Technical Manual

The ACT®

www.act.org

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Preface

This manual contains technical information about the ACT® college readiness assessment. The principal purpose of this manual is to document the technical characteristics of the ACT in light of its intended purposes. ACT regularly conducts research as part of the ongoing formative evaluation of its programs. The research is intended to ensure that the programs remain technically sound.

The content of this manual responds to requirements of the testing industry as established in the *Code of Professional Responsibilities in Educational Measurement* (NCME Ad Hoc Committee on the Development of a Code of Ethics, 1995), the *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 1999), and the *Code of Fair Testing Practices in Education* (Joint Committee on Testing Practices, 2004). This manual is divided into six chapters. These chapters include the following information:

Chapter 1: An overview of the ACT, its history, its philosophical basis, and the population it serves

Chapter 2: Detailed description of the ACT tests

Chapter 3: Description of ACT's College and Career Readiness Standards and ACT's College Readiness Benchmarks

Chapter 4: Technical characteristics, such as norms, scaling, equating, and reliabilities, of the ACT tests.

Chapter 5: Validity evidence for the most common uses of the ACT tests

Chapter 6: Description of the noncognitive components of the ACT

We encourage individuals who want more detailed information on a topic discussed in this manual, or on a related topic, to contact ACT. We also encourage qualified researchers to use ACT data in their research. Please direct comments or inquiries to Research Services, ACT, P.O. Box 168, Iowa City, Iowa 52243-0168.

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Chapter 1
The ACT

ACT's Mission

ACT is a nonprofit organization dedicated to helping people achieve education and workplace success.

Overview and Purpose of the ACT

The ACT college readiness assessment is a comprehensive system of data collection, processing, and reporting designed to help high school students develop postsecondary educational plans and to help postsecondary educational institutions meet the needs of their students. One component of the ACT is a battery of four multiple-choice tests of educational achievement—English, Mathematics, Reading, and Science—and an optional Writing Test. The ACT also collects information about students' high school courses and grades, educational and career aspirations, extracurricular activities, and special educational needs. The ACT tests are taken under standardized conditions; the noncognitive components are completed when students register to take the ACT.

ACT makes available to test takers and prospective test takers extensive materials about test preparation and the interpretation of test results. Many of the materials are provided online at **www.actstudent.org**. Each year, ACT publishes *Preparing for the ACT*, a booklet that includes a practice test, strategies to prepare for the tests, and a list of "what to expect on test day"; millions of copies are printed and distributed for use, free of charge, to students interested in taking the ACT. The brochure *National Online Registration* also published annually, contains instructions for registering. The score reports examinees receive contains three sections: (a) Your ACT Scores, (b) Your College Reports, and (c) Planning Your Education and Career. The report is accompanied by a booklet, *Using Your ACT Results*, which provides interpretive information about the test results, describes ACT services and policies, and tells examinees how to contact ACT for further information.

ACT data are used for many purposes. High schools use ACT data in academic advising and counseling, evaluation studies, accreditation documentation, and public relations. Colleges use ACT results for admissions and course placement. States use the ACT as part of their statewide assessment. Many of the agencies that provide scholarships, loans, and other types of financial assistance to students tie such assistance to students' academic qualifications, as measured by ACT scores. Many state and national agencies also use ACT data to identify talented students and award scholarships.

The ACT functions both as a stand-alone program and as part of the secondary school level of an integrated series of assessment programs that includes ACT Explore®, ACT Plan®, and the ACT. The assessments in ACT Explore and ACT Plan are curriculum-based and take a longitudinal approach to assessment, career and educational planning, instructional support, and evaluation. ACT Explore, for eighth and ninth graders, is designed as an early indicator of college readiness, to stimulate career exploration, and to facilitate development of a plan for the student's high school program. ACT Plan, the tenth-grade component, is designed to improve all students' planning and preparation for education, training, work, and career after high school. The ACT, typically taken in the eleventh or twelfth grade, measures students' academic readiness for college in key content areas, and also includes an optional Writing Test. A curriculum-based test, the ACT assesses student mastery of both college and career readiness standards and, in many states, state learning standards. When used together, these three assessments give educators at the middle school and secondary school levels a powerful, interrelated sequence of instruments to measure student educational achievement and assess college readiness from eighth through twelfth grade. These programs measure what students are able to do with what they have learned in school, not abstract qualities such as intelligence or aptitude.

The three programs are scored along a common scale extending from 1 to 36; the maximum score on ACT Explore is 25, the maximum ACT Plan score is 32, and the maximum ACT score is 36. Because they are reported on the same score scale, these assessment results inform students, parents, teachers, and counselors about individual student strengths and weaknesses while there is still time to address them.

ACT Explore, ACT Plan, and the ACT provide information about how well a student performs compared to other students. They also provide standards-based interpretations through the ACT College and Career Readiness Standards—statements that describe students' performance in terms of the knowledge and skills they have acquired. Because the College and Career Readiness Standards focus on the integrated, higher-order thinking skills that students develop in Grades K–12 and that are important for success both during and after high school, the Standards provide a common language for secondary and postsecondary educators.

Using the College and Career Readiness Standards, secondary educators can pinpoint the skills students have and those they are ready to learn next. The Standards clarify college expectations in terms that high school teachers understand. The Standards also offer teachers guidance for improving instruction to help correct student deficiencies in specific areas. Results can be used to identify students who are on track to being ready for college. ACT's College Readiness Benchmark Scores—for English Composition, Algebra, Social Sciences, and Biology—were developed to help identify examinees who would likely be ready for doing college-level work in these courses or course areas. Chapter 3 gives details about the College and Career Readiness Standards and the College Readiness Benchmarks.

ACT Explore, ACT Plan, and the ACT are designed to help students plan for further education and explore careers, based on their own skills, interests, and aspirations. The results give high schools a way to get students engaged in planning their own futures. When they know what colleges expect, in terms they can understand, students can take ownership and control of their information, and they can use it to help make a smooth transition to postsecondary education or training. Table 1.1 summarizes the assessment components.

Table 1.1
Components of ACT Explore, ACT Plan, and the ACT

Component	Grades 8/9	Grade 10	Grades 11/12
Career and education planning	ACT Explore: Interest Inventory Needs Assessment	ACT Plan: Interest Inventory Course Taking Needs Assessment	The ACT: Interest Inventory Course Taking and Grades Student Profile
Objective assessments	ACT Explore: English Mathematics Reading Science	ACT Plan: English Mathematics Reading Science	The ACT: English Mathematics Reading Science Writing (optional)
Instructional support	College and Career Readiness Standards College and Career Readiness Standards Information Services	College and Career Readiness Standards College and Career Readiness Standards Information Services	College and Career Readiness Standards College and Career Readiness Standards Information Services
Evaluation	Summary Reports ACT Explore/ACT Plan Linkage Reports	Summary Reports ACT Explore/ACT Plan Linkage Reports ACT Plan/ACT Linkage Reports	Summary Reports ACT Plan/ACT Linkage Reports

Code of Fair Testing Practices in Education and *Code of Professional Responsibilities in Educational Measurement*

Since publication of the original edition in 1988, ACT has endorsed the *Code of Fair Testing Practices in Education* (Joint Committee on Testing Practices, 2004), a statement of the obligations to test takers of those who develop, administer, or use educational tests and test data. The development of the *Code* was sponsored by a joint committee of the American Association for Counseling and Development, Association for Measurement and Evaluation in Counseling and Development, American Educational Research Association, American Psychological Association, American Speech-Language-Hearing Association, and National Council on Measurement in Education to advance, in the public interest, the quality of testing practices.

The *Code* sets forth fairness criteria in four areas: developing and selecting appropriate tests, administering and scoring tests, reporting and interpreting test results, and informing test takers. Separate standards are provided for test developers and for test users in each of these four areas.

ACT's endorsement of the *Code* represents a commitment to vigorously safeguard the rights of individuals participating in its testing programs. ACT employs an ongoing review process whereby each of its testing programs is routinely reviewed to ensure that it upholds the standards set forth in the *Code* for appropriate test development practice and test use.

Similarly, ACT endorses and is committed to complying with the *Code of Professional Responsibilities in Educational Measurement* (NCME Ad Hoc Committee on the Development of a Code of Ethics, 1995), a statement of professional responsibilities for those who develop assessments; market and sell assessments; select assessments; administer assessments; interpret, use, and communicate assessment results; educate about assessment; and evaluate programs and conduct research on assessments.

Philosophical Basis for the ACT Tests

Underlying the ACT tests is the belief that students' preparation for college and the workplace is best assessed by measuring, as directly as possible, the academic skills that they will need to perform college-level work. The required academic skills can be assessed most directly by reproducing as faithfully as possible the complexity of college-level work. Therefore, the tests of educational achievement are designed to determine how skillfully students solve problems, grasp implied meanings, draw inferences, evaluate ideas, and make judgments in subject-matter areas important to success in college.

Accordingly, the ACT tests are oriented toward the general content areas of college and high school instructional programs. The test questions require students to integrate the knowledge and skills they possess in major curriculum areas with the information provided by the test. Thus, scores on the tests have a direct relationship to the students' educational progress in curriculum-related areas and possess a meaning that is readily grasped by students, parents, and educators.

Tests of general educational achievement are used in the ACT because, in contrast to other types of tests, they best satisfy the diverse requirements of tests used to facilitate the transition from secondary to post-secondary education. By comparison, measures of examinee knowledge of specific course content (as opposed to curriculum areas) do not readily provide a common baseline for comparing students for the purposes of admission, placement, or awarding scholarships because high school courses vary extensively. In addition, such tests might not measure students' skills in problem solving and in the integration of knowledge from a variety of courses.

Tests of educational achievement can also be contrasted with tests of academic aptitude. The stimuli and test questions for aptitude tests are often chosen precisely for their dissimilarity to instructional materials, and each test within a battery of aptitude tests is designed to be homogeneous in psychological structure. With such an approach, these tests may not reflect the complexity of college-level work or the interactions among the skills measured. Moreover, because aptitude tests are not directly related to instruction, they may not be as useful as tests of educational achievement for making placement decisions in college.

The advantage of tests of educational achievement over other types of tests for use in the transition from high school to college and the workplace becomes evident when their use is considered in the context of the educational system. Because tests of educational achievement measure many of the same skills that are taught in high school, the best preparation for tests of educational achievement is high school coursework. Long-term learning in school, rather than short-term cramming and coaching, becomes the obvious best form of test preparation. Thus, tests of educational achievement tend to serve as motivators by sending students a clear message that high test scores are not simply a matter of innate ability but reflect a level of achievement that has been earned as a result of hard work.

Because the ACT stresses such general concerns as the complexity of college-level work and the integration of knowledge from a variety of sources, students may be influenced to acquire skills necessary to handle these concerns. In this way, the ACT may serve to aid high schools in developing in their students the critical thinking skills that are important for success in college and later life.

The tests of the ACT therefore are designed not only to accurately reflect educational goals that are widely accepted and judged by educators to be important, but also to give educational considerations, rather than statistical and empirical techniques, paramount importance.

The Population Served by the ACT

Over three million students take the ACT each year. More than 3,000 postsecondary institutions (including scholarship agencies, state educational systems, individual public and private universities, four-year colleges, junior and community colleges, nursing schools, and technical schools) require or recommend that applicants submit ACT results.

For the majority of students, postsecondary education begins shortly after high school graduation. Students typically take the ACT during their sophomore, junior, or senior year of high school or shortly before they enroll at a postsecondary institution. Thus, most students who take the ACT are between the ages of sixteen and twenty.

Self-reported data describing the ACT examinee population for the 2013 high school graduating class are presented in Table 1.2. These data are based on the 1,799,243 students who graduated in the spring of 2013 and who took the ACT either during their sophomore, junior, or senior year in high school. For students who took the test two or more times, the most current test score is used.

Historically, ACT has advised students to take the ACT after they have completed a substantial portion of the coursework covered by these tests. Given the curriculum of most secondary schools and the course of study followed by the majority of the students, this point is usually reached by spring of the junior year. However, this varies from student to student and with the four academic areas measured by the ACT.

Table 1.2
Demographic Characteristics of the 2013 ACT–Tested High School Graduating Class

Demographic	%[a]
Sex	
Female	53
Male	46
No response	<1
Grade Level When Tested	
Senior	55
Junior	45
Other	<1
No response	<1
Racial-Ethnic Background	
African American/Black	13
White	58
American Indian/Alaska Native	1
Hispanic/Latino	14
Asian	4
Native Hawaiian/Other Pac. Isl.	<1
Two or more races	4
Prefer no response/blank	6

[a]Due to rounding, some columns may not add to exactly 100%.

