunity, as part of the instructional mix, to work regularly and productively with text at appropriately challenging levels of complexity within successive grade bands (TNTP 2018). The regrettable outcome is that over the thirteen-year span of K–12 schooling, too few students climb the staircase of increasing text complexity that ends with them becoming skilled, independent readers of the kinds of texts typically required in first-year, entry-level college courses and in workforce training programs (Schak et al. 2017).

The primary reason for this failure is the well-intended but mistaken belief that if students work only or primarily with texts they can read with fairly minimal support (that is, within their "instructional" level or "zone of proximal development"), no matter how far below grade level this is, students will still progress toward grade level (Allington 2013). This approach has no support in the research literature beyond the earliest grades and has not been borne out in practice (Shanahan 2011).

Compounding the problem of inadequate exposure to complex text is the fact that the K–12 system has not provided all students with the opportunity to engage regularly in the volume and range of reading necessary to grow the vocabulary and knowledge base needed to comprehend text at the college and career readiness level by no later than the end of twelfth grade (TNTP 2018; Landauer and Dumais 1997; Cervetti, Wright, and Hwang 2016). Reading comprehension improves through practice, and the more varied and frequent those practice opportunities are, the greater the increase in capacity. It is important to note here the complementary relationship between volume and range of reading and the ability to read complex text. It is from frequent, wide-ranging reading that vocabulary grows and knowledge is gained; these acquisitions, in turn, facilitate the development of reading ability. This relationship is essential to growing students' capacity to read complex text independently and proficiently (Cervetti, Wright, and Hwang 2016; Cunningham and Stanovich 1998; Guthrie et al. 2009; Landauer and Dumais 1997; Nagy, Anderson, and Herman 1987). The majority of students who do not reach this level by the end of high school are from low-income families, making both access to complex text and expectations for amount of reading significant equity issues (Schak et al. 2017).

While significant challenges remain to getting all students fluent with complex text no later than the end of high school, there is no question about the centrality of the ability to read and analyze such texts independently to college and career readiness. Studies have demonstrated that this ability is a crucial differentiator between those who are college ready and not college ready (ACT 2006; Nelson et al. 2012).

Text Complexity on the Digital SAT Suite

Text complexity is a key consideration on the digital SAT Suite Reading and Writing section. Each of the suite's testing programs presents test takers with broadly defined ranges of appropriately challenging texts across various subject areas. Table 27 summarizes the text complexity ranges sampled by each of the testing programs.

Table 27. Digital SAT Suite Reading and Writing Text Complexity Ranges, by Testing Program.

Digital SAT Suite Program	Text Complexity Range
SAT	Grades 6–8, 9–11, and 12–14
PSAT/NMSQT / PSAT 10	Grades 6–8, 9–11, and 12–14
PSAT 8/9	Grades 6–8 and 9–11

As the table indicates, grades 12–14 texts do not appear on PSAT 8/9, as College Board made the determination that these texts were too advanced to be appropriate for use in assessing eighth and ninth graders.

To ascertain a text's complexity, College Board uses both a robust quantitative measure and a qualitative rubric. The quantitative tool takes a text of any size and produces three measurements: Syntactic Complexity, Academic Vocabulary, and an overall model prediction. The Syntactic Complexity measure evaluates more than two dozen text attributes, including mean sentence length before the sentence root, the number of dependent clauses per sentence, and intersentence cohesion. The Academic Vocabulary measure evaluates more than a dozen text attributes, including the average frequency with which words in the text appear in a corpus of college-level textbooks, the average age at which people typically acquire the words in the text, and the average concreteness of words in the text. Syntactic Complexity and Academic Vocabulary are calculated values. The model prediction is inferred from a model that has been trained on the CommonLit dataset binned into the ranges used on the digital SAT Suite.

5.2.1.2. *CLOSE READING AND USE OF TEXTUAL EVIDENCE*

Why Close Reading and Textual Evidence Use Are Important

The driving question for K–12 educators about text complexity is what to do to provide access to complex texts for all their students, not just the students performing well enough to be in traditional college preparatory tracks in high school. Two research-based means of attaining such access are employing close reading techniques and making regular use of evidence. Using close reading techniques and identifying and discussing evidence are highly efficient means of attaining competencies in literacy closely linked to readiness for and success in college, workforce training, and civic engagement in a democratic republic. In particular, the ability to identify and deploy evidence when reading and writing analytically is consistently highly ranked in polls of employers and college faculty (Hart Research Associates 2018; ACT 2016, 2018, 2020; College Board 2019; ICAS 2002). Facility with evidence is also considered essential to attaining the academic literacies that enable students from a variety of minority cultural and linguistic backgrounds to integrate successfully into postsecondary academic and technical settings (Preto-Bay 2004; Papashane and Hlalele 2014).

Close reading is sustained, purposeful intellectual work that centers on carefully reading a brief but rich and complex text (or excerpt from a longer work) in order to understand what the text says and how it says it (Beers and Probst 2012; Fisher et al. 2014; Shanahan, n.d.; Lapp et al. 2015). *Evidence* is support within a text itself, in such forms as direct quotations, paraphrases, structural elements, and quantitative data, for a reader's interpretive claim regarding the text. Evidence from text is marshaled in support of an answer to a question—either the reader's own or one posed to the reader—regarding the information, ideas, or events the text is communicating.

Gathering such evidence is arguably the primary activity readers engage in when reading closely. All other reading-related activities—for example, monitoring comprehension, questioning the text, rereading, and summarizing while reading—circle back to evidence gathering. Students have to read closely in order to locate the evidence needed to answer their own and others' questions about what an author is saying, make an effective point in a discussion, or prepare a formal response to the text. Reading for evidence demands the careful attention that is the hallmark of close reading. In turn, the process of collecting evidence returns the reader, sometimes repeatedly, to the text in a focused way. Seeking evidence provides a purpose and structure for close reading and, in so doing, leads to more careful consideration of the text than does reading with a less clear aim.

The motivation for developing and assessing students' command of textual evidence can be boiled down to three key considerations:

- Evidence skills are highly valued across and beyond disciplines.
- Comprehension, analysis, and use of evidence differentiate experts from novices.
- Exposure to and practice with evidence in reading contexts improves reasoning.

The centrality of evidence skills to educational standards is difficult to overstate. Facility with evidence is a key standard in the NAEP Writing and Reading frameworks (NAGB 2017, 2019), an anchor standard of the Common Core State Standards for Reading, for Writing, and for Speaking and Listening (NGA Center for Best Practices and CCSSO 2010a), a major pillar of the Next Generation Science Standards (NGSS Lead States 2013), and one of the four main dimensions of the *College, Career, and Civic Life (C3) Framework for Social Studies State Standards* (NCSS 2013). College Board's 2019 National Curriculum Survey Report (College Board 2019) shows that postsecondary faculty across disciplines place high value on students' skill at identifying relevant evidence. Beyond academic disciplines, scholars and public commentators routinely identify facility with evidence as a crucial component of civic life (e.g., Rosenfeld 2019).

Research on the cognitive practices of disciplinary novices and disciplinary experts shows that a major differentiator between the two groups is how they comprehend and analyze evidence: low-skill and high-skill individuals differ not merely in what they know about a given subject but also in what they know about "how to establish warrant and determine the validity of competing truth claims" using evidence (Wineburg 1991). Think-aloud studies show that when reading, expert readers analyze and evaluate evidence presented in the text significantly more than do novice readers (Nelms and Segura-Totten 2019). Linguistic evidence shows that when speaking or writing about target subjects, the biggest differentiator between experts and novices is that the former are much more likely to use words associated with causal relationships and cognitive processes and much less likely to use emotion-oriented language (Kim et al. 2011), hallmarks of evidence-based reasoning and communication. Experts are more likely to seek out evidential information and to deploy it than novices are (Peffer and Ramezani 2019).

One of the more intriguing findings of recent years regarding evidence skills is that *reading about* experiments that provide evidence relevant to claims is associated with greater conclusion accuracy and generalization ability than is *performing* those experiments (Renken and Nuñez 2009). Though this may seem counterintuitive, it accords with findings that suggest that print exposure to evidence-based arguments improves readers' own argumentation. Research suggests that direct instruction in argumentation coupled with analysis of arguments presented in text improves reasoning skills (e.g., Larson, Britt, and Kurby 2009), that reading-based inquiry instruction models improve argumentation (Probosari et al. 2019), and that the most effective intervention in this regard is instruction in warrants that link evidence to claims (von der Mühlen et al. 2019). Data suggest that evidence and argumentation skills acquired this way can be applied to new and varied contexts (Zohar and Nemet 2002). College Board's hope is that digital SAT Suite questions assessing command of textual evidence will not merely provide an assessment of students' skills with evidence but will actually improve those skills by providing focused practice in text-based evidential reasoning.

As with textual evidence, the motivation for developing and assessing students' command of quantitative evidence can similarly be distilled succinctly:

- Graphical literacy is highly valued across and beyond disciplines.
- Exposure to and practice with quantitative evidence improves data literacy.

The importance of graphical literacy has been recognized for decades (e.g., Fry 1981), and graphical literacy is a key component of the NAEP Writing and Reading Frameworks (NAGB 2017, 2019), the Common Core State Standards for Reading and for Writing (NGA Center for Best Practices and CCSSO 2010a), the Next Generation Science Standards (NGSS Lead States 2013), and the *College, Career, and Civic Life (C3) Framework for Social Studies State Standards* (NCSS 2013). College Board's 2019 National Curriculum Survey Report (College Board 2019) shows that postsecondary faculty across disciplines place high value on students' ability to read, understand, and analyze graphical data displays. Additionally, numerous scholars and commentators have noted that graphical literacy is an essential component of everyday life in the twenty-first century (e.g., Galesic and Garcia-Retamero 2011).

Evidence suggests that high levels of exposure to visually presented information in daily life are insufficient to achieve graphical literacy: so-called digital natives do not inherently have significantly developed visual literacy skills (Brumberger 2011). Instead, students' data literacy and facility with graphics improves through exposure to authentic data in learning contexts (e.g., Kjelvik and Schultheis 2019). Explicit instruction in graphical literacy that makes use of complex, realistic data is associated with both greater student comprehension of graphically presented data and improved student attitudes toward working with graphics (Harsh and Schmitt-Harsh 2016). This effect has been found among children (e.g., Phillips 1997) and college students (e.g., Picone et al. 2007) and is strongest for relatively simple graphs, such as bar graphs (ibid.). Research suggests that students should practice working with both specific data points and inferred trends (Tairab and Khalaf

Al-Naqbi 2004). College Board again hopes that these questions help improve students' graphical literacy by providing opportunities for deliberate, meaningful practice.

The careful attention that evidence collecting requires provides a payoff in the form of deepened comprehension. Whether pursuing their own learning goals or responding to questions or tasks presented to them, students need to pay careful attention to the text. The brain activates while reading, and the brains of successful readers activate in ways different than those of less proficient readers (Wolf 2018). Collecting evidence is one means of forcing the kind of attention and careful reading that can achieve deep understanding.

Close Reading and Use of Textual Evidence on the Digital SAT Suite

Close Reading

The digital SAT Suite Reading and Writing section places a premium on close reading. All test questions in the Information and Ideas content domain stress the comprehension and analysis of brief, rich texts—ideal for close reading—sampled from a range of academic disciplines and representing ways of reasoning and using evidence in those fields. Information and Ideas questions ask test takers to, for example, determine which of four quotations from a work of literature (prose fiction, poetry, drama, or literary nonfiction) best supports an interpretive claim about a character, narrator, or speaker; make a reasonable, text-based inference about the significance of a scientific phenomenon; and accurately and reasonably use data from a table or graph to assess the outcome of a governmental policy. Central Ideas and Details questions in this content domain ask students to determine the main points and understand the key supporting information of texts. As the name implies, Inferences questions call on students to make reasonable, text-based inferences by using explicitly stated and implied information and ideas. Although Information and Ideas questions draw heavily on the abilities of close reading, analysis, and reasoning, they do not require test takers to have deep background knowledge on the topics addressed or to have read any of the published works, such as novels or plays, that the questions draw from. All the information needed to answer the questions is provided as part of the questions themselves.

Other types of questions on the digital SAT Suite also call on close reading skills. In the Craft and Structure content domain, students must extend their close reading skills to address the two topically related passages found in Cross-Text Connections questions and to assess the rhetorical effects of authorial choices in Text Structure and Purpose and in Words in Context questions. In the Expression of Ideas content domain, Rhetorical Synthesis questions require test takers to selectively integrate information and ideas provided in bullet form in order to achieve a specified writerly goal. In these questions, test takers are presented with a series of two or more factual propositions situated in an academic discipline such as science or history/social studies and directed to strategically blend the content conveyed into a single, often syntactically sophisticated sentence. Each question specifies the particular rhetorical goal to be achieved, such as to support a generalization or to emphasize a contrast. The sentence test takers select from the four offered answer choices must not only include only relevant information (and exclude irrelevant information) from the set of propositions but must also achieve the specified goal. These questions do not address the conventions of Standard English—all answer choices are grammatical—but rather focus on the combining and blending of information in the service of indicated writerly goals. (Test takers' mastery of core conventions of Standard English are addressed by other test questions; see section 3.5.4.) Transitions questions, in the Expression of Ideas content domain, require test takers to determine the most logical transition word or phrase between or among information and ideas presented in texts.

Command of Evidence

In Command of Evidence: Textual questions, test takers are presented with scenario-based assertions and must select the evidence that best supports, illustrates, or weakens the assertion, as directed by the question. Textual evidence questions in informational contexts are typically based on published studies, research papers, and similar works. These questions could describe a hypothesis, claim, or conclusion and ask students to identify the evidence that would strengthen or weaken that hypothesis, claim, or conclusion. Textual evidence questions in literature contexts may present a claim about a significant work of U.S. or world literature and ask students to evaluate quotations from that work to determine which one best supports the provided claim; alternatively, these questions may describe a technique or pattern, such as an author's use of repetition, and ask students to identify which of the provided quotations from a work by that author best illustrates the author's use of that technique or pattern.

To ensure that informational textual evidence questions assess students' ability to link evidence with assertions rather than students' knowledge of actual states of affairs, these questions present evidence in conditional terms, asking students to identify the choice (such as the result of an experiment) that *would be* the best evidence for or against a proposition *if* that choice were true. This means that these questions may present scenarios or evidence that are hypothetical; for example, a question may posit the existence of a follow-up study to evaluate an actual previous finding or may present evidence that could have been collected in an actual study but was not. It also means that students do not need to know or even consider whether such-and-such a finding actually occurred to successfully answer the questions. Similarly, textual evidence questions in literature contexts do not require prior knowledge of the texts in question: the relevant assertion for which students are asked to find the best evidence is presented with the stimulus text, and the quotations in the answer choices are evaluable on their own, without knowledge of their context in the original work.

The scenarios and assertions in Command of Evidence: Textual questions are also representative of situations and tasks students encounter in academic settings. For these questions, scenarios are closely aligned with one of the several academic domains sampled by the digital SAT Suite Reading and Writing section (literature, history/social studies, the humanities, science) and their subdomains. For example, when the domain sampled is literature, a key driver of representativeness is the selection of literary works used in the questions, which reflect mainstream literature curricula (e.g., *Ethan Frome* rather than *Smuggler's Run: A Han Solo & Chewbacca Adventure*). For all Command of Evidence: Textual questions, an important consideration for representativeness is that the evidence presented reflect disciplinary standards and typical practices (e.g., personal experiences have little evidentiary power in the sciences; literary analysis distinguishes between assertions made by characters and the views of the author).

Since Command of Evidence: Textual questions assess test takers' ability to reason about evidence, the evidence presented links to the assertion via inference. That evidence does not, in other words, simply restate or paraphrase the assertion or otherwise make the item a literal comprehension task. Naturally, the scope and challenge of reasoning required varies based on testing population, intended question difficulty, and the particular context being considered, but all questions require at least some reasoning on test takers' part.

In Command of Evidence: Quantitative questions, test takers are presented with brief texts accompanying figures (tables, line graphs, bar graphs). These texts may describe the figure with little reference to outside information, may describe the actual circumstances surrounding the data (e.g., conditions under which data were collected, a hypothesis being evaluated, relevant historical or scientific context), or may present a hypothetical scenario pertaining to the data. Texts are accurate (if describing real circumstances) or plausible (if describing hypothetical scenarios). When a Command of Evidence: Quantitative question includes a description of actual circumstances, such as a specific team's hypothesis or methodology, test developers consult the original research paper or other relevant documentation to ensure that the description is accurate. Note, however, that the description in the stimulus is not *exhaustive*: it includes only information that is necessary to clarify the data and support students' completion of the task. Both to avoid unnecessary time expenditure on the part of students and to keep the focus of Command of Evidence: Quantitative questions on graphical literacy skills, informational "noise" in stimuli is minimized. The data, scenarios, and assertions in such questions are not merely plausible but also representative of data, situations, and tasks students encounter in academic settings. This goal is achieved by closely aligning questions and the data they use with one of the several academic domains sampled by the digital SAT Suite Reading and Writing section and their subdomains.

The level of cognitive complexity and question difficulty in Command of Evidence: Quantitative questions varies considerably, ranging from straightforward data-point identification through analyses of data patterns to sophisticated syntheses of data with information and ideas in stimulus texts. This range of approaches and challenge provides valuable information about students' graphical data literacy skills across a wide range of attainment.

5.2.1.3. *DRAWING INFERENCES*

Why Drawing Inferences Is Important

Decades of research (e.g., van den Broek and Helder 2017) have established that beyond fundamental decoding skills and vocabulary knowledge, much of what we think of as reading comprehension is, in fact, a web of inferencing skills. Not only sentence-by-sentence processing but also word-by-word processing appears to be highly influenced by causal inferencing on the part of readers (Kuperberg, Paczynski, and Ditman 2011). Readers use inferencing skills both to impose coherence on texts that do not cohere (or are perceived to not cohere) and to determine the purposes and significance of textual elements and information in texts that are perceived as coherent (Graesser, Singer, and Trabasso 1994). So central is inferencing to reading that many comprehension failures are, in fact, inferencing failures (Cain and Oakhill 1999).

Inferencing is a very broad category of activity, covering everything from simple mental substitutions of nouns for textual pronouns to drawing complex conclusions requiring multiple steps to reach. Early and simple inferencing ability is a strong predictor of later comprehension ability (Oakhill and Cain 2012). As readers develop in skill and maturity, the number and complexity of inferences they can draw from a text increase (Casteel and Simpson 1991), and as readers reach fluency, reading comprehension is strongly mediated by logical reasoning skills (Segers and Verhoeven 2016), with inferential reasoning skills surpassing memory of the relevant text as a driver of comprehension (Oakhill 1984).

Scholars have pointed out that while teaching logical inferencing is relatively straightforward, applying it (or general "critical thinking" skills) is much harder because inferencing typically must occur in knowledge domain contexts, to which people may struggle to map abstract inferencing skills (e.g., Willingham 2019). Although there may be general inferencing skills, those skills are rarely activated in decontextualized settings (Kendeou 2015). And not only are inferencing skills activated in contexts, but research also suggests that exposure to specific reading contexts—namely, complex texts with logically stated arguments—improves reasoning skills along with general comprehension (Osana et al. 2007). Assessing inferencing skills through context-based tasks is thus justifiable not only as a representative reading task but also because exposing students to texts with abundant causal and logical structures is productive of the very skills being assessed. In other words, exposing students to logically stated arguments both allows for the assessment of student inferencing ability and can *improve* student inferencing ability.

Given the centrality of inferencing skill to reading comprehension, it is unsurprising that the ability to make logical inferences from texts is included under the first standard in the Common Core ELA/literacy College and Career Readiness Anchor Standards (NGA Center for Best Practices and CCSSO 2010a) and was rated by postsecondary faculty as the second-most important reading skill (after explicit comprehension) in College Board's 2019 National Curriculum Survey Report (College Board 2019).

Drawing Inferences on the Digital SAT Suite

Inferencing, whether at the word, sentence, or textual level, is a routine requirement of the digital SAT Suite Reading and Writing section. The sort of complex inferencing described above, however, is most clearly represented in the Inferences questions in the Information and Ideas content domain.

Consistent with the evidence suggesting the educational value of encountering reasoning-dense prose as well as with the digital SAT Suite's aim of offering an efficient testing experience, Inferences questions distill the logical relationships inherent in longer pieces of complex, college-level prose down to single, tightly reasoned argumentative units. Each unit is presented up to the point at which the conclusion is introduced, and test takers must select the choice that most logically completes the argument. This approach allows the questions to focus students' time and attention on only the material relevant to the skill being assessed while still exposing students to the kinds of logically dense text that are characteristic of higher-level reading contexts and that help students improve as readers and thinkers.

The texts for Inferences questions reflect the logical density of authentic academic or high-level general interest prose. The texts do not take the structure of a formal logical proof but rather represent a plausible approximation of an argumentative unit that a student would encounter in an academic reading context. Accordingly, Inferences texts are presented in prose that is clear, precise, and naturalistic (neither schematic on the one extreme nor "literary" on the other), and they build toward conclusions that are nontrivial for the target testing population.

Texts read like authentic writing in the various disciplines sampled by the Reading and Writing section, such as in the science-based sample below.

> Ecologists Anna Traveset and Nuria Riera investigated a decline in the population of the shrub *Daphne rodriguezii* from some areas of Spain's Balearic Islands. Traveset and Riera observed that the greatest population of *D. rodriguezii* is found in the area where Lilford's wall lizard (*Podarcis lilfordi*), which has been reduced in many parts of the islands, still thrives; that *P. lilfordi* appears to be the only natural disperser of *D. rodriguezii* seeds; and that seeds that are not consumed by *P. lilfordi* tend to accumulate beneath parent plants, where they are easily consumed by other animals and where they may struggle to thrive due to competition. Taken together, these observations suggest that ______
>
> A) **the decline of the *P. lilfordi* population has contributed to the decline in the *D. rodriguezii* population.**
>
> B) the decline in the population of *D. rodriguezii* may be attributable to an increase in the consumption of the plants' seeds by *P. lilfordi*.
>
> C) potential dispersers of *D. rodriguezii* seeds have been outcompeted by *P. lilfordi*, leading to a decline in the population of *D. rodriguezii*.
>
> D) the islands' population of *D. rodriguezii* must have been established before the island's population of *P. lilfordi*.

The text above stands in contrast to the hypothetical text below, which gets at the same general sort of inferencing skill but in a context rooted in logic rather than the discipline-based reasoning central to digital SAT Suite Inferences questions.

> The perennial shrub *Daphne rodriguezii* is more widespread in Central America than is the flower species *Plumeria pudica*. *Daphne rodriguezii* is less widespread, however, than is the plant *Heliconia stricta*. It can be concluded that ________
>
> ***Heliconia stricta* is more widespread than is *Plumeria pudica*.**

The fact that Inferences questions are written in naturalistic language and situated in real contexts means that there are likely to be multiple ways of expressing the conclusion of any given argumentative unit, and, in some cases, there may even be other conclusions that one *could* draw from the information but that are not presented in the answer choices and that are not as good as the keyed response in the sense that they are less likely, less complete, or less significant. An Inferences question, therefore, does not ask students to identify the *correct* form of the *only* valid conclusion, as in a formal proof, but rather the most logical conclusion among the answer choices given. The conclusion in the key follows from the information in the stimulus text and is a strong "real-world" conclusion, which allows test takers to select the key affirmatively rather than select the "least bad" option through elimination.

Although Inferences questions are situated within recognizable academic domains, skilled readers are able to correctly answer the questions with only the information provided in the questions themselves and the general domain knowledge imparted by a typical rigorous high school curriculum. Inferences questions may, for example, presume that students are familiar with the idea that organisms evolve but would not presume that students know what kinds of alterations in the nucleotide sequence of the genome are most likely to produce phenotypic changes. In other words, the assessment focus of Inferences questions is on students' ability to draw reasonable inferences from complex texts, not on deep prior knowledge of the material presented.

5.2.1.4. *VOCABULARY AND KNOWLEDGE*

Why Vocabulary and Knowledge Are Important

The roles of vocabulary and knowledge in students' reading comprehension have long been overlooked in practice despite extensive research attesting to their importance. Instructional focus has instead been on the teaching and learning of discrete skills and strategies, often out of context, with the unrequited hope that they would transfer from one text to the next (Wexler 2019). Skills and strategies do indeed have a role to play in increasing students' reading comprehension, but their value pales in comparison to that of vocabulary and knowledge.

Failure to understand and act on this fact renders many students unprepared for college and workforce training as they depart high school. In particular, students from families with lower levels of formal education and students whose first language is not English frequently enter K–12 schooling with less knowledge of words and less academic domain knowledge than do their peers (Garcia 2015). Word and domain knowledge (as well as world knowledge) are essential to proficient reading comprehension, increasingly so as texts become more complex in higher grades. The failure to address this situation is one of the primary causes of the continuing gap in performance between struggling readers and their classmates who are able to access readings at or above their grade level.

The relationship between vocabulary and reading comprehension has been understood for nearly a century (Whipple 1925; Chall and Jacobs 2003). Decades of subsequent research have affirmed a close connection between vocabulary knowledge and reading comprehension skills (see, for example, Nation 2009 for an overview). This association has been found in beginning readers (e.g., Silva and Cain 2015), elementary school students (e.g., Quinn et al. 2015), middle school students (e.g., Lawrence et al. 2019), secondary school students (e.g., Ahmed et al. 2016), students with disabilities (e.g., O'Connor 2014), second-language learners (e.g., Masrai 2019), and readers of nonalphabetic languages (e.g., Dong et al. 2020).

In 2002 Isabel Beck, Margaret McKeown, and Linda Kucan introduced the notion of dividing up all words and phrases in English into three tiers as a way to create priorities within vocabulary instruction. In this scheme (Beck, McKeown, and Kucan 2013), tier one words and phrases (e.g., *family*, *fun*, *games*, *table*) are basic vocabulary and are commonly learned by children in their native language(s) through everyday discourse. Though young students will not necessarily learn all tier one words and phrases in English at the same rate, especially if they are learning English as a second or subsequent language, they will learn almost all of them sooner or later. Tier three words and phrases (e.g., *membrane*, *perimeter*, *manifest destiny*, *checks and balances*, *metaphor*) are used less frequently, and seldom in everyday conversation, and are generally specific to particular domains of knowledge (e.g., biology, geometry). Thus, they tend to appear in texts of only certain subjects, such as *tectonic* in geology texts (though tier three words and phrases sometimes "jump domains," as in *The election results signaled a tectonic shift in voter attitudes*).

Tier two words and phrases (e.g., *influence*, *produce*, *variety*, *exclusive*, *particular*) are likely to appear in a wider variety of texts than are tier three words and phrases and, unlike their tier one counterparts, appear with increasing frequency the more sophisticated that text gets. Tier two words and phrases do not have a home in any one academic subject since they occupy texts universally. While subject area teachers are eager to teach the tier three words and phrases that are the province of their disciplines (since these words and phrases often name the concepts in their fields) and while tier one words and phrases tend to be acquired through everyday discourse, tier two words and phrases are in danger of being left unattended, the responsibility of no one. Before the advent of college and career readiness standards, which shone a spotlight on the centrality of vocabulary and called out the special place of tier two ("general academic") vocabulary in students' K–12 and post–high school success, teachers tended to assume their students already understood the meaning of words and phrases in this category. If teachers thought about tier two words and phrases at all, they probably underestimated the frequency with which such vocabulary appears in the texts they assigned and failed to grasp the disproportionate role these words and phrases have in conveying texts' meaning (Snow 2010; Adams 2009).