Chapter 2
The ACT College Readiness Assessment

Description of the ACT Tests

The ACT contains four multiple-choice tests—English, Mathematics, Reading, and Science—and an optional Writing Test. These tests are designed to measure skills that are most important for success in post-secondary education and that are acquired in secondary education.

The fundamental idea underlying the development and use of these tests is that the best way to determine how well prepared students are for further education is to measure as directly as possible the academic skills that students will need to perform college-level work. The content specifications describing the knowledge and skills to be measured by the ACT were determined through a detailed analysis of relevant information: First, the curriculum frameworks for grades seven through twelve were obtained for all states in the United States that had published such frameworks. Second, textbooks on state-approved lists for courses in grades seven through twelve were reviewed. Third, educators at the secondary and postsecondary levels were consulted on the importance of the knowledge and skills included in the reviewed frameworks and textbooks.

Because one of the primary purposes of the ACT is to assist in college admission decisions, in addition to taking the steps described above, ACT conducted a detailed survey to ensure the appropriateness of the content of the ACT tests for this particular use. College faculty members across the nation who were familiar with the academic skills required for successful college performance in language arts, mathematics, and science were surveyed. They were asked to rate numerous knowledge and skill areas on the basis of their importance to success in entry-level college courses and to indicate which of these areas students should be expected to master before entering the most common entry-level courses. They were also asked to identify the knowledge and skills whose mastery would qualify a student for advanced placement. A series of consultant panels were convened, at which the experts reached consensus regarding the important knowledge and skills in English and reading, mathematics, and science, given current and expected curricular trends.

Curriculum study is ongoing at ACT. Curricula in each content area (English, mathematics, reading, science, and writing) in the ACT tests are reviewed on a periodic basis. ACT's analyses include reviews of tests, curriculum guides, and national standards; surveys of current instructional practice; and meetings with content experts (ACT, 2007a, 2009b, 2013c).

The tests in the ACT are designed to be developmentally and conceptually linked to those of ACT Explore (Grades 8 and 9) and ACT Plan (Grade 10). To reflect that continuity, the names of the content area tests are the same across the three programs. Moreover, the programs are similar in their focus on thinking skills and in their common curriculum base. The test specifications for the ACT are consistent with, and should be seen as a logical extension of, the content and skills measured in ACT Explore and ACT Plan.

The English Test

The ACT English Test is a 75-item, 45-minute test that measures understanding of the conventions of standard written English (punctuation, grammar and usage, and sentence structure) and of rhetorical skills (strategy, organization, and style). Spelling, vocabulary, and rote recall of rules of grammar are not tested. The test consists of five essays, or passages, each accompanied by a sequence of multiple-choice test items. Different passage types are employed to provide a variety of rhetorical situations. Passages are chosen not only for their appropriateness in assessing writing skills, but also to reflect students' interests and experiences. Some items refer to underlined portions of the passage and offer several alternatives to the portion underlined. These items include "NO CHANGE" to the underlined portion in the passage as one of the possible responses. Some items are identified by a number or numbers in a box. These items ask about a section of the passage, or about the passage as a whole. The student must decide which choice best answers the question posed.

Three scores are reported for the English Test: a total test score based on all 75 items, a subscore in

Usage/Mechanics based on 40 items, and a subscore in Rhetorical Skills based on 35 items.

The Mathematics Test

The ACT Mathematics Test is a 60-item, 60-minute test that is designed to assess the mathematical reasoning skills that students across the United States have typically acquired in courses taken up to the beginning of Grade 12. The test presents multiple-choice items that require students to use their mathematical reasoning skills to solve practical problems in mathematics. Knowledge of basic formulas and computational skills are assumed as background for the problems, but memorization of complex formulas and extensive computation are not required. The material covered on the test emphasizes the major content areas that are prerequisite to successful performance in entry-level courses in college mathematics. Six content areas are included: pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry.

The items included in the Mathematics Test cover four cognitive levels: knowledge and skills, direct application, understanding concepts, and integrating conceptual understanding. "Knowledge and skills" items require the student to use one or more facts, definitions, formulas, or procedures to solve problems that are presented in purely mathematical terms. "Direct application" items require the student to use one or more facts, definitions, formulas, or procedures to solve straightforward problem sets in real-world situations. "Understanding concepts" items test the student's depth of understanding of major concepts by requiring reasoning from a concept to reach an inference or a conclusion. "Integrating conceptual understanding" items test the student's ability to achieve an integrated understanding of two or more major concepts so as to solve nonroutine problems.

Calculators, although not required, are permitted for use on the Mathematics Test. Almost any four-function, scientific, or graphing calculator may be used on the Mathematics Test. A few restrictions do apply to the calculator used. These restrictions can be found on ACT's website at **www.act.org**.

Four scores are reported for the Mathematics Test: a total test score based on all 60 items, a subscore in Pre-Algebra/Elementary Algebra based on 24 items, a subscore in Intermediate Algebra/Coordinate Geometry based on 18 items, and a subscore in Plane Geometry/Trigonometry based on 18 items.

The Reading Test

The ACT Reading Test is a 40-item, 35-minute test that measures reading comprehension as a product of skill in referring and reasoning. That is, the test items require students to derive meaning from several texts by: (a) referring to what is explicitly stated and (b) reasoning to determine implicit meanings. Specifically, items ask students to use referring and reasoning skills to determine main ideas; locate and interpret significant details; understand sequences of events; make comparisons; comprehend cause-effect relationships; determine the meaning of context-dependent words, phrases, and statements; draw generalizations; and analyze the author's or narrator's voice or method. The test comprises four sections, each containing one long or two shorter prose passages that are representative of the level and kinds of text commonly encountered in first-year college curricula. Each passage is preceded by a heading that identifies what type of passage it is (e.g., "Literary Narrative"), names the author, and may include a brief note that helps in understanding the passage. Each section is accompanied by a set of multiple-choice test items. These items focus on the complex of complementary and mutually supportive skills that readers must bring to bear in studying written materials across a range of subject areas. They do not test the rote recall of facts from outside the passage or rules of formal logic, nor do they contain isolated vocabulary questions. In sections that contain two short passages, some of the questions involve both of the passages in the section.

Three scores are reported for the Reading Test: a total test score based on all 40 items, a subscore in Social Studies/Sciences reading skills (based on the 20 items in the social sciences and natural sciences sections of the test), and a subscore in Arts/Literature reading skills (based on the 20 items in the literary narrative and humanities sections of the test).

The Science Test

The ACT Science Test is a 40-item, 35-minute test that measures the interpretation, analysis, evaluation, reasoning, and problem-solving skills required in the natural sciences. The content of the Science Test is drawn from biology, chemistry, physics, and the Earth/space sciences, all of which are represented in the test. Students are assumed to have a minimum of two years of introductory science, which ACT's National Curriculum Surveys have identified as typically one year of biology and one year of physical science and/or Earth science. Thus, it is expected that students have acquired the introductory content of biology, physical science, and Earth science, are familiar with the nature of scientific inquiry, and have been exposed to laboratory investigation.

The test presents several sets of scientific information, each followed by a number of multiple-choice test items. The scientific information is conveyed in one of three different formats: data representation (graphs, tables, and other schematic forms), research summaries (descriptions of several related experiments), or conflicting viewpoints (expressions of several related hypotheses or views that are inconsistent with one another).

The items included in the Science Test cover three cognitive levels: understanding, analysis, and generalization. "Understanding" items require students to recognize and understand the basic features of, and concepts related to, the provided information. "Analysis" items require students to examine critically the relationships between the information provided and the conclusions drawn or hypotheses developed. "Generalization" items require students to generalize from given information to gain new information, draw conclusions, or make predictions.

One score is reported for the Science Test: a total test score based on all 40 items.

The Writing Test (optional)

The ACT Writing Test is a 30-minute essay test that measures students' writing skills—specifically those writing skills emphasized in high school English classes and in entry-level college composition courses. The test consists of one writing prompt that defines an issue and describes two points of view on that issue. The students are asked to respond to a question about their position on the issue described in the writing prompt. In doing so, they may adopt one or the other of the perspectives described in the prompt, or they may present a different point of view on the issue. The essay score is not affected by the point of view taken on the issue.

Taking the Writing Test does not affect a student's score on the multiple-choice tests or the Composite score for those tests. Rather, two additional scores are provided: a Combined English/Writing score and a Writing subscore. Also provided are comments on the student's essay.

Test Development Procedures for Multiple-Choice Tests

This section describes the procedures that are used in developing the four multiple-choice tests described above. The test development cycle required to produce each new form of the ACT tests takes as long as two and one-half years and involves several stages, beginning with a review of the test specifications.

Review of Test Specifications

Two types of test specifications are used in developing the ACT tests: content specifications and statistical specifications.

Content specifications. Content specifications for the ACT tests were developed through the curricular analysis discussed above. While care is taken to ensure that the basic structure of the ACT tests remains the same from year to year so that the scale scores are comparable, the specific characteristics of the test items used in each specification category are reviewed regularly. Consultant panels are convened to review both the tryout versions and the new forms of each test to verify their content accuracy and the match of the content of the tests to the content specifications. At these panels, the characteristics of the items that fulfill the content specifications are also reviewed. While the general content of the test remains constant, the particular kinds of items in a specification category may change slightly. The basic structure of the content specifications for each of the ACT multiple-choice tests is provided in Tables 2.1 through 2.4 on pages 9–12.

Statistical specifications. Statistical specifications for the tests indicate the level of difficulty (proportion correct) and minimum acceptable level of discrimination (biserial correlation) of the test items to be used.

The tests are constructed with a target mean item difficulty of about .58 for the ACT population and a range of difficulties from about .20 to .89. The distribution of item difficulties was selected so that the tests will effectively differentiate among students who vary widely in their level of achievement.

With respect to discrimination indices, items should have a biserial correlation of 0.20 or higher with test scores measuring comparable content. Thus, for example, performance on mathematics items should correlate 0.20 or higher with performance on the relevant Mathematics Test subscore.

Selection of Item Writers

Each year, ACT contracts with item writers to construct items for the ACT. The item writers are content specialists in the disciplines measured by the ACT tests. Most are actively engaged in teaching at various levels, from high school to university, and at a variety of institutions, from small private schools to large public institutions. ACT makes every attempt to include item writers who represent the diversity of the population of the United States with respect to ethnic background, gender, and geographic location.

Before being asked to write items for the ACT tests, potential item writers are required to submit a sample set of materials for review. Each item writer receives an item writer's guide that is specific to the content area. The guides include examples of items and provide item writers with the test specifications and ACT's requirements for content and style. Included are specifications for fair portrayal of all groups of individuals, avoidance of subject matter that may be unfamiliar to members of certain groups within society, and nonsexist use of language.

Each sample set submitted by a potential item writer is evaluated by ACT Test Development staff. A decision concerning whether to contract with the item writer is made on the basis of that evaluation.

Each item writer under contract is given an assignment to produce a small number of items. The small size of the assignment ensures production of a diversity of material and maintenance of the security of the testing program, since any item writer will know only a small proportion of the items produced. Item writers work closely with ACT content specialists, who assist them in producing items of high quality that meet the test specifications.

Item Construction

The item writers must create items that are educationally important and psychometrically sound. A large number of items must be constructed because, even with good writers, many items fail to meet ACT's standards.

Each item writer submits a set of items, called a *unit*, in a given content area. Most Mathematics Test items are discrete (not passage-based); some items may belong to a set of several items (e.g., several items based on the same paragraph or chart). All items on the English and Reading Tests are related to prose passages. All items on the Science Test are related to passages and/or other stimulus material (such as graphs and tables).

Review of Items

After a unit is accepted, it is edited to meet ACT's specifications for content accuracy, word count, item classification, item format, and language. During the editing process, all test materials are reviewed for fair portrayal and balanced representation of groups within society and for nonsexist use of language. The unit is reviewed several times by ACT staff to ensure that it meets all of ACT's standards.

Copies of each unit are then submitted to content and fairness experts for external reviews prior to the pretest administration of these units. The content review panel consists of high school teachers, curriculum specialists, and college and university faculty members. The content panel reviews the unit for content accuracy, educational importance, and grade-level appropriateness. The fairness review panel consists of experts in diverse educational areas who represent both genders and a variety of racial and ethnic backgrounds. The fairness panel reviews the unit to help ensure fairness to all examinees. Any comments on the units by the content consultants are discussed in a panel meeting with all the content consultants and ACT staff, and appropriate changes are made to the unit(s). All fairness consultants' comments are reviewed and discussed, and appropriate changes are made to the unit(s).

(*Text continues on p.* 13.)

Table 2.1

Content Specifications for the ACT English Test

Six elements of effective writing are included in the English Test. These elements and the approximate proportion of the test devoted to each are given below.

Content/Skills	Proportion of test	Number of items
Usage/Mechanics	.53	40
Punctuation	.13	10
Grammar and Usage	.16	12
Sentence Structure	.24	18
Rhetorical Skills	.47	35
Strategy	.16	12
Organization	.15	11
Style	.16	12
Total	1.00	75

Scores reported: Usage/Mechanics (40 items)
Rhetorical Skills (35 items)
Total test score (75 items)

a. *Punctuation.* The items in this category test the student's knowledge of the conventions of internal and end-of-sentence punctuation, with emphasis on the relationship of punctuation to meaning (for example, avoiding ambiguity, indicating appositives).

b. *Grammar and Usage.* The items in this category test the student's understanding of agreement between subject and verb, between pronoun and antecedent, and between modifiers and the words modified; verb formation; pronoun case; formation of comparative and superlative adjectives and adverbs; and idiomatic usage.

c. *Sentence Structure.* The items in this category test the student's understanding of relationships between and among clauses, placement of modifiers, and shifts in construction.

d. *Strategy.* The items in this category test the student's ability to develop a given topic by choosing expressions appropriate to an essay's audience and purpose; to judge the effect of adding, revising, or deleting supporting material; and to judge the relevancy of statements in context.

e. *Organization.* The items in this category test the student's ability to organize ideas and to choose effective opening, transitional, and closing sentences.

f. *Style.* The items in this category test the student's ability to select precise and appropriate words and images, to maintain the level of style and tone in an essay, to manage sentence elements for rhetorical effectiveness, and to avoid ambiguous pronoun references, wordiness, and redundancy.

Table 2.2

Content Specifications for the ACT Mathematics Test

The items in the Mathematics Test are classified according to six content areas. These areas and the approximate proportion of the test devoted to each are given below.

Content area	Proportion of test	Number of items
Pre-Algebra	.23	14
Elementary Algebra	.17	10
Intermediate Algebra	.15	9
Coordinate Geometry	.15	9
Plane Geometry	.23	14
Trigonometry	.07	4
Total	1.00	60

Scores reported: Pre-Algebra/Elementary Algebra (24 items)
Intermediate Algebra/Coordinate Geometry (18 items)
Plane Geometry/Trigonometry (18 items)
Total test score (60 items)

a. *Pre-Algebra.* Items in this content area are based on operations using whole numbers, decimals, fractions, and integers; place value; square roots and approximations; the concept of exponents; scientific notation; factors; ratio, proportion, and percent; linear equations in one variable; absolute value and ordering numbers by value; elementary counting techniques and simple probability; data collection, representation, and interpretation; and understanding simple descriptive statistics.

b. *Elementary Algebra.* Items in this content area are based on properties of exponents and square roots, evaluation of algebraic expressions through substitution, using variables to express functional relationships, understanding algebraic operations, and the solution of quadratic equations by factoring.

c. *Intermediate Algebra.* Items in this content area are based on an understanding of the quadratic formula, rational and radical expressions, absolute value equations and inequalities, sequences and patterns, systems of equations, quadratic inequalities, functions, modeling, matrices, roots of polynomials, and complex numbers.

d. *Coordinate Geometry.* Items in this content area are based on graphing and the relations between equations and graphs, including points, lines, polynomials, circles, and other curves; graphing inequalities; slope; parallel and perpendicular lines; distance; midpoints; and conics.

e. *Plane Geometry.* Items in this content area are based on the properties and relations of plane figures, including angles and relations among perpendicular and parallel lines; properties of circles, triangles, rectangles, parallelograms, and trapezoids; transformations; the concept of proof and proof techniques; volume; and applications of geometry to three dimensions.

f. *Trigonometry.* Items in this content area are based on understanding trigonometric relations in right triangles; values and properties of trigonometric functions; graphing trigonometric functions; modeling using trigonometric functions; use of trigonometric identities; and solving trigonometric equations.

Table 2.3

Content Specifications for the ACT Reading Test

The items in the Reading Test are based on passages that are representative of the kinds of writing commonly encountered in first-year college curricula, including literary narrative or prose fiction, the social sciences, the humanities, and the natural sciences. The four content areas and the approximate proportion of the test devoted to each are given below.

Reading passage content	Proportion of test	Number of items
Literary Narrative/Prose Fiction	.25	10
Social Studies	.25	10
Humanities	.25	10
Natural Sciences	.25	10
Total	1.00	40

Scores reported: Social Studies/Sciences (Social Studies, Natural Sciences: 20 items)
Arts/Literature (Literary Narrative/Prose Fiction, Humanities: 20 items)
Total test score (40 items)

a. *Literary Narrative or Prose Fiction.* The items in the Literary Narrative category are based on passages from short stories, novels, memoirs, and personal essays. Items in the Prose Fiction category are based on passages from short stories and novels.

b. *Social Studies.* The items in this category are based on passages in the content areas of anthropology, archaeology, biography, business, economics, education, geography, history, political science, psychology, and sociology.

c. *Humanities.* The items in this category are based on passages from memoirs and personal essays and in the content areas of architecture, art, dance, ethics, film, language, literary criticism, music, philosophy, radio, television, and theater.

d. *Natural Sciences.* The items in this category are based on passages in the content areas of anatomy, astronomy, biology, botany, chemistry, ecology, geology, medicine, meteorology, microbiology, natural history, physiology, physics, technology, and zoology.

Table 2.4

Content Specifications for the ACT Science Test

The Science Test is based on the type of content that is typically covered in high school science courses. Materials are drawn from the biological sciences, the Earth/space sciences, physics, and chemistry. Advanced knowledge in these subjects is not required, but background knowledge acquired in general introductory science courses is needed to answer some of the questions. The test emphasizes scientific reasoning skills over recall of scientific content, skill in mathematics, or skill in reading. Minimal arithmetic and algebraic computations may be required to answer some items. The three formats and the approximate proportion of the test devoted to each are given below.

Content area[a]	Format	Proportion of test	Number of items
Biology Earth/Space Sciences Physics Chemistry	Data Representation	.30	12
	Research Summaries	.50	20
	Conflicting Viewpoints	.20	8
Total		1.00	40

[a] All four content areas are represented in the test. The content areas are distributed over the different formats in such a way that at least one passage, and no more than two passages, represents each content area.

Score reported: Total test score (40 items)

a. *Data Representation.* This format presents students with graphic and tabular material similar to that found in science journals and texts. The items associated with this format measure skills such as graph reading, interpretation of scatterplots, and interpretation of information presented in tables, diagrams, and figures.

b. *Research Summaries.* This format provides students with descriptions of one or more related experiments. The items focus on the design of experiments and the interpretation of experimental results.

c. *Conflicting Viewpoints.* This format presents students with expressions of several hypotheses or views that, being based on differing premises or on incomplete data, are inconsistent with one another. The items focus on the understanding, analysis, and comparison of alternative viewpoints or hypotheses.

(*Text continued from p.* 8.)

Item Tryouts

The items that are judged to be acceptable in the review process are assembled into tryout units for pretesting on samples from the national examinee population. These samples are carefully selected to be representative of the total examinee population. Each sample is administered a tryout unit from one of the four academic areas covered by the ACT tests. The time limits for the tryout units permit the majority of students to respond to all items.

Item Analysis of Tryout Units

Item analyses are performed on the tryout units. For a given unit the sample is divided into low-, medium-, and high-performing groups by the individuals' scores on the ACT test in the same content area (taken at the same time as the tryout unit). The cutoff scores for the three groups are the 27th and the 73rd percentile points in the distribution of those scores. These percentile points maximize the critical ratio of the difference between the mean scores of the upper and lower groups, assuming that the standard error of measurement in each group is the same and that the scores for the entire examinee population are normally distributed (Millman & Greene, 1989).

Proportions of students in each of the groups correctly answering each tryout item are tabulated, as well as the proportion in each group selecting each of the incorrect options. Biserial and point-biserial correlation coefficients between each item score (correct/incorrect) and the total score on the corresponding test of the regular (national) test form are also computed.

Item analyses serve to identify statistically effective test items. Items that are either too difficult or too easy, and items that fail to discriminate between students of high and low educational achievement as measured by their corresponding ACT test scores, are eliminated or revised for future item tryouts. The biserial and point-biserial correlation coefficients, as well as the differences between proportions of students answering the item correctly in each of the three groups, are used as indices of the discriminating power of the tryout items.

Each item is reviewed following the item analysis. ACT staff members scrutinize items flagged for statistical reasons to identify possible problems. Some items are revised and placed in new tryout units following further review. The review process also provides feedback that helps decrease the incidence of poor quality items in the future.

Assembly of New Forms

Items that are judged acceptable in the review process are placed in an item pool. Preliminary forms of the ACT tests are constructed by selecting from this pool items that match the content and statistical specifications for the tests.

For each test in the battery, items for the new forms are selected to match the content distribution for the tests shown in Tables 2.1 through 2.4. Items are also selected to comply with the statistical specifications described on page 7. The distributions of item difficulty levels obtained on recent forms of the four tests are displayed in Table 2.5. The data in Table 2.5 are taken from random samples of approximately 2,000 students from each of the six national test dates during the 2011–2012 academic year. In addition to the item difficulty distributions, item discrimination indices in the form of observed mean biserial correlations and completion rates are reported.

The completion rate is an indication of how speeded a test is for a group of students. A test is considered to be speeded if most students do not have sufficient time to answer the items in the time allotted. The completion rate reported in Table 2.5 for each test is the average completion rate for the six national test dates during the 2011–2012 academic year. The completion rate for each test is computed as the average proportion of examinees who answered each of the last five items.

Table 2.5
Difficulty[a] Distributions and Mean Discrimination[b] Indices for ACT Test Items, 2011–2012

Difficulty range	Observed difficulty distributions (frequencies) English	Mathematics	Reading	Science
.00–.09	0	0	0	0
.10–.19	2	9	0	0
.20–.29	4	37	3	13
.30–.39	23	52	14	36
.40–.49	46	47	44	52
.50–.59	56	58	44	39
.60–.69	98	80	61	50
.70–.79	123	38	49	28
.80–.89	88	34	23	22
.90–1.00	10	5	2	0
No. of items[c]	450	360	240	240
Mean diff.	.66	.54	.61	.55
Mean disc.	.58	.60	.58	.50
Avg. completion rate[d]	92	91	94	93

[a]Difficulty is the proportion of examinees correctly answering the item.
[b]Discrimination is the item–total score biserial correlation coefficient.
[c]Six forms consisting of the following number of items per test:
English 75, Mathematics 60, Reading 40, Science 40.
[d]Mean proportion of examinees who answered each of the last five items.

Content and Fairness Review of Test Forms

The preliminary versions of the test forms are subjected to several reviews to ensure that the items are accurate and that the overall test forms are fair and conform to good test construction practice. The first review is performed by ACT staff. Items are checked for content accuracy and conformity to ACT style. The items are also reviewed to ensure that they are free of clues that could allow testwise students to answer the item correctly even though they lack knowledge in the subject areas or the required skills.

The preliminary versions of the test forms are then submitted to content and fairness experts for external review before the operational administration of the test forms. These experts are different individuals from those consulted for the content and fairness reviews of tryout units.

Two panels, a content review panel and a fairness review panel, are then convened to discuss with ACT staff the consultants' reviews of the forms. The content review panel consists of high school teachers, curriculum specialists, and college and university faculty members. The content panel reviews the forms for content accuracy, educational importance, and grade-level appropriateness. The fairness review panel consists of experts in diverse areas of education who represent both genders and a variety of racial and ethnic backgrounds. The fairness panel reviews the forms to help ensure fairness to all examinees.

After the panels complete their reviews, ACT summarizes the results. All comments from the consultants are reviewed by ACT staff members, and appropriate changes are made to the test forms. Whenever significant changes are made, the revised components are again reviewed by the appropriate consultants and by ACT staff. If no further corrections are needed, the test forms are prepared for printing.

In all, at least sixteen independent reviews are made of each test item before it appears on an operational form of the ACT. The many reviews are performed to help ensure that each student's level of achievement is accurately and fairly evaluated.

Review Following Operational Administration

After each operational administration, item analysis results are reviewed for any anomalies such as substantial changes in item difficulty and discrimination indices between tryout and operational administrations. Only after all anomalies have been thoroughly checked and the final scoring key approved are score reports produced. Examinees may challenge any items that they feel are questionable. Once a challenge to an item is raised and reported, the item is reviewed by content specialists in the content area assessed by the item. In the event that a problem is found with an item, actions are taken to eliminate or minimize the influence of the problem item as necessary. In all cases, the person who challenges an item is sent a letter indicating the results of the review.