Domain and world knowledge, too, support comprehension in a variety of ways (Britton and Graesser 2014). Knowledge strengthens readers' ability to generate the inferences from text that lead to high-level comprehension, it enhances readers' ability to combine information from parts of a text (or multiple texts) into a coherent understanding, and it allows readers to integrate textual information with their prior knowledge.

Vocabulary and Knowledge on the Digital SAT Suite

Vocabulary

Although vocabulary knowledge and skills are so central to reading comprehension that any robust assessment of the latter will, to some degree, assess the former, there is merit to assessing vocabulary skills in a focused way. While vocabulary knowledge may be *necessary* for comprehension, it is not *sufficient* for comprehension (Biemiller 2005). A variety of factors affect overall comprehension, making it difficult to provide useful information about student achievement, progress, and needs with regard to vocabulary acquisition and mastery if vocabulary skills are only assessed indirectly through more general comprehension tasks.

Adult (including college-level) readers rarely activate vocabulary knowledge in the absence of context. Instead, readers access and apply their vocabulary stores as they encounter or produce words in particular contexts (e.g., reading a news article or chemistry textbook, writing a sales report or term paper), and despite the renewed emphasis on direct vocabulary instruction in the twenty-first century, most vocabulary *acquisition* occurs through repeated contextual exposure (Stahl 2003). Assessments of vocabulary knowledge and skill that do not reflect the contextual nature of vocabulary acquisition and activation may risk underestimating what students know and can do (Pearson, Hiebert, and Kamil 2007). The importance of contextualized vocabulary is reflected in the findings of College Board's 2019 National Curriculum Survey Report (College Board 2019), where postsecondary faculty rated the context-based understanding of word meanings as a skill of high importance.

In the context of the digital SAT Suite, the three-tier vocabulary model (Beck, McKeown, and Kucan 2013) is best thought of as a general framework for evaluating words under consideration for inclusion in test questions. Words in Context questions in the Craft and Structure content domain focus on high-utility academic, or tier two, words. These are words, typically acquired through direct instruction or reading exposure, that have broad applicability across academic and career contexts and are central to unlocking the meaning of text, particularly of the kinds of complex text encountered in secondary and postsecondary instruction as well as in the workplace. It is worth recalling that word tiers do not (and are not intended to) include static, universally recognized banks of words. Words and senses of words rise and decline in frequency and general familiarity (e.g., the increasing prevalence of terms such as *application* and *program* in reference to computer technology), common words can have specialized meanings in different contexts (e.g., *selection* in a biology context vs. common speech), and people can reasonably disagree about whether particular words properly belong to one tier or another.

Additionally, there are many words that are not discipline specific (and so may not commonly be thought of as tier three) but are nevertheless sufficiently rare in writing across domains that they are not worth including in Words in Context questions. Words such as *lassitude*, *supercilious*, and *adumbrate*—while they have real-world value and appeal in certain limited contexts—have low enough frequency to preclude their being tested profitably on the digital SAT Suite and are not the focus of Words in Context questions.

In addition to the guidance of the three-tier framework, College Board uses empirical evidence to guide the selection of focal words for Words in Context questions, namely

- test-based age-of-acquisition ratings (originally generated by Dale and O'Rourke 1981, updated and validated by Brysbaert and Biemiller 2017), which provide test-based data about the age by which people tend to have acquired the meanings of given words;
- human-rater age-of-acquisition ratings (Kuperman, Stadthagen-Gonzalez, and Brysbaert 2012), which indicate the age by which people believe that they had learned given words; and
- word frequency data gathered by College Board from a corpus of hundreds of the most frequently assigned introductory-level college textbooks across subject areas, which reveal the words that students most need to know to comprehend the texts they are actually being assigned in U.S. colleges and universities.

These measures, used in conjunction with the judgment of experienced test developers, ensure that the words being tested in Words in Context questions are of high utility for college- and career-ready readers.

Words in Context questions present high-utility academic words in rich contexts, by which is meant contexts reflective of college- and career-ready reading experiences and aligned with specified knowledge domains. Many Words in Context questions discuss real people, places, research findings, books, artworks, events, and so on, and even Words in Context questions that include generic elements are grounded in real contexts (e.g., an art critic's claim about abstract expressionist painters, a researcher's study of panda metabolism).

Knowledge

Although the digital SAT Suite Reading and Writing section is expressly not a measure of test takers' knowledge in the subject areas the section samples, and while digital SAT Suite Reading and Writing questions contain all the information needed to answer them correctly, they do call on test takers' abilities to read and comprehend appropriately challenging texts in these areas, to use critical reasoning and analytical skills developed in and particular to subject area courses, and to apply these skills and knowledge to questions grounded in texts and contexts reflecting the academic demands of these areas. In other words, knowledge building in the subject areas lays the foundation for success on the tests and, more importantly, in test takers' postsecondary educational pursuits. For additional information on the discipline-based nature of the digital SAT Suite Reading and Writing section, see section 5.2.1.6.

5.2.1.5. *STANDARD ENGLISH CONVENTIONS*

Why Standard English Conventions Are Important

Standard English is the variety of English that has tended to be most valued in academic and professional settings (Beason 2001; O'Neill 2018). Although there is some variation in the grammatical forms (such as passive voice) and levels of formality preferred in different academic disciplines and workplace settings, decades of research have shown that effective use of Standard English is a fundamental expectation in academic and professional settings. The term *Standard English* (also sometimes *Standardized English*) refers to the spoken and written language varieties that are expected in most institutional contexts in the United States, such as government and schools. The *conventions* of Standard English are the patterns, or "rules," of grammar, usage, punctuation, capitalization, and spelling that are generally accepted in the present day.

However, the conventions of Standard English are not just about rules and "correctness." They also contribute to clear and effective communication in academic and other institutional contexts. For instance, in Joseph Williams and Joseph Bizup's well-known book on writing, *Style: Lessons in Clarity and Grace* (2017), readers are taught to put their most important ideas and "actors" in the subjects of their sentences and to vary sentence length using subordinate clauses for rhetorical effect. Having a language to talk about grammatical concepts such as these can help students become aware of the conventions of Standard English in different disciplines and make deliberate, well-informed choices about how to use language for clear and effective written and formal spoken communication. Thus, understanding and controlling for the conventions of Standard English to accomplish specific purposes and to reach intended audiences are valuable academic and professional skills that contribute to college and career readiness.

Terms such as *conventions*, *usage*, and *effective communication* can help teachers convey the changing nature of Standard English more accurately than can terms such as *proper English*, *correct English*, and *rules*. *Conventions* and *usage* also reflect a descriptive view of Standardized English rather than a prescriptive one. Prescriptive views of language are based in a static view of English as having just one "correct" variety and as being governed by a prescribed set of rules—even when those rules are rarely adhered to in practice. One example of a prescriptive rule is "Don't split an infinitive"—a directive that is regularly broken in written Standard English and whose violation is rarely viewed by readers as an error (Beason 2001). Descriptive views of language, on the other hand, acknowledge that what counts as acceptable or effective Standard English changes over time and is determined by how real people use and respond to language patterns.

Thus, descriptive views of Standard English seek to convey current uses of and perspectives on language conventions rather than a static and potentially outdated vision of what the conventions of Standard English "should" be.

In discussions of grammar and conventions, it is also helpful to distinguish Standard English from *vernacular* or *nonstandard dialects*. All languages, including English, encompass multiple varieties, or *dialects*. The term *dialect* refers to the patterns of language used by a particular group with a shared regional or social affiliation. We all speak a dialect even if we are unaware of it. The terms *vernacular dialect* and *nonstandard dialect* help distinguish other language varieties from Standardized English, the variety typically used and expected in academic and professional settings, but the use of those terms should not be taken to imply that these language varieties are less grammatical, less logical, or less communicative or expressive than Standard English. Some well-researched vernacular dialects in the United States include Appalachian English, African American English, and Chicano English. Decades of research have shown that valuing, discussing, and building on students' home languages and dialects benefit their language and literacy learning (Heath 1983; Lee 2007). Conversely, telling students that the nonstandard varieties of language they are using are wrong or improper can hinder students' language and literacy learning.

Teachers as well as students benefit from viewing the conventions of Standard English as tools for clear and effective communication in academic and professional settings rather than simply as rules. This descriptive, communicative perspective on Standard English changes the teacher's role from being a judge of whether prescriptive rules of grammar have been followed to being a coinvestigator of patterns of conventions and usage in different academic subjects and genres. It also provides teachers with a more productive answer to the student question "Why do we have to know this?" Developing students' awareness and command of the conventions of Standard English is beneficial to their future academic and professional pursuits, and this work can be undertaken in creative, engaging ways. By teaching conventions of Standard English as meaningful and useful, educators can empower students to succeed in college, the workplace, and beyond.

Standard English Conventions on the Digital SAT Suite

The digital SAT Suite Reading and Writing section addresses core conventions of Standard English sentence structure, usage, and punctuation in context-bound ways focused on enhancing the communicative power of text rather than simple demonstrations of "correctness." Test questions in the Standard English Conventions content domain take two main forms. Boundaries questions require test takers to apply Standard English conventions when editing short texts (typically one or two sentences in length) to ensure that the resultant sentence(s) conventionally separate or join phrases, clauses, or sentences. These questions address such matters as standard end punctuation, semicolon and colon use, and the conventional use (or nonuse) of punctuation, such as commas, dashes, and parentheses, to set off (or not set off) information and ideas within sentences. Form, Structure, and Sense questions, on the other hand, assess test takers' ability to apply core Standard English grammar and usage conventions in context, such as ensuring subject-verb agreement, using verb tenses and aspects appropriately, and appropriately forming and using plurals and genitives (possessives). In both broad types of questions, test takers work in authentic, meaningful contexts grounded in the academic disciplines, and the focus is on enhancing the communicative power and clarity of text.

5.2.1.6. *DISCIPLINARY LITERACY*

Why Disciplinary Literacy Is Important

As students advance through school, the texts they read become more specialized. A second grader's social studies textbook is different from a high school junior's history book, and young children's science texts are akin to their social studies books in a way not true of high school texts in the same subjects. To read these more specialized texts properly—in ways that would lead to thorough comprehension and sophisticated interpretations appropriate to those disciplines—students need to approach them with a knowledge of a discipline and its purposes, content, and methodologies.

The term *content knowledge* refers to an awareness or understanding of information on a particular topic. Knowing the distinction between *meiosis* and *mitosis*, that the Great Depression began in 1929, and that *Narrative of the Life of Frederick Douglass, an American Slave* was one of three autobiographies written by this magisterial author, orator, and activist are all examples of content knowledge. It is important that students learn some of the facts and information (content knowledge) produced by the disciplines. However, other kinds of knowledge matter too.

Students should also develop knowledge of a discipline. This *disciplinary knowledge* encompasses an awareness of a discipline's purposes and methodologies: how and why experts do their work, what constitutes a reasonable claim, and how one can appropriately refute such claims. In a history class, it may be important that students learn what the Battle of the Bulge was (a German offensive during World War II) and some facts about it (e.g., the Germans were defeated). But disciplinary knowledge leads students to search for the causes of the battle, to ask why it was considered so significant, or to question the particular interpretation of it in the text they are reading. Students need to gain both content knowledge and disciplinary knowledge; they need to know not only the whats but also the whys and hows of a discipline.

It is this disciplinary knowledge that underlies a discipline's literate practices, and students must have such knowledge if they are to read and write appropriately within a discipline. Disciplinary knowledge includes an understanding of how a field creates, communicates, and evaluates information. Knowing about the discipline can help students understand whether a given text is important and, if it is, what in it is essential. Often students asked to highlight the important information in a text—a popular content area reading strategy—end up underlining nothing or everything because they lack the disciplinary insights that would allow them to distinguish the vital from the incidental (Dunlosky et al. 2013).

Students who recognize what is important in a history text (e.g., who the author is, historical figures' intentions) or science text (e.g., what processes are involved in mitosis or chemical reactions) are better able than their peers to separate wheat from chaff. Disciplinary awareness can help students identify and evaluate the evidence in written arguments. Experimental evidence, for instance, is especially important in arguments in science but not so much in history. Students can use knowledge of a discipline to determine the voice to adopt in writing, how to use the technical vocabulary of a field, and so on in ways consistent with the core beliefs, values, and practices in that field. Accordingly, literacy instruction with disciplinary texts should be closely aligned with the mores, normative standards, traditions, skills, and social discourse practices of the disciplines.

As different as the various disciplines and their specializations may be, one thing remains the same: experts in all fields read and write. Experts in scientific and other technical fields, for example, spend substantial amounts of time reading and writing (Kwon 2017; National Science Foundation 1976; Tenopir, King, and Bush 2004). Scientists read journal articles, review research literature, make grant applications, collaborate through email exchanges, create detailed records of experiments in laboratory notebooks, write journal articles and research reports, and engage in dozens of other daily reading and writing tasks in their work routines. It is fair to say that one could not participate in science successfully without the ability to read well and with great stamina and to communicate in writing in ways characteristic of science. Given the ubiquity of reading and writing within the disciplines, it seems only right that schools not only have students read and write throughout the curriculum but also give them explicit guidance in the special text features and ways of reading and writing specific to various fields of study.

One reason students struggle in college, the workplace, or the military is lack of sufficient literacy skills. Because so many students are underprepared, a high percentage of them require remediation in college, with about 40 percent of first-year postsecondary students nationwide requiring remedial support in reading or writing (Bautsch 2013). The National Assessment of Educational Progress (NAEP) reports that only 37 percent of twelfth graders taking the 2019 NAEP Reading assessment scored at or above the proficient level in reading (NCES, n.d.). Especially worrying is that proficiency in literacy in the United States is highly unequal: according to 2018 data from the Programme for International Student Assessment (PISA), the gap in reading scores between students in the top and bottom quarters of the economic, social, and cultural status index in the United States was larger than that in all but two countries where it was measured (Schleicher 2019).

According to NAEP, the problem is not one of basic literacy. Nearly all students in the United States are able to read and write: they can sign their names, decode and understand simple messages, and the like. What is missing is the ability to read complex texts in sophisticated ways and to communicate complicated ideas subtly and persuasively—outcomes more likely to be accomplished through a disciplinary literacy approach than one aimed at trying to teach general reading comprehension or writing skills.

Disciplinary Literacy on the Digital SAT Suite

The requirements of literacy in the disciplines deeply inform the digital SAT Suite Reading and Writing section. Texts appearing in the section reflect the demands of literacy in the disciplines of literature, history/social studies, the humanities, and science. Science and social science texts, for example, discuss hypotheses, methodology, data, conclusions, and implications and may be accompanied by informational graphics (tables and graphs) that display associated data and otherwise complement the information and ideas conveyed in words. Questions throughout the Reading and Writing section call on test takers to respond in ways appropriate to the various disciplines. These demands begin with the stimulus texts associated with individual questions. These texts, though brief, are richly reflective of the concerns, methods, and ways of thinking and creating knowledge in the various academic disciplines from which they sample. They pose scenarios, present information and ideas, assert claims, and offer evidence in ways that embody the norms and conventions of the subject areas. While literature questions ask test takers to support interpretive claims about published works using actual quotations from the texts or present excerpts from published works for test takers to analyze, questions set in science or social science contexts may ask test takers to accurately and skillfully use data from experiments or observational studies, represented in a table or graph, to support or challenge an argumentative claim appropriate to those fields. To answer these questions successfully, test takers need not only broad-based reading comprehension and data analysis skills but also an understanding of how and for what purposes various subject areas create and convey knowledge. In this way (and in others), questions on the Reading and Writing section encourage test takers' development of disciplinary knowledge in authentic ways, even as the questions themselves provide all the information necessary to answer them without topic-specific background knowledge.

5.2.2. MATH

Four topics, each corresponding to one of the digital SAT Suite Math section content domains, are discussed in this section: (1) algebra, (2) advanced math, (3) problem-solving and data analysis, and (4) geometry and trigonometry. Each subsection discusses why the given topic is important for college and career readiness for all students and how the topic is addressed on the digital SAT Suite tests.

5.2.2.1. *ALGEBRA*

Why Algebra Is Important

There has been substantial and sustained interest in promoting students' success in algebra for a generation or more. In large-scale studies (e.g., Adelman 2006; Gamoran and Hannigan 2000; Lee and Mao 2021; Trusty and Niles 2004), success in algebra has been linked to increased secondary and postsecondary course taking, improved high school and college graduation rates, and more productive job and career outcomes. For instance, in examining nationally representative longitudinal data to study the long-term educational and career trajectories of students who were enrolled in tenth grade in 1980 (i.e., presumptive members of the high school graduating class of 1982), Rose and Betts (2001, xix) found that "math curriculum is strongly related to student outcomes more than 10 years later," including college graduation rates and earnings. Notably, Rose and Betts found that "the biggest difference [among student outcomes] is between courses at or above the algebra/geometry level and courses below the algebra/geometry level" (xix–xx), by which they meant vocational math and prealgebra.

Recognition of the importance of strong skills in algebra has led to efforts to incorporate algebraic thinking into the elementary school curriculum (e.g., Kieran et al. 2016). Furthermore, while taking first-year algebra (Algebra I) was historically a part of the ninth-grade curriculum, many students now take this course in eighth grade or earlier (Stein et al. 2011). In almost all districts, a passing grade in Algebra I is a requirement for high school graduation.

Facility with algebra opens many doors for students; lack of such facility carries the significant risk of keeping those doors shut, whether we consider educational or vocational aspirations. Mastering concepts taught in algebra courses is viewed as a key prerequisite on the path to higher-level math courses, particularly calculus (e.g., Kaput 1995; National Mathematics Advisory Panel 2008; Rakes et al. 2010; Stein et al. 2011). Biag and Williams (2014) extend this value proposition further by noting that students failing Algebra I (and potentially having to retake it) are in danger of being cut off from advanced high school science coursework given those courses' algebra prerequisite. Lack of algebra skills and knowledge can also inhibit or exclude students from pursuing a range of well-paying blue- and white-collar jobs, including, among others, careers as carpenters, electricians, millwrights, and sheet metal workers as well as actuaries, architects, dietitians and nutritionists, and market research analysts (Weedmark 2018).

In short, lack of access to or success in high-quality Algebra I instruction is a significant and, arguably, insuperable barrier to students' academic success in high school, postsecondary education, and well-paying careers. Algebra, and specifically the Algebra I course, is, therefore, an enormously important milestone in students' math learning.

Algebra on the Digital SAT Suite

Coursework in algebra is very important in each student's math journey, and facility with algebra provides students with opportunity for further success, while lack of facility burdens them with risk of reduced opportunity. As a result, skills in algebra have significant representation on the digital SAT Suite exams. Questions in the Algebra content domain of each exam align most closely with topics covered in a typical rigorous first-year secondary algebra course, including assessing the skills and knowledge associated with working with linear expressions, linear equations in one and two variables, linear functions, systems of linear equations, and linear inequalities. Test questions cover such skills and knowledge as creating and using a linear equation; identifying an expression or equation that represents a situation; interpreting parts of a linear equation in context; making connections between linear equations, graphs, tables, and contexts; determining the number of solutions and the conditions that lead to different numbers of solutions; and calculating and solving. The test questions aligned to algebra skill/knowledge elements range in difficulty from relatively easy to relatively complex and challenging. The test questions require students to demonstrate skill in generalization, abstraction, and symbolization, with a strong emphasis on equivalence and using structure. Many of the test questions are constructed to allow for more than one solving strategy.

5.2.2.2. *ADVANCED MATH*

Why Advanced Math Is Important

This subsection proposes a working definition of *advanced math* focused on a broad conceptual divide between a key focus of Algebra I and higher-level math: while Algebra I attends centrally to the concept of linear equations and functions, advanced math, as we treat it here, focuses centrally on nonlinear equations and functions. One way to quickly conceptualize this distinction is to note that linear equations and functions graph as straight lines, while nonlinear equations and functions do not. Because nonlinear equations and functions are more conceptually complex than linear ones and because an understanding of the former builds on an understanding of the latter, nonlinear properties can reasonably be categorized as "advanced." Indeed, as students progress in their study of math, they build on their earlier experiences with algebraic expressions and linear functions to investigate the ways in which nonlinear equations and linear functions are powerful tools for making sense of and modeling phenomena in their worlds.

Advanced math skills and knowledge, as we have defined them here, are relevant to secondary-level students in numerous ways. First, advanced math in high school serves as a bridge to still more advanced coursework in math in both high school and college, and it opens access to coursework in secondary and postsecondary science that has advanced math prerequisites. Carnevale and Fasules (2021, 1), for example, pulled together data from the U.S. Census Bureau and the Occupational Information Network, a database sponsored by the U.S. Department of Labor's Employment and Training Administration, and found that "jobs in science, technology, engineering, and math (STEM) use the highest levels of math, with 92 percent of STEM workers needing to know at least Algebra II. . . . Most STEM jobs require even higher-level math, with 67 percent requiring college-level math such as calculus." Thus, the study of advanced math is an essential pathway toward STEM-related professions.

Second, attaining advanced math skills and knowledge in high school is important for college and career readiness for students seeking entry into a wide range of blue- and white-collar occupations, both outside and, especially, within STEM fields. Based on statistical analysis of employment data as well as input from business leaders and over three hundred two- and four-year faculty, the American Diploma Project (2004) found a convergence between the knowledge and skills employers seek in new workers and those that college faculty expect of entering students. In particular, both employers and college faculty expect high school graduates to be able to apply math concepts typically taught in advanced secondary coursework in algebra. This finding for the continued work in math beyond a first course in algebra is consistent with the more recent recommendation from the report *Catalyzing Change in High School Mathematics: Initiating Critical Conversations* (National Council of Teachers of Mathematics 2018). This report recommends that high schools offer continuous four-year math pathways, including two to three years in a common pathway that includes focused attention on learning the concept of function (one of the "Essential Concepts" in high school math).

Third, acquisition of advanced math skills and knowledge is associated with positive educational and economic outcomes for students. Advanced math is typically a requirement for entry into a four-year college. For example, in an analysis of college-going California high school students, Asim, Kurlaender, and Reed (2019) found that compared to the overall population of high school seniors, a significantly larger proportion of students who applied and were admitted to either a California State University or a University of California institution took advanced math courses (for which advanced algebra is a prerequisite) in their senior year. This is consistent with prior research that found similar correlations to college entry as well as to college completion (e.g., Gottfried, Bozick, and Srinivasan 2014; Long, Conger, and Iatarola 2012). Research also has identified correlations between higher earnings and completion of more and higher levels of math (e.g., Rose and Betts 2004). Indeed, Moses and Cobb (2001) refer to algebra as the new civil right, as students who do not have access to higher-level math have less access to economic mobility.

Fourth, principles and methods of advanced math can be applied productively to analyze and understand a gamut of academic and real-world scenarios that students will encounter throughout their lives. Because many authentic applications, both within the field of math and in the real world, are nonlinear, students will need to work with quadratic, polynomial, rational, exponential, and other nonlinear functions. For example, quadratic functions are useful models for understanding and analyzing real-world situations such as forecasting business profit and loss, modeling projectile motion, and describing the movement of bouncing objects. Polynomial functions can be used to model the curves in a roller coaster, the concentration of a particular drug in the bloodstream, and other real-world situations. Rational functions are useful for analyzing real-world phenomena such as density, work, rates of change, and volume. Modeling with exponential functions is also important in such contexts as bacteria growth, the depreciating value of a vehicle, or the value of an investment over time. The study of these different nonlinear function types can develop both the habits of mind and habits of interaction that students need to become powerful users of math, to better interpret and understand their worlds, and to make better predictions about phenomena of interest.

Advanced Math on the Digital SAT Suite

The advanced math topics assessed on the digital SAT Suite exams extend those covered in the Algebra content domain topics into nonlinear equations and functions and align most closely with topics mastered in a typical rigorous second-year secondary algebra course and sometimes beyond. Since these Advanced Math test questions build on skills and knowledge first mastered with linear expressions and equations, it follows that these topics should also be well represented on college and career readiness exams such as those of the digital SAT Suite. As a result, skill/knowledge elements in Advanced Math are represented on the digital SAT Suite exams in relatively high proportions.

The Advanced Math content domain assesses skills and knowledge associated with working with quadratic, exponential, polynomial, rational, radical, absolute value, and conic section equations and functions. Similar to Algebra questions, test questions in the Advanced Math domain cover such skill/knowledge elements as creating and using a nonlinear equation; identifying an expression or equation that represents a situation; interpreting parts of an equation in context; making connections between equations, graphs, tables, and contexts; determining the number of solutions and the conditions that lead to different numbers of solutions; and evaluating and solving using nonlinear equations and systems that include a nonlinear equation. The test questions in the Advanced Math domain range in difficulty from relatively easy to relatively complex and challenging. Many of the test questions represent challenging, authentic problems in context for which students can draw on strategies developed during their coursework to solve.

5.2.2.3. *PROBLEM-SOLVING AND DATA ANALYSIS*

Why Problem-Solving and Data Analysis Are Important

Data are everywhere, and working with, understanding, and learning from data have become necessities in our daily lives. Personal data are commonly collected through our digital devices, and our daily behaviors are routinely recorded. Businesses, governments, and other entities use data analytics and powerful computing technology applied to massive pools of information to inform decision making (Pence 2014), with examples including developing marketing targeted to consumer interests; predicting rises and falls of demand for products and services; improving app-based navigation; aiding healthcare providers in suggesting courses of treatment; detecting financial fraud; and tracking the spread of foodborne illness (Rice 2022; Helms 2015).

Now more than ever, then, it is essential that all students leave secondary school prepared to live and work in a data-driven world (Engel 2017). The development of statistical thinking and data acumen is imperative today, as every individual must use data to make informed decisions involving numerous aspects of their lives (National Academies of Sciences, Engineering, and Medicine 2018; Wilkerson 2020). Many college majors require coursework in statistics (American Statistical Association, n.d.), and statistician jobs are expected to grow by about 35 percent between 2020 and 2030 (U.S. Bureau of Labor Statistics 2021). Postsecondary education in statistics is also changing to meet the demands of twenty-first-century life and careers, with the *Guidelines for Assessment and Instruction in Statistical Education (GAISE) College Report* calling for the preparation of students in statistics at the college level to shift from centering on the application of a list of formulas to a focus on developing the skills of interpretation and understanding data (GAISE College Report ASA Revision Committee 2016). Enrollment of college students in statistics has steadily increased, with the latest (2015) data from the ongoing survey conducted by the Conference Board of the Mathematical Sciences (CBMS) of math and statistics departments at two- and four-year colleges and universities showing that 737,000 students took statistics courses as part of their undergraduate work (Blair, Kirkman, and Maxwell 2018). This represents a 56 percent increase in enrollment in statistics classes since the year 2000, the initial year the CBMS survey was administered.

With ubiquity of data comes responsibility. Although not all students will become statisticians or professional data analysts, they still must be able to check data sources and "mind" the data they encounter. Data minding (Meng 2021, 1161) is a "stringent quality inspection process that scrutinizes data conceptualization, data preprocessing, data curation and data provenance." In other words, students, regardless of their educational plans and intended career paths, must be data literate, able and disposed to act as knowledgeable users of data themselves as well as informed consumers of other people's efforts to use data to support claims and guide actions.

Problem-Solving and Data Analysis on the Digital SAT Suite

The previous subsection builds an argument that it is essential that students leave secondary school prepared to work with data, armed with statistical thinking skills and data acumen. Additionally, students need to understand concepts from the study of probability in order to understand the importance of randomness in statistics.