Also, after each operational administration, DIF (differential item functioning) analysis procedures are conducted on the test data. DIF can be described as a statistical difference between the probability of the specific population group (the "focal" group) getting the item right and the comparison population group (the "base" group) getting the item right given that both groups have the same level of achievement with respect to the content being tested. The procedures currently used for the analysis include the standardized difference in proportion-correct (STD) procedure and the Mantel-Haenszel common odds-ratio (MH) procedure.

Both the STD and MH techniques are designed for use with multiple-choice items, and both require data from significant numbers of examinees to provide reliable results. For a description of these statistics and their performance overall in detecting DIF, see the ACT Research Report entitled *Performance of Three Conditional DIF Statistics in Detecting Differential Item Functioning on Simulated Tests* (Spray, 1989). In the analysis of items in an ACT form, large samples representing examinee groups of interest (e.g., males and females) are selected from the total number of examinees taking the test. The examinees' responses to each item on the test are analyzed using the STD and MH procedures. Compared with pre-established criteria, the items with STD or MH values exceeding the tolerance level are flagged. The flagged items are then further reviewed by the content specialists for possible explanations of the unusual STD or MH results. In the event that a problem is found with an item, actions will be taken as necessary to eliminate or minimize the influence of the problem item.

Test Development Procedures for the Writing Test

This section describes the procedures that are used in developing essay prompts for the ACT Writing Test. These include many of the same stages as those used to develop the multiple-choice tests.

Selection and Training of Prompt Writers

ACT holds a prompt writing workshop each year in which new essay prompts are developed. The participants invited to take part in this prompt development process are both high school and post-secondary teachers who are specialists in writing, and who represent the diversity of the United States' population in ethnic background, gender, and geographic location.

Prompt Construction

Prompts developed for the Writing Test provide topics that not only offer adequate complexity and depth so that examinees can write a thoughtful and engaging essay, but also are within the common experiences of high school students. Topics are carefully chosen so that they are neither too vast nor simplistic, and so that they do not require specialized prior knowledge. The topics are designed so that a student should be able to respond to a topic within the 30-minute time constraint of the test.

Content and Fairness Review of Prompts

After Writing Test prompts are developed and then refined by ACT writing specialists, the prompts go through a rigorous review process by external experts. These fairness and bias experts carefully review each prompt to ensure that neither the language nor the content of a prompt will be offensive to a test taker, and that no prompt will disadvantage any student from any geographic, socioeconomic, or cultural background.

Field Testing of Prompts

New Writing Test prompts are field-tested throughout the United States every year. Students from rural and urban settings, small and large schools, and both public and private schools write responses to the new prompts, which are then read and scored by trained ACT readers.

Review of Field Tests and Operational Administration

Once scoring of the new Writing Test prompts has been completed, the prompts are analyzed for acceptability, validity, and accessibility. The new field-tested prompts are also reviewed to ensure that they are compatible with previous operational prompts, that they function in the same way as previous prompts, and that they adhere to ACT's rigorous standards.

ACT Scoring Procedures

For each of the four multiple-choice tests in the ACT (English, Mathematics, Reading, and Science), the raw scores (number of correct responses) are converted to scale scores ranging from 1 to 36.

The Composite score is the average of the four scale scores rounded to the nearest whole number (fractions of 0.5 or greater round up). The minimum Composite score is 1; the maximum is 36.

In addition to the four ACT test scores and Composite score, seven subscores are reported: two each for the English Test and the Reading Test and three for the Mathematics Test. As is done for each of the four tests, the raw scores for the subscore items are converted to scale scores. These subscores are reported on a score scale ranging from 1 to 18. The four test scores and seven subscores are derived independently of one another. The subscores in a content area do not necessarily add to the test score in that area.

In addition to the above scores, if the student took the Writing Test, the student's essay is read and scored independently by two trained readers using a six-point scoring rubric. Essays are evaluated on the evidence they demonstrate of student ability to make and articulate judgments; develop and sustain a position on an issue; organize and present ideas in a logical way; and communicate clearly and effectively using the conventions of standard written English. Essays are scored holistically—that is, on the basis of the overall impression created by all the elements of the writing. Each reader rates an essay on a scale ranging from 1 to 6. The sum of the readers' ratings is a student's Writing Test subscore on a scale ranging from 2 to 12. A student who takes the Writing Test also receives a Combined English/Writing score on a score scale ranging from 1 to 36. Writing Test results do not affect a student's Composite score.

Electronic scanning devices are used to score the four multiple-choice tests of the ACT, thus minimizing the potential for scoring errors. If a student believes that a scoring error has been made, ACT hand-scores the answer document (for a fee) upon receipt of a written request from the student. Strict confidentiality of each student's record is maintained.

If a student believes that a Writing Test essay has been incorrectly scored, that score may be appealed, and the essay will be reviewed and rescored (for a fee) by two new expert readers. The two new readers score the appealed essay without knowledge of the original score, and the new score is adjudicated by ACT staff writing specialists before being finalized.

For certain test dates (specified in the current year's booklet *Registering for the ACT*), examinees may obtain (upon payment of an additional fee) a copy of the test items used in determining their scores, the correct answers, a list of their answers, and a table to convert raw scores to the reported scale scores. For an additional fee, a student may also obtain a copy of his or her answer document. These materials are available only to students who test during regular administrations of the ACT on specified national test dates. If for any reason ACT must replace the test form scheduled for use at a test center, this offer is withdrawn and the student's fee for this optional service is refunded.

ACT reserves the right to cancel test scores when there is reason to believe the scores are invalid. Cases of irregularities in the test administration process—falsifying one's identity, impersonating another examinee (surrogate testing), unusual similarities in answers of examinees at the same test center, or other indicators that the test scores may not accurately reflect the examinee's level of educational achievement, including but not limited to examinee misconduct—may result in ACT's canceling the test scores. For a detailed description of how ACT handles score cancellations, refer to ACT's Terms and Conditions of Registration.

Chapter 3
ACT's College and Career Readiness Standards and College Readiness Benchmarks

ACT's College and Career Readiness Standards

Description of the College and Career Readiness Standards

In 1997, ACT began an effort to make ACT Explore, ACT Plan, and the ACT test results more informative and useful. This effort yielded ACT's College and Career Readiness Standards. The College and Career Readiness Standards are statements that describe what students who score in various score ranges on the tests are *likely* to know and to be able to do. For example, students who score in the 16–19 range on the ACT Plan English Test typically are able to "determine the most logical place for a sentence in a paragraph," while students who score in the 28–32 score range are able to "determine the most logical place for a sentence in a fairly complex paragraph." The Standards reflect a progression of skills in each of the five tests: English, Reading, Mathematics, Science, and Writing. ACT has organized the standards by *strands*—related areas of knowledge and skill within each test—for ease of use by teachers and curriculum specialists. The complete College and Career Readiness Standards are presented on pages 26–37 and posted on ACT's website: **www.act.org**. They also are available in poster format. To order additional posters, please email customerservices@act.org. ACT also offers College and Career Readiness Standards Information Services, a supplemental reporting service based on the Standards.

College and Career Readiness Standards for ACT Explore, ACT Plan, and the ACT are provided for six score ranges (13–15, 16–19, 20–23, 24–27, 28–32, and 33–36) along a score scale that is common to ACT Explore (1–25), ACT Plan (1–32), and the ACT (1–36). Students who score in the 1–12 range are most likely beginning to develop the skills and knowledge described in the 13–15 score range. The Standards are cumulative, which means that if students score, for example, in the 20–23 range on the English Test, they are likely able to demonstrate most or all of the skills and understandings in the 13–15, 16–19, and 20–23 score ranges.

College and Career Readiness Standards for Writing, which ACT developed in 2005, are available only for the ACT and are provided for five score ranges (3–4, 5–6, 7–8, 9–10, and 11–12) based on ACT Writing Test scores attained (sum of two readers' ratings using the six-point holistic scoring rubric for the ACT Writing Test). Scores below 3 on the Writing Test do not permit useful generalizations about students' writing abilities.

Since ACT Explore, ACT Plan, and the ACT are designed to measure students' progressive development of knowledge and skills in the same four academic areas through Grades 8–12, the Standards are correlated across programs as much as possible. The Standards in the 13–15, 16–19, 20–23, and 24–27 score ranges apply to scores for all three programs. The Standards in the 28–32 score range are specific to ACT Plan and the ACT, and the Standards in the 33–36 score range are specific to the ACT. Figure 3.1 illustrates the score-range overlap among the three programs.

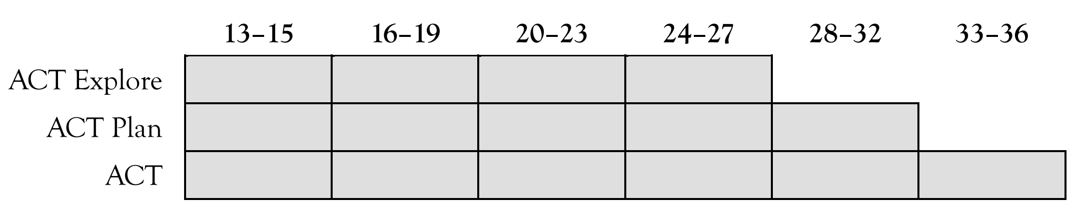


Figure 3.1. Score ranges for ACT Explore, ACT Plan, and the ACT.

Determining the Score Ranges for the College and Career Readiness Standards

When ACT began work on the College and Career Readiness Standards in 1997, the first step was to determine the number of score ranges and the width of each score range. To do this, ACT staff reviewed ACT Explore, ACT Plan, and the ACT normative data and considered the relationships among. This information was considered within the context of how the test scores are used—for example, the use of the ACT scores in college admissions and course-placement decisions.

In reviewing the normative data, ACT staff analyzed the distribution of student scores across the respective score scales (ACT Explore 1–25, ACT Plan 1–32, and the ACT 1–36). The staff also considered course placement research that ACT has conducted over the last 40 years. ACT's Course Placement Service provides colleges and universities with cutoff scores that are used for placement into appropriate entry-level college courses. Cutoff scores based on admissions and course-placement criteria were used to help define the score ranges of all three assessments.

After analyzing all the data and reviewing different possible score ranges, ACT staff concluded that the score ranges 1–12, 13–15, 16–19, 20–23, 24–27, 28–32, and 33–36 would best distinguish students' levels of achievement so as to assist teachers, administrators, and others in relating ACT Explore, ACT Plan, and the ACT multiple-choice test scores to students' skills and understandings.

Developing the College and Career Readiness Standards

After reviewing the normative data, college admissions criteria, and information obtained through ACT's Course Placement Service, content area test specialists wrote the College and Career Readiness Standards based on their analysis of the skills and knowledge students need in order to respond successfully to test items that were answered correctly by 80% or more of the examinees who scored within each score range. Content specialists analyzed test items taken from dozens of test forms. The 80% criterion was chosen because it offers those who use the College and Career Readiness Standards a high degree of confidence that students scoring in a given score range will most *likely* be able to demonstrate the skills and knowledge described in that range.

The process. Four ACT content teams were identified, one for each of the multiple-choice tests (English, Mathematics, Reading, and Science) included in ACT Explore, ACT Plan, and the ACT. Each content team was provided with numerous test forms along with tables that showed the percentages of students in each score range who answered each test item correctly (the item difficulties). Item difficulties were computed separately based on groups of students whose scores fell within each of the defined score ranges.

The College and Career Readiness Standards were identified by test, by program, beginning with the ACT. Each content team was provided with 10 forms of the ACT and the item difficulties computed separately for each score range for each of the items on the forms. For example, the mathematics content team reviewed 10 forms of the ACT Mathematics Test. There are 60 items in each ACT Mathematics Test form, so 600 ACT Mathematics items were reviewed in all. An illustrative table displaying the information provided to the mathematics content team for one ACT Mathematics Test form is shown in Table 3.1.

The shaded areas in Table 3.1 show the items that met the .80-or-above item difficulty criterion for each of the score ranges. As illustrated in Table 3.1, a cumulative effect can be noted: the items that are correctly answered by 80% of the students in Score Range 16–19 also appear in Score Range 20–23; the items that are correctly answered by 80% of the students in Score Range 20–23 also appear in Score Range 24–27; and so on. By using this information, the content teams were able to isolate and review the items by score ranges across test forms.

Table 3.2 reports the total number of test items reviewed for each content area and for each testing program.

The procedures described allowed the content teams to conceptualize what is measured by each of the academic tests. Each content team followed the same basic process as they reviewed the test items in each multiple-choice academic test in the three assessment programs, ACT Explore, ACT Plan, and the ACT:

1. Multiple forms of each academic test were distributed.
2. The knowledge, skills, and understandings that are necessary to answer the test items in each score range were identified.

Table 3.1
Illustrative Listing of Mathematics Items by Score Range

Item no.	Item difficulties for students scoring in the score range of: 13–15	16–19	20–23	24–27	28–32	33–36
1	.62	.89	.98	.99	1.00	1.00
2		.87	.98	.99	.99	1.00
6	.60	.86	.94	.97	.99	.99
7	.65	.92	.98	.99	.99	1.00
20		.84	.94	.97	.98	.99
27		.85	.97	.99	.99	.99
4			.92	.97	.99	1.00
5			.94	.97	.99	.99
.			.	.	.	.
.			.	.	.	.
.			.	.	.	.
8			.82	.95	.98	.99
9			.80	.89	.96	.99
21			.82	.92	.97	.99
13				.90	.97	.99
15				.90	.97	.99
17				.87	.98	1.00
18				.83	.93	.98
22				.81	.91	.98
24				.83	.96	.98
29				.87	.98	1.00
34				.86	.95	.99
36				.82	.93	.99
39				.85	.96	.99
44				.84	.96	.99
25					.95	.99
28					.97	1.00
.					.	.
.					.	.
.					.	.
35					.86	.96
47					.86	.97
32						.95
33						.92
46						.90
49						.95
51						.98
52						.98
53						.92
56						.98
57						.86
58						.95
59						.86
60						.96

Table 3.2
Number of Items Reviewed During 1997 National Review

Content area	Number of items for each testing program ACT Explore	ACT Plan	ACT
English	40	50	75
Mathematics	30	40	60
Reading	30	25	40
Science	28	30	40
Number of items per form	128	145	215
Total number of test forms reviewed	4	9	10
Total number of items reviewed	512	1,305	2,150

3. The *additional* knowledge, skills, and understandings that are necessary to answer the test items in the *next* score range were identified. This process was repeated for all the score ranges.
4. All the lists of statements identified by each content specialist were merged into a composite list. The composite list was distributed to a larger group of content specialists.
5. The composite list was reviewed by each content specialist, and ways to generalize and to consolidate the various skills and understandings were identified.
6. The content specialists met as a group to discuss the individual, consolidated lists and prepared a master list of skills and understandings, organized by score ranges.
7. The master list was used to review at least three additional test forms, and adjustments and refinements were made as necessary.
8. The adjustments were reviewed by the content specialists and "final" revisions were made.
9. The "final" list of skills and understandings was used to review additional test forms. The purpose of this review was to determine whether the College and Career Readiness Standards adequately and accurately described the skills and understandings measured by the items, by score range.
10. The College and Career Readiness Standards were once again refined.

These steps were used to review test items for all four multiple-choice academic tests in all three testing programs. As work began on the ACT Plan and ACT Explore test items, the College and Career Readiness Standards developed for the ACT were used as a baseline, and modifications or revisions were made as necessary.

Conducting an independent review of the College and Career Readiness Standards. As a means of gathering content validity evidence, ACT invited nationally recognized scholars from high school and university English, mathematics, reading, science, and education departments to review the College and Career Readiness Standards. These teachers and researchers were asked to provide ACT with independent, authoritative reviews of the College and Career Readiness Standards.

The content area experts were selected from among candidates having experience with and an understanding of the academic tests on ACT Explore, ACT Plan, and the ACT. The selection process sought and achieved a diverse representation by gender, ethnic background, and geographic location. Each participant had extensive and current knowledge of his or her field, and many had acquired national recognition for their professional accomplishments.

The reviewers were asked to evaluate whether the College and Career Readiness Standards (a) accurately reflected the skills and knowledge needed to correctly respond to test items (in specific score ranges) in ACT Explore, ACT Plan, and the ACT and (b) represented a continuum of increasingly sophisticated skills and understandings across the score ranges. Each national content area team consisted of three college faculty members currently teaching courses in curriculum and instruction, and three classroom teachers, one each from Grades 8, 10, and 12. The reviewers were provided with the complete set of College and Career Readiness Standards and a sample of test items falling in each of the score ranges, by academic test and program.

The samples of items to be reviewed by the consultants were randomly selected for each score range in all four academic tests for all three assessment programs. ACT believed that a random selection of items would ensure a more objective outcome than would preselected items. Ultimately, 17 items for each score range were selected (85 items per testing program, or a total of 255 items for all three programs). Before identifying the number of items that would comprise each set of items in each score range, it was first necessary to determine the target criterion for the level of agreement among the consultants. ACT decided upon a target criterion of 70%. It was deemed most desirable for the percentage of matches to be estimated with an accuracy of plus or minus 0.05. That is, the standard error of the estimated percent of matches to the Standards should be no greater than 0.05. To estimate a percentage around 70% with that level of accuracy, 85 observations were needed. Since there were five score ranges, the number of items per score range to be reviewed was 17 (85 ÷ 5 = 17).

The consultants had two weeks to review the College and Career Readiness Standards. Each reviewer received a packet of materials that contained the College and Career Readiness Standards, sets of randomly selected items (17 per score range), introductory material about the College and Career Readiness Standards, a detailed set of instructions, and two evaluation forms.

The sets of materials submitted for the experts' review were drawn from 13 ACT forms, 8 ACT Plan forms, and 4 ACT Explore forms. The consultants were asked to perform two main tasks in their area of expertise: Task 1—Judge the consistency between the Standards and the corresponding sample items provided for each score range; Task 2—Judge the degree to which the Standards represent a cumulative progression of increasingly sophisticated skills and understandings from the lowest score range to the highest score range. The reviewers were asked to record their ratings using a five-point Likert scale that ranged from *Strongly Agree* to *Strongly Disagree.* They were also asked to suggest revisions to the language of the Standards that would help the Standards better reflect the skills and knowledge measured by the sample items.

ACT collated the consultants' ratings and comments as they were received. The consultants' reviews in all but two cases reached ACT's target criterion, as shown in Table 3.3. That is, 70% or more of the consultants' ratings were *Agree* or *Strongly Agree* when judging whether the Standards adequately described the skills required by the test items and whether the Standards adequately represented the cumulative progression of increasingly sophisticated skills from the lowest to the highest score ranges. The two exceptions were the ACT Explore English Test and the ACT Reading Test, where the degree of agreement was 65% and 60%, respectively. Each ACT staff content area team met to review all comments made by all the national consultants. The teams reviewed all suggestions and adopted a number of helpful clarifications in the language of the Standards, particularly in the language of the ACT Explore English Test Standards and the ACT Reading Test Standards—those two cases in which the original language had failed to meet the target criterion.

Refining the College and Career Readiness Standards for ACT Explore and ACT Plan

In 2001, the score scale for ACT Explore and ACT Plan was refined. This required that the College and Career Readiness Standards for ACT Explore and ACT Plan be reexamined.

The approach used in 1997 to develop the Standards was used to reexamine the Standards for ACT Explore and ACT Plan in 2000. Staff reviewed items, at each ACT Explore and ACT Plan score interval, that were answered correctly by 80% or more of the ACT Explore and ACT Plan examinees. Using the ACT Plan College and Career Readiness Standards as a baseline, ACT Explore test items were reviewed to ensure that the ACT Plan College and Career Readiness Standards adequately described the skills and understandings students were being asked to demonstrate in each score range.

As in the 1997 study, a national independent panel of content experts was convened in each of the four multiple-choice academic tests to ensure that the refined ACT Explore/ACT Plan Standards (a) accurately reflected the skills and knowledge needed to correctly respond to test items in the common score ranges and (b) represented a continuum of increasingly sophisticated skills and understandings across the entire score range. As was the case in 1997, content area experts were identified in the areas of English, mathematics, reading, and science. Each content area team consisted of three reviewers, one each from middle school/junior high, high school, and college/university.

Table 3.3
Percentage of Agreement of 1997 National Expert Review

	ACT Explore		ACT Plan/ACT		
	Task 1	Task 2	Task 1 (ACT Plan)	Task 1 (ACT)	Task 2
English	65%	80%	75%	75%	86%
Mathematics	80%	100%	70%	95%	100%
Reading	75%	75%	75%	60%	100%
Science	95%	100%	100%	70%	80%

For each academic test, the consultants were asked to review sets of test items, arranged by score range, and the corresponding College and Career Readiness Standards. The ACT Plan reviewers received two sets of test items, an ACT Explore set and an ACT Plan set, along with the corresponding Standards. A criterion of 17 items per score range was chosen.

As was the case in 1997, the reviewers were asked to record their ratings using a five-point Likert scale that ranged from *Strongly Agree* to *Strongly Disagree*. They were also asked to suggest revisions to the language of the Standards that would help the Standards better reflect the skills and knowledge measured by the sample items. A target criterion of 70% agreement was again identified. The consultants' review in all cases reached ACT's target criterion, as shown in Table 3.4.

The College and Career Readiness Standards in Writing

In 2005, College and Career Readiness Standards for Writing were developed. These are statements of what students who score in various ranges on the ACT Writing Test are likely to be able to do. College and Career Readiness Standards for Writing are provided for five Writing Test score ranges: 3–4, 5–6, 7–8, 9–10, and 11–12.

The score ranges and the College and Career Readiness Standards for the ACT Writing Test were derived from the ACT Writing Test scoring rubric. The Writing Test scoring rubric is a six-point descriptive scale to which Writing Test essays are compared in order to determine their score. Each essay written for the Writing Test is scored by two trained readers, each of whom gives it a rating from 1 (low) to 6 (high). The sum of those two ratings is a student's Writing Test subscore (2–12).

The scoring rubric originated as the final step in the lengthy process of developing the ACT Writing Test. In designing a test to measure students' writing proficiency, ACT staff examined secondary and postsecondary writing practice, instruction, and assessment across the nation, including direct writing assessments used by postsecondary institutions to make admissions and course placement decisions, state writing content standards for grades 9–12, literature published over the past thirty years on direct writing assessments and on the teaching of composition at the postsecondary level, and results of the 2002–2003 ACT National Curriculum Survey® (ACT, 2003). ACT also created an ACT National Writing Test Advisory Panel, whose members include some of the foremost national experts on writing instruction, writing assessment, and ESL and developmental writing. Together, ACT writing experts and the panelists developed detailed specifications for the Writing Test such as the type of writing to be elicited, the writing prompt format, and the scoring criteria to be used in the scoring rubric. Extensive field testing resulted in student papers that ACT writing experts studied in order to refine and clarify score point descriptions for the scoring rubric.

The scoring rubric is based on five main scoring criteria that are considered when determining a student's score. These same five criteria serve as the five strands for the Writing College and Career Readiness Standards. To establish the score point skill descriptors for the Standards, further review of college admissions and course placement criteria and further scrutiny of student writing responses were undertaken. Grounding both the rubric and the Writing College and Career Readiness Standards in student essays—and the writing patterns evident in large numbers of essays—increases confidence that students scoring in a given score range will most *likely* be able to demonstrate the skills and knowledge described in that range.

Table 3.4
Percentage of Agreement of 2000 National Expert Review

	ACT Explore		ACT Plan	
	Task 1	**Task 2**	**Task 1**	**Task 2**
English	90%	100%	73%	100%
Mathematics	75%	100%	100%	100%
Reading	100%	100%	87%	100%
Science	75%	100%	90%	100%

To determine the score ranges for the College and Career Readiness Standards, ACT staff considered the differences in writing skill ability evident in essays between levels of the scoring rubric. Based on similarities found among written responses at certain adjacent score points, ACT staff determined that the six score ranges 2, 3–4, 5–6, 7–8, 9–10, and 11–12 would best distinguish students' levels of writing achievement so as to assist teachers, administrators, and others in relating ACT test scores to students' skills and understandings.

Because the ACT is curriculum based, ACT and independent consultants conduct a review every three to four years to ensure that the knowledge and skills described in the Standards and outlined in the test specifications and rubric continue to reflect those being taught in classrooms nationwide.

Periodic Review of the College and Career Readiness Standards

In addition to the regularly scheduled independent reviews conducted by national panels of subject matter experts, ACT also periodically conducts internal reviews of the College and Career Readiness Standards. ACT identifies three to four new forms of the ACT, ACT Plan, and ACT Explore (for ACT Explore, fewer forms are available) and then analyzes the data and the corresponding test items, by score range. The purposes of these reviews are to ensure that (a) the Standards reflect the knowledge and skills being measured by the items in each score range and (b) the Standards reflect a cumulative progression of increasingly sophisticated skills and understandings from the lowest score range to the highest. Minor refinements intended to clarify the language of the Standards have resulted from these reviews.