Two foundational topics that flow through the math curriculum, typically starting in grade 6 and continuing through high school, are developing an understanding of proportional reasoning and applying proportional relationships to solve single-step and multistep problems. Proportional reasoning is an important skill when solving percent-based problems, including discounts, tips, sales tax, interest, unit rates, and percent increase and decrease, and thus it is assessed, at appropriately challenging levels, throughout the digital SAT Suite, including on the SAT.

The Problem-Solving and Data Analysis content domain assesses knowledge and skills in solving problems using ratios, rates, proportional relationships, unit analysis, percentages, probability and conditional probability, one- and two-variable data, scatterplots, and models. Unlike topics covered in the Algebra and Advanced Math content domains, the topics addressed by the digital SAT Suite in Problem-Solving and Data Analysis are not aligned to those covered in a specific secondary-level course. State education systems include the topics covered in this domain in a variety of courses, starting with middle school/junior high school math and continuing through high school. The test questions in the Problem-Solving and Data Analysis domain range in difficulty from relatively easy to relatively complex and challenging and test a wide range of reasoning skills.

5.2.2.4. *GEOMETRY AND TRIGONOMETRY*

Why Geometry and Trigonometry Are Important

Because geometry, historically the study of shapes and their properties, originates in the study of the measurement of the earth (*Merriam-Webster* 2021), it is one of the oldest branches of math and is, in some ways, the most immediately relevant. Freudenthal (1971) argued that the study of math should be tied to the world in which we live, else it is easily forgotten and rarely used. Geometry is inherently related to modeling the world around us, which includes measuring objects in space and developing spatial and deductive reasoning.

The value of geometry in K–12 education extends beyond the typical merits of understanding a subject to helping lay the foundations for achievement in other branches of math. Topics in geometry and measurement were considered Critical Foundations of Algebra by the National Mathematics Advisory Panel (NMAP) (2008). The report the panel produced specifically discussed the importance of similar triangles to understanding slope and linear functions. In addition, the panel suggested that to prepare for algebra, “students should be able to analyze the properties of two- and three-dimensional shapes using formulas to determine perimeter, area, volume, and surface area” and “should also be able to find unknown lengths, angles, and areas” (18). Similarly, the authors of the Common Core State Standards for Mathematics (CCSSM) (NGA Center for Best Practices and Council of Chief State School Officers 2010b, 84) observed that “solving real-world and mathematical problems involving angle measure, area, surface area, and volume” are high priorities for college and career readiness. Additionally, a survey of college math faculty (Er 2018) rated reasoning and generalization—skills developable through the study of geometry—as both the most important math competencies for incoming college students to have previously mastered and the least likely to have been attained. Further, the study of geometry prepares students for trigonometry and precalculus, the latter of which Atuahene and Russell (2016) have shown that 53 percent of first-year college students struggle with, earning D, F, or W (withdrawal) grades at the end of a semester-long course. Geometry and trigonometry content is important not only academically for STEM fields (e.g., engineering, medicine) but also for careers in the trades (e.g., transportation, construction) and the arts (Morgan 2018).

Historical assessment data from students in the United States relative to students from other nations show a long-term trend of weak performance on items related to geometric reasoning and measurement (Carpenter et al. 1980; Fey 1984; Stigler, Lee, and Stevenson 1990). More recent findings have not improved the picture. Data from the Trends in International Mathematics and Science Study (TIMSS) highlighted geometry and measurement as the biggest areas of weakness for eighth-grade students from the United States (Ginsburg et al. 2005), and geometry performance by U.S. high school students was the lowest among the sixteen participating countries (Mullis et al. 1998). The most recent National Assessment of Educational Progress (NAEP) with publicly released test items (NAGB 2013) includes a grade 12 question asking students to determine the area of a triangle in a 3D figure. Only 5 percent of U.S. students were able to give a correct answer and show how they found the area of the figure. Additionally, it is well documented that U.S. high school students struggle with formal proof (e.g., Stylianides, Stylianides, and Weber 2017), which is why they need more opportunities for informal reasoning and sense making. These data are concerning given the importance of these topics for college and career readiness.

Geometry and Trigonometry on the Digital SAT Suite

Geometry is all about modeling the world around us, and knowledge of geometry helps lay the foundation for further achievement in math. Skills, knowledge, and concepts learned in the study of geometry are included in questions in the Geometry and Trigonometry content domain (for the PSAT 8/9 only, the Geometry domain) but are also woven into questions in the Algebra and Advanced Math domains, where geometric objects are sometimes used as contexts for building functions or modeling real-world scenarios. Geometry content on the digital SAT Suite is covered in secondary-level courses from grade 6 through high school. Trigonometry skills and knowledge are tested only on the SAT, PSAT/NMSQT, and PSAT 10, as these are typically taught and learned only in more advanced high school courses.

Test questions in the Geometry and Trigonometry content domain involve applying skills and knowledge in finding areas, perimeters, volumes, and surface areas; using concepts and theorems related to lines, angles, and triangles (PSAT 8/9 includes triangle angle sum theorem only); solving problems using right triangles (SAT, PSAT/NMSQT, and PSAT 10 only); solving problems using right triangle trigonometry (SAT, PSAT/NMSQT, and PSAT 10 only); calculating using sine, cosine, and tangent (SAT only); solving problems using radian measure and trigonometric ratios in the unit circle (SAT only); and using definitions, properties, and theorems relating to circles (SAT only). These test questions vary in difficulty from easy to very hard and allow students to demonstrate problem-solving skills and knowledge using a variety of solving strategies.

5.3 Discussion of Select Additional Topics

This section offers treatments on a small number of topics likely of interest to various users (and potential users) of the digital SAT Suite:

- the appropriateness of the use of short passages on the Reading and Writing section
- the allowance of a calculator throughout the Math section
- the appearance of "below-grade-level" content in the Math section

5.3.1. USE OF SHORT PASSAGES IN THE READING AND WRITING SECTION

One of the concerns that may emerge from an examination of the test specifications for the digital SAT Suite Reading and Writing section is the lack of the extended-length passages that appeared in the paper-based SAT Suite's Evidence-Based Reading and Writing section. As discussed in chapter 2 and in more detail in chapter 4, the transition to the digital SAT Suite Reading and Writing section entails a shift toward shorter stimulus passages, each associated with a single question, instead of sets of test questions associated with a single long passage or pair of passages. People learning of this for the first time may well wonder, first, whether this results in a reduction of the challenge or rigor of the assessment and, second, whether this signals that reading stamina—the ability to persist in the face of long and/or complex reading—is no longer considered of value by College Board. The answer to both these questions is a firm "no," as discussed in the next two subsections.

5.3.1.1. *RIGOR*

The Reading and Writing section of the digital SAT Suite is no less rigorous than the paper-based SAT Suite Evidence-Based Reading and Writing section, including in terms of the level of challenge represented by both the stimulus passages and the associated test questions. Evidence for this conclusion comes from a comparison of the characteristics of passages and questions in both paper and digital versions of the SAT Suite and from an analysis of test takers' statistical performance on the assessments in both modes.

Comparison of Paper and Digital Passage and Question Features

Passages. An examination of two passages—one used in the paper-based SAT Suite, the other a sample digital-suite question also found in chapter 4—is useful here as a way to illustrate that although the length of passages has decreased with the move to the digital SAT Suite, the challenge level and other desirable features of the passages have not changed.

Figure 3. Side-by-Side Comparison of Paper-Based and Digital SAT Reading Passages.

Paper-and-Pencil SAT Passage (Excerpt)

This passage is adapted from Sabrina Richards, "Pleasant to the Touch." ©2012 by The Scientist.

In the early 1990s, textbooks acknowledged that humans had slow-conducting nerves, but asserted that those nerves only responded to two types of stimuli: pain and temperature. Sensations of pressure and vibration were believed to travel only along myelinated, fast-signaling nerve fibers, which also give information about location. Experiments blocking nerve fibers supported this notion. Preventing fast fibers from firing (either by clamping the relevant nerve or by injecting the local anesthetic lidocaine) seemed to eliminate the sensation of pressure altogether, but blocking slow fibers only seemed to reduce sensitivity to warmth or a small painful shock.

Håkan Olausson and his Gothenburg University colleagues Åke Vallbo and Johan Wessberg wondered if slow fibers responsive to gentle pressure might be active in humans as well as in other mammals. In 1993, they corralled 28 young volunteers and recorded nerve signals while gently brushing the subjects' arms with their fingertips. Using a technique called microneurography, in which a fine filament is inserted into a single nerve to capture its electrical impulses, the scientists were able to measure how quickly—or slowly—the nerves fired. They showed that soft stroking prompted two different signals, one immediate and one delayed. The delay, Olausson explains, means that the signal from a gentle touch on the forearm will reach the brain about a half second later. This delay identified nerve impulses traveling at speeds characteristic of slow, unmyelinated fibers—about 1 meter/second—confirming the presence of these fibers in human hairy skin. (In contrast, fast-conducting fibers, already known to respond to touch, signal at a rate between 35 and 75 m/s.) . . .

Digital SAT Passage

Jan Gimsa, Robert Sleigh, and Ulrike Gimsa have hypothesized that the sail-like structure running down the back of the dinosaur *Spinosaurus aegyptiacus* improved the animal's success in underwater pursuits of prey species capable of making quick, evasive movements. To evaluate their hypothesis, a second team of researchers constructed two battery-powered mechanical models of *S. aegyptiacus*, one with a sail and one without, and subjected the models to a series of identical tests in a water-filled tank.

Commentary: These two passages have comparable levels of text complexity, are both grounded in academic discourse, and exhibit similar degrees of scientific reasoning. However, on the real exam, the paper-and-pencil-based passage requires the processing of six additional paragraphs beyond what is excerpted here before students can begin answering the several associated questions. Thus, the digital SAT passage above accomplishes the same general goal of assessing reading, analysis, and reasoning in the academic disciplines but in a more compact, focused form that nevertheless does not simplify the task for students.

Questions. Continuing the example from figure 3, we can observe in figure 4 that the two passages are equally capable of eliciting complex, higher-order thinking from test takers. The keyed response (best answer) to each question is in boldface.

Figure 4. Side-by-Side Comparison of Paper-Based and Digital SAT Reading Comprehension Questions.

Paper-and-Pencil SAT Question

Based on the passage, textbook authors in the early 1990s would most likely have expected which condition to result from the blocking of fast fibers?

A) The rate at which other nerve fibers fired would increase.

B) The test subject would perceive gentle stimuli as painful.

C) The body would compensate by using slow fibers to sense pressure.

D) The ability to perceive vibrations would be impaired.

Digital SAT Question

Which finding from the model tests, if true, would most strongly support Gimsa and colleagues' hypothesis?

A) The model with a sail took significantly longer to travel a specified distance while submerged than the model without a sail did.

B) The model with a sail displaced significantly more water while submerged than the model without a sail did.

C) The model with a sail had significantly less battery power remaining after completing the tests than the model without a sail did.

D) The model with a sail took significantly less time to complete a sharp turn while submerged than the model without a sail did.

Both the above questions call for students to demonstrate high levels of reading, analysis, and reasoning skills and knowledge. Notably, both questions require students to demonstrate the ability to infer reasonably from the information provided in the associated passage to determine the most appropriate text-supported conclusion. Although the preceding is only one pair of examples, it illustrates the digital SAT Suite Reading and Writing section's capability of eliciting cognitively complex thinking from students despite the more compact, focused nature of the stimulus passage. If anything, the digital passage and question actually serve to reduce the requirement on students to demonstrate cognitively lower-level abilities of skimming, scanning, and recognizing relevant information in favor of demonstrating the higher-order abilities of analyzing, inferring, and synthesizing. The Reading and Writing section includes both literal- and higher-order reading questions but emphasizes the latter as more central to the assessment of college and career readiness in reading.

In section 5.3.1.2, we offer additional evidence, this time in the form of a sample student think-aloud response from a cognitive lab study (College Board 2024), indicating that digital-suite Reading and Writing questions are capable of eliciting cognitively complex thinking from test takers and thus exhibit appropriate levels of rigor in accordance with college and career readiness requirements.

Comparison of Paper and Digital Question Performance

We can also consider the question of SAT Suite test rigor in broad statistical terms. As observed in section 5.1.7, two concordance studies, conducted in 2022, established a direct relationship between paper-based and digital SAT scores, meaning that the two versions of the test are comparable and their results can be used side by side meaningfully. As part of those studies, the correlation between the section score of the paper-and-pencil Evidence-Based Reading and Writing section and the raw IRT theta score of the digital Reading and Writing section was found to be 0.869, a high result suggesting that the two versions of the SAT ELA/literacy section, as intended, test similar content in similar ways.

In addition, as discussed in section 5.1.11, College Board's pilot predictive validity study, which focused on first-semester college performance, showed that digital SAT scores are as predictive of students' college performance as are paper-based SAT scores, and the organization's convergent validity study indicated that students' digital SAT scores were strongly positively related to their scores on the paper-based SAT and that the strength of the relationships between the digital SAT and other measures of academic achievement—high school GPA, PSAT/NMSQT total score, and average AP Exam score—paralleled the strength of the relationships found between the paper-based SAT and these same measures.

Taken together, these concordance, pilot predictive validity, and convergent validity study results support the claim that the Reading and Writing section of the digital SAT (and, by extension, the other highly similar tests of the suite) possesses statistical characteristics and utility highly comparable to those of the paper-based SAT (and the paper-and-pencil PSAT-related assessments).

5.3.1.2. *STAMINA*

The second question that may arise concerning the transition to shorter test passages on the digital SAT Suite's Reading and Writing section is whether something critical—an indirect assessment of students' reading stamina—that may have been present in the paper-based SAT Suite is missing from the digital suite. Relatedly, some may wonder whether College Board is devaluing the importance of reading stamina in students' college and career readiness.

Before exploring this issue in detail, it is critical to clarify that the SAT Suite assessments, whether in their paper-based or digital iteration, are not intended to directly measure students' reading stamina. For this reason, College Board did not provide any information about students' reading stamina with paper-based SAT score reports and does not provide such information with digital SAT Suite score reports. Similarly, College Board is not aware of any research that would support using differences in students' scores on either the paper-based or digital

SAT Suite assessments to infer differences in students' reading stamina. Although some casual observers may assume that SAT Suite assessments indirectly assess students' reading stamina in a way that manifests in their scores, this would not be a psychometrically appropriate interpretation of those scores. There is not sufficient evidence that would allow a user of SAT Suite assessment scores to draw valid conclusions about how much (if any) of the difference in students' scores can be attributed to differences in those students' reading stamina as opposed to differences in other ELA/literacy–related attributes—such as inferencing skills, vocabulary knowledge, or facility with grammatical conventions—that are directly assessed in the SAT Suite.

In the reading field, there is widespread consensus that stamina is an important attribute in reading comprehension specifically and in academic success more generally (e.g., Hiebert 2014). This consensus is clearly reflected in the design of College Board's secondary instructional programs, including Pre-AP and AP. These programs call on students to routinely read extended texts in various academic subject areas and to respond productively to these texts—in classroom discussions, daily assignments, longer-term projects, and the like—in ways that demonstrate both their comprehension and their ability to persist through readings that may pose significant challenges to understanding, both in terms of length and richness of subject matter. Through these and other offerings, College Board continues to signal its strong belief in reading stamina as a critical factor in fostering students' academic development and college and career readiness.

The question then becomes whether the absence of extended passages on assessments is of special concern. Although the matter is subject to reasonable debate, the evidence College Board has collected suggests that there is not a strong warrant to favor long passages over shorter ones on assessments such as those of the SAT Suite.

It is important, first, to note that even the extended-length passages on the paper-and-pencil SAT Suite—which could be up to 750 words long—were themselves only proxies of the much longer texts students have to read in secondary and postsecondary classrooms. Typical secondary and college-level reading assignments are orders of magnitude longer than the longest passages used on the paper-based SAT Suite or, indeed, on single-sitting assessments of any kind. Short of specifying very long texts to be read in advance of testing, it is simply not possible for single-sitting assessments such as the SAT Suite tests to replicate the reading stamina requirements of naturally occurring academic settings, and it would be an undue burden on test takers even to try to replicate those requirements.

One reason that paper-and-pencil SAT Suite reading passages were as long as they were is because the previously published texts excerpted or adapted for the Reading Test, and as exemplified in figure 3, contain numerous elaborations—examples, analogies, clarifying remarks, and other devices used by authors to create cohesive, readable texts. Daley and Rawson (2019) found that such elaborations, particularly in textbooks assigned to students, are associated with substantial time burdens on readers but do not increase readers' comprehension of the information and ideas presented and that "unelaborated" texts, such as those found on the digital SAT Suite Reading and Writing section, convey information and ideas more efficiently.

Furthermore, the research literature offers ambiguous signals about the ideal length of reading assessment texts. Efforts to understand the effect of passage length on reading comprehension and its assessment trace all the way back to the 1950s. Derrick (1953, 2), for instance, posed the following research question: "Are there reading skills which can be tested when [test] items are written on a connected passage of 1000 words that cannot be" on a much shorter passage? His study answered in the negative: there appeared to be no reading skills that can be directly assessed with a long passage that cannot also be directly assessed with much shorter passages. "This evidence," Derrick concluded, "should give pause to those who reject by fiat the conventional reading test which uses relatively short reading passages" (69).

In the years since Derrick's (1953) study, various researchers with differing interests have investigated the question of the effect of text length on measures of reading comprehension, reaching no firm consensus. Engineer (1977; cited in Alderson 2000, 108–9) determined that texts of longer than a thousand words evoked qualitatively different reading comprehension responses than did shorter texts and concluded that such length served to reduce the impact of word- and sentence-level textual factors on comprehension, allowing readers to focus more on the text at a discourse level.

Mehrpour and Riazi (2004), on the other hand, found no significant reading comprehension performance differences, as measured by responses to multiple-choice questions, between samples of adult learners given either a set of standard TOEFL passages or the same set of passages reduced in length by roughly a third. Jalilehvand (2012) presented samples of similar-ability Iranian high school students with either a long (309-word) text or a shorter version of the same text (218 words), which was either accompanied or not by an illustration (not described in the study but presumably intended to provide additional context for the comprehension task). Jalilehvand found no significant effect of text length on comprehension, as measured by multiple-choice and true-false questions. Bae and Lee (2018) examined the performance of college-age students on the Korean College Scholastic Ability Test (CSAT) on both multiple-choice fill-in-the-blank and open-ended inference questions. They found that doubling or tripling the length of the test's roughly 150-word passages (by adding text before or after the original excerpts) had no significant effect on test takers' performance on the multiple-choice questions, although higher-achieving students, on average, did better on the open-ended questions when more information was provided in the passages.

Although studying students younger than those in the digital SAT Suite population and focused on potential differences between silent and oral reading, Grant's

(1980) examination of reading comprehension among a sample of average-ability sixth graders is still intriguing. Grant found no significant differences in reading achievement, as measured by literal- and inferential-level questioning, when participants were asked to read either an intact narrative passage of 672 words or the first roughly two hundred words of that narrative, whether silently or orally. Interestingly, however, Grant also found that those participants asked to retell the narrative (via spontaneous recall and open-ended questioning) demonstrated significantly greater comprehension than those participants who only answered direct questions about the text, although participants in both conditions answered the direct questions at similar rates, leading Grant to speculate that "information is supplied during spontaneous recall and open-ended questioning that is significantly different than the type of information sought by means of traditional questioning" (59).

Newsom and Gaite (1971) found that after one week, their adult participants exhibited significantly better retention of information from a short passage of about 300 words than from the roughly 2,300-word fiction passage from which the short passage was derived. Rothkopf and Billington (1983) found a negative association between passage length and comprehension due to information acquisition (rather than recall) difficulties—in other words, they found that it was harder for test takers to acquire relevant information from longer than from shorter passages. Mesmer and Hiebert (2015) also found a negative effect of length on comprehension in texts of the same quantitative complexity level, although they did not identify a causal factor. Surber (1992) found that students attend more closely to shorter texts than to longer ones. In Surber's experiment, students read long texts almost twice as quickly on a per-word basis as they read short texts and highlighted 70 percent fewer sentences of text. Surber raises the possibility that shorter texts induce "greater depth of processing" than do longer texts, but as he only tested the recall of basic information, which was not affected by text length, this possibility was not directly evaluated.

At present, then, the research literature lacks a firm consensus on the role of text length on reading comprehension assessment. Some studies found an effect, though not always in favor of longer texts, while others did not.

We can, however, draw out two factors that may go some distance toward explaining the discrepancies in study results. First, the absolute (rather than just proportional) difference in length between "short" and "long" texts seems to matter. Jalilehvand's (2012) "short" and "long" reading passages differed in length by only roughly one hundred words, whereas Newsom and Gaite's (1971) passages differed in length by approximately two thousand words; the former found no significant recall differences, while the latter did. Second, the nature of the recall task seems to matter. Both Bae and Lee (2018) and Grant (1980) found evidence of qualitatively different kinds and/or degrees of recall when such tasks involved traditional direct questioning as opposed to more open-ended or spontaneous recall.

While the research literature cited above offers no clear consensus, we make two tentative assertions based on the findings. First, the difference between longer paper-based and shorter digitally based SAT Suite passages may, in the main, not be significant enough in magnitude to lead to meaningful differences in how test takers approach associated questions. Second, such evidence as there is in the literature implies that even if such differences exist in theory, they are not elicited by the use of multiple-choice questions as the basis for assessment—though they might be were open-ended response tasks used instead. At the very least, the extant literature offers no strong case that the length of passages used in the digital SAT Suite's Reading and Writing section poses a significant barrier to valid comprehension assessment.

Given the lack of strong consensus in the research literature to guide digital SAT Suite test design and development with respect to optimal text length, it makes sense now to turn briefly to evidence collected by College Board itself that substantiates the ability of the section's short passages to elicit the sorts of cognitively complex thinking required for college and career readiness. A finding that the section's short passages could induce test takers to such higher-order thinking would go a long way toward establishing that the text lengths used in the section are appropriate to the purposes of the assessments.

We find such evidence in College Board's verbal protocol (think-aloud) study of the processes used by a heterogenous sample of the digital SAT test-taking population as they read and answered select questions from the suite's tests. As described fully in College Board (2024) and summarized briefly in section 5.1.12 of this document, College Board undertook a rigorous mixed-methods approach to examine whether participating students answered select digital SAT Suite questions in ways suggestive of cognitively complex thinking. All twenty Reading and Writing questions used in the study yielded evidence of requiring elements of such thinking from students. In broad terms, this suggests that the short length of the passages used in the Reading and Writing section are, at a minimum, not a barrier to a valid assessment of reading achievement aligned with college and career readiness expectations.

An example taken from the larger report (College Board 2024) serves to concretize the claim. Question 7 of the study, a medium-difficulty multiple-choice question in a humanities context testing the Central Ideas and Details skill/knowledge element, is particularly useful for this exercise, as many readers, similar to Engineer (1977; cited in Alderson 2000, 109), may well wonder whether a short passage, such as one of those on the digital SAT Suite's Reading and Writing section, is capable of meaningfully eliciting a "main idea" response from test takers.

Figure 5. Sample Digital SAT Suite Reading and Writing Question (reprinted from College Board 2024).

In many of his sculptures, artist Richard Hunt uses broad forms rather than extreme accuracy to hint at specific people or ideas. In his first major work, *Arachne* (1956), Hunt constructed the mythical character Arachne, a weaver who was changed into a spider, by welding bits of steel together into something that, although vaguely human, is strange and machine-like. And his large bronze sculpture *The Light of Truth* (2021) commemorates activist and journalist Ida B. Wells using mainly flowing, curved pieces of metal that create stylized flame.

Which choice best states the text's main idea about Hunt?

A) He uses different kinds of materials depending on what kind of sculpture he plans to create.

B) He tends to base his art on important historical figures rather than on fictional characters.

C) He often depicts the subjects of his sculptures using an unrealistic style.

D) He has altered his approach to sculpture over time, and his works have become increasingly abstract.

In examining the passage itself, we observe that although brief, the text exhibits features capable of being summarized meaningfully by a "main idea" statement. The first sentence of the passage asserts the main claim, while the second and final sentences provide examples illustrating and supporting the claim. Moreover, to accurately establish the passage's central claim, readers must recognize the text's structure and distinguish the main point from secondary ones (in this case, supporting examples). Though reduced in scope, this passage requires readers to make the same sorts of "moves" as would a hypothetical longer passage in which, say, elaboration about the main claim is provided in an opening paragraph, while subsequent paragraphs flesh out examples in detail. In other words, the above passage possesses the writing characteristics necessary to serve as the basis for a "main idea" question.

Interactions of participants in the study with this question further substantiate the notion that the question's short passage is sufficiently long to elicit a "main idea"–type response irrespective of its length. For this question, students need to ascertain that the passage's main idea is that Richard Hunt uses abstraction rather than "extreme accuracy" to depict his artistic subjects, an assertion best represented by answer choice C. This idea is directly expressed in the passage's first sentence, while the rest of the passage provides supporting examples in the form of *Arachne* and *The Light of Truth*.

In ruling out the distractors, students should recognize that choice A represents, at best, a subordinate, rather than main, point made by the passage; that choice B is factually incorrect per the passage; and that choice D is unsupported by the passage.

Student RW14, one of the study's participants, offers some interpretive commentary on Hunt and his works, as depicted in the passage, while recounting the passage's key elements.

> Okay. So once again, before even looking at the . . . answer choices, Richard Hunt. That's the artist. What is the text stating about the artist himself? So, at the start, it just states his name. He "uses broad forms rather than extreme accuracy," so maybe stating he's more artistic because he uses something different than—he doesn't try to be as accurate. "To hint at specific people or ideas." Talked about his first major work, how he constructed the mythical character. So once again, a mythical character instead of some historical leader. That shows more creativity to me. "A weaver who was changed"—yeah. Literally, a weaver who turns into a spider. That shows way more creativity to me. "By welding bits of steel together into something that, although vaguely human, is strange and machine-like." So this is just screaming "creativity" to me. And then "his large bronze [sculpture] *The Light of Truth*"—so that one does credit a historical person, but it does state using creativity stuff, "stylized flame."

The student then describes their sense of the gist of the passage before reading the answer choices.

> So to me, I think they're just calling him creative and good at his work, so I'm looking for answer choices that kind of fit that.

As it turns out, this encapsulation does not directly embody the question's narrower and more precise best answer. Nonetheless, the student has demonstrated strong comprehension of the passage and called attention to the fact that Hunt created art representing both historical and mythical figures, a point that will subsequently rule out one of the question's distractors.

Student RW14 then correctly determines that choice A, one of the distractors, represents a subordinate rather than main idea of the passage.

> [Choice A,] "He uses different kinds of materials depending on what kind of sculpture he plans to create." So I'm just going to go back to the materials used. It talks about "welding bits of steel together." And then this one talks about "flowing, curved pieces." The same thing. I swear it said bronze somewhere. [*mumbles while reading aloud*] "And his [large] bronze"—so he did use bronze for this other one, but he used steel for the spider. I don't think that's the main idea, so I'm going to probably cross that out. I don't think that's the main idea. I can just go ahead and move on.

Student RW14's prior summation of the passage content enables them to easily block another distractor, choice B.

> [Choice B,] "He tends to base his art on important historical figures [rather than on fictional characters]." Okay, I'm just going to go ahead and cut that there. Yeah. He made Ida B. Wells, but he also made Spider-Arachne Man. So, no, I'm going to go ahead and cross that out.