Interpreting and Using the College and Career Readiness Standards

Because new ACT Explore, ACT Plan, and the ACT test forms are developed at regular intervals and because no one test form measures all of the skills and knowledge included in any particular Standard, the College and Career Readiness Standards must be interpreted as skills and knowledge that *most* students who score in a particular score range are *likely* to be able to demonstrate. Since there were relatively few test items that were answered correctly by 80% or more of the students who scored in the lower score ranges, the standards in these ranges should be interpreted cautiously.

It is important to recognize that the ACT Explore, ACT Plan, and the ACT tests neither measure everything students have learned nor does any test measure everything necessary for students to know to be successful in their next level of learning. The tests include questions from a large domain of skills and from areas of knowledge that have been judged important for success in high school, college, and beyond. Thus, the College and Career Readiness Standards should be interpreted in a responsible way that will help students, parents, teachers, and administrators to:

- Identify skill areas in which students might benefit from further instruction
- Monitor student progress and modify instruction to accommodate learners' needs
- Encourage discussion among principals, curriculum coordinators, and classroom teachers as they evaluate their academic programs
- Enhance discussions between educators and parents to ensure that students' course selections are appropriate and consistent with their post–high school plans
- Enhance the communication between secondary and postsecondary institutions

- Identify the knowledge and skills students entering their first year of postsecondary education should know and be able to do in the academic areas of language arts, mathematics, and science
- Assist students as they identify skill areas they need to master in preparation for college-level coursework

ACT's College Readiness Benchmarks

Description of the College Readiness Benchmarks

The ACT College Readiness Benchmarks (see Table 3.5) are the minimum ACT test scores required for students to have a high probability of success in credit-bearing college courses—English Composition I, social sciences courses, College Algebra, or Biology. In addition to the Benchmarks for the ACT, there are corresponding Benchmarks for ACT Explore, taken in eighth and/or ninth grades, and ACT Plan, taken in tenth grade, to gauge student progress in becoming ready for college. Students who meet a Benchmark on the ACT have approximately a 50% chance of earning a B or better and approximately a 75% chance or better of earning a C or better in the corresponding college course or courses. Students who meet a Benchmark on ACT Explore or ACT Plan have approximately a 50% chance of meeting the ACT Benchmark in the same subject, and are likely to have approximately this same chance of earning a B or better grade in the corresponding college course(s) by the time they graduate high school.

Data Used to Establish the Benchmarks for the ACT

The ACT College Readiness Benchmarks are empirically derived based on the actual performance of students in college. As part of its research services, ACT provides reports to colleges to help them place students in entry-level courses as accurately as possible. In providing these research services, ACT has an extensive database consisting of course grade and test score data from a large number of first-year students and across a wide range of postsecondary institutions. These data provide an overall measure of what it takes to be successful in selected first-year college courses. Data from 214 institutions and over 230,000 students were used to establish the Benchmarks. The numbers and types of colleges varied by course. Because the sample of colleges in this study is a "convenience" sample (that is, based on data from colleges that chose to participate in ACT's research services), there is no guarantee that it is representative of all colleges in the United States. Therefore, ACT weighted the sample so that it would be representative of all ACT-tested college students in terms of college type (2-year and 4-year) and selectivity.

Procedures Used to Establish the Benchmarks for ACT Explore and ACT Plan

The College Readiness Benchmarks for ACT Explore and ACT Plan were developed using records of students who had taken ACT Explore or ACT Plan, followed by the ACT in Grades 11 or 12. Separate Benchmarks were developed for ACT Explore for Grade 8 and Grade 9, and ACT Plan for Grade 10. The sample sizes used to develop the ACT Explore and ACT Plan Benchmarks ranged from 210,000 for the ACT Explore Grade 9 Benchmarks to approximately 1.5 million for the ACT Plan Grade 10 Benchmarks. To establish the Benchmarks, the probability of meeting the appropriate ACT Benchmark was estimated at each ACT Explore and ACT Plan test score point. Next, the ACT Explore and ACT Plan test scores were identified in English, Reading, Mathematics, and Science that corresponded most closely to a 50% probability of success at meeting each of the four Benchmarks established for the ACT.

Table 3.5

ACT College Readiness Benchmarks

College course or course area	ACT subject-area test	ACT Explore Benchmark grade 8	ACT Explore Benchmark grade 9	ACT Plan Benchmark	The ACT Test Benchmark
English Composition I	English	13	14	15	18
Social Sciences	Reading	16	17	18	22
College Algebra	Mathematics	17	18	19	22
Biology	Science	18	19	20	23

Intended Uses of the Benchmarks for Students, Schools, Districts, and States

The ACT, ACT Plan, and ACT Explore results give students an indication of how likely they are to be ready for college-level work. The results let students know if they have developed or are developing the foundation for the skills they will need by the time they finish high school. ACT Plan and ACT Explore results provide an early indication of college readiness. Students who score at or above the College Readiness Benchmarks in English, mathematics, and science are likely to be on track to do well in entry-level college courses in these subjects. Students scoring at or above the reading Benchmark are likely to be developing the level of reading skills they will need in all of their college courses. For students taking ACT Explore and ACT Plan, this assumes that these students will continue to work hard and take challenging courses throughout high school.

Researchers and policymakers can use the Benchmarks to monitor the educational progress of schools, districts, and states. Middle and high school personnel can use the Benchmarks for ACT Explore and ACT Plan as a means of evaluating students' early progress toward college readiness so that timely interventions can be made when necessary, or as an educational counseling or career planning tool.

Interpreting ACT Explore, ACT Plan, and the ACT Test Scores With Respect to Both ACT's College and Career Readiness Standards and ACT's College Readiness Benchmarks

The performance levels on ACT Explore, ACT Plan and the ACT tests necessary for students to be ready to succeed in college-level work are defined by ACT's College Readiness Benchmarks. Meanwhile, the skills and knowledge a student currently has (and areas for improvement) can be identified by examining the student's ACT Explore, ACT Plan and the ACT test scores with respect to ACT's College and Career Readiness Standards. These two empirically derived tools are designed to help a student translate test scores into a clear indicator of the student's current level of college readiness and to help the student identify key knowledge and skill areas needed to improve the likelihood of achieving college success.

ACT College and Career Readiness Standards—English

	Production of Writing		Knowledge of Language
	Topic Development in Terms of Purpose and Focus	**Organization, Unity, and Cohesion**	**Knowledge of Language**
13–15	Delete material because it is obviously irrelevant in terms of the topic of the essay	Determine the need for transition words or phrases to establish time relationships in simple narrative essays (e.g., *then*, *this time*)	Revise vague, clumsy, and confusing writing that creates obvious logic problems
16–19	Delete material because it is obviously irrelevant in terms of the focus of the essay Identify the purpose of a word or phrase when the purpose is simple (e.g., identifying a person, defining a basic term, using common descriptive adjectives) Determine whether a simple essay has met a straightforward goal	Determine the most logical place for a sentence in a paragraph Provide a simple conclusion to a paragraph or essay (e.g., expressing one of the essay's main ideas)	Delete obviously redundant and wordy material Revise expressions that deviate markedly from the style and tone of the essay
20–23	Determine relevance of material in terms of the focus of the essay Identify the purpose of a word or phrase when the purpose is straightforward (e.g., describing a person, giving examples) Use a word, phrase, or sentence to accomplish a straightforward purpose (e.g., conveying a feeling or attitude)	Determine the need for transition words or phrases to establish straightforward logical relationships (e.g., *first*, *afterward*, *in response*) Determine the most logical place for a sentence in a straightforward essay Provide an introduction to a straightforward paragraph Provide a straightforward conclusion to a paragraph or essay (e.g., summarizing an essay's main idea or ideas) Rearrange the sentences in a straightforward paragraph for the sake of logic	Delete redundant and wordy material when the problem is contained within a single phrase (e.g., "alarmingly startled," "started by reaching the point of beginning") Revise expressions that deviate from the style and tone of the essay Determine the need for conjunctions to create straightforward logical links between clauses Use the word or phrase most appropriate in terms of the content of the sentence when the vocabulary is relatively common
24–27	Determine relevance of material in terms of the focus of the paragraph Identify the purpose of a word, phrase, or sentence when the purpose is fairly straightforward (e.g., identifying traits, giving reasons, explaining motivations) Determine whether an essay has met a specified goal Use a word, phrase, or sentence to accomplish a fairly straightforward purpose (e.g., sharpening an essay's focus, illustrating a given statement)	Determine the need for transition words or phrases to establish subtle logical relationships within and between sentences (e.g., *therefore*, *however*, *in addition*) Provide a fairly straightforward introduction or conclusion to or transition within a paragraph or essay (e.g., supporting or emphasizing an essay's main idea) Rearrange the sentences in a fairly straightforward paragraph for the sake of logic Determine the best place to divide a paragraph to meet a particular rhetorical goal Rearrange the paragraphs in an essay for the sake of logic	Revise vague, clumsy, and confusing writing Delete redundant and wordy material when the meaning of the entire sentence must be considered Revise expressions that deviate in subtle ways from the style and tone of the essay Determine the need for conjunctions to create logical links between clauses Use the word or phrase most appropriate in terms of the content of the sentence when the vocabulary is uncommon
28–32	Determine relevance when considering material that is plausible but potentially irrelevant at a given point in the essay Identify the purpose of a word, phrase, or sentence when the purpose is subtle (e.g., supporting a later point, establishing tone) or when the best decision is to delete the text in question Use a word, phrase, or sentence to accomplish a subtle purpose (e.g., adding emphasis or supporting detail, expressing meaning through connotation)	Determine the need for transition words or phrases to establish subtle logical relationships within and between paragraphs Determine the most logical place for a sentence in a fairly complex essay Provide a subtle introduction or conclusion to or transition within a paragraph or essay (e.g., echoing an essay's theme or restating the main argument) Rearrange the sentences in a fairly complex paragraph for the sake of logic and coherence	Revise vague, clumsy, and confusing writing involving sophisticated language Delete redundant and wordy material that involves fairly sophisticated language (e.g., "the outlook of an aesthetic viewpoint") or that sounds acceptable as conversational English Determine the need for conjunctions to create subtle logical links between clauses Use the word or phrase most appropriate in terms of the content of the sentence when the vocabulary is fairly sophisticated
33–36	Identify the purpose of a word, phrase, or sentence when the purpose is complex (e.g., anticipating a reader's need for background information) or requires a thorough understanding of the paragraph and essay Determine whether a complex essay has met a specified goal Use a word, phrase, or sentence to accomplish a complex purpose, often in terms of the focus of the essay	Determine the need for transition words or phrases, basing decisions on a thorough understanding of the paragraph and essay Provide a sophisticated introduction or conclusion to or transition within a paragraph or essay, basing decisions on a thorough understanding of the paragraph and essay (e.g., linking the conclusion to one of the essay's main images)	Delete redundant and wordy material that involves sophisticated language or complex concepts or where the material is redundant in terms of the paragraph or essay as a whole Use the word or phrase most appropriate in terms of the content of the sentence when the vocabulary is sophisticated

ACT College and Career Readiness Standards—English (continued)