The student then uses passage-based reasoning to provisionally settle on the question's best answer, in doing so making the intended leap from the passage's reference to "broad forms" (and the two examples that follow) to choice C's use of "unrealistic style."

> [Choice C,] "He often depicts the subjects of his sculpture[s] using an unrealistic style." That kind of works because it kind of calls to—he doesn't use accuracy. He uses "broad forms," so he tries to be more creative. That kind of calls "creative" to me. So I'm going to put a little dash next to that to the side, and I'm going to move on to the third—or final [answer choice].

The passage does not support choice D's assertion that Hunt has "altered his approach to sculpture over time" or that "his works have become increasingly abstract," as both 1956's *Arachne* and 2021's *The Light of Truth* are essentially equally abstract in style. As student RW14 considers this distractor, they make a misstep in reasoning: they correctly reject the answer choice but do so on the errant basis that Hunt's works have grown *less* abstract over time.

> [Choice D,] "He has altered his approach to sculpture over time, and his works have become increasingly abstract." Okay. What I'm thinking here is even though his first sculpture was *Arachne*—the spider, whatever—and he welded bits of steel together to create something vaguely human, he just used bits of steel, and even though it was abstract—I'd say that was pretty abstract. And Ida B. Wells, using some interesting bits of what? It's still metal and still Ida B. Wells, so I wouldn't call that abstract. So I'm not really loving this one.

The student later clarifies that their main reason for ruling out this choice was because they "don't think [it] says enough about that here in the passage" to make it the best answer. While the student's rationale remains incomplete and imperfect, they nonetheless evince conceptual awareness that part of the task posed in this question is to differentiate between the main idea and subordinate ideas.

Ultimately, the student reaffirms the best answer choice, C, tying their selection back to their initial assessment of the passage's message.

> "He often depicts the subjects [of his sculptures using] an unrealistic style." I like that one because it kind of talks about creativity, which is what I was saying before.

As the above indicates, student RW14's response exhibits the sorts of cognitively complex thinking that we would expect a question about any passage's main idea to elicit: it demonstrates understanding of the text's structure, identifies and paraphrases its main point, and distinguishes that main point from subordinate ideas and details in the passage.

5.3.1.3. *SUBSECTION CONCLUSION*

In sum, neither the research literature nor empirical evidence collected by College Board provides a clear basis for disfavoring short reading passages over longer ones for the purposes of comprehension assessment using multiple-choice questions. In terms of stamina demands, long passages do not lend much greater verisimilitude to assessment tasks than do shorter passages, as neither genuinely replicates the stamina requirements of academic and real-world settings. Such long passages are also likely to contain elaborations in the form of anecdotes, quotations, digressions, and the like that do not add materially to the assessment task and whose inclusion may, as some research suggests, in fact impede the attainment of information and ideas from texts. Research dating back roughly seventy years has yielded ambiguous results, with some studies finding no significant effect of text length on comprehension measures while others found either positive or negative effects. Finally, an examination of the statistical performance of questions across paper and digital modes as well as verbal protocol evidence collected by College Board (2024) strongly suggest that the short passages used in the digital SAT Suite's Reading and Writing section are rigorous and fully capable of eliciting the kinds of cognitively complex behavior required by college and career readiness.

At the same time, this above assessment should not be read as a sharp critique of the use of extended passages in reading comprehension assessments, as has been done in the paper-based SAT Suite. As noted, there is a paucity of evidence in favor of using extended passages in reading comprehension assessments, not a critical mass of evidence against such a practice. Accordingly, the evidence represented here should be viewed in a more limited way, as supporting College Board's design choice with the digital suite to move to shorter, more compact, more focused reading passages. This choice should also be contextualized within College Board's strong and ongoing commitment to the use of longer readings in instructional settings, including in classroom-based tasks and assessments developed by teachers.

5.3.2. ALLOWANCE OF A CALCULATOR THROUGHOUT THE MATH SECTION

One change introduced into the digital SAT Suite Math section is that students are allowed to use a calculator—either the Desmos Graphing Calculator built directly into Bluebook, the test delivery platform, or their own approved device—on all Math questions. On the paper-based SAT Suite, the Math section was divided into two separately timed portions: one for which students could use a calculator if they so chose and one where they could not. Permitting a calculator to be used throughout the Math section, as in the digital SAT Suite, has obvious advantages for ease of test administration for students as well as test proctors: a single section with a uniform rule about calculator use is much easier to deal with than two separate test portions, each with a distinct calculator-use rule. Readers of this document may, however, wonder whether something important has been lost in the transition.

At the time of the redesign of the SAT Suite in the early 2010s, College Board made the decision to introduce a no-calculator portion into the Math Test. The explicit rationale, grounded in some evidence, was that because fluency with rational number arithmetic was important to postsecondary educators, a no-calculator portion on the SAT Suite Math Tests would offer assurance to those educators that students who scored well on the tests did not lack such fluency (College Board 2015, 38). The decision to include a no-calculator portion was also motivated by concerns among other stakeholder groups—notably, as Banks (2011) documents, many parents and teachers, who feared students' dependence on the tool at the expense of their ability to master basic skills and to perform calculations mentally or on paper.

As laudable as the goal of promoting students' ability to perform certain kinds of calculations in their heads or on paper may have been, the decision was and is at odds with both how and how often students use calculators as tools in their schoolwork and daily lives and with extant and emerging evidence about the value of calculator use in educational settings.

In 2000, Barton examined two decades' worth of existing research literature (including meta-analyses) on the relationship of calculator use to math achievement (in terms of overall achievement, conceptual understanding, and procedural knowledge) and conducted her own meta-analysis of more recent studies focused on high school and college-level treatments of math topics ranging from algebra to calculus. With some inevitable caveats, as well as the acknowledgment that *how* calculators are used in instruction is as important as *whether* they are, Barton found that prior research tended to support calculator use. Her own meta-analysis of fifty-two studies in which a treatment group using calculator technology (specifically, graphing calculators and/or computer algebra systems [CAS]) at least part of the time was compared with a control group that did not use such technology suggested positive impacts of calculator use on overall achievement and conceptual understanding, while most studies showed no effect on students' procedural knowledge. This last finding is of particular relevance here because the paper-based SAT Suite's no-calculator portion was, as has been mentioned, intended to promote students' development of procedural knowledge (specifically, their ability to perform certain calculations mentally or by hand).

Since Barton's work, other studies have tended to confirm the ubiquity and value of calculator use in the math classroom. Ellington's (2003, 455–56; emphasis in original) meta-analysis of fifty-four research studies pertaining to precollege students' achievement in and attitudes toward math concluded that "when calculators were part of *both* testing and instruction, the operational skills, computational skills, skills necessary to understand mathematical concepts, and problem-solving skills improved for participating students" and that "allowing students to use calculators in mathematics may result in better attitudes toward mathematics." Ellington's later (2006) meta-analysis of forty-two studies comparing use and nonuse of graphing calculators without CAS and conducted primarily at the high school and college level reached similar conclusions. Heller et al. (2005, 18) found that "the more access students had to graphing calculators, and the more graphing calculators were used during [Algebra I] instruction, the higher the students' end-of-course test scores," though the testing was done without calculators, and the authors noted that having teachers who had received good professional development in graphing calculator use was also important, as were some opportunities for students in the classroom to work without calculators.

Permitting the use of calculators in instruction and assessment also has important equity implications. The benefits and requirements for strategic use of the calculator as a tool are embedded in both professional position statements on calculator use in schools (e.g., National Council of Teachers of Mathematics 2015a, 2015b) and college and career readiness standards for all students (e.g., NGA Center for Best Practices and CCSSO 2010b). Researchers Boyle and Farreras (2015), who concluded that "using calculators improves mathematical performance in college students as it does with precollege students," contend that "prohibiting the use of calculators underestimates the mathematical performance of college students." In addition, there is some, albeit slender, research suggesting that learning to use a calculator strategically carries benefits for students with a range of physical and cognitive disabilities as well as for those students who do not have such disabilities (Bouck, Joshi, and Johnson 2013; see also Bouck, Bouck, and Hunley 2015 for additional discussion and qualifications).

The allowance of a calculator throughout the digital SAT Suite Math section aligns well with the broad professional consensus presented above. So, too, does the section's provision of a graphing calculator built into Bluebook, the test delivery platform, which gives all students access to a high-quality tool with established benefits for demonstrations of math achievement. Practice opportunities within the test delivery platform (see section 2.2.10) offer all students the chance to become familiar with the specific tool made available to them during testing. At the same time, students who prefer to use their own approved calculator may still do so. Having the choice is important because student comfort with the tools they will use during testing is vital to obtaining an accurate assessment of their achievement in math.

Finally, because strategic calculator use is embedded in the math achievement construct being measured by the digital SAT Suite, there is no risk that students' use of the tool will in any way compromise the validity of the assessments or the data yielded by them. Furthermore, because College Board's SAT Suite math content experts design and develop questions with full knowledge that students may be using a calculator as an aid to solving the problems posed to them, these test developers carefully examine each question to ensure that calculator use does not trivialize or otherwise short-circuit the intended rigor of the questions; moreover, in furtherance of the goal of supporting strategic (rather than indiscriminate) use of the calculator as a tool, College Board test developers also create some questions for which a calculator is either not needed or its use is not particularly beneficial to solving the problem.

5.3.3. THE APPEARANCE OF "BELOW-GRADE-LEVEL" CONTENT IN THE MATH SECTION

The digital SAT Suite Math section, like the paper-based SAT Suite Math Tests, includes coverage of some topics, such as ratios, rates, and proportions as well as area, perimeter, and volume, that, by a strict reading of many state academic standards documents, should have been mastered by students at grades earlier than some or all of those aligned with the SAT Suite assessments' typical test-taking populations. This circumstance has provoked some questioning of the Math design and the appropriateness of the inclusion of such topics in a series of tests of college and career readiness.

As noted in section 5.1.9, the digital SAT Suite is not designed to measure students' attainment of any particular set of state academic standards but rather students' attainment of essential college and career readiness prerequisites. Although the digital SAT Suite, like its predecessor, accords well with college and career readiness standards generally, the suite's tests are not intended to assess student outcomes in particular grades or courses, as would, for example, end-of-course tests. Thus, the design of the digital SAT Suite Math section may purposefully deviate from specific grade-level expectations in some standards documents, when the evidence warrants, in order to better achieve the suite's purpose of assessing college and career readiness.

College Board has, in fact, determined that there are sound reasons for including such content on the tests, even when doing so seems to defy expectations laid out in standards documents.

First, while topics such as ratios, rates, and proportions are often expected to be learned prior to some or all of the grades targeted by the various digital SAT Suite testing programs, their mastery remains foundational to higher-level math in subsequent grades. It makes sense, therefore, to assess students' attainment of such skills and knowledge on the digital SAT Suite, in part because the scenarios and applications in which such topics are tested may well be more complex than those encountered in middle school or junior high school and in part because students' inability to demonstrate mastery of these skills and knowledge on the tests can make students aware of these shortcomings and lead them to engage productively in remedying them.

Second, and related to the first, the digital SAT Suite tests are broad-based measures of student achievement relative to college and career readiness outcomes and have diverse populations of students taking them. If only on-grade-level content were presented to students, College Board would learn almost nothing about what struggling students *can* do; we would only learn about what they *cannot* do. Students who are having difficulty with on-grade-level math may well still be able to demonstrate attainment of foundational math skills and knowledge, and this insight allows for more targeted practice interventions, whether for the digital SAT Suite or at the classroom level.

Thus, having some "below-grade-level" content in the Math section is appropriate given the purpose of the digital SAT Suite to measure college and career readiness outcomes; the heterogeneity of the suite's test-taking populations, which exhibit wide divergence in achievement levels; and the importance of identifying both what students can and cannot demonstrate in order to promote targeted instructional interventions.

CHAPTER 6

Conclusion

The digital SAT Suite represents an evolution and refinement of the paper-based SAT Suite introduced in the 2015–2016 academic year. Like its predecessor, the digital suite is built on strong evidentiary foundations and retains as its primary purpose the assessment of students' attainment of crucial academic skills and knowledge in literacy and math prerequisite for success in postsecondary education. While being easier to take, easier to give, more relevant, and more secure than its paper-based predecessor, the digital SAT Suite samples robustly from the same content domains, maintains the same level of assessment rigor, sustains the same highly desirable content and psychometric properties, and provides students and their families, educators, policymakers, and other stakeholders with clear, actionable information about student achievement.

This document has provided an authoritative, up-to-date, highly detailed overview of the digital suite, its constituent test sections, and the test questions that compose the tests. As studies and other undertakings described in prospect in this assessment framework are completed, the document will be periodically revised, enabling it to remain a convenient, reliable, and useful source of information about the tests over the coming years.

References

Abedi, Jamal, and Edynn Sato. 2008. *Linguistic Modification.* Washington, DC: U.S. Department of Education. https://ncela.ed.gov/files/uploads/11/abedi_sato.pdf.

ACT. 2006. *Reading between the Lines: What the ACT Reveals about College Readiness in Reading.* Iowa City, IA: ACT. https://eric.ed.gov/?id=ED490828.

ACT. 2016. *National Curriculum Survey 2016.* Iowa City, IA: ACT. https://www.act.org/content/dam/act/unsecured/documents/NCS_Report_Web_2016.pdf.

ACT. 2018. *The Condition of College and Career Readiness: National 2018.* Iowa City, IA: ACT. https://www.act.org/content/dam/act/unsecured/documents/cccr2018/National-CCCR-2018.pdf.

ACT. 2020. *ACT National Curriculum Survey 2020.* Iowa City, IA: ACT. https://www.act.org/content/dam/act/unsecured/documents/NCS_Report_Web_2020.pdf.

Adams, Marilyn Jager. 2009. "The Challenge of Advanced Texts." In *Reading More, Reading Better*, edited by Elfrieda H. Hiebert, 163–89. New York: Guilford.

Adelman, Clifford. 2006. *The Toolbox Revisited: Paths to Degree Completion from High School through College*. Washington, DC: U.S. Department of Education. https://www2.ed.gov/rschstat/research/pubs/toolboxrevisit/toolbox.pdf.

AERA (American Educational Research Association), APA (American Psychological Association), and NCME (National Council for Measurement in Education). 2014. *Standards for Educational and Psychological Testing.* Washington, DC: AERA. https://www.testingstandards.net/uploads/7/6/6/4/76643089/standards_2014edition.pdf.

Ahmed, Yusra, David J. Francis, Mary York, Jack M. Fletcher, Marcia Barnes, and Paulina A. Kulesz. 2016. "Validation of the Direct and Inferential Mediation (DIME) Model of Reading Comprehension in Grades 7 through 12." *Contemporary Educational Psychology* 44–45 (January–April): 68–82. https://doi.org/10.1016/j.cedpsych.2016.02.002.

Alderson, J. Charles. 2000. *Assessing Reading*. Cambridge, UK: Cambridge University Press.

Allington, Richard L. 2013. "What Really Matters When Working with Struggling Readers." *Reading Teacher* 66, no. 7 (April): 520–30.

American Diploma Project. 2004. *Ready or Not: Creating a High School Diploma That Counts*. Washington, DC: Achieve. https://www.achieve.org/publications/ready-or-not-creating-high-school-diploma-counts#:~:text=Ready%20or%20Not%20is%20the,mathematics%20and%20English%20Language%20Arts.

American Statistical Association. 2022. *Ethical Guidelines for Statistical Practice.* Alexandria, VA: American Statistical Association. https://www.amstat.org/docs/default-source/amstat-documents/ethicalguidelines.pdf?sfvrsn=bdeeafdd_3.

Asim, Minahil, Michal Kurlaender, and Sherrie Reed. 2019. *12th Grade Course-Taking and the Distribution of Opportunity for College Readiness in Mathematics.* Stanford, CA: Policy Analysis for California Education. https://files.eric.ed.gov/fulltext/ED600439.pdf.

Atuahene, Francis, and Tammy A. Russell. 2016. "Mathematics Readiness of First-Year University Students." *Journal of Developmental Education* 39, no. 3 (Spring): 12–32. https://files.eric.ed.gov/fulltext/EJ1130188.pdf.

Bae, Minryoung, and Byungmin Lee. 2018. "Effects of Text Length and Question Type on Test-takers' Performance on Fill-in-the-Blank Items on Korean CSAT." *English Teaching* 73, no. 4 (Winter): 149–74. **https://files.eric.ed.gov/fulltext/EJ1306306.pdf**.

Banks, Sarah. 2011. "A Historical Analysis of Attitudes toward the Use of Calculators in Junior High and High School Math Classrooms in the United States Since 1975." Master of education research thesis, Cedarville University. **https://digitalcommons.cedarville.edu/cgi/viewcontent.cgi?article=1030&context=education_theses**.

Barton, Susan. 2000. "What Does the Research Say about Achievement of Students Who Use Calculator Technologies and Those Who Do Not?" In *Electronic Proceedings of the Thirteenth Annual International Conference on Technology in Collegiate Mathematics*, edited by Gail Goodell. Boston: Addison-Wesley. **http://www.math.odu.edu/~bogacki/epictcm/VOL13/C025/paper.pdf**.

Bautsch, Brenda. 2013. "Reforming Remedial Education." *Hot Topics in Higher Education.* Denver, CO: National Conference of State Legislatures. **https://www.ncsl.org/documents/educ/REMEDIALEDUCATION_2013.pdf**.

Beason, Larry. 2001. "Ethos and Error: How Business People React to Errors." *College Composition and Communication* 53, no. 1 (September): 33–64. **https://doi.org/10.2307/359061**.

Beck, Isabel L., Margaret G. McKeown, and Linda Kucan. 2013. *Bringing Words to Life: Robust Vocabulary Instruction*, 2nd ed. New York: Guilford.

Beers, G. Kylene, and Robert E. Probst. 2012. *Notice and Note: Strategies for Close Reading.* Portsmouth, NH: Heinemann.

Biag, Manuelito, and Imeh Williams. 2014. *Examining Students' Math Course-Taking and Educational Outcomes in the Garden Grove Unified School District (Year 1).* Stanford, CA: John W. Gardner Center for Youth and Their Communities. **https://files.eric.ed.gov/fulltext/ED573648.pdf**.

Biemiller, Andrew. 2005. "Size and Sequence in Vocabulary Development: Implications for Choosing Words for Primary Grade Vocabulary Instruction." In *Teaching and Learning Vocabulary: Bringing Research to Practice*, edited by Elfrieda H. Hiebert and Michael L. Kamil, 223–42. Mahwah, NJ: Erlbaum.

Blair, Richelle, Ellen E. Kirkman, and James W. Maxwell. 2018. *Statistical Abstract of Undergraduate Programs in the Mathematical Sciences in the United States: Fall 2015 CBMS Survey.* Providence, RI: American Mathematical Society. **http://www.ams.org/profession/data/cbms-survey/cbms2015-Report.pdf**.

Bouck, Emily C., Mary K. Bouck, and Megan Hunley. 2015. "The Calculator Effect: Understanding the Impact of Calculators as Accommodations for Secondary Students with Disabilities." *Journal of Special Education Technology* 30, no. 2 (June): 77–88. **https://doi.org/10.1177%2F0162643415617371**.

Bouck, Emily C., Gauri S. Joshi, and Linley Johnson. 2013. "Examining Calculator Use among Students with and without Disabilities Educated with Different Mathematical Curricula." *Educational Studies in Mathematics* 83, no. 3 (July): 369–85. **http://dx.doi.org/10.1007/s10649-012-9461-3**.

Boyle, Robert W., and Ingrid G. Farreras. 2015. "The Effect of Calculator Use on College Students' Mathematical Performance." *International Journal of Research in Education and Science* 1, no. 2 (Summer): 95–100. **https://files.eric.ed.gov/fulltext/EJ1105220.pdf**.

Britton, Bruce K., and Arthur C. Graesser, eds. 2014. *Models of Understanding Text.* New York: Psychology Press. First published 1996.

Brumberger, Eva. 2011. "Visual Literacy and the Digital Native: An Examination of the Millennial Learner." *Journal of Visual Literacy* 30 (1): 19–47. **https://doi.org/10.1080/23796529.2011.11674683**.

Bruno, Paul, and Dan Goldhaber. 2021. "What Pandemic-Related Test Waiver Requests Suggest about States' Testing Priorities." *Phi Delta Kappan* 103, no. 3 (November): 48–53. **https://kappanonline.org/pandemic-test-waiver-bruno-goldhaber/**.

Brysbaert, Marc, and Andrew Biemiller. 2017. "Text-Based Age-of-Acquisition Norms for 44 Thousand English Word Meanings." *Behavior Research Methods* 49, no. 4 (August): 1520–23. https://doi.org/10.3758/s13428-016-0811-4.

Cain, Kate, and Jane V. Oakhill. 1999. "Inference Making Ability and Its Relation to Comprehension Failure in Young Children." *Reading and Writing* 11, nos. 5–6 (December): 489–503. https://doi.org/10.1023/A:1008084120205.

Carnevale, Anthony P., and Megan L. Fasules. 2021. "How Useful Is High School Math on the Job? *Medium*, March 9, 2021. https://medium.com/georgetown-cew/how-useful-is-high-school-math-on-the-job-f5ae9002df12.

Carpenter, Thomas P., Mary Kay Corbitt, Henry S. Kepner Jr., Mary Montgomery Lindquist, and Robert Reys. 1980. "Results of the Second NAEP Mathematics Assessment: Secondary School." *Mathematics Teacher* 73, no. 5 (May): 329–38. https://www.jstor.org/stable/27962023.

Casteel, Mark A., and Greg B. Simpson. 1991. "Textual Coherence and the Development of Inferential Generation Skills." *Journal of Research in Reading* 14, no. 2 (September): 116–29. https://doi.org/10.1111/j.1467-9817.1991.tb00013.x.

Center for Universal Design. 1997. *The Principles of Universal Design*, version 2.0. Raleigh, NC: North Carolina State University, Center for Universal Design. https://projects.ncsu.edu/ncsu/design/cud/about_ud/udprinciplestext.htm.

Cervetti, Gina N., Tanya S. Wright, and HyeJin Hwang. 2016. "Conceptual Coherence, Comprehension, and Vocabulary Acquisition: A Knowledge Effect?" *Reading and Writing* 29, no. 4 (April): 761–79.

Chall, Jeanne S., and Vicki A. Jacobs. 2003. "The Classic Study on Poor Children's Fourth-Grade Slump." *American Educator* 27, no. 1 (Spring): 14–15. https://www.aft.org/periodical/american-educator/spring-2003/classic-study-poor-childrens-fourth-grade-slump.

Citizens Financial Group. 2021. "Citizens Survey Shows That Affordability Concerns Remain Top of Mind for Students and Families. *Business Wire*, August 4, 2021. https://www.businesswire.com/news/home/20210804005179/en/.

College Board. 2015. *Test Specifications for the Redesigned SAT.* New York: College Board. https://satsuite.collegeboard.org/media/pdf/test-specifications-redesigned-sat-1.pdf.

College Board. 2018. *Guidelines on the Uses of College Board Test Scores and Related Data.* New York: College Board. https://research.collegeboard.org/pdf/guidelines-uses-college-board-test-scores-and-data.pdf.

College Board. 2019. *College Board National Curriculum Survey Report 2019.* New York: College Board. https://satsuite.collegeboard.org/media/pdf/national-curriculum-survey-report.pdf.

College Board. 2022a. *SAT Suite of Assessments Annual Report 2022: Total Group*. New York: College Board. https://reports.collegeboard.org/media/pdf/2022-total-group-sat-suite-of-assessments-annual-report.pdf.

College Board. 2022b. *Trends in College Pricing and Student Aid 2022*. Trends in Higher Education Series. New York: College Board. https://research.collegeboard.org/media/pdf/trends-in-college-pricing-student-aid-2022.pdf.

College Board. 2024. *The Cognitively Complex Thinking Required by Select Digital SAT Suite Questions*. New York: College Board. https://satsuite.collegeboard.org/media/pdf/digital-sat-cognitive-lab-report.pdf.

College Board and HumRRO. 2020. *The Complex Thinking Required by Select SAT Items: Evidence from Student Cognitive Interviews.* New York: College Board. https://satsuite.collegeboard.org/media/pdf/sat-cognitive-lab-report.pdf.

Cunningham, Anne E., and Keith E. Stanovich. 1998. "What Reading Does for the Mind." *American Educator* 22, no. 1–2 (Spring–Summer): 8–15.

Dale, Edgar, and Joseph O'Rourke. 1981. *The Living Word Vocabulary: The Words We Know, A National Vocabulary Inventory.* Chicago, IL: World Book–Childcraft International.

Daley, Nola, and Katherine A. Rawson. 2019. "Elaborations in Expository Text Impose a Substantial Time Cost but Do Not Enhance Learning." *Educational Psychology Review* 31, no. 1 (March): 197–222. **https://doi.org/10.1007/s10648-018-9451-9**.

Derrick, Clarence. 1953. "Three Aspects of Reading Comprehension as Measured by Tests of Different Lengths." PhD diss., University of Chicago. ETS Research Bulletin RB-53-08. **https://doi.org/10.1002/j.2333-8504.1953.tb00039.x**.

Dong, Yang, Shu-Na Peng, Yuan-Ke Sun, Sammy Xiao-Ying Wu, and Wei-Sha Wang. 2020. "Reading Comprehension and Metalinguistic Knowledge in Chinese Readers: A Meta-Analysis." *Frontiers in Psychology* 10:3037 (February): 1–15. **https://doi.org/10.3389/fpsyg.2019.03037**.

Dunlosky, John, Katherine A. Rawson, Elizabeth J. Marsh, Mitchell J. Nathan, and Daniel T. Willingham. 2013. "Improving Students' Learning with Effective Learning Techniques: Promising Directions from Cognitive and Educational Psychology." *Psychological Science in the Public Interest* 14, no. 1 (January): 4–58. **https://doi.org/10.1177/1529100612453266**.

Ellington, Aimee J. 2003. "A Meta-Analysis of the Effects of Calculators on Students' Achievement and Attitude Levels in Precollege Mathematics Classes." *Journal for Research in Mathematics Education* 34, no. 5 (November): 433–63. **https://doi.org/10.2307/30034795**.

Ellington, Aimee J. 2006. "The Effects of Non-CAS Graphing Calculators on Student Achievement and Attitude Levels in Mathematics: A Meta-Analysis." *School Science and Mathematics* 106, no. 1 (January): 16–26. **https://doi.org/10.1111/J.1949-8594.2006.TB18067.X**.

Engel, Joachim. 2017. "Statistical Literacy for Active Citizenship: A Call for Data Science Education." *Statistics Education Research Journal* 16, no. 1 (May): 44–49. **http://iase-web.org/documents/SERJ/SERJ16(1)_Engel.pdf**.

Er, Sidika Nihan. 2018. "Mathematics Readiness of First-Year College Students and Missing Necessary Skills: Perspectives of Mathematics Faculty." *Journal of Further and Higher Education* 42 (7): 937–52. **https://doi.org/10.1080/0309877X.2017.1332354**.

Fey, James T., ed. 1984. *Computing and Mathematics. The Impact on Secondary School Curricula.* Reston, VA: National Council of Teachers of Mathematics.

Fisher, Douglas, Nancy Frey, Heather Anderson, and Marisol Thayre. 2014. *Text-Dependent Questions, Grades 6–12: Pathways to Close and Critical Reading.* Thousand Oaks, CA: Corwin.