	Conventions of Standard English Grammar, Usage, and Punctuation		
	Sentence Structure and Formation	**Usage Conventions**	**Punctuation Conventions**
13–15	Determine the need for punctuation or conjunctions to join simple clauses Recognize and correct inappropriate shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences	Form the past tense and past participle of irregular but commonly used verbs Form comparative and superlative adjectives	Delete commas that create basic sense problems (e.g., between verb and direct object)
16–19	Determine the need for punctuation or conjunctions to correct awkward-sounding fragments and fused sentences as well as obviously faulty subordination and coordination of clauses Recognize and correct inappropriate shifts in verb tense and voice when the meaning of the entire sentence must be considered	Determine whether an adjective form or an adverb form is called for in a given situation Ensure straightforward subject-verb agreement Ensure straightforward pronoun-antecedent agreement Use idiomatically appropriate prepositions in simple contexts Use the appropriate word in frequently confused pairs (e.g., *there* and *their*, *past* and *passed*, *led* and *lead*)	Delete commas that markedly disturb sentence flow (e.g., between modifier and modified element) Use appropriate punctuation in straightforward situations (e.g., simple items in a series)
20–23	Recognize and correct marked disturbances in sentence structure (e.g., faulty placement of adjectives, participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers, lack of parallelism within a simple series of verbs)	Use the correct comparative or superlative adjective or adverb form depending on context (e.g., "He is the oldest of my three brothers") Ensure subject-verb agreement when there is some text between the subject and verb Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*) Recognize and correct expressions that deviate from idiomatic English	Delete commas when an incorrect understanding of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause) Delete apostrophes used incorrectly to form plural nouns Use commas to avoid obvious ambiguity (e.g., to set off a long introductory element from the rest of the sentence when a misreading is possible) Use commas to set off simple parenthetical elements
24–27	Recognize and correct disturbances in sentence structure (e.g., faulty placement of phrases, faulty coordination and subordination of clauses, lack of parallelism within a simple series of phrases) Maintain consistent and logical verb tense and pronoun person on the basis of the preceding clause or sentence	Form simple and compound verb tenses, both regular and irregular, including forming verbs by using *have* rather than *of* (e.g., *would have gone*, not *would of gone*) Ensure pronoun-antecedent agreement when the pronoun and antecedent occur in separate clauses or sentences Recognize and correct vague and ambiguous pronouns	Delete commas in long or involved sentences when an incorrect understanding of the sentence suggests a pause that should be punctuated (e.g., between the elements of a compound subject or compound verb joined by *and*) Recognize and correct inappropriate uses of colons and semicolons Use punctuation to set off complex parenthetical elements Use apostrophes to form simple possessive nouns
28–32	Recognize and correct subtle disturbances in sentence structure (e.g., danglers where the intended meaning is clear but the sentence is ungrammatical, faulty subordination and coordination of clauses in long or involved sentences) Maintain consistent and logical verb tense and voice and pronoun person on the basis of the paragraph or essay as a whole	Ensure subject-verb agreement in some challenging situations (e.g., when the subject-verb order is inverted or when the subject is an indefinite pronoun) Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom* Use the appropriate word in less-common confused pairs (e.g., *allude* and *elude*)	Use commas to avoid ambiguity when the syntax or language is sophisticated (e.g., to set off a complex series of items) Use punctuation to set off a nonessential/ nonrestrictive appositive or clause Use apostrophes to form possessives, including irregular plural nouns Use a semicolon to link closely related independent clauses
33–36	Recognize and correct very subtle disturbances in sentence structure (e.g., weak conjunctions between independent clauses, run-ons that would be acceptable in conversational English, lack of parallelism within a complex series of phrases or clauses)	Ensure subject-verb agreement when a phrase or clause between the subject and verb suggests a different number for the verb Use idiomatically and contextually appropriate prepositions in combination with verbs in situations involving sophisticated language or complex concepts	Delete punctuation around essential/restrictive appositives or clauses Use a colon to introduce an example or an elaboration

<table>
<tr><th colspan="4">ACT College and Career Readiness Standards—Mathematics</th></tr>
<tr><th></th><th>Topics in the flow to
Number and Quantity</th><th>Topics in the flow to
Algebra</th><th>Topics in the flow to
Functions</th></tr>
<tr><td rowspan="2">13–15</td><td rowspan="2">Perform one-operation computation with whole numbers and decimals
Recognize equivalent fractions and fractions in lowest terms
Locate positive rational numbers (expressed as whole numbers, fractions, decimals, and mixed numbers) on the number line</td><td colspan="2">Solve problems in one or two steps using whole numbers and using decimals in the context of money</td></tr>
<tr><td>Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$)
Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals</td><td>Extend a given pattern by a few terms for patterns that have a constant increase or decrease between terms</td></tr>
<tr><td rowspan="2">16–19</td><td rowspan="2">Recognize one-digit factors of a number
Identify a digit’s place value
Locate rational numbers on the number line

Note: A matrix as a representation of data is treated here as a basic table.</td><td colspan="2">Solve routine one-step arithmetic problems using positive rational numbers, such as single-step percent
Solve some routine two-step arithmetic problems
Relate a graph to a situation described qualitatively in terms of familiar properties such as before and after, increasing and decreasing, higher and lower
Apply a definition of an operation for whole numbers (e.g., a ◘ $b = 3a - b$)</td></tr>
<tr><td>Substitute whole numbers for unknown quantities to evaluate expressions
Solve one-step equations to get integer or decimal answers
Combine like terms (e.g., $2x + 5x$)</td><td>Extend a given pattern by a few terms for patterns that have a constant factor between terms</td></tr>
<tr><td rowspan="2">20–23</td><td rowspan="2">Exhibit knowledge of elementary number concepts such as rounding, the ordering of decimals, pattern identification, primes, and greatest common factor
Write positive powers of 10 by using exponents
Comprehend the concept of length on the number line, and find the distance between two points
Understand absolute value in terms of distance
Find the distance in the coordinate plane between two points with the same x-coordinate or y-coordinate
Add two matrices that have whole number entries</td><td colspan="2">Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and estimating by using a given average value in place of actual values
Perform straightforward word-to-symbol translations
Relate a graph to a situation described in terms of a starting value and an additional amount per unit (e.g., unit cost, weekly growth)</td></tr>
<tr><td>Evaluate algebraic expressions by substituting integers for unknown quantities
Add and subtract simple algebraic expressions
Solve routine first-degree equations
Multiply two binomials
Match simple inequalities with their graphs on the number line (e.g., $x \ge -\frac{3}{5}$)
Exhibit knowledge of slope</td><td>Evaluate linear and quadratic functions, expressed in function notation, at integer values</td></tr>
<tr><td rowspan="2">24–27</td><td rowspan="2">Order fractions
Find and use the least common multiple
Work with numerical factors
Exhibit some knowledge of the complex numbers
Add and subtract matrices that have integer entries</td><td colspan="2">Solve multistep arithmetic problems that involve planning or converting common derived units of measure (e.g., feet per second to miles per hour)
Build functions and write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions)
Match linear equations with their graphs in the coordinate plane</td></tr>
<tr><td>Recognize that when numerical quantities are reported in real-world contexts, the numbers are often rounded
Solve real-world problems by using first-degree equations
Solve first-degree inequalities when the method does not involve reversing the inequality sign
Match compound inequalities with their graphs on the number line (e.g., $-10.5 < x \le 20.3$)
Add, subtract, and multiply polynomials
Identify solutions to simple quadratic equations
Solve quadratic equations in the form $(x + a)(x + b) = 0$, where a and b are numbers or variables
Factor simple quadratics (e.g., the difference of squares and perfect square trinomials)
Work with squares and square roots of numbers
Work with cubes and cube roots of numbers
Work with scientific notation
Work problems involving positive integer exponents
Determine when an expression is undefined
Determine the slope of a line from an equation</td><td>Evaluate polynomial functions, expressed in function notation, at integer values
Find the next term in a sequence described recursively
Build functions and use quantitative information to identify graphs for relations that are proportional or linear
Attend to the difference between a function modeling a situation and the reality of the situation
Understand the concept of a function as having a well-defined output value at each valid input value
Understand the concept of domain and range in terms of valid input and output, and in terms of function graphs
Interpret statements that use function notation in terms of their context
Find the domain of polynomial functions and rational functions
Find the range of polynomial functions
Find where a rational function’s graph has a vertical asymptote
Use function notation for simple functions of two variables</td></tr>
</table>

ACT College and Career Readiness Standards—Mathematics (continued)

	Topics in the flow to **Geometry**	Topics in the flow to **Statistics and Probability**
13–15	Estimate the length of a line segment based on other lengths in a geometric figure Calculate the length of a line segment based on the lengths of other line segments that go in the same direction (e.g., overlapping line segments and parallel sides of polygons with only right angles) Perform common conversions of money and of length, weight, mass, and time within a measurement system (e.g., dollars to dimes, inches to feet, and hours to minutes)	Calculate the average of a list of positive whole numbers Extract one relevant number from a basic table or chart, and use it in a single computation
16–19	Exhibit some knowledge of the angles associated with parallel lines Compute the perimeter of polygons when all side lengths are given Compute the area of rectangles when whole number dimensions are given Locate points in the first quadrant	Calculate the average of a list of numbers Calculate the average given the number of data values and the sum of the data values Read basic tables and charts Extract relevant data from a basic table or chart and use the data in a computation Use the relationship between the probability of an event and the probability of its complement
20–23	Use properties of parallel lines to find the measure of an angle Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°) Compute the area and perimeter of triangles and rectangles in simple problems Find the length of the hypotenuse of a right triangle when only very simple computation is involved (e.g., 3-4-5 and 6-8-10 triangles) Use geometric formulas when all necessary information is given Locate points in the coordinate plane Translate points up, down, left, and right in the coordinate plane	Calculate the missing data value given the average and all data values but one Translate from one representation of data to another (e.g., a bar graph to a circle graph) Determine the probability of a simple event Describe events as combinations of other events (e.g., using *and*, *or*, and *not*) Exhibit knowledge of simple counting techniques
24–27	Use several angle properties to find an unknown angle measure Count the number of lines of symmetry of a geometric figure Use symmetry of isosceles triangles to find unknown side lengths or angle measures Recognize that real-world measurements are typically imprecise and that an appropriate level of precision is related to the measuring device and procedure Compute the perimeter of simple composite geometric figures with unknown side lengths Compute the area of triangles and rectangles when one or more additional simple steps are required Compute the area and circumference of circles after identifying necessary information Given the length of two sides of a right triangle, find the third when the lengths are Pythagorean triples Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths Determine the slope of a line from points or a graph Find the midpoint of a line segment Find the coordinates of a point rotated 180° around a given center point	Calculate the average given the frequency counts of all the data values Manipulate data from tables and charts Compute straightforward probabilities for common situations Use Venn diagrams in counting Recognize that when data summaries are reported in the real world, results are often rounded and must be interpreted as having appropriate precision Recognize that when a statistical model is used, model values typically differ from actual values

<table>
<tr><th colspan="4">ACT College and Career Readiness Standards—Mathematics (continued)</th></tr>
<tr><th></th><th>Topics in the flow to
Number and Quantity</th><th>Topics in the flow to
Algebra</th><th>Topics in the flow to
Functions</th></tr>
<tr><td rowspan="2">28–32</td><td rowspan="2">Apply number properties involving prime factorization
Apply number properties involving even/odd numbers and factors/multiples
Apply number properties involving positive/negative numbers
Apply the facts that π is irrational and that the square root of an integer is rational only if that integer is a perfect square
Apply properties of rational exponents
Multiply two complex numbers
Use relations involving addition, subtraction, and scalar multiplication of vectors and of matrices</td><td colspan="2">Solve word problems containing several rates, proportions, or percentages
Build functions and write expressions, equations, and inequalities for common algebra settings (e.g., distance to a point on a curve and profit for variable cost and demand)
Interpret and use information from graphs in the coordinate plane
Given an equation or function, find an equation or function whose graph is a translation by a specified amount up or down</td></tr>
<tr><td>Manipulate expressions and equations
Solve linear inequalities when the method involves reversing the inequality sign
Match linear inequalities with their graphs on the number line
Solve systems of two linear equations
Solve quadratic equations
Solve absolute value equations</td><td>Relate a graph to a situation described qualitatively in terms of faster change or slower change
Build functions for relations that are inversely proportional
Find a recursive expression for the general term in a sequence described recursively
Evaluate composite functions at integer values</td></tr>
<tr><td rowspan="2">33–36</td><td rowspan="2">Analyze and draw conclusions based on number concepts
Apply properties of rational numbers and the rational number system
Apply properties of real numbers and the real number system, including properties of irrational numbers
Apply properties of complex numbers and the complex number system
Multiply matrices
Apply properties of matrices and properties of matrices as a number system</td><td colspan="2">Solve complex arithmetic problems involving percent of increase or decrease or requiring integration of several concepts (e.g., using several ratios, comparing percentages, or comparing averages)
Build functions and write expressions, equations, and inequalities when the process requires planning and/or strategic manipulation
Analyze and draw conclusions based on properties of algebra and/or functions
Analyze and draw conclusions based on information from graphs in the coordinate plane
Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$
Given an equation or function, find an equation or function whose graph is a translation by specified amounts in the horizontal and vertical directions</td></tr>
<tr><td>Solve simple absolute value inequalities
Match simple quadratic inequalities with their graphs on the number line
Apply the remainder theorem for polynomials, that $P(a)$ is the remainder when $P(x)$ is divided by $(x - a)$</td><td>Compare actual values and the values of a modeling function to judge model fit and compare models
Build functions for relations that are exponential
Exhibit knowledge of geometric sequences
Exhibit knowledge of unit circle trigonometry
Match graphs of basic trigonometric functions with their equations
Use trigonometric concepts and basic identities to solve problems
Exhibit knowledge of logarithms
Write an expression for the composite of two simple functions</td></tr>
</table>

ACT College and Career Readiness Standards—Mathematics (continued)