Fishman, Rachel, Elin Johnson, Sophie Nguyen, and Lupita Romo-González. 2021. *Varying Degrees 2021: New America's Fifth Annual Survey on Higher Education.* Washington, DC: New America. **https://www.newamerica.org/education-policy/reports/varying-degrees-2021/**.

Freudenthal, Hans. 1971. "Geometry between the Devil and the Deep Sea." *Educational Studies in Mathematics* 3, no. 3/4 (June): 413–35. **https://www.jstor.org/stable/3482035**.

Fry, Edward. 1981. "Graphical Literacy." *Journal of Reading* 24, no. 5 (February): 383–89. **https://www.jstor.org/stable/40032373**.

GAISE College Report ASA Revision Committee. 2016. *Guidelines for Assessment and Instruction in Statistics Education College Report 2016.* Alexandria, VA: American Statistical Association. **https://www.amstat.org/asa/files/pdfs/GAISE/GaiseCollege_Full.pdf**.

Galesic, Mirta, and Rocio Garcia-Retamero. 2011. "Graph Literacy: A Cross-Cultural Comparison." *Medical Decision Making* 31, no. 3 (May–June): 444–57.

Gallup and Lumina Foundation. 2015. *The 2014 Gallup–Lumina Foundation Study of the American Public's Opinion on Higher Education: Postsecondary Education Aspirations and Barriers*. Washington, DC: Gallup. **https://news.gallup.com/file/poll/182462/Gallup-Lumina%20Foundation%20Study%202014%20Report.pdf**.

Gamoran, Adam, and Eileen C. Hannigan. 2000. "Algebra for Everyone? Benefits of College-Preparatory Mathematics for Students with Diverse Abilities in Early Secondary School." *Educational Evaluation and Policy Analysis* 22, no. 3 (January): 241–54. **https://doi.org/10.3102/01623737022003241**.

Garcia, Emma. 2015. *Inequalities at the Starting Gate: Cognitive and Noncognitive Skill Gaps between 2010–2011 Kindergarten Classmates.* Washington, DC: Economic Policy Institute. **https://files.epi.org/pdf/85032c.pdf**.

Ginsburg, Alan, Geneise Cooke, Steve Leinwand, Jay Noell, and Elizabeth Pollock. 2005. *Reassessing U.S. International Mathematics Performance: New Findings from the 2003 TIMSS and PISA.* Washington, DC: American Institutes for Research. **https://files.eric.ed.gov/fulltext/ED491624.pdf**.

Gottfried, Michael A., Robert Bozick, and Sinduja V. Srinivasan. 2014. "Beyond Academic Math: The Role of Applied STEM Course Taking in High School." *Teachers College Record* 116, no. 7 (July): 1–35. **http://dx.doi.org/10.1177/016146811411600703**.

Graesser, Arthur C., Murray Singer, and Tom Trabasso. 1994. "Constructing Inferences during Narrative Text Comprehension." *Psychological Review* 101, no. 3 (July): 371–95. **https://doi.org/10.1037/0033-295X.101.3.371**.

Grant, Norma Louise. 1980. "The Effects of Passage Length and Reading Mode on Retellings and Question Responses of Sixth Grade Children." EdD diss., University of Arizona. **https://repository.arizona.edu/handle/10150/282204**.

Guthrie, John T., Angela McRae, Cassandra S. Coddington, Susan Lutz Klauda, Allan Wigfield, and Pedro Barbosa. 2009. "Impacts of Comprehensive Reading Instruction on Diverse Outcomes of Low- and High-Achieving Readers." *Journal of Learning Disabilities* 42, no. 3 (May–June): 195–214. **https://doi.org/10.1177%2F0022219408331039**.

Hanson, Melanie. 2022. "Student Loan Debt Statistics." EducationData.org, April 10, 2022. **https://educationdata.org/student-loan-debt-statistics**.

Harsh, Joseph A., and Mikaela Schmitt-Harsh. 2016. "Instructional Strategies to Develop Graphing Skills in the College Science Classroom." *American Biology Teacher* 78, no. 1 (January): 49–56. **https://doi.org/10.1525/abt.2016.78.1.49**.

Hart Research Associates. 2018. Fulfilling the American Dream: Liberal Education and the Future of Work, Selected Findings from Online Surveys of Business Executives and Hiring Managers. Washington, DC: Association of American Colleges and Universities. **https://www.aacu.org/research/fulfilling-the-american-dream-liberal-education-and-the-future-of-work**.

Heath, Shirley Brice. 1983. Ways with Words: Language, Life, and Work in Communities and Classrooms. Cambridge: Cambridge University Press.

Heller, Joan I., Deborah A. Curtis, Rebecca Jaffe, and Carol J. Verboncoeur. 2005. *Impact of Handheld Graphing Calculator Use on Student Achievement in Algebra I.* Oakland, CA: Heller Research Associates. **https://files.eric.ed.gov/fulltext/ED493688.pdf**.

Helms, Josh. 2015. "Five Examples of How Federal Agencies Use Big Data." IBM Center for the Business of Government (blog). February 25, 2015. **https://www.businessofgovernment.org/blog/five-examples-how-federal-agencies-use-big-data**.

Hiebert, Elfrieda H. 2014. *The Forgotten Reading Proficiency: Stamina in Silent Reading.* Santa Cruz, CA: TextProject and University of California, Santa Cruz.

ICAS (Intersegmental Committee of the Academic Senates) of the California Community Colleges, the California State University, and the University of California. 2002. *Academic Literacy: A Statement of Competencies Expected of Students Entering California's Public Colleges and Universities*. Sacramento, CA: ICAS. **https://senate.universityofcalifornia.edu/_files/reports/acadlit.pdf**.

Jalilehvand, Maryam. 2012. "The Effects of Text Length and Picture on Reading Comprehension of Iranian EFL Students." *Asian Social Science* 8, no. 3 (March): 329–37. **https://doi.org/10.5539/ass.v8n3p329**.

Kaplan. 2015. “Kaplan Test Prep and MONEY Survey: To Pay for College, Parents Will Take Staycations, Trim Retirement Savings and Defer Home Improvements, among Other Financial Sacrifices.” Kaplan, November 18, 2015. https://www.kaptest.com/blog/press/2015/11/18/kaplan-test-prep-and-money-survey-to-pay-for-college-parents-will-take-staycations-trim-retirement-savings-and-defer-home-improvements-among-other-financial-sacrifices/.

Kaput, James J. 1995. “Long-Term Algebra Reform: Democratizing Access to Big Ideas.” In *The Algebra Initiative Colloquium*, vol. 1, edited by Carole B. Lacampagne, William Blair, and Jim Kaput, 33–52. Washington, DC: U.S. Department of Education. https://files.eric.ed.gov/fulltext/ED385436.pdf.

Kendeou, Panayiota. 2015. “A General Inference Skill.” In *Inferences during Reading*, edited by Edward J. O’Brien, Anne E. Cook, and Robert F. Lorch Jr., 160–81. Cambridge: Cambridge University Press.

Kieran, Carolyn, JeongSuk Pang, Deborah Schifter, and Swee Fong Ng. 2016. *Early Algebra: Research into Its Nature, Its Learning, Its Teaching*. Cham, Switzerland: SpringerOpen. https://library.oapen.org/handle/20.500.12657/27822.

Kim, Kyungil, Jinhee Bae, Myung-Woo Nho, and Chang Hwan Lee. 2011. “How Do Experts and Novices Differ? Relation versus Attribute and Thinking versus Feeling in Language Use.” *Psychology of Aesthetics, Creativity, and the Arts* 5, no. 4 (November): 379–88. https://doi.org/10.1037/a0024748.

Kjelvik, Melissa K., and Elizabeth H. Schultheis. 2019. “Getting Messy with Authentic Data: Exploring the Potential of Using Data from Scientific Research to Support Student Data Literacy.” *CBE—Life Sciences Education* 18, no. 2 (May). https://doi.org/10.1187/cbe.18-02-0023.

Klebs, Shelbe, Rachel Fishman, Sophie Nguyen, and Tamara Hiler. 2021. *One Year Later: COVID-19’s Impact on Current and Future College Students.* Washington, DC: Third Way. https://www.thirdway.org/memo/one-year-later-covid-19s-impact-on-current-and-future-college-students.

Kuperberg, Gina R., Martin Paczynski, and Tali Ditman. 2011. “Establishing Causal Coherence across Sentences: An ERP Study.” *Journal of Cognitive Neuroscience* 23, no. 5 (May): 1230–46. https://doi.org/10.1162/jocn.2010.21452.

Kuperman, Victor, Hans Stadthagen-Gonzalez, and Marc Brysbaert. 2012. “Age of Acquisition Ratings for 30,000 English Words.” *Behavior Research Methods* 44, no. 4 (December): 978–90. https://doi.org/10.3758/s13428-012-0210-4.

Kwon, Nahyun. 2017. “How Work Positions Affect the Work Activity and Information Behaviour of Laboratory Scientists in the Research Lifecycle: Applying Activity Theory.” *Information Research* 22, no. 1, paper 744 (March). https://files.eric.ed.gov/fulltext/EJ1138647.pdf.

Landauer, Thomas K., and Susan T. Dumais. 1997. “A Solution to Plato’s Problem: The Latent Semantic Analysis Theory of Acquisition, Induction, and Representation of Knowledge.” *Psychological Review* 104, no. 2 (April): 211–40. https://psycnet.apa.org/doi/10.1037/0033-295X.104.2.211.

Lapp, Diane, Barbara Moss, Maria Grant, and Kelly Johnson. 2015. *A Close Look at Close Reading: Teaching Students to Analyze Complex Texts, Grades K–5.* Alexandria, VA: ASCD. https://files.ascd.org/staticfiles/ascd/pdf/siteASCD/publications/books/close-look-at-close-reading-k-5-sample-chapters.pdf.

Larson, Aaron A., M. Anne Britt, and Christopher A. Kurby. 2009. “Improving Students’ Evaluation of Informal Arguments.” *Journal of Experimental Education* 77, no. 4 (August): 339–66. https://doi.org/10.3200/JEXE.77.4.339-366.

Lawrence, Joshua Fahey, Aste Mjelve Hagen, Jin Kyoung Hwang, Grace Lin, and Arne Lervåg. 2019. “Academic Vocabulary and Reading Comprehension: Exploring the Relationships across Measures of Vocabulary Knowledge.” *Reading and Writing* 32, no. 2 (February): 285–306. https://doi.org/10.1007/s11145-018-9865-2.

Lee, Carol D. 2007. *Culture, Literacy, and Learning: Taking Bloom in the Midst of the Whirlwind*. New York: Teachers College Press.

Lee, Se Woong, and Xinyi Mao. 2021. "Algebra by the Eighth Grade: The Association between Early Study of Algebra I and Students' Academic Success." *International Journal of Science and Mathematics Education* 19, no. 6 (August): 1271–89. **https://doi.org/10.1007/s10763-020-10116-3**.

Long, Mark C., Dylan Conger, and Patrice Iatarola. 2012. "Effects of High School Course-Taking on Secondary and Postsecondary Success." *American Educational Research Journal* 49, no. 2 (April): 285–322. **https://doi.org/10.3102%2F0002831211431952**.

Ma, Jennifer, Matea Pender, and Meredith Welch. 2019. *Education Pays 2019: The Benefits of Higher Education for Individuals and Society.* New York: College Board. **https://research.collegeboard.org/pdf/education-pays-2019-full-report.pdf**.

Martin, Andrew J., and Goran Lazendic. 2018. "Computer-Adaptive Testing: Implications for Students' Achievement, Motivation, Engagement, and Subjective Test Experience." *Journal of Educational Psychology* 110, no. 1 (January): 27–45. **https://psycnet.apa.org/doi/10.1037/edu0000205**.

Masrai, Ahmed. 2019. "Vocabulary and Reading Comprehension Revisited: Evidence for High-, Mid-, and Low-Frequency Vocabulary Knowledge." *SAGE Open* 9, no. 2 (April-June): 1–13. **https://doi.org/10.1177/2158244019845182**.

Mehrpour, Saeed, and Abdolmehdi Riazi. 2004. "The Impact of Text Length on EFL Students' Reading Comprehension." *Asian EFL Journal.* 6 (3): 1–13. **http://www.asian-efl-journal.com/Sept_04_sm_ar.pdf**.

Meng, Xiao-Li. 2021. "Enhancing (Publications on) Data Quality: Deeper Data Minding and Fuller Data Confession." *Journal of the Royal Statistical Society Series A (Statistics in Society)* 184, no. 4 (October): 1161–75. **https://doi.org/10.1111/rssa.12762**.

Merriam-Webster, s.v. "geometry (*n.*)," accessed November 17, 2021, **https://www.merriam-webster.com/dictionary/geometry**.

Mesmer, Heidi Anne, and Elfrieda H. Hiebert. 2015. "Third Graders' Reading Proficiency Reading Texts Varying in Complexity and Length: Responses of Students in an Urban, High-Needs School." *Journal of Literacy Research* 47, no. 4 (December): 473–504. **https://journals.sagepub.com/doi/pdf/10.1177/1086296X16631923**.

Mislevy, Robert J., and Michelle M. Riconsente. 2005. *Evidence-Centered Assessment Design: Layers, Structures, and Terminology*. PADI Technical Report 9. Menlo Park, CA: SRI International. **https://padi.sri.com/downloads/TR9_ECD.pdf**.

Morgan, Leigh Ann. 2018. "What Careers Require Geometry." *Houston Chronicle*, July 1, 2018. **https://work.chron.com/careers-require-geometry-10361.html**.

Moses, Robert P., and Charles E. Cobb Jr. 2001. *Radical Equations: Civil Rights from Mississippi to the Algebra Project.* Boston, MA: Beacon.

Mullis, Ina V. S., Michael O. Martin, Albert E. Beaton, Eugenio J. Gonzalez, Dana L. Kelly, and Teresa A. Smith. 1998. *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: TIMSS International Study Center, Boston College. **https://files.eric.ed.gov/fulltext/ED414207.pdf**.

NAGB (National Assessment Governing Board). 2013. "Grade 12 Sample [NAEP] Mathematics Questions." Washington, DC: NAGB. **https://www.nationsreportcard.gov/mathematics/sample-questions/?grade=12**.

NAGB (National Assessment Governing Board). 2017. *Writing Framework for the 2017 National Assessment of Educational Progress.* Washington, DC: NAGB. **https://www.nagb.gov/content/dam/nagb/en/documents/publications/frameworks/writing/2017-writing-framework.pdf**.

NAGB (National Assessment Governing Board). 2019. *Reading Framework for the 2019 National Assessment of Educational Progress.* Washington, DC: NAGB. **https://www.nagb.gov/content/dam/nagb/en/documents/publications/frameworks/reading/2019-reading-framework.pdf**.

Nagy, William E., Richard C. Anderson, and Patricia A. Herman. 1987. "Learning Word Meanings from Context during Normal Reading." *American Educational Research Journal* 24, no. 2 (Summer): 237–70. https://doi.org/10.2307/1162893.

Nation, Kate. 2009. "Reading Comprehension and Vocabulary: What's the Connection?" *Beyond Decoding: The Behavioral and Biological Foundations of Reading Comprehension*, edited by Richard K. Wagner, Christopher Schatschneider, and Caroline Phythian-Sence, 176–94. New York: Guilford.

National Academies of Sciences, Engineering, and Medicine. 2018. *Envisioning the Data Science Discipline: The Undergraduate Perspective, Interim Report.* Washington, DC: National Academies Press. https://doi.org/10.17226/24886.

National Council of Teachers of Mathematics. 2015a. *Calculator Use in Elementary Grades: A Position of the National Council of Teachers of Mathematics.* Reston, VA: National Council of Teachers of Mathematics. https://www.nctm.org/uploadedFiles/Standards_and_Positions/Position_Statements/Calculator%20Use%20in%20Elementary%20Grades%20July%202015.pdf.

National Council of Teachers of Mathematics. 2015b. *Strategic Use of Technology in Teaching and Learning Mathematics: A Position of the National Council of Teachers of Mathematics.* Reston, VA: National Council of Teachers of Mathematics. https://www.nctm.org/uploadedFiles/Standards_and_Positions/Position_Statements/Strategic%20Use%20of%20Technology%20July%202015.pdf.

National Council of Teachers of Mathematics. 2018. *Catalyzing Change in High School Mathematics: Initiating Critical Conversations*. Reston, VA: National Council of Teachers of Mathematics.

National Mathematics Advisory Panel. 2008. *Foundations for Success: The Final Report of the National Mathematics Advisory Panel*. Washington, DC: U.S. Department of Education. https://files.eric.ed.gov/fulltext/ED500486.pdf.

National Science Foundation. 1976. *Reviews of Data on Science Resources No. 27: Education and Work Activities of Federal Scientific and Technical Personnel, January 1974.* NSF 76-308. Washington, DC: Government Printing Office. https://files.eric.ed.gov/fulltext/ED137062.pdf.

National Student Clearinghouse Research Center. 2022. *Term Enrollment Estimates: Fall 2021.* Current Term Enrollment Estimates Report Series. Herndon, VA: National Student Clearinghouse. https://nscresearchcenter.org/wp-content/uploads/CTEE_Report_Fall_2021.pdf.

National Student Clearinghouse Research Center. 2023. *Current Term Enrollment Estimates: Fall 2022 Expanded Edition*. Herndon, VA: National Student Clearinghouse. https://nscresearchcenter.org/current-term-enrollment-estimates/.

NCES (National Center for Education Statistics). n.d. "NAEP Report Card: Reading, National [2019] Achievement-Level Results." Washington, DC: Institute of Education Sciences, U.S. Department of Education. Accessed May 13, 2022. https://www.nationsreportcard.gov/reading/nation/achievement/?grade=12.

NCSS (National Council for the Social Studies). 2013. The College, Career, and Civic Life (C3) Framework for Social Studies State Standards: Guidance for Enhancing the Rigor of K–12 Civics, Economics, Geography, and History. Silver Spring, MD: NCSS. https://www.socialstudies.org/system/files/2022/c3-framework-for-social-studies-rev0617.2.pdf.

Nelms, April A., and Miriam Segura-Totten. 2019. "Expert-Novice Comparison Reveals Pedagogical Implications for Students' Analysis of Primary Literature." *CBE—Life Sciences Education* 18, no. 4 (November). https://doi.org/10.1187/cbe.18-05-0077.

Nelson, Jessica, Charles Perfetti, David Liben, and Meredith Liben. 2012. *Measures of Text Difficulty: Testing Their Predictive Value for Grade Levels and Student Performance.* Report to the Gates Foundation. New York: Student Achievement Partners. https://achievethecore.org/page/1196/measures-of-text-difficulty-testing-their-predictive-value-for-grade-levels-and-student-performance.

Newsom, R. S., and A. J. H. Gaite. 1971. "Prose Learning: Effects of Pretesting and Reduction of Passage Length." *Psychological Reports* 28, no. 1 (February): 123–9. https://doi.org/10.2466/pr0.1971.28.1.123.

NGA (National Governors Association) Center for Best Practices and CCSSO (Council of Chief State School Officers). 2010a. *Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects.* Washington, DC: National Governors Association Center for Best Practices. http://www.corestandards.org/ELA-Literacy/.

NGA (National Governors Association) Center for Best Practices and CCSSO (Council of Chief State School Officers). 2010b. *Common Core State Standards for Mathematics.* Washington, DC: NGA Center for Best Practices. http://www.corestandards.org/wp-content/uploads/Math_Standards1.pdf.

NGSS (Next Generation Science Standards) Lead States. 2013. *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press. https://www.nextgenscience.org/.

Oakhill, Jane V. 1984. "Inferential and Memory Skills in Children's Comprehension of Stories." *British Journal of Educational Psychology* 54, no. 1 (February): 31–39. https://doi.org/10.1111/j.2044-8279.1984.tb00842.x.

Oakhill, Jane, and Kate Cain. 2012. "The Precursors of Reading Ability in Young Readers: Evidence from a Four-Year Longitudinal Study." *Scientific Studies of Reading* 16, no. 2 (March): 91–121. https://doi.org/10.1080/10888438.2010.529219.

O'Connor, Rollanda E. 2014. *Teaching Word Recognition: Effective Strategies for Students with Learning Difficulties*, 2nd ed. New York: Guilford.

O'Neill, Kathryn S. 2018. "Applying the Pareto Principle to the Analysis of Students' Errors in Grammar, Mechanics and Style." *Research in Higher Education Journal* 34 (May): 1–12. https://www.aabri.com/manuscripts/172738.pdf.

Osana, Helena P., Guy L. Lacroix, Bradley J. Tucker, Einat Idan, and Guillaume Jabbour. 2007. "The Impact of Print Exposure Quality and Inference Construction on Syllogistic Reasoning." *Journal of Educational Psychology* 99, no. 4 (November): 888–902. https://psycnet.apa.org/doi/10.1037/0022-0663.99.4.888.

Papashane, Maseeeng, and Dipane Hlalele. 2014. "Academic Literacy: A Critical Cognitive Catalyst towards the Creation of Sustainable Learning Ecologies in Higher Education." *Mediterranean Journal of Social Sciences* 5, no. 10 (June): 661–71. http://dx.doi.org/10.5901/mjss.2014.v5n10p661.

Peffer, Melanie E., and Niloofar Ramezani. 2019. "Assessing Epistemological Beliefs of Experts and Novices via Practices in Authentic Science Inquiry." *International Journal of STEM Education* 6, no. 3 (January). https://doi.org/10.1186/s40594-018-0157-9.

Pence, Harry E. 2014. "What Is Big Data and Why Is It Important?" *Journal of Educational Technology Systems* 43, no. 2 (December): 159–71. https://doi.org/10.2190%2FET.43.2.d.

Phillips, Richard J. 1997. "Can Juniors Read Graphs? A Review and Analysis of Some Computer-Based Activities." *Journal of Information Technology for Teacher Education* 6 (1): 49–58. https://doi.org/10.1080/14759399700200005.

Picone, Chris, Jennifer Rhode, Laura Hyatt, and Tim Parshall. 2007. "Assessing Gains in Undergraduate Students' Abilities to Analyze Graphical Data." *Teaching Issues and Experiments in Ecology* 5, Research no. 1 (July): 1–54. https://www.esa.org/tiee/vol/v5/research/picone/pdf/Picone_etal2007.pdf.

Preto-Bay, Ana Maria. 2004. "The Socio-Cultural Dimension of Academic Literacy Development and the Explicit Teaching of Genres as Community Heuristics." *Reading Matrix* 4, no. 3 (November): 86–117.

Probosari, Riezky Maya, Fatima Widyastuti, Sajidan, Suranto, and Baskoro Adi Prayitno. 2019. "Students' Argument Style through Scientific Reading-Based Inquiry: Improving Argumentation Skill in Higher Education." Second International Conference on Science, Mathematics, Environment, and Education, Surakarta, Indonesia, July 26–28, 2019. *AIP Conference Proceedings* 2194, 020088, December 18, 2019. **https://doi.org/10.1063/1.5139820**.

Quinn, Jamie M., Richard K. Wagner, Yaacov Petscher, and Danielle Lopez. 2015. "Developmental Relations between Vocabulary Knowledge and Reading Comprehension: A Latent Change Score Modeling Study." *Child Development* 86, no. 1 (January–February): 159–75. **https://doi.org/10.1111/cdev.12292**.

Rakes, Christopher R., Jeffrey C. Valentine, Maggie B. McGatha, and Robert N. Ronau. 2010. "Methods of Instructional Improvement in Algebra: A Systematic Review and Meta-Analysis." *Review of Educational Research* 80, no. 3 (September): 372–400. **https://doi.org/10.3102/0034654310374880**.

Renken, Maggie DeHart, and Narina Nuñez. 2009. "Evidence for Improved Conclusion Accuracy after Reading about Rather than Conducting a Belief-Inconsistent Simple Physics Experiment." *Applied Cognitive Psychology* 24, no. 6 (June): 792–811. **https://doi.org/10.1002/acp.1587**.

Rice, Mae. 2023. "22 Big Data Examples and Applications." Built In (blog). July 11, 2022. **https://builtin.com/big-data/big-data-examples-applications**.

Rose, David H., Anne Meyer, Nicole Strangman, and Gabrielle Rappolt. 2002. *Teaching Every Student in the Digital Age: Universal Design for Learning.* Alexandria, VA: Association for Supervision and Curriculum Development.

Rose, Heather, and Julian R. Betts. 2001. *Math Matters: The Links between High School Curriculum, College Graduation, and Earnings.* San Francisco, CA: Public Policy Institute of California. **https://www.ppic.org/wp-content/uploads/content/pubs/report/R_701JBR.pdf**.

Rose, Heather, and Julian R. Betts. 2004. "The Effect of High School Courses on Earnings." *Review of Economics and Statistics* 86, no. 2 (May): 497–513. **https://doi.org/10.1162/003465304323031076**.

Rosenfeld, Sophia. 2019. *Democracy and Truth: A Short History.* Philadelphia: University of Pennsylvania Press.

Rothkopf, Ernst Z., and M. J. Billington. 1983. "Passage Length and Recall with Text Size Held Constant: Effects of Modality, Pacing, and Learning Set." *Journal of Verbal Learning and Verbal Behavior* 22, no. 6 (December): 667–81. **https://psycnet.apa.org/doi/10.1016/S0022-5371(83)90395-X**.

Schak, Oliver, Ivan Metzger, Jared Bass, Clare McCann, and John English. 2017. *Developmental Education: Challenges and Strategies for Reform.* Washington, DC: U.S. Department of Education. **https://www2.ed.gov/about/offices/list/opepd/education-strategies.pdf**.

Schleicher, Andreas. 2019. *PISA [Programme for International Student Assessment] 2018: Insights and Interpretations.* Paris: Organisation for Economic Co-operation and Development [OECD]. **https://www.oecd.org/pisa/PISA%202018%20Insights%20and%20Interpretations%20FINAL%20PDF.pdf**.

Segers, Eliane, and Ludo Verhoeven. 2016. "How Logical Reasoning Mediates the Relation between Lexical Quality and Reading Comprehension." *Reading and Writing* 29 (April): 577–90. **https://doi.org/10.1007/s11145-015-9613-9**.

Shanahan, Timothy. n.d. "Common Core: Close Reading." *Instructor Magazine*. Accessed November 23, 2018.

Shanahan, Timothy. 2011. "Rejecting Instructional Level Theory." *Shanahan on Literacy* (blog). August 21, 2011. **https://www.shanahanonliteracy.com/blog/rejecting-instructional-level-theory#sthash.9cfgEmt2.dpbs**.

Silva, Macarena, and Kate Cain. 2015. "The Relations between Lower and Higher Level Comprehension Skills and Their Role in Prediction of Early Reading Comprehension." *Journal of Educational Psychology* 107, no. 2 (May): 321–31. **https://doi.org/10.1037/a0037769**.

Snow, Catherine E. 2010. "Academic Language and the Challenge of Reading for Learning about Science." *Science* 328, no. 5977 (April): 450–52. https://www.researchgate.net/publication/43299100_Academic_Language_and_the_Challenge_of_Reading_for_Learning_About_Science.

Snyder, Amanda Jacobson. 2022. "More than 3 in 4 Americans Believe College Is Difficult to Afford." Morning Consult, October 11, 2022. https://morningconsult.com/2022/10/11/college-affordability-student-loans-survey-data/.

Stein, Mary Kay, Julia Heath Kaufman, Milan Sherman, and Amy F. Hillen. 2011. "Algebra: A Challenge at the Crossroads of Policy and Practice." *Review of Educational Research* 81, no. 4 (December): 453–92. https://doi.org/10.3102%2F0034654311423025.

Stigler, James W., Shing-Ying Lee, and Harold W. Stevenson. 1990. *Mathematical Knowledge of Japanese, Chinese, and American Elementary School Children.* Reston, VA: National Council of Teachers of Mathematics.

Stylianides, Gabriel J., Andreas J. Stylianides, and Keith Weber. 2017. "Research on the Teaching and Learning of Proof: Taking Stock and Moving Forward." In *Compendium for Research in Mathematics Education*, edited by Jinfa Cai, 237–66. Reston, VA: National Council of Teachers of Mathematics.

Surber, John R. 1992. "The Effect of Test Expectation, Subject Matter, and Passage Length on Study Tactics and Retention." *Reading Research and Instruction* 31 (3): 32–40. https://doi.org/10.1080/19388079209558086.

Tairab, Hassan H., and Ali K. Khalaf Al-Naqbi. 2004. "How Do Secondary School Science Students Interpret and Construct Scientific Graphs?" *Journal of Biological Education* 38, no. 3 (June): 127–32. https://doi.org/10.1080/00219266.2004.9655920.

Tenopir, Carol, Donald W. King, and Amy Bush. 2004. "Medical Faculty's Use of Print and Electronic Journals: Changes over Time and in Comparison with Scientists." *Journal of the Medical Library Association* 92, no. 2 (April): 233–41. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC385305/.

Thompson, Sandra J., Christopher J. Johnstone, and Martha L. Thurlow. 2002. *Universal Design Applied to Large Scale Assessments.* Synthesis Report 44. Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes. https://nceo.umn.edu/docs/onlinepubs/synth44.pdf.

TNTP (The New Teacher Project). 2018. *The Opportunity Myth: What Students Can Show Us about How School Is Letting Them Down—and How to Fix It.* New York: TNTP. https://tntp.org/publications/view/student-experiences/the-opportunity-myth.

Trusty, Jerry, and Spencer G. Niles. 2004. "Realized Potential or Lost Talent: High School Variables and Bachelor's Degree Completion." *Career Development Quarterly* 53, no. 1 (September): 2–15. https://doi.org/10.1002/j.2161-0045.2004.tb00651.x.

U.S. Bureau of Labor Statistics. 2021. "Top Ten Fastest Growing Occupations, Excluding Pandemic Recovery." Graph. Washington, DC: U.S. Bureau of Labor Statistics. https://www.bls.gov/emp/graphics/fastest-growing-occupations.htm.

Van den Broek, Paul, and Anne Helder. 2017. "Cognitive Processes in Discourse Comprehension: Passive Processes, Reader-Initiated Processes, and Evolving Mental Representations." *Discourse Processes* 54, nos. 5–6 (April): 360–72. https://doi.org/10.1080/0163853X.2017.1306677.

Von der Mühlen, Sarah, Tobias Richter, Sebastian Schmid, and Kristen Berthold. 2019. "How to Improve Argumentation Comprehension in University Students: Experimental Test of a Training Approach." *Instructional Science* 47 (April): 215–37. https://doi.org/10.1007/s11251-018-9471-3.

Weedmark, David. 2018. "A List of Careers That Use Algebra." HoustonChronicle.com, June 29, 2018. https://work.chron.com/list-careers-use-algebra-14592.html.

Wexler, Natalie. 2019. *The Knowledge Gap: The Hidden Cause of America's Broken Education System—and How to Fix It.* New York: Avery.

Whipple, Guy Montrose, ed. 1925. *The Twenty-fourth Yearbook of the National Society for the Study of Education, Part 1: Report of the National Committee on Reading.* Bloomington, IL: Public School Publishing.

Wilkerson, Trena. 2020. “Statistics Education: An Imperative for Our Future.” National Council of Teachers of Mathematics President’s Messages: Trena Wilkerson. November 2020. **https://www.nctm.org/News-and-Calendar/Messages-from-the-President/Archive/Trena-Wilkerson/Statistics-Education_-An-Imperative-for-Our-Future/**.

Williams, Joseph M., and Joseph Bizup. 2017. *Style: Lessons in Clarity and Grace*, 12th ed. New York: Pearson.

Willingham, Daniel T. 2019. “How to Teach Critical Thinking.” *Education: Future Frontiers.* Occasional Paper Series. Parramatta, Australia: NSW (New South Wales) Department of Education. **http://www.danielwillingham.com/uploads/5/0/0/7/5007325/willingham_2019_nsw_critical_thinking2.pdf**.

Wineburg, Samuel S. 1991. “Historical Problem Solving: A Study of the Cognitive Processes Used in the Evaluation of Documentary and Pictorial Evidence.” *Journal of Educational Psychology* 83, no. 1 (March): 73–87. **https://doi.org/10.1037/0022-0663.83.1.73**.

Wolf, Maryanne. 2018. *Reader, Come Home: The Reading Brain in a Digital World.* New York: Harper.

Zohar, Anat, and Flora Nemet. 2002. “Fostering Students’ Knowledge and Argumentation Skills through Dilemmas in Human Genetics.” *Journal of Research in Science Teaching* 39, no. 1 (January): 35–62. **https://doi.org/10.1002/tea.10008**.

Appendix A: Digital SAT Suite Summary Tables

Table A28. Overall Test Specifications for the Digital SAT Suite.

Characteristic	Reading and Writing Section	Math Section
Administration	Two-stage adaptive test design: one Reading and Writing section administered via two separately timed modules	Two-stage adaptive test design: one Math section administered via two separately timed modules
Test length (number of operational and pretest questions)	1st module: 25 operational questions and 2 pretest questions 2nd module: 25 operational questions and 2 pretest questions	1st module: 20 operational questions and 2 pretest questions 2nd module: 20 operational questions and 2 pretest questions
Time per module	1st module: 32 minutes 2nd module: 32 minutes	1st module: 35 minutes 2nd module: 35 minutes
Total number of questions	54 questions	44 questions
Total time allotted	64 minutes	70 minutes
Average time per question	1.19 minutes	1.59 minutes
Scores reported	Total score Section scores (Reading and Writing; Math)	
Question type(s) used	Discrete; four-option multiple-choice	Discrete; four-option multiple-choice (≈75%) and student-produced response (SPR) (≈25%)
Stimulus subject areas	Literature, history/social studies, the humanities, science	Science, social studies, real-world topics
Word count	25–150 (6-character) words per stimulus text (or pair of texts)	Approximately 30% of questions in context; a majority of in-context questions have 50 (6-character) words or fewer
Informational graphics	Tables, bar graphs, line graphs	A wide range of data displays, geometric figures, and *xy*-plane graphs
Text complexity bands	Grades 6–8, grades 9–11, grades 12–14 (Grades 12–14 excluded from PSAT 8/9)	N/A (see section 2.3.12)

Table A29. Digital SAT Suite Reading and Writing Section Content Domains and Operational Question Distribution.

Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Information and Ideas	Students will use comprehension, analysis, and reasoning skills and knowledge as well as what is stated and implied in texts (including in any accompanying informational graphics) to locate, interpret, evaluate, and integrate information and ideas.	Central Ideas and Details Command of Evidence • Textual • Quantitative Inferences	≈26% / 12–14 questions
Craft and Structure	Students will use comprehension, vocabulary, analysis, synthesis, and reasoning skills and knowledge to use and determine the meaning of high-utility academic words and phrases in context, evaluate texts rhetorically, and make supportable connections between multiple topically related texts.	Words in Context Text Structure and Purpose Cross-Text Connections	≈28% / 13–15 questions
Expression of Ideas	Students will use revision skills and knowledge to improve the effectiveness of written expression in accordance with specified rhetorical goals.	Rhetorical Synthesis Transitions	≈20% / 8–12 questions
Standard English Conventions	Students will use editing skills and knowledge to make text conform to core conventions of Standard English sentence structure, usage, and punctuation.	Boundaries Form, Structure, and Sense	≈26% / 11–15 questions

Table A30. Digital SAT Math Section Content Domains and Operational Question Distribution.

Math Section Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Algebra	Students will interpret, create, use, represent, and solve problems using linear representations and make connections between different representations of linear relationships.	Linear equations in one variable Linear equations in two variables Linear functions Systems of two linear equations in two variables Linear inequalities in one or two variables	≈35%/ 13–15 questions

Math Section Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Advanced Math	Students will interpret, rewrite, fluently solve, make strategic use of structure, and create absolute value, quadratic, exponential, polynomial, rational, radical, and other nonlinear equations and make connections between different representations of a nonlinear relationship between two variables.	Equivalent expressions Nonlinear equations in one variable and systems of equations in two variables Nonlinear functions	≈35%/ 13–15 questions
Problem-Solving and Data Analysis	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; fit models to data and compare linear and exponential growth; and calculate, compare, and interpret mean, median, and range, compare distributions with the same and different standard deviation, understand basic study design, and interpret margin of error.	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability Inference from sample statistics and margin of error Evaluating statistical claims: observational studies and experiments	≈15%/ 5–7 questions
Geometry and Trigonometry	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; determine congruence, similarity, and sufficiency using concepts and theorems about vertical angles, triangles, and parallel lines cut by a transversal; solve problems using the Pythagorean theorem, right triangle and unit circle trigonometry, and properties of special right triangles; and use properties and theorems relating to circles to solve problems.	Area and volume Lines, angles, and triangles Right triangles and trigonometry Circles	≈15%/ 5–7 questions

Table A31. Digital PSAT/NMSQT and PSAT 10 Math Section Content Domains and Operational Question Distribution.

Math Section Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Algebra	Students will interpret, create, use, represent, and solve problems using linear representations and make connections between different representations of linear relationships.	Linear equations in one variable Linear equations in two variables Linear functions Systems of two linear equations in two variables Linear inequalities in one or two variables	≈35%/ 13–15 questions
Advanced Math	Students will interpret, rewrite, fluently solve, make strategic use of structure, and create absolute value, quadratic, exponential, polynomial, rational, radical, and other nonlinear equations and make connections between different representations of a nonlinear relationship between two variables.	Equivalent expressions Nonlinear equations in one variable and systems of equations in two variables Nonlinear functions	≈32.5%/ 12–14 questions
Problem-Solving and Data Analysis	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; fit models to data and compare linear and exponential growth; and calculate, compare, and interpret mean, median, and range and compare distributions with the same and different standard deviation.	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability Inference from sample statistics	≈20%/ 7–9 questions
Geometry and Trigonometry	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; determine congruence, similarity, and sufficiency using concepts and theorems about vertical angles, triangles, and parallel lines cut by a transversal; and solve problems using the Pythagorean theorem and right triangle trigonometry.	Area and volume Lines, angles, and triangles Right triangles and right triangle trigonometry	≈12.5%/ 4–6 questions

Table A32. Digital PSAT 8/9 Math Section Content Domains and Operational Question Distribution.

Math Section Content Domain	Domain Description (Claim)	Skill/Knowledge Testing Points	Operational Question Distribution
Algebra	Students will interpret, create, use, represent, and solve problems using linear representations and make connections between different representations of linear relationships.	Linear equations in one variable Linear equations in two variables Linear functions Systems of two linear equations in two variables Linear inequalities in one or two variables	≈42.5%/ 16–18 questions
Advanced Math	Students will rewrite, fluently solve, and make strategic use of structure, absolute value, quadratic, exponential, polynomial, and other nonlinear equations and make connections between different representations of a nonlinear relationship between two variables.	Equivalent expressions Nonlinear equations in one variable and systems of equations in two variables Nonlinear functions	≈20%/ 7–9 questions
Problem-Solving and Data Analysis	Using quantitative reasoning, students will fluently solve problems using percentages, proportional relationships, ratios, rates, and units; analyze and interpret distributions of data; use various representations of data to find relative frequency, probabilities, and conditional probabilities; fit models to data; and calculate, compare, and interpret mean, median, and range.	Ratios, rates, proportional relationships, and units Percentages One-variable data: distributions and measures of center and spread Two-variable data: models and scatterplots Probability and conditional probability	≈25%/ 9–11 questions
Geometry	Students will solve problems associated with length, area, volume, and scale factors using geometric figures; apply theorems such as triangle sum; and solve problems using the Pythagorean theorem.	Area and volume Lines, angles, and triangles, including right triangles	≈12.5%/ 4–6 questions

Appendix B: Digital SAT Suite Detailed Skill/Knowledge Testing Points

The following tables present in detail the skill/knowledge testing points in the Reading and Writing and Math sections of the digital SAT Suite tests.

Table A33. Digital SAT Suite Reading and Writing Section Skill/Knowledge Testing Points.

Content Dimension	Description
Text Complexity	The passages (and pairs of passages) on the Reading and Writing section represent a range of text complexities from grades 6–8 through grades 12–14. (Grades 12–14 passages are excluded from appearing on PSAT 8/9.)
Information and Ideas	Students will use comprehension, analysis, and reasoning skills and knowledge as well as what is stated and implied in texts (including in any accompanying informational graphics) to locate, interpret, evaluate, and integrate information and ideas.
Central Ideas and Details	Students will determine the central idea of a text and/or interpret the key details supporting that idea.
Command of Evidence	Students will determine the evidence in a text that best supports a specified claim or point.
Textual	Students will determine the textual evidence (e.g., a fact, detail, or example from a text) that best supports a specified claim or point.
Quantitative	Students will determine the quantitative evidence (i.e., data from an informational graphic) that best supports a specified claim or point.
Inferences	Students will draw reasonable inferences based on explicit and/or implicit information and ideas in a text.
Craft and Structure	Students will use comprehension, vocabulary, analysis, synthesis, and reasoning skills and knowledge to use and determine the meaning of high-utility academic words and phrases in context, evaluate texts rhetorically, and make supportable connections between multiple topically related texts.
Words in Context	Students will determine the meaning of a high-utility academic word or phrase in context or use such vocabulary in a contextually appropriate way.
Text Structure and Purpose	Students will analyze the structure of a text or determine the main rhetorical purpose of a text.
Cross-Text Connections	Students will draw reasonable connections between two texts on related topics.

Content Dimension	Description
Expression of Ideas	Students will use revision skills and knowledge to improve the effectiveness of written expression in accordance with specified rhetorical goals.
Rhetorical Synthesis	Students will strategically integrate information and ideas on a topic to form an effective sentence achieving a specified rhetorical aim.
Transitions	Students will determine the most effective transition word or phrase to logically connect information and ideas in a text.
Standard English Conventions	Students will use editing skills and knowledge to make text conform to core conventions of Standard English sentence structure, usage, and punctuation.
Boundaries	Students will edit text to ensure that sentences are conventionally complete.
Between Sentences	Students will use contextually appropriate punctuation to properly mark the end of a sentence.
Within Sentences	Students will coordinate clauses within a sentence or elements in a series using appropriate punctuation and, in some cases, a conjunction or conjunctive adverb; incorporate supplementary information (e.g., appositives, parentheticals) using appropriate punctuation; and recognize circumstances in which no punctuation is needed to set off sentence elements.
Form, Structure, and Sense	Students will edit text to conform to conventional usage.
Subject-Verb Agreement	Students will ensure agreement in number between a subject and a verb.
Pronoun-Antecedent Agreement	Students will ensure agreement in number between a pronoun and its antecedent.
Verb Finiteness	Students will use verbs and verbals (i.e., gerunds, participles, infinitives) in contextually appropriate ways.
Verb Tense and Aspect	Students will use contextually appropriate tenses and aspects of verbs.
Subject-Modifier Placement	Students will place modifying elements in sentences (e.g., participles) in contextually appropriate ways.
Genitives and Plurals	Students will make contextually appropriate choices among singular, plural, singular possessive, and plural possessive nouns and pronouns and among possessive determiners (*its*, *their*, *your*), contractions (*it's*, *they're*, *you're*), and adverbs (*there*).

Table A34. Digital SAT Suite Math Section Skill/Knowledge Testing Points: Algebra

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Linear equations in one variable	Create and use linear equations in one variable to solve problems in a variety of contexts. Identify or create a linear equation in one variable that represents a context. For a linear equation in one variable, interpret a constant, variable, factor, term, or the solution in a context. Solve a linear equation in one variable, making strategic use of algebraic structure. For a linear equation in one variable, determine the conditions under which the equation has no solution, a unique solution, or infinitely many solutions. Fluently solve a linear equation in one variable.	Create and use linear equations in one variable to solve problems in a variety of contexts. Identify or create a linear equation in one variable that represents a context. For a linear equation in one variable, interpret a constant, variable, factor, term, or the solution in a context. Solve a linear equation in one variable, making strategic use of algebraic structure. For a linear equation in one variable, determine the conditions under which the equation has no solution, a unique solution, or infinitely many solutions. Fluently solve a linear equation in one variable.	Create and use linear equations in one variable to solve problems in a variety of contexts. Identify or create a linear equation in one variable that represents a context. For a linear equation in one variable, interpret a constant, variable, factor, term, or the solution in a context. Solve a linear equation in one variable, making strategic use of algebraic structure. Fluently solve a linear equation in one variable.

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Linear functions	Algebraically, a linear function can be defined by a linear expression in one variable or by a linear equation in two variables. In the first case, the variable is the input and the value of the expression is the output. In the second case, one of the variables is designated as the input and determines a unique value of the other variable, which is the output. • Create and use linear functions to solve problems in a variety of contexts. • Identify or create a linear function to model a relationship between two quantities. • For a linear function that represents a context, interpret the meaning of an input/output pair, constant, variable, factor, or term based on the context, including situations where seeing structure provides an advantage. • Interpret the graph of a linear function in a context. • Make connections between a table, an algebraic representation, or a graph of a linear function not in context. • Make connections between a table, an algebraic representation, or a graph of a linear function in context. • For a linear function that represents a context, given an input value, find and interpret the output value using the given representation, or given an output value, find and interpret the input value using the given representation, if it exists. • Write the rule for a linear function given two input/output pairs or one input/output pair and the rate of change. • Evaluate a linear function given an input value, or find the input value for a corresponding output.	Algebraically, a linear function can be defined by a linear expression in one variable or by a linear equation in two variables. In the first case, the variable is the input and the value of the expression is the output. In the second case, one of the variables is designated as the input and determines a unique value of the other variable, which is the output. • Create and use linear functions to solve problems in a variety of contexts. • Identify or create a linear function to model a relationship between two quantities. • For a linear function that represents a context, interpret the meaning of an input/output pair, constant, variable, factor, or term based on the context, including situations where seeing structure provides an advantage. • Interpret the graph of a linear function in a context. • Make connections between a table, an algebraic representation, or a graph of a linear function not in context. • Make connections between a table, an algebraic representation, or a graph of a linear function in context. • For a linear function that represents a context, given an input value, find and interpret the output value using the given representation, or given an output value, find and interpret the input value using the given representation, if it exists. • Write the rule for a linear function given two input/output pairs or one input/output pair and the rate of change. • Evaluate a linear function given an input value, or find the input value for a corresponding output.	Algebraically, a linear function can be defined by a linear expression in one variable or by a linear equation in two variables. In the first case, the variable is the input and the value of the expression is the output. In the second case, one of the variables is designated as the input and determines a unique value of the other variable, which is the output. • Create and use linear functions to solve problems in a variety of contexts. • Identify or create a linear function to model a relationship between two quantities. • For a linear function that represents a context, interpret the meaning of an input/output pair, constant, variable, factor, or term based on the context, including situations where seeing structure provides an advantage. • Interpret the graph of a linear function in a context. • Make connections between a table, an algebraic representation, or a graph of a linear function not in context. • Make connections between a table, an algebraic representation, or a graph of a linear function in context. • For a linear function that represents a context, given an input value, find and interpret the output value using the given representation, or given an output value, find and interpret the input value using the given representation, if it exists. • Write the rule for a linear function given two input/output pairs or one input/output pair and the rate of change. • Evaluate a linear function given an input value, or find the input value for a corresponding output.

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Linear equations in two variables	A linear equation in two variables can be used to represent a constraint or condition on two variable quantities in situations where neither of the variables is regarded as an input or an output. A linear equation can also be used to represent a straight line in the coordinate plane. • Create and use a linear equation in two variables to solve problems in a variety of contexts. • Identify or create a linear equation in two variables to model a constraint or condition on two quantities. • For a linear equation in two variables that represents a context, interpret a solution, constant, variable, factor, or term based on the context, including situations where seeing structure provides an advantage. • Interpret the graph of a linear equation in the form $Ax + By = C$ in a context. • Make connections between: » an algebraic representation and a graph of a linear equation in two variables not in context. » a table and an algebraic representation or between a table and a graph of a linear equation in two variables not in context. • Make connections between a table, an algebraic representation, or a graph of a linear equation in two variables in a context. • For a linear equation in two variables that represents a context, given a value of one quantity in the relationship, find a value of the other, if it exists. • Write an equation for a line given two points on the line, one point and the slope of the line, or one point and a parallel or perpendicular line.	A linear equation in two variables can be used to represent a constraint or condition on two variable quantities in situations where neither of the variables is regarded as an input or an output. A linear equation can also be used to represent a straight line in the coordinate plane. • Create and use a linear equation in two variables to solve problems in a variety of contexts. • Identify or create a linear equation in two variables to model a constraint or condition on two quantities. • For a linear equation in two variables that represents a context, interpret a solution, constant, variable, factor, or term based on the context, including situations where seeing structure provides an advantage. • Interpret the graph of a linear equation in the form $Ax + By = C$ in a context. • Make connections between: » an algebraic representation and a graph of a linear equation in two variables not in context. » a table and an algebraic representation or between a table and a graph of a linear equation in two variables not in context. • Make connections between a table, an algebraic representation, or a graph of a linear equation in two variables in a context. • For a linear equation in two variables that represents a context, given a value of one quantity in the relationship, find a value of the other, if it exists. • Write an equation for a line given two points on the line, one point and the slope of the line, or one point and a parallel or perpendicular line.	A linear equation in two variables can be used to represent a constraint or condition on two variable quantities in situations where neither of the variables is regarded as an input or an output. A linear equation can also be used to represent a straight line in the coordinate plane. • Create and use a linear equation in two variables to solve problems in a variety of contexts. • Identify or create a linear equation in two variables to model a constraint or condition on two quantities. • For a linear equation in two variables that represents a context, interpret a solution, constant, variable, factor, or term based on the context, including situations where seeing structure provides an advantage. • Interpret the graph of a linear equation in the form $Ax + By = C$ in a context. • Make connections between: » an algebraic representation and a graph of a linear equation in two variables not in context. » a table and an algebraic representation or between a table and a graph of a linear equation in two variables not in context. • Make connections between a table, an algebraic representation, or a graph of a linear equation in two variables in a context. • For a linear equation in two variables that represents a context, given a value of one quantity in the relationship, find a value of the other, if it exists. • Write an equation for a line given two points on the line, one point and the slope of the line, or one point and a parallel or perpendicular line.

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Systems of two linear equations in two variables	Create and use a system of two linear equations in two variables to solve problems in a variety of contexts. Identify or create a system of linear equations in two variables to model constraints or conditions on two quantities. Solve a system of two linear equations in two variables, making strategic use of algebraic structure. For a system of linear equations in two variables, determine the conditions under which the system has no solution, a unique solution, or infinitely many solutions. Make connections between an algebraic representation and a graph of a system of linear equations in two variables not in context. Make connections between an algebraic representation and a graph of a system of linear equations in two variables in a context. Fluently solve a system of linear equations in two variables.	Create and use a system of two linear equations in two variables to solve problems in a variety of contexts. Identify or create a system of linear equations in two variables to model constraints or conditions on two quantities. Solve a system of two linear equations in two variables, making strategic use of algebraic structure. For a system of linear equations in two variables, determine the conditions under which the system has no solution, a unique solution, or infinitely many solutions. Make connections between an algebraic representation and a graph of a system of linear equations in two variables not in context. Make connections between an algebraic representation and a graph of a system of linear equations in two variables in a context. Fluently solve a system of linear equations in two variables.	Create and use a system of two linear equations in two variables to solve problems in a variety of contexts. Identify or create a system of linear equations in two variables to model constraints or conditions on two quantities. Solve a system of two linear equations in two variables, making strategic use of algebraic structure. Make connections between an algebraic representation and a graph of a system of linear equations in two variables not in context. Make connections between an algebraic representation and a graph of a system of linear equations in two variables in a context. Fluently solve a system of linear equations in two variables.
Linear inequalities in one or two variables	Create and use linear inequalities in one or two variables to solve problems in a variety of contexts. Identify or create linear inequalities in one or two variables to model constraints or conditions on two quantities. For linear inequalities in one or two variables, interpret a constant, variable, factor, term, or solution, including situations where seeing structure provides an advantage. Given a linear inequality or system of linear inequalities, interpret a point in the *xy*-plane in terms of the solution set. Make connections between tabular, algebraic, and graphical representations of linear inequalities in one or two variables by deriving one from the other.	Create and use linear inequalities in one or two variables to solve problems in a variety of contexts. Identify or create linear inequalities in one or two variables to model constraints or conditions on two quantities. For linear inequalities in one or two variables, interpret a constant, variable, factor, term, or solution, including situations where seeing structure provides an advantage. Given a linear inequality or system of linear inequalities, interpret a point in the *xy*-plane in terms of the solution set. Make connections between tabular, algebraic, and graphical representations of linear inequalities in one or two variables by deriving one from the other.	Create and use linear inequalities in one or two variables to solve problems in a variety of contexts. Identify or create linear inequalities in one or two variables to model constraints or conditions on two quantities. For linear inequalities in one or two variables, interpret a constant, variable, factor, term, or solution, including situations where seeing structure provides an advantage. Given a linear inequality or system of linear inequalities, interpret a point in the *xy*-plane in terms of the solution set.

Table A35. Digital SAT Suite Math Section Skill/Knowledge Testing Points: Advanced Math

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Equivalent expressions	Make strategic use of algebraic structure and the properties of operations to identify and create equivalent expressions: • by factoring polynomials limited to finding a common factor, rewriting binomials that represent a difference of two squares, and rewriting trinomials as the product of two binomials. • including rewriting simple rational expressions, rewriting expressions with rational exponents in radical form, and factoring polynomials not included in the preceding bullet. Fluently add, subtract, and multiply polynomials.	Make strategic use of algebraic structure and the properties of operations to identify and create equivalent expressions by factoring polynomials limited to finding a common factor, rewriting binomials that represent a difference of two squares, and rewriting trinomials as the product of two binomials. Fluently add, subtract, and multiply polynomials.	Make strategic use of algebraic structure and the properties of operations to identify and create equivalent expressions by factoring polynomials limited to finding a common factor, rewriting binomials that represent a difference of two squares, and rewriting trinomials as the product of two binomials. Fluently add, subtract, and multiply polynomials.
Nonlinear equations in one variable and systems of equations in two variables	Make strategic use of algebraic structure, the properties of operations, and/or reasoning about equality to solve: • quadratic equations in one variable presented in a wide variety of forms. • linear absolute value equations in one variable or simple rational and radical equations in one variable. • polynomial equations in one variable that are written in factored form. Make strategic use of algebraic structure, the properties of operations, and reasoning about equality to solve systems of linear and nonlinear equations in two variables. Determine the conditions under which a quadratic equation has no real solutions, one real solution, or two real solutions. Relate the solutions of a system of a linear and a nonlinear equation in two variables to the graphs of the equations in the system.	Make strategic use of algebraic structure, the properties of operations, and/or reasoning about equality to solve: • quadratic equations in one variable presented in a wide variety of forms. • linear absolute value equations in one variable or simple rational and radical equations in one variable. Make strategic use of algebraic structure, the properties of operations, and reasoning about equality to solve systems of linear and nonlinear equations in two variables. Determine the conditions under which a quadratic equation has no real solutions, one real solution, or two real solutions. Relate the solutions of a system of a linear and a nonlinear equation in two variables to the graphs of the equations in the system.	Make strategic use of algebraic structure, the properties of operations, and/or reasoning about equality to solve quadratic equations in one variable presented in a wide variety of forms. Make strategic use of algebraic structure, the properties of operations, and reasoning about equality to solve systems of linear and nonlinear equations in two variables. Relate the solutions of a system of a linear and a nonlinear equation in two variables to the graphs of the equations in the system. Given an equation or formula in two or more variables, view it as an equation in a single variable of interest where the other variables are parameters, and solve for the variable of interest. Fluently solve quadratic equations in one variable, written as a quadratic expression in standard form, where using the quadratic formula or completing the square is the most efficient method for solving the equation.

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Nonlinear equations in one variable and systems of equations in two variables *(continued)*	Given an equation or formula in two or more variables, view it as an equation in a single variable of interest where the other variables are parameters, and solve for the variable of interest. Fluently solve quadratic equations in one variable, written as a quadratic expression in standard form, where using the quadratic formula or completing the square is the most efficient method for solving the equation.	Given an equation or formula in two or more variables, view it as an equation in a single variable of interest where the other variables are parameters, and solve for the variable of interest. Fluently solve quadratic equations in one variable, written as a quadratic expression in standard form, where using the quadratic formula or completing the square is the most efficient method for solving the equation.	
Nonlinear functions	Create and use quadratic or exponential functions to solve problems in a variety of contexts. Identify or create an appropriate quadratic or exponential function to model a relationship between quantities. For a quadratic or exponential function that represents a context: • interpret the meaning of an input/output pair including an intercept or initial value, including situations where seeing structure provides an advantage. • interpret the meaning of a constant, variable, factor, or term based on the context, including situations where seeing structure provides an advantage. For a quadratic or exponential function in a context: • interpret a point on the graph. • interpret parts of the graph (other than a point or intercept). Make connections between a table, an algebraic representation, or a graph of a: • quadratic or exponential function that does not involve a transformation, not in context. • polynomial function, simple rational function, or quadratic or exponential function that involves a transformation, not in context.	Create and use quadratic or exponential functions to solve problems in a variety of contexts. Identify or create an appropriate quadratic or exponential function to model a relationship between quantities. For a quadratic or exponential function that represents a context: • interpret the meaning of an input/output pair including an intercept or initial value, including situations where seeing structure provides an advantage. • interpret the meaning of a constant, variable, factor, or term based on the context, including situations where seeing structure provides an advantage. For a quadratic or exponential function in a context: • interpret a point on the graph. • interpret parts of the graph (other than a point or intercept). Make connections between a table, an algebraic representation, or a graph of a: • quadratic or exponential function that does not involve a transformation, not in context. • polynomial function, simple rational function, or quadratic or exponential function that involves a transformation, not in context.	For a quadratic or exponential function that represents a context, interpret the meaning of an input/output pair including an intercept or initial value, including situations where seeing structure provides an advantage. For a quadratic or exponential function in a context, interpret a point on the graph. Make connections between a table, an algebraic representation, or a graph of a quadratic or exponential function that does not involve a transformation, not in context. Make connections between a table, an algebraic representation, or a graph of a quadratic or exponential function that does not involve a transformation, in a context. Use function notation to represent and interpret input/output pairs. Evaluate a nonlinear function given an input value; or, for a quadratic function, find the input value for a corresponding output.

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Nonlinear functions *(continued)*	Make connections between a table, an algebraic representation, or a graph of a: • quadratic or exponential function that does not involve a transformation, in a context. • polynomial function, simple rational function, or other nonlinear function in a context, or a quadratic or exponential function that involves a transformation in a context. Determine the most suitable form of the expression representing the output of the function to display key features for: • a quadratic function. • an exponential function. Understand and use the fact that for the graph of $y = f(x)$, the solutions to $f(x) = 0$ correspond to x-intercepts of the graph and $f(0)$ corresponds to the y-intercept of the graph; make connections between the input/output pairs and points on a graph; interpret this information in a context. Use function notation to represent and interpret input/output pairs: • evaluate a nonlinear function given an input value; or, for a quadratic function, find the input value for a corresponding output. • for exponential, polynomial, radical, and rational functions, find the input value for a corresponding output.	Make connections between a table, an algebraic representation, or a graph of a: • quadratic or exponential function that does not involve a transformation, in a context. • polynomial function, simple rational function, or other nonlinear function in a context, or a quadratic or exponential function that involves a transformation in a context. Determine the most suitable form of the expression representing the output of the function to display key features for: • a quadratic function. • an exponential function. Use function notation to represent and interpret input/output pairs: • evaluate a nonlinear function given an input value; or, for a quadratic function, find the input value for a corresponding output. • for exponential, polynomial, radical, and rational functions, find the input value for a corresponding output.	

Table A36. Digital SAT Suite Math Section Skill/Knowledge Testing Points: Problem-Solving and Data Analysis

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Ratios, rates, proportional relationships, and units	Questions will require students to solve problems by using a proportional relationship between quantities, calculating or using a ratio or rate, and/or using units, derived units, and unit conversion. • Apply proportional relationships, ratios, and rates in a wide variety of contexts. Examples include, but are not limited to, scale drawings and problems in the natural and social sciences. • Solve problems involving derived units, including those that arise from products (e.g., kilowatt-hours) and quotients (e.g., population per square kilometer). • Solve problems involving: » a one-step unit conversion. » a multistep or multidimensional unit conversion. • Understand and use the fact that when two quantities are in a proportional relationship, if one changes by a scale factor, then the other also changes by the same scale factor.	Questions will require students to solve problems by using a proportional relationship between quantities, calculating or using a ratio or rate, and/or using units, derived units, and unit conversion. • Apply proportional relationships, ratios, and rates in a wide variety of contexts. Examples include, but are not limited to, scale drawings and problems in the natural and social sciences. • Solve problems involving derived units, including those that arise from products (e.g., kilowatt-hours) and quotients (e.g., population per square kilometer). • Solve problems involving: » a one-step unit conversion. » a multistep or multidimensional unit conversion. • Understand and use the fact that when two quantities are in a proportional relationship, if one changes by a scale factor, then the other also changes by the same scale factor.	Questions will require students to solve problems by using a proportional relationship between quantities, calculating or using a ratio or rate, and/or using units, derived units, and unit conversion. • Apply proportional relationships, ratios, and rates in a wide variety of contexts. Examples include, but are not limited to, scale drawings and problems in the natural and social sciences. • Solve problems involving derived units, including those that arise from products (e.g., kilowatt-hours) and quotients (e.g., population per square kilometer). • Solve problems involving: » a one-step unit conversion. » a multistep or multidimensional unit conversion. • Understand and use the fact that when two quantities are in a proportional relationship, if one changes by a scale factor, then the other also changes by the same scale factor.
Percentages	Use percentages to solve problems in a variety of contexts: • including, but not limited to, discounts, interest, taxes, and tips. • including those that involve percent increases and decreases for many different quantities. Understand and use the relationship between percent change and growth factor (5% and 1.05, for example); include percentages greater than or equal to 100%.	Use percentages to solve problems in a variety of contexts: • including, but not limited to, discounts, interest, taxes, and tips. • including those that involve percent increases and decreases for many different quantities. Understand and use the relationship between percent change and growth factor (5% and 1.05, for example); include percentages greater than or equal to 100%.	Use percentages to solve problems in a variety of contexts: • including, but not limited to, discounts, interest, taxes, and tips. • including those that involve percent increases and decreases for many different quantities. Understand and use the relationship between percent change and growth factor (5% and 1.05, for example); include percentages greater than or equal to 100%.

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
One-variable data: Distributions and measures of center and spread	Analyze and interpret numerical data distributions represented with frequency tables, histograms, dot plots, and box plots. For quantitative variables, calculate, compare, and interpret mean, median, and range. Compare distributions using measures of center and spread, including: • distributions with different means and the same standard deviations. • distributions with different standard deviations. Understand and describe the effect of outliers on mean and median.	Analyze and interpret numerical data distributions represented with frequency tables, histograms, dot plots, and box plots. For quantitative variables, calculate, compare, and interpret mean, median, and range. Compare distributions using measures of center and spread, including: • distributions with different means and the same standard deviations. • distributions with different standard deviations. Understand and describe the effect of outliers on mean and median.	Analyze and interpret numerical data distributions represented with frequency tables, histograms, dot plots, and box plots. For quantitative variables, calculate, compare, and interpret mean, median, and range. Compare distributions using measures of center and spread, including distributions with different means and the same standard deviations. Understand and describe the effect of outliers on mean and median.
Two-variable data: Models and scatterplots	Analyze and interpret data represented in a scatterplot, but do not make predictions. Analyze and interpret data represented in a scatterplot to make predictions. Fit linear models to data represented in a scatterplot. Fit quadratic and exponential models to data represented in a scatterplot. Given a relationship between two quantities, read and interpret graphs modeling the relationship. Compare linear and exponential growth.	Analyze and interpret data represented in a scatterplot, but do not make predictions. Analyze and interpret data represented in a scatterplot to make predictions. Fit linear models to data represented in a scatterplot. Fit quadratic and exponential models to data represented in a scatterplot. Given a relationship between two quantities, read and interpret graphs modeling the relationship. Compare linear and exponential growth.	Analyze and interpret data represented in a scatterplot, but do not make predictions. Fit linear models to data represented in a scatterplot. Given a relationship between two quantities, read and interpret graphs modeling the relationship.
Probability and conditional probability	Use one- and two-way tables, area models, and other representations to find relative frequency, probabilities, and conditional probabilities. • Calculate, express, or interpret the probability or conditional probability of an event using a data display showing frequencies for a single variable, a two-way table, an area model, or a description of a situation. Infrequently, given a probability, determine an unknown number in a data display showing frequencies for a single variable, a two-way table, or a description of a situation, including using a probability to determine the frequency of an event.	Use one- and two-way tables, area models, and other representations to find relative frequency, probabilities, and conditional probabilities. • Calculate, express, or interpret the probability or conditional probability of an event using a data display showing frequencies for a single variable, a two-way table, an area model, or a description of a situation. Infrequently, given a probability, determine an unknown number in a data display showing frequencies for a single variable, a two-way table, or a description of a situation, including using a probability to determine the frequency of an event.	Use one- and two-way tables, area models, and other representations to find relative frequency, probabilities, and conditional probabilities. • Calculate, express, or interpret the probability or conditional probability of an event using a data display showing frequencies for a single variable, a two-way table, an area model, or a description of a situation. Infrequently, given a probability, determine an unknown number in a data display showing frequencies for a single variable, a two-way table, or a description of a situation, including using a probability to determine the frequency of an event.

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Inference from sample statistics and margin of error	Use sample mean and sample proportion to estimate population mean and population proportion. Interpret margin of error. Understand that a larger sample size generally leads to a smaller margin of error.	Use sample mean and sample proportion to estimate population mean and population proportion.	
Evaluating statistical claims: Observational studies and experiments	With random samples, identify or describe which population the results can be extended to. Given a description of a study with or without random assignment, determine whether there is evidence for a causal relationship. Understand why random assignment provides evidence for a causal relationship in an experimental study. Understand issues related to sampling methods and why a result can be extended only to the population from which the sample was selected.		

Table A37. Digital SAT Suite Math Section Skill/Knowledge Testing Points: Geometry and Trigonometry

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Area and volume	Solve real-world and mathematical problems about the: • area or perimeter of a geometric figure or an object that can be modeled by a geometric figure using given information. • surface area or volume of a geometric figure or an object that can be modeled by a geometric figure using given information such as length, area, surface area, or volume. Apply knowledge that changing by a scale factor of *k* changes all lengths by a factor of *k*, changes all areas by a factor of k^2, and changes all volumes by a factor of k^3. Demonstrate procedural fluency by selecting the correct: • area formula and correctly calculating a specified value. • surface area or volume formula and correctly calculating a specified value.	Solve real-world and mathematical problems about the: • area or perimeter of a geometric figure or an object that can be modeled by a geometric figure using given information. • surface area or volume of a geometric figure or an object that can be modeled by a geometric figure using given information such as length, area, surface area, or volume. Apply knowledge that changing by a scale factor of *k* changes all lengths by a factor of *k*, changes all areas by a factor of k^2, and changes all volumes by a factor of k^3. Demonstrate procedural fluency by selecting the correct: • area formula and correctly calculating a specified value. • surface area or volume formula and correctly calculating a specified value.	Solve real-world and mathematical problems about the: • area or perimeter of a geometric figure or an object that can be modeled by a geometric figure using given information. • surface area or volume of a geometric figure or an object that can be modeled by a geometric figure using given information such as length, area, surface area, or volume. Apply knowledge that changing by a scale factor of *k* changes all lengths by a factor of *k*, changes all areas by a factor of k^2, and changes all volumes by a factor of k^3. Demonstrate procedural fluency by selecting the correct: • area formula and correctly calculating a specified value. • surface area or volume formula and correctly calculating a specified value.
Lines, angles, and triangles	Use concepts and theorems relating to congruence and similarity of triangles to solve problems. Determine which statements may be required to prove certain relationships or to satisfy a given theorem. Apply knowledge that changing by a scale factor of *k* changes all lengths by a factor of *k*, but angle measures remain unchanged. Know and directly apply relevant theorems such as the: • triangle angle sum theorem. • vertical angle theorem and the relationship of angles formed when a transversal cuts parallel lines.	Use concepts and theorems relating to congruence and similarity of triangles to solve problems. Determine which statements may be required to prove certain relationships or to satisfy a given theorem. Apply knowledge that changing by a scale factor of *k* changes all lengths by a factor of *k*, but angle measures remain unchanged. Know and directly apply relevant theorems such as the: • triangle angle sum theorem. • vertical angle theorem and the relationship of angles formed when a transversal cuts parallel lines.	Know and directly apply the triangle angle sum theorem.

Content Dimension	SAT Description	PSAT/NMSQT and PSAT 10 Description	PSAT 8/9 Description
Right triangles and trigonometry	Solve problems in a variety of contexts using: • the Pythagorean theorem. • properties of special right triangles. • right triangle trigonometry. Use similarity to calculate values of sine, cosine, and tangent. Solve problems using the relationship between sine and cosine of complementary angles.	Solve problems in a variety of contexts using: • the Pythagorean theorem. • properties of special right triangles. • right triangle trigonometry.	Solve problems in a variety of contexts using the Pythagorean theorem.
Circles	Use definitions, properties, and theorems relating to circles and parts of circles such as radii, diameters, tangents, angles, arc lengths, and sector areas to solve problems. Solve problems using either radian measure or trigonometric ratios in the unit circle. Create an equation to represent a circle in the *xy*-plane. Describe how a change to the equation representing a circle affects the graph of the circle in the *xy*-plane or how a change to the graph of a circle affects the equation that represents the circle. Understand that the ordered pairs that satisfy an equation of the form $(x-h)^2+(y-k)^2=r^2$ form a circle when plotted in the *xy*-plane. Convert between angle measures in degrees and radians. Complete the square in an equation representing a circle to determine properties of the circle when it is graphed in the *xy*-plane and use the distance formula in problems related to circles.		

Appendix C: Digital SAT Suite Test Development Process Overview

This appendix outlines the test development process used in producing the digital SAT Suite assessments. Its main purpose is to acquaint readers with the rigorous approach College Board uses to develop questions and tests for the digital suite and thereby provide greater transparency into a critical aspect of developing and delivering the digital SAT Suite assessments.

Test Construct and Content Domain Definitions

As discussed in section 3.2.1 and section 4.2.1, early in the design of the digital SAT Suite assessments, College Board staff defined the *constructs* (concepts) to be tested and the broad *content domains* (categories) that would be used to organize testing points within these constructs. This process resulted, first, in two base constructs—(1) Reading and Writing and (2) Math—which codified the parameters of the two corresponding test sections and, second, four content domains per section—Information and Ideas, Craft and Structure, Expression of Ideas, and Standard English Conventions in the Reading and Writing section and Algebra, Advanced Math, Problem-Solving and Data Analysis, and Geometry and Trigonometry in the Math section. (Due to the absence of trigonometric testing points in PSAT 8/9, the last content domain in Math is simply "Geometry" at that program level.)

Skill/Knowledge Elements Articulation

College Board content and measurement experts then used a wide range of evidence to determine the specific skills and knowledge to be tested in each section and content domain. The primary source of evidence for making these determinations was what was then being tested on the paper-and-pencil SAT Suite assessments. Proceeding thusly offered several advantages. First, the paper-and-pencil SAT Suite tests had themselves been based on high-quality evidence about what students need to know and be able to do to be college and career ready. By design, this process did not result in a complete transliteration of the paper-based SAT Suite tests to the digital versions, as slight adjustments to the content, skills, and knowledge measured as well as more substantive changes to the ways in which these skills and knowledge were assessed were necessary to (1) align the tests with emergent evidence about critical college and career readiness prerequisites and (2) facilitate the design goals for the digital suite, which centrally included reducing test length while maintaining test validity and reliability. Second, concordance between the paper-based and digital SAT Suites would be facilitated by having the two suites of assessments as similar as possible in what they measured. Third, strong similarity in the content, skills, and knowledge tested in the two suites would ease stakeholder transition to the digital-suite tests, as most of what these individuals and groups already knew about the SAT Suite would carry over to the digital format.

For Math, this process resulted in paper-based and digital SAT Suite skill/knowledge testing points and question formats being virtually identical. For Reading and Writing, where more changes were anticipated, the extra step of *domain mapping* was added. This process established which skills and knowledge would be tested, using what format(s), at what cognitive complexities and question difficulties, and in what proportions on the digital SAT Suite exams. This mapping yielded a preliminary set of Reading and Writing test specifications that would be evaluated and refined throughout the rest of the design process. For more details on the domain mapping task in Reading and Writing, see section 5.1.2.

Test Specifications Development

College Board staff then produced initial test specifications for the digital SAT Suite assessments. These content and statistical specifications (the final versions of the former of which are discussed throughout this document) established such parameters as how many questions were to be included in each section; how long, in terms of minutes, each test section was to be; how many questions in each content domain should appear in each section; what statistical properties (e.g., difficulty) successful test questions and pools of test questions should have; and so on. These specifications were refined throughout the test design process as new evidence from an array of studies was collected and analyzed. (See section 5.1 for discussion of these studies.) Feedback from both College Board and independent experts was also used to refine the initial design as represented in the specifications.

Reading and Writing Question Prototyping and Piloting

Early versions of Reading and Writing test questions were prototyped and piloted on samples of the student population of interest. From early piloting, College Board content and measurement experts were able to assess how well various approaches to testing Reading and Writing skill/knowledge elements in the digital format were working and to make adjustments to improve question conception, clarity, precision, and measurement quality. For more details, see section 5.1.4. Such prototyping and piloting were not required for the Math section, as the skill/knowledge elements being tested and the question formats being used in the digital versions of the section were almost identical to those in the corresponding sections of the paper tests.

Question Development

Question development for the digital SAT Suite begins with highly skilled and trained subject matter experts. These experts are given question development assignments aligned to the test specifications, the successful completion of which ensures that College Board has sufficient breadth and depth of question pools to enable each student taking one of the digital SAT Suite tests to receive a highly comparable but unique test form. Once the content for a given test question is at least provisionally set, the experts then leverage technology to increase the development yield beyond what would be possible in a traditional authoring process, in which questions are produced one at a time.

To this end, College Board has invested in technologies to facilitate automated item generation (AIG; Drasgow, Luecht, and Bennett 2006; Gierl, Zhou, and Alves 2008; Fu et al. 2022) for the digital SAT Suite as a systematic, research-based alternative to traditional test question development approaches. AIG as employed by College Board is a “best of both worlds” approach in which subject matter experts iteratively employ technology in strategic, thoughtful ways to increase the efficiency and productivity of their work, which in turn improves question variety and therefore the student testing experience while greatly augmenting test security.

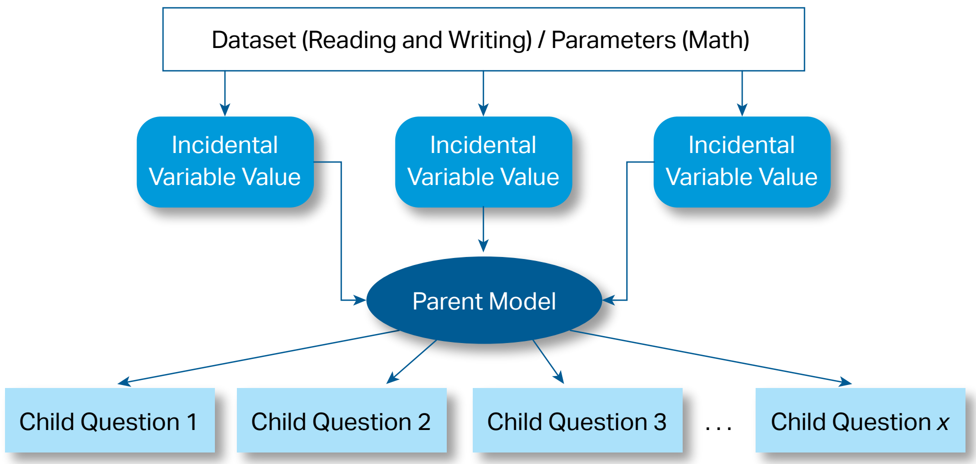
Central to AIG as implemented in the digital SAT Suite is the development of question templates that we refer to as *parent models*. These models may be thought of as “base” versions of test questions. Although parent models are not themselves questions as students would be administered on test day, they do define the characteristics of a given “family” of closely related questions, such as the general topic to be addressed, the skill/knowledge element to be assessed, and the intended difficulty of the resultant questions. An individual parent model consists of both static and variable elements; these static elements are merged with differing values assigned to the variable elements to produce *child questions*, a set of substantively highly similar (*isomorphic*) but superficially distinct questions, any one of which could be used on any student’s test form. The generation of many interchangeable child questions from a single parent model greatly increases the yield of test development, with attendant gains in test security, while maintaining the ability of test development and measurement staff to apply rigorous quality control processes to the resultant output.

The features varied within a given parent model are *incidental* in the sense that their alteration does not affect the cognitive or statistical characteristics of the generated child questions. In other words, any student receiving any of the child questions from a particular parent model should have a highly comparable experience with the question, irrespective of which child question they are administered. This hypothesized isomorphism is verified or refuted by evaluating whether pretested child questions from a given parent model fall within the same narrow range of performance. Parent models for which this hypothesis is refuted are precluded from future operational use, although, at the discretion of College Board test development staff, they may be reedited and their child questions re-pretested.

Permissible values for the variable elements in a given parent model are carefully defined by test development staff to yield isomorphic child questions. For Reading and Writing test development, these values are represented in a *dataset*. Math test development employs a similar technique in which *parameters* delimit the range of numerical quantities that may appear across the child questions. As discussed below, both Reading and Writing datasets and Math parameters are thoughtfully constructed so as to yield a set of superficially distinct but cognitively and statistically similar child questions.

Figure 6 displays the parent model / child question concept diagrammatically.

Figure 6. Digital SAT Suite Automated Item Generation (AIG) Development Paradigm.



In figure 6, "child question *x*" indicates that the number of child questions generated from a given parent model is variable. In theory, a parent model could produce a number of questions limited only by the size and complexity of the Reading and Writing dataset or the breadth of the range of the Math parameters; in practice, however, the number of questions produced from an individual parent model is intentionally kept relatively low so as to preclude the resultant question pools from becoming overly homogenized and predictable.

College Board content experts develop parent models in response to carefully constructed assignments that derive from ongoing analysis of the digital SAT Suite question pool. These assignments identify high-level characteristics of the parent models to be developed, such as the skill/knowledge element to be assessed (e.g., use of textual evidence), the subject area the skill should be assessed within, if any (e.g., science), the targeted stimulus complexity, when appropriate (e.g., a reading level equivalent to grades 9–11), and the intended difficulty of the parent model. Content experts then devise tasks that align with these assignments and with the detailed test specifications on which all content experts have been trained. For all Reading and Writing development and for the development of in-context questions in Math, content experts begin by researching potential stimulus topics that align with the parent model assignment, meet content and fairness guidelines, and seem likely to yield multiple child questions that are cognitively and psychometrically equivalent (i.e., isomorphic).

Potential topics (e.g., economists' explanations for various import/export patterns around the world, a study about the nutritional needs of bears) for questions set in contexts are defined by College Board content experts to ensure high-level appropriateness for the assignment. As part of this process, these content experts may consult the detailed digital-suite test specifications and content and fairness guidelines, empirical research underlying the specifications, additional research on the topic in question, textbooks in the relevant subject area commonly used at the targeted grade level, studies identifying essential skills and knowledge in relevant entry-level college courses, performance data from previously developed questions, and other resources to evaluate the topic's viability for the given assignment.

Once a task and topic have been identified, content experts craft the parent model. When developing parent models, content experts consult detailed test specifications to ensure that the task presented in the model is aligned with the evidentiary base of the question type (e.g., linear equations in one variable). In addition to documented criteria for question soundness and fairness, content experts consult internal documentation on the production of isomorphic child questions. This documentation, which is heavily informed by a robust body of academic literature on AIG as well as experience gained from prior test development, helps guide content experts in selecting the portions of a parent model to vary across child questions.

For Reading and Writing questions, all acceptable variable values are preidentified by content experts adhering to all content and fairness guidelines for the suite. For Math questions, these variable elements are defined by carefully determined parameters set by content experts and informed by research and experience regarding those aspects of math questions that do and do not impact consistency of child question performance. Once identified, variable constraints and values are used within College Board's question development applications to generate the child questions. Content experts then iteratively work to improve parent models in light of evaluations of the child questions.

For all Reading and Writing questions and for all Math in-context questions, all aspects of parent models, including both static elements and values for variable elements, are vetted for factual accuracy (where that concept makes sense) or plausibility (where it does not, as in literature). Additionally, the parameters for all Math questions, whether in context or not, are carefully set to ensure that the variable quantities presented to students across the child questions are equally accurate/plausible and are equally easy or challenging to work with.

Once a parent model has been created, a robust internal review process ensures that it and its child questions meet quality standards. Parent models and child questions are reviewed by College Board's team of experienced content experts, who have received training on each question type by the team leads to ensure consistency and calibration. Multiple content experts review the parent model, all variable content, and the generated child questions. Such reviews ensure that tasks are aligned to the intended constructs, key affirmatively rather than only by elimination of weaker answer choices, are free from fairness problems, and are appropriately targeted to the intended difficulty level and to educational attainment of the test-taking population. Parent model authors revise content in response to review feedback until the model meets documented quality standards. Additionally, parent models and child questions receive multiple rounds of review by College Board's editorial team to ensure they are free from errors and render correctly in the digital platform and in alternative formats.

Pretesting

Once finalized, all parent models are pretested on a large, representative sample of the digital SAT Suite test-taking population. Prior to the launch of the digital SAT Suite, pretesting was conducted using a special-study method; in the time since the tests have become operational, College Board has used an embedded pretesting model, in which small numbers of pretest questions are incorporated, or *embedded*, into the test forms students receive. Students' responses to these questions do not affect their scores, but they do provide College Board with statistical information used to evaluate the questions' suitability for future use as operational (scored) questions. (See section 2.2.4 for more details on embedded pretesting in the suite.)

Each parent model developed for the digital SAT Suite goes through the pretesting process. A subset of the child questions from each parent model is pretested. These subsets are carefully selected to be broadly representative of the full range of content assessed by the parent model such that pretesting of these subsets results in a clear picture of the performance of the child questions as a whole without the need to pretest each and every child question from a parent model.

A key purpose of this pretesting is to establish whether all pretested child questions from a given parent model perform within a very narrow difficulty range—plus or minus 0.05 of the mean difficulty of all the model's pretested child questions. If this is the case, then the *isomorphic hypothesis*—the claim that the child questions are similar enough to be used interchangeably in test assembly—is considered verified, and, barring other concerns, the parent model and all its child questions, both pretested and unpretested, are considered available for use. If this is not the case, or if other problems with the parent model and/or its child questions are identified (e.g., an inability to differentiate sufficiently between students with higher and lower levels of achievement on the construct of interest), then the parent model and its child questions are discarded, though, at the discretion of the test developers, the parent model may be reedited and a subset of its child questions again pretested. The statistical characteristics of each "passed" parent model are derived from data aggregated across its pretested child questions, and each child question from a "passed" parent model is assigned the statistical characteristics of the parent model for the purposes of scoring. Differential item functioning (DIF) analysis is also performed at the parent model level to examine whether, in statistical terms, the pretested child questions in aggregate significantly favor or disfavor one or more defined population subgroups (e.g., students identifying as female relative to students identifying as male) based on an analysis of samples matched in terms of achievement on the construct of interest. (For more information on the use of DIF analysis in the digital SAT Suite, see section 2.2.7.)

Test Panel Assembly

Multistage adaptive panels for the digital SAT Suite are assembled at the module level (i.e., medium-difficulty routing modules administered in the first stage of adaptive testing and the lower- and higher-difficulty modules administered in the second stage). (See section 2.2.3 for a description of multistage adaptive testing for the digital SAT Suite.) Module assembly is accomplished using automated test assembly (ATA) software, a type of application commonly used in large-scale assessment programs, which evaluates both content specifications and statistical targets in question selection. The resulting modules meet specifications both individually and in combination (i.e., an initial [routing] module in combination with its lower- or higher-difficulty second-stage modules). The use of ATA software ensures that each panel assigned to students meets the same content and statistical specifications, thus yielding unique but closely parallel testing experiences within and across test administrations.

External Content and Fairness Reviews

College Board routinely engages independent experts—primarily active teachers at the secondary and postsecondary levels—to evaluate digital SAT Suite test materials for content soundness and fairness.

These reviews take two main forms. The first of these consists of semiannual reviews of representative sample test forms and/or panels. Using the same content and fairness criteria employed by College Board staff, these experts provide both high-level feedback about the test panels' and/or forms' appropriateness for college and career readiness testing and input on the soundness and fairness of individual test questions (discussions of the latter of which often leading back to conversations about the larger test design). These external reviewers are tasked with providing advance written feedback to College Board on the test materials at the question, module, form/panel, and "batch" levels and then discussing their findings with both College Board staff and other independent reviewers. College Board test development staff take careful notes at these proceedings and resolve the feedback subsequent to the meetings.

The second form of review consists of external fairness reviews of individual (child) questions. All Reading and Writing child questions and all Math child questions set in context (as opposed to "pure" math questions) are routed through this process. Highly diverse and expert teams of independent reviewers, using College Board fairness criteria, read through these questions and identify potential concerns at the individual child question level, at the parent model level, or both. College Board test developers then take this feedback and make determinations about whether to retain or discard particular child questions or possibly entire parent models. Parent models receiving a "do not use" designation are removed from further consideration and use, although, as noted above, test developers may elect to reedit a parent model and re-pretest a subset of its child questions.

Together, these external review methods ensure that College Board test developers receive routine, highly expert independent input on both the test design and the development of individual test questions, feedback that is, in turn, incorporated into the test development and assembly processes.

Test Administration

Students (with the important though limited exception of those who require paper-based testing accommodations) take the digital SAT Suite tests on a digital device using Bluebook, a custom-built digital exam application that they download in advance of test day. If a student does not have a suitable device for weekend testing, they can request to borrow one from College Board to use on test day.

Bluebook was built to withstand momentary internet outages. If their internet connection is lost during testing, students will still be able to progress through the test without disruption. If a student's computer runs out of battery power, they can simply plug in, restart their device, and pick up where they left off—all their work will have been saved, and they will not have lost testing time.

Bluebook includes many universal tools for students, including

- a way to flag questions to come back to during the same module in a test section;
- a countdown clock, which students can choose to show or hide until the five-minutes-remaining mark, when it can no longer be hidden;
- a built-in version of the Desmos Graphing Calculator, which students can elect to use on the entire Math section (or they may bring and use their own approved calculator);
- an answer choice eliminator for multiple-choice question answer options that students have ruled out; and
- a reference sheet consisting of common math formulas, for use during testing in the Math section.

College Board has dedicated customer service representatives ready to troubleshoot issues on test day for students and test centers. College Board has also introduced the role of technology coordinator at each test center to provide additional support.

Postoperational Administration Statistical Review

Postoperational administration statistical reviews of the digital SAT will include four components: (1) initial scale confirmatory analyses, (2) analyses of embedded pretest questions, (3) trend analyses and psychometric summaries, and (4) test security or irregularity analyses. Each of these activities is briefly described below.

Concordance and vertical scaling studies (see sections 5.1.7 and 5.1.8) have established the digital SAT Suite scale, and the use of item response theory (IRT) and ability estimation provides the basis for calculating scale scores in near real time. In initial digital SAT administrations, additional analyses were undertaken to confirm the properties of the scale. Similar analyses occurred for initial administrations of PSAT/NMSQT, PSAT 10, and PSAT 8/9.

Once tests in the digital SAT Suite began being administered operationally, psychometric analyses of embedded pretest questions commenced. In these analyses, both classical test theory (CTT) and IRT analyses of the embedded pretest questions are performed.

Periodically, College Board's Psychometrics group will summarize student testing performance for tests within the digital SAT Suite. This may comprise administration-specific analyses or analyses covering a period of time. Such analyses will include compilation of score distributions overall and by various population subgroups as well as estimates of reliability and conditional standard errors of measurement.

A final aspect of ongoing psychometric analyses concerns test security. The nature of the digital administrations and the use of a large number of highly comparable but unique multistage adaptive panels has changed the test security analyses College Board has traditionally undertaken for its paper-based (and linear digital) tests. Specific test security procedures for the digital SAT Suite are being finalized, comprise a strand of research conducted during 2022, 2023, and into 2024, and will likely evolve over time to respond to emerging security threats.

Test Materials Challenge Process

To further promote test transparency, College Board continues to make available to test takers and proctors methods for reporting concerns about test materials to the organization. Students may report any concerns they may have about the accuracy, correctness, or appropriateness of test questions they are administered to their proctors or directly to College Board via established channels. In the rare event that a problem is uncovered with a test question during its evaluation process, College Board will take additional steps, up to and including (1) determining whether a question is flawed and should not be scored and (2) ensuring that any flawed question does not appear in its present form in any other future operational materials.

References

Drasgow, Fritz, Richard M. Luecht, and Randy E. Bennett. 2006. "Technology and Testing." In Robert L. Brennan (Ed.), *Educational Measurement*, 4th ed. Washington, DC: American Council on Education/Praeger, 471–515.

Gierl, Mark J., Jiawen Zhou, and Cecilia Alves. 2008. "Developing a Taxonomy of Item Model Types to Promote Assessment Engineering." *Journal of Technology, Learning, and Assessment* 7, no. 2 (December): 4–50. **https://files.eric.ed.gov/fulltext/EJ838625.pdf**.

Fu, Yanyan, Edison M. Choe, Hwanggyu Lim, and Jaehwa Choi. 2022. "An Evaluation of Automatic Item Generation: A Case Study of Weak Theory Approach." *Educational Measurement Issues and Practice* 41, no. 4 (October): 1–13. **https://doi.org/10.1111/emip.12529**.

Appendix D: Digital SAT Suite Test Directions

The following sections display the test directions for the digital SAT, which are identical to those for the PSAT-related assessments. Note that these directions are subject to potential refinement prior to operational testing or release of practice test forms.

Test Overview

The digital SAT consists of a Reading and Writing section and a Math section.

Section 1: Reading and Writing (54 Questions)

There are two modules in the Reading and Writing section. Each module has 27 questions.

Section 2: Math (44 Questions)

There are two modules in the Math section. Each module has 22 questions.

Modules

Within each section, the two modules are timed separately. If time permits, you can review your answers in a given module. When the timer reaches zero, you will automatically move on. Once you move on from any module, you cannot return to it.

Directions

Directions for answering the questions appear at the start of each section. You can view these directions from the top-left corner of the screen at any time.

Section 1: Reading and Writing

Directions ^

The questions in this section address a number of important reading and writing skills. Each question includes one or more passages, which may include a table or graph. Read each passage and question carefully, and then choose the best answer to the question based on the passage(s).

All questions in this section are multiple-choice with four answer choices. Each question has a single best answer.

Section 2: Math

Directions

The questions in this section address a number of important math skills.

Use of a calculator is permitted for all questions. A reference sheet, calculator, and these directions can be accessed throughout the test.

Unless otherwise indicated:

- All variables and expressions represent real numbers.
- Figures provided are drawn to scale.
- All figures lie in a plane.
- The domain of a given function *f* is the set of all real numbers *x* for which $f(x)$ is a real number.

For **multiple-choice questions**, solve each problem and choose the correct answer from the choices provided. Each multiple-choice question has a single correct answer.

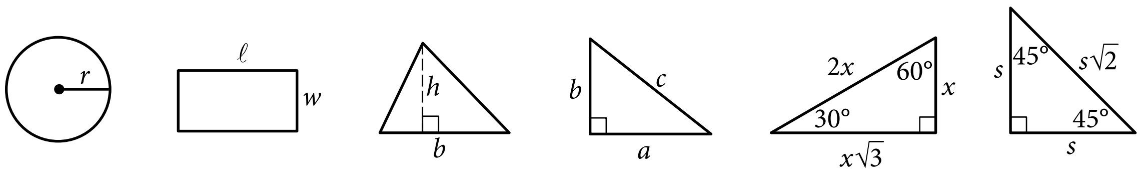
For **student-produced response questions**, solve each problem and enter your answer as described below.

- If you find **more than one correct answer**, enter only one answer.
- You can enter up to 5 characters for a **positive** answer and up to 6 characters (including the negative sign) for a **negative** answer.
- If your answer is a **fraction** that doesn't fit in the provided space, enter the decimal equivalent.
- If your answer is a **decimal** that doesn't fit in the provided space, enter it by truncating or rounding at the fourth digit.
- If your answer is a **mixed number** (such as $3\frac{1}{2}$), enter it as an improper fraction (7/2) or its decimal equivalent (3.5).
- Don't enter **symbols** such as a percent sign, comma, or dollar sign.

Examples

Answer	Acceptable ways to enter answer	Unacceptable: will NOT receive credit
3.5	3.5 3.50 7/2	31/2 3 1/2
$\frac{2}{3}$	2/3 .6666 .6667 0.666 0.667	0.66 .66 0.67 .67
$-\frac{1}{3}$	-1/3 -.3333 -0.333	-.33 -0.33

REFERENCE



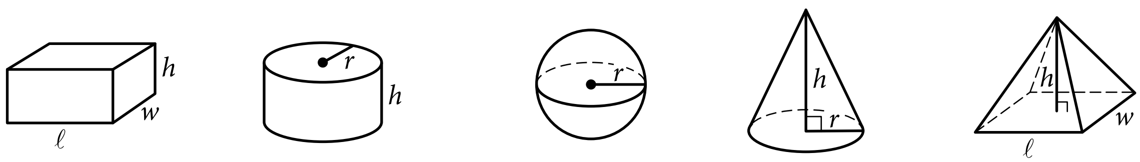
$A = \pi r^2$
$C = 2\pi r$

$A = \ell w$

$A = \frac{1}{2}bh$

$c^2 = a^2 + b^2$

Special Right Triangles



$V = \ell wh$

$V = \pi r^2 h$

$V = \frac{4}{3}\pi r^3$

$V = \frac{1}{3}\pi r^2 h$

$V = \frac{1}{3}\ell wh$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is 2π.

The sum of the measures in degrees of the angles of a triangle is 180.

Appendix E: Linear Test Specifications

Although the tests of the digital SAT Suite are primarily taken adaptively via a digital device, certain circumstances—chiefly, those associated with students who need a linear test form as an accommodation—dictate that test takers be administered a nonadaptive test form, whether paper-based or via Bluebook, the digital test delivery platform. To ensure that the testing experience of those students using linear test forms, and therefore the interpretations made based on the scores they receive, are as comparable as possible to those of students using the digital adaptive test delivery mode, specifications for the linear versions of the digital SAT Suite tests are as similar as possible to those of the digitally delivered adaptive tests. However, because the linear tests are, by definition, not adaptive, test lengths, in terms of number of questions and time allotted, are slightly longer than for their digital counterparts, although the time per question is the same for the digital adaptive and linear versions.

Table A38 and table A39 compare at a high level the digital (adaptive) and linear SAT Suite test specifications for Reading and Writing and Math, respectively, in terms of the ways in which the two testing modes differ with respect to length and the lack of inclusion of pretest questions in the linear format. In other respects, the linear specifications are the same as those for the digital adaptive versions.

Table A38. Comparison of Digital Adaptive SAT Suite and Linear (Nonadaptive) Test Specifications: Reading and Writing.

	Reading and Writing Section Test Delivery Method	
Characteristic	**Digital Adaptive**	**Linear**
Administration	Two-stage adaptive test design: one Reading and Writing section administered via two separately timed modules	One Reading and Writing section administered via two separately timed modules
Test length (number of operational and pretest questions)	1st module: 25 operational questions and 2 pretest questions 2nd module: 25 operational questions and 2 pretest questions	1st module: 33 questions, all operational 2nd module: 33 questions, all operational
Time per module	1st module: 32 minutes 2nd module: 32 minutes	1st module: 39 minutes 2nd module: 39 minutes
Total number of questions	54 questions	66 questions
Total time allotted	64 minutes	78 minutes
Average time per question	1.19 minutes	1.19 minutes

Table A39. Comparison of Digital Adaptive SAT Suite and Linear (Nonadaptive) Test Specifications: Math.

Characteristic	Math Section Test Delivery Method: Digital Adaptive	Math Section Test Delivery Method: Linear
Administration	Two-stage adaptive test design: one Math section administered via two separately timed modules	One Math section administered via two separately timed modules
Test length (number of operational and pretest questions)	1st module: 20 operational questions and 2 pretest questions 2nd module: 20 operational questions and 2 pretest questions	1st module: 27 questions, all operational 2nd module: 27 questions, all operational
Time per module	1st module: 35 minutes 2nd module: 35 minutes	1st module: 43 minutes 2nd module: 43 minutes
Total number of questions	44 questions	54 questions
Total time allotted	70 minutes	86 minutes
Average time per question	1.59 minutes	1.59 minutes

Table A40 compares the distribution of operational test questions by Reading and Writing and Math content domain between the two test delivery methods and across program levels. The proportions of questions by content domain are approximately the same in both methods.

Table A40. Comparison of Operational Test Question Distribution across Content Domains in SAT Suite Digital Adaptive and Linear (Nonadaptive) Tests, by Testing Program.

Content Domain	SAT: Digital Adaptive	SAT: Linear	PSAT/NMSQT and PSAT 10: Digital Adaptive	PSAT/NMSQT and PSAT 10: Linear	PSAT 8/9: Digital Adaptive	PSAT 8/9: Linear
Reading and Writing Section						
Information and Ideas	12–14	16–18	12–14	16–18	12–14	16–18
Craft and Structure	13–15	17–20	13–15	17–20	13–15	17–20
Expression of Ideas	8–12	11–15	8–12	11–15	8–12	11–15
Standard English Conventions	11–15	15–20	11–15	15–20	11–15	15–20
Math Section						
Algebra	13–15	16–20	13–15	16–21	16–18	20–26
Advanced Math	13–15	16–20	12–14	16–19	7–9	8–10
Problem-Solving and Data Analysis	5–7	7–11	7–9	9–12	9–11	12–16
Geometry and Trigonometry (SAT, PSAT/NMSQT, PSAT 10) / Geometry (PSAT 8/9)	5–7	7–11	4–6	6–8	4–6	6–7

Table A41 compares the total length (in minutes) of the digital adaptive and linear SAT Suite tests.

Table A41. Comparison of Digital Adaptive SAT Suite and Linear (Nonadaptive) Tests, by Time.

Test Delivery Method	Length (in Minutes)
Digital Adaptive	134 (2 hours, 14 minutes)
Linear	164 (2 hours, 44 minutes)

Appendix F: Test Specifications Comparison of the Paper-Based and Digital SAT Suites

Table A42. Test Specifications Comparison of the Paper-Based and Digital SAT Suites

	SAT Suite of Assessments Program					
	SAT		PSAT/NMSQT and PSAT 10		PSAT 8/9	
Characteristic	**Paper-Based**	**Digital**	**Paper-Based**	**Digital**	**Paper-Based**	**Digital**
Administration Model						
	Linear paper-and-pencil and linear digital	Two-stage multistage adaptive digital	Linear paper-and-pencil and linear digital (PSAT 10 only)	Two-stage multistage adaptive digital	Linear paper-and-pencil and linear digital	Two-stage multistage adaptive digital
Main Components						
Reading and Writing	Evidence-Based Reading and Writing section, composed of separately timed Reading and Writing and Language Tests	Reading and Writing section	Evidence-Based Reading and Writing section, composed of separately timed Reading and Writing and Language Tests	Reading and Writing section	Evidence-Based Reading and Writing section, composed of separately timed Reading and Writing and Language Tests	Reading and Writing section
Math	Math section, composed of separately timed no-calculator and calculator-allowed portions	Math section; calculator allowed on all questions	Math section, composed of separately timed no-calculator and calculator-allowed portions	Math section; calculator allowed on all questions	Math section, composed of separately timed no-calculator and calculator-allowed portions	Math section; calculator allowed on all questions
Length, in minutes						
Overall	180	134	165	134	145	134
Reading and Writing	100 (Reading: 65, Writing and Language: 35)	64, in 2 32-minute modules	95 (Reading: 60, Writing and Language: 35)	64, in 2 32-minute modules	85 (Reading: 55, Writing and Language: 30)	64, in 2 32-minute modules
Math	80 (no-calculator: 25, calculator-allowed: 55	70, in 2 35-minute modules	70 (no-calculator: 25, calculator-allowed: 45)	70, in 2 35-minute modules	60 (no-calculator: 20, calculator-allowed: 40)	70, in 2 35-minute modules

	SAT Suite of Assessments Program					
	SAT		PSAT/NMSQT and PSAT 10		PSAT 8/9	
Characteristic	**Paper-Based**	**Digital**	**Paper-Based**	**Digital**	**Paper-Based**	**Digital**
Length, in number of questions						
Overall	154	98	139	98	120	98
Reading and Writing	96 (Reading: 52, Writing and Language: 44); all questions operational	54, including 4 pretest questions	91 (Reading: 47, Writing and Language: 44); all questions operational	54, including 4 pretest questions	82 (Reading: 42, Writing and Language: 40); all questions operational	54, including 4 pretest questions
Math	58 (no-calculator: 20, calculator-allowed: 38); all questions operational	44, including 4 pretest questions	48 (no-calculator: 17, calculator-allowed: 31); all questions operational	44, including 4 pretest questions	38 (no-calculator: 13, calculator-allowed: 25); all questions operational	44, including 4 pretest questions
Average time per question, in minutes						
Overall	1.17	1.37	1.19	1.37	1.21	1.37
Reading and Writing	1.04 (Reading: 1.25, Writing and Language: 0.80)	1.19	1.04 (Reading: 1.28, Writing and Language: 0.80)	1.19	1.04 (Reading: 1.31, Writing and Language: 0.75)	1.19
Math	1.38 (no-calculator: 1.25, calculator-allowed: 1.45)	1.59	1.46 (no-calculator: 1.47, calculator-allowed: 1.45)	1.59	1.58 (no-calculator: 1.54, calculator-allowed: 1.60)	1.59
Scores reported						
	1 total score 2 section scores 3 test scores 7 subscores 2 cross-test scores	1 total score 2 section scores	1 total score 2 section scores 3 test scores 7 subscores 2 cross-test scores	1 total score 2 section scores	1 total score 2 section scores 3 test scores 6 subscores 2 cross-test scores	1 total score 2 section scores
Score scales						
Total score	400–1600	400–1600	320–1520	320–1520	240–1440	240–1440
Section scores	200–800	200–800	160–760	160–760	120–720	120–720
Test scores	10–40	N/A	8–38	N/A	6–36	N/A
Subscores	1–15	N/A	1–15	N/A	1–15	N/A
Cross-test scores	10–40	N/A	10–40	N/A	10–40	N/A

Characteristic	SAT Suite of Assessments Program					
	SAT		PSAT/NMSQT and PSAT 10		PSAT 8/9	
	Paper-Based	Digital	Paper-Based	Digital	Paper-Based	Digital
Content domains and question distribution						
Reading and Writing Note: Digital-suite percentages are for operational questions only.	Reading: Information and Ideas (30–40%), Rhetoric (30–40%), Synthesis (20–30%) Writing and Language: Expression of Ideas (55%), Standard English Conventions (45%)	Information and Ideas (≈26%), Craft and Structure (≈28%), Expression of Ideas (≈20%), Standard English Conventions (≈26%)	Reading: Information and Ideas (30–40%), Rhetoric (30–40%), Synthesis (20–30%) Writing and Language: Expression of Ideas (55%), Standard English Conventions (45%)	Information and Ideas (≈26%), Craft and Structure (≈28%), Expression of Ideas (≈20%), Standard English Conventions (≈26%)	Reading: Information and Ideas (30–40%), Rhetoric (30–40%), Synthesis (20–30%) Writing and Language: Expression of Ideas (55%), Standard English Conventions (45%)	Information and Ideas (≈26%), Craft and Structure (≈28%), Expression of Ideas (≈20%), Standard English Conventions (≈26%)
Math Note: Digital-suite percentages are for operational questions only.	Heart of Algebra (33%), Passport to Advanced Math (28%), Problem-Solving and Data Analysis (29%), Additional Topics in Math (10%)	Algebra (≈35%), Advanced Math (≈35%), Problem-Solving and Data Analysis (≈15%), Geometry and Trigonometry (≈15%)	Heart of Algebra (33%), Passport to Advanced Math (29%), Problem-Solving and Data Analysis (33%), Additional Topics in Math (4%)	Algebra (≈35%), Advanced Math (≈32.5%), Problem-Solving and Data Analysis (≈20%), Geometry and Trigonometry (≈12.5%)	Heart of Algebra (42%), Passport to Advanced Math (16%), Problem-Solving and Data Analysis (42%)	Algebra (≈42.5%), Advanced Math (≈20%), Problem-Solving and Data Analysis (≈25%), Geometry (≈12.5%)
Question format(s)						
Reading and Writing	Set based	Discrete	Set based	Discrete	Set based	Discrete
Math	Discrete, set based	Discrete	Discrete, set based	Discrete	Discrete, set based	Discrete
Question type(s)						
Reading and Writing	Four-option multiple-choice with a single best answer	Four-option multiple-choice with a single best answer	Four-option multiple-choice with a single best answer	Four-option multiple-choice with a single best answer	Four-option multiple-choice with a single best answer	Four-option multiple-choice with a single best answer
Math	Four-option multiple-choice with a single correct answer (78%); student-produced response, some with multiple correct responses (22%)	Four-option multiple-choice with a single correct answer (≈75%); student-produced response, some with multiple correct responses (≈25%)	Four-option multiple-choice with a single correct answer (83%); student-produced response, some with multiple correct responses (17%)	Four-option multiple-choice with a single correct answer (≈75%); student-produced response, some with multiple correct responses (≈25%)	Four-option multiple-choice with a single correct answer (82%); student-produced response (SPR), some with multiple correct responses (18%)	Four-option multiple-choice with a single correct answer (≈75%); student-produced response, some with multiple correct responses (≈25%)

	SAT Suite of Assessments Program					
	SAT		PSAT/NMSQT and PSAT 10		PSAT 8/9	
Characteristic	**Paper-Based**	**Digital**	**Paper-Based**	**Digital**	**Paper-Based**	**Digital**
	Passage/context topics and question distribution					
Reading and Writing passages	U.S. and world literature (prose fiction; Reading only), careers (Writing and Language only), history/social studies, the humanities (Writing and Language only), science	Literature (prose fiction, poetry, drama, literary nonfiction), history/ social studies, the humanities, science	U.S. and world literature (prose fiction; Reading only), careers (Writing and Language only), history/social studies, the humanities (Writing and Language only), science	Literature (prose fiction, poetry, drama, literary nonfiction), history/ social studies, the humanities, science	U.S. and world literature (prose fiction; Reading only), careers (Writing and Language only), history/social studies, the humanities (Writing and Language only), science	Literature (prose fiction, poetry, drama, literary nonfiction), history/ social studies, the humanities, science
Math contexts	Social studies, science, real-world problem-solving	Social studies, science, real-world problem-solving	Social studies, science, real-world problem-solving	Social studies, science, real-world problem-solving	Social studies, science, real-world problem-solving	Social studies, science, real-world problem-solving
	Passage/context length, in standard (6-character) words					
Reading (R) and Writing (WL) passages	5 R passages: 500 to 750 each 4 WL passages: 400 to 450 each	54 passages: 25 to 150 each	5 R passages: 500 to 750 each 4 WL passages: 400 to 450 each	54 passages: 25 to 150 each	5 R passages: 500 to 750 each 4 WL passages: 400 to 450 each	54 passages: 25 to 150 each
Math contexts	In-context questions (≈35% of total): Word count per question varies.	In-context questions (≈30% of total): majority with fewer than 50 words	In-context questions (≈35% of total): Word count per question varies.	In-context questions (≈30% of total): majority with fewer than 50 words	In-context questions (≈35% of total): Word count per question varies.	In-context questions (≈30% of total): majority with fewer than 50 words
	Passage text complexity bands (Reading and Writing only)					
	Early postsecondary Grades 11-CCR Grades 9–10	Grades 12–14 Grades 9–11 Grades 6–8	Grades 11-CCR Grades 9–10	Grades 12–14 Grades 9–11 Grades 6–8	Grades 9–10 Grades 6–8	Grades 9–11 Grades 6–8
	Informational graphics					
Reading and Writing	Typically tables and graphs; associated with select history/ social studies and science passages	Tables, bar graphs, line graphs	Typically tables and graphs; associated with select history/ social studies and science passages	Tables, bar graphs, line graphs	Typically tables and graphs; associated with select history/ social studies and science passages	Tables, bar graphs, line graphs

	SAT Suite of Assessments Program					
	SAT		PSAT/NMSQT and PSAT 10		PSAT 8/9	
Characteristic	**Paper-Based**	**Digital**	**Paper-Based**	**Digital**	**Paper-Based**	**Digital**
Math	Wide range of data displays and mathematical figures	Wide range of data displays and mathematical figures	Wide range of data displays and mathematical figures	Wide range of data displays and mathematical figures	Wide range of data displays and mathematical figures	Wide range of data displays and mathematical figures