	Topics in the flow to **Geometry**	Topics in the flow to **Statistics and Probability**
28–32	Use relationships involving area, perimeter, and volume of geometric figures to compute another measure (e.g., surface area for a cube of a given volume and simple geometric probability) Use the Pythagorean theorem Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles Apply basic trigonometric ratios to solve right-triangle problems Use the distance formula Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point Find the coordinates of a point reflected across a vertical or horizontal line or across $y = x$ Find the coordinates of a point rotated 90° about the origin Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle)	Calculate or use a weighted average Interpret and use information from tables and charts, including two-way frequency tables Apply counting techniques Compute a probability when the event and/or sample space are not given or obvious Recognize the concepts of conditional and joint probability expressed in real-world contexts Recognize the concept of independence expressed in real-world contexts
33–36	Use relationships among angles, arcs, and distances in a circle Compute the area of composite geometric figures when planning and/or visualization is required Use scale factors to determine the magnitude of a size change Analyze and draw conclusions based on a set of conditions Solve multistep geometry problems that involve integrating concepts, planning, and/or visualization	Distinguish between mean, median, and mode for a list of numbers Analyze and draw conclusions based on information from tables and charts, including two-way frequency tables Understand the role of randomization in surveys, experiments, and observational studies Exhibit knowledge of conditional and joint probability Recognize that part of the power of statistical modeling comes from looking at regularity in the differences between actual values and model values

	ACT College and Career Readiness Standards—Reading			
	Key Ideas and Details			
	Close Reading	**Central Ideas, Themes, and Summaries**	**Relationships**	**Word Meanings and Word Choice**
13–15	Locate basic facts (e.g., names, dates, events) clearly stated in a passage Draw simple logical conclusions about the main characters in somewhat challenging literary narratives	Identify the topic of passages and distinguish the topic from the central idea or theme	Determine when (e.g., first, last, before, after) an event occurs in somewhat challenging passages Identify simple cause-effect relationships within a single sentence in a passage	Understand the implication of a familiar word or phrase and of simple descriptive language
16–19	Locate simple details at the sentence and paragraph level in somewhat challenging passages Draw simple logical conclusions in somewhat challenging passages	Identify a clear central idea in straightforward paragraphs in somewhat challenging literary narratives	Identify clear comparative relationships between main characters in somewhat challenging literary narratives Identify simple cause-effect relationships within a single paragraph in somewhat challenging literary narratives	Analyze how the choice of a specific word or phrase shapes meaning or tone in somewhat challenging passages when the effect is simple Interpret basic figurative language as it is used in a passage
20–23	Locate important details in somewhat challenging passages Draw logical conclusions in somewhat challenging passages Draw simple logical conclusions in more challenging passages Paraphrase some statements as they are used in somewhat challenging passages	Infer a central idea in straightforward paragraphs in somewhat challenging literary narratives Identify a clear central idea or theme in somewhat challenging passages or their paragraphs Summarize key supporting ideas and details in somewhat challenging passages	Order simple sequences of events in somewhat challenging literary narratives Identify clear comparative relationships in somewhat challenging passages Identify clear cause-effect relationships in somewhat challenging passages	Analyze how the choice of a specific word or phrase shapes meaning or tone in somewhat challenging passages Interpret most words and phrases as they are used in somewhat challenging passages, including determining technical, connotative, and figurative meanings
24–27	Locate and interpret minor or subtly stated details in somewhat challenging passages Locate important details in more challenging passages Draw subtle logical conclusions in somewhat challenging passages Draw logical conclusions in more challenging passages Paraphrase virtually any statement as it is used in somewhat challenging passages Paraphrase some statements as they are used in more challenging passages	Infer a central idea or theme in somewhat challenging passages or their paragraphs Identify a clear central idea or theme in more challenging passages or their paragraphs Summarize key supporting ideas and details in more challenging passages	Order sequences of events in somewhat challenging passages Understand implied or subtly stated comparative relationships in somewhat challenging passages Identify clear comparative relationships in more challenging passages Understand implied or subtly stated cause-effect relationships in somewhat challenging passages Identify clear cause-effect relationships in more challenging passages	Analyze how the choice of a specific word or phrase shapes meaning or tone in somewhat challenging passages when the effect is subtle Analyze how the choice of a specific word or phrase shapes meaning or tone in more challenging passages Interpret virtually any word or phrase as it is used in somewhat challenging passages, including determining technical, connotative, and figurative meanings Interpret most words and phrases as they are used in more challenging passages, including determining technical, connotative, and figurative meanings
28–32	Locate and interpret minor or subtly stated details in more challenging passages Locate important details in complex passages Draw subtle logical conclusions in more challenging passages Draw simple logical conclusions in complex passages Paraphrase virtually any statement as it is used in more challenging passages	Infer a central idea or theme in more challenging passages or their paragraphs Summarize key supporting ideas and details in complex passages	Order sequences of events in more challenging passages Understand implied or subtly stated comparative relationships in more challenging passages Identify clear comparative relationships in complex passages Understand implied or subtly stated cause-effect relationships in more challenging passages Identify clear cause-effect relationships in complex passages	Analyze how the choice of a specific word or phrase shapes meaning or tone in complex passages Interpret virtually any word or phrase as it is used in more challenging passages, including determining technical, connotative, and figurative meanings Interpret words and phrases in a passage that makes consistent use of figurative, general academic, domain-specific, or otherwise difficult language
33–36	Locate and interpret minor or subtly stated details in complex passages Locate important details in highly complex passages Draw logical conclusions in complex passages Draw simple logical conclusions in highly complex passages Draw complex or subtle logical conclusions, often by synthesizing information from different portions of the passage Paraphrase statements as they are used in complex passages	Identify or infer a central idea or theme in complex passages or their paragraphs Summarize key supporting ideas and details in highly complex passages	Order sequences of events in complex passages Understand implied or subtly stated comparative relationships in complex passages Identify clear comparative relationships in highly complex passages Understand implied or subtly stated cause-effect relationships in complex passages Identify clear cause-effect relationships in highly complex passages	Analyze how the choice of a specific word or phrase shapes meaning or tone in passages when the effect is subtle or complex Interpret words and phrases as they are used in complex passages, including determining technical, connotative, and figurative meanings Interpret words and phrases in a passage that makes extensive use of figurative, general academic, domain-specific, or otherwise difficult language

	ACT College and Career Readiness Standards—Reading (continued)			
	Craft and Structure		Integration of Knowledge and Ideas	
	Text Structure	**Purpose and Point of View**	**Arguments**	**Multiple Texts**
13–15	Analyze how one or more sentences in passages relate to the whole passage when the function is stated or clearly indicated	Recognize a clear intent of an author or narrator in somewhat challenging literary narratives	Analyze how one or more sentences in passages offer reasons for or support a claim when the relationship is clearly indicated	Make simple comparisons between two passages
16–19	Analyze how one or more sentences in somewhat challenging passages relate to the whole passage when the function is simple Identify a clear function of straightforward paragraphs in somewhat challenging literary narratives	Recognize a clear intent of an author or narrator in somewhat challenging passages	Analyze how one or more sentences in somewhat challenging passages offer reasons for or support a claim when the relationship is simple	Make straightforward comparisons between two passages
20–23	Analyze how one or more sentences in somewhat challenging passages relate to the whole passage Infer the function of straightforward paragraphs in somewhat challenging literary narratives Identify a clear function of paragraphs in somewhat challenging passages Analyze the overall structure of somewhat challenging passages	Identify a clear purpose of somewhat challenging passages and how that purpose shapes content and style Understand point of view in somewhat challenging passages	Analyze how one or more sentences in somewhat challenging passages offer reasons for or support a claim Identify a clear central claim in somewhat challenging passages	Draw logical conclusions using information from two literary narratives
24–27	Analyze how one or more sentences in somewhat challenging passages relate to the whole passage when the function is subtle Analyze how one or more sentences in more challenging passages relate to the whole passage Infer the function of paragraphs in somewhat challenging passages Identify a clear function of paragraphs in more challenging passages Analyze the overall structure of more challenging passages	Infer a purpose in somewhat challenging passages and how that purpose shapes content and style Identify a clear purpose of more challenging passages and how that purpose shapes content and style Understand point of view in more challenging passages	Analyze how one or more sentences in more challenging passages offer reasons for or support a claim Infer a central claim in somewhat challenging passages Identify a clear central claim in more challenging passages	Draw logical conclusions using information from two informational texts
28–32	Analyze how one or more sentences in complex passages relate to the whole passage Infer the function of paragraphs in more challenging passages Analyze the overall structure of complex passages	Infer a purpose in more challenging passages and how that purpose shapes content and style Understand point of view in complex passages	Analyze how one or more sentences in complex passages offer reasons for or support a claim Infer a central claim in more challenging passages	Draw logical conclusions using information from multiple portions of two literary narratives
33–36	Analyze how one or more sentences in passages relate to the whole passage when the function is subtle or complex Identify or infer the function of paragraphs in complex passages Analyze the overall structure of highly complex passages	Identify or infer a purpose in complex passages and how that purpose shapes content and style Understand point of view in highly complex passages	Analyze how one or more sentences in passages offer reasons for or support a claim when the relationship is subtle or complex Identify or infer a central claim in complex passages Identify a clear central claim in highly complex passages	Draw logical conclusions using information from multiple portions of two informational texts

ACT College and Career Readiness Standards—Science

	Interpretation of Data	Scientific Investigation	Evaluation of Models, Inferences, and Experimental Results
13–15	Select one piece of data from a simple data presentation (e.g., a simple food web diagram) Identify basic features of a table, graph, or diagram (e.g., units of measurement) Find basic information in text that describes a simple data presentation	Find basic information in text that describes a simple experiment Understand the tools and functions of tools used in a simple experiment	Find basic information in a model (conceptual)
16–19	Select two or more pieces of data from a simple data presentation Understand basic scientific terminology Find basic information in text that describes a complex data presentation Determine how the values of variables change as the value of another variable changes in a simple data presentation	Understand the methods used in a simple experiment Understand the tools and functions of tools used in a complex experiment Find basic information in text that describes a complex experiment	Identify implications in a model Determine which models present certain basic information
20–23	Select data from a complex data presentation (e.g., a phase diagram) Compare or combine data from a simple data presentation (e.g., order or sum data from a table) Translate information into a table, graph, or diagram Perform a simple interpolation or simple extrapolation using data in a table or graph	Understand a simple experimental design Understand the methods used in a complex experiment Identify a control in an experiment Identify similarities and differences between experiments Determine which experiments utilized a given tool, method, or aspect of design	Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text Identify key assumptions in a model Determine which models imply certain information Identify similarities and differences between models
24–27	Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table) Compare or combine data from a complex data presentation Determine how the values of variables change as the value of another variable changes in a complex data presentation Determine and/or use a simple (e.g., linear) mathematical relationship that exists between data Analyze presented information when given new, simple information	Understand a complex experimental design Predict the results of an additional trial or measurement in an experiment Determine the experimental conditions that would produce specified results	Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with two or more data presentations, models, and/or pieces of information in text Determine whether presented information, or new information, supports or contradicts a simple hypothesis or conclusion, and why Identify the strengths and weaknesses of models Determine which models are supported or weakened by new information Determine which experimental results or models support or contradict a hypothesis, prediction, or conclusion
28–32	Compare or combine data from a simple data presentation with data from a complex data presentation Determine and/or use a complex (e.g., nonlinear) mathematical relationship that exists between data Perform a complex interpolation or complex extrapolation using data in a table or graph	Determine the hypothesis for an experiment Determine an alternate method for testing a hypothesis	Determine which complex hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text Determine whether presented information, or new information, supports or weakens a model, and why Use new information to make a prediction based on a model
33–36	Compare or combine data from two or more complex data presentations Analyze presented information when given new, complex information	Understand precision and accuracy issues Predict the effects of modifying the design or methods of an experiment Determine which additional trial or experiment could be performed to enhance or evaluate experimental results	Determine which complex hypothesis, prediction, or conclusion is, or is not, consistent with two or more data presentations, models, and/or pieces of information in text Determine whether presented information, or new information, supports or contradicts a complex hypothesis or conclusion, and why

ACT College and Career Readiness Standards for Science are measured in rich and authentic contexts based on science content that students encounter in science courses. This content includes:

Life Science/Biology	Physical Science/Chemistry, Physics	Earth and Space Science
• Animal behavior • Animal development and growth • Body systems • Cell structure and processes • Ecology • Evolution • Genetics • Homeostasis • Life cycles • Molecular basis of heredity • Origin of life • Photosynthesis • Plant development, growth, structure • Populations • Taxonomy	• Atomic structure • Chemical bonding, equations, nomenclature, reactions • Electrical circuits • Elements, compounds, mixtures • Force and motions • Gravitation • Heat and work • Kinetic and potential energy • Magnetism • Momentum • The periodic table • Properties of solutions • Sound and light • States, classes, and properties of matter • Waves	• Earthquakes and volcanoes • Earth's atmosphere • Earth's resources • Fossils and geological time • Geochemical cycles • Groundwater • Lakes, rivers, oceans • Mass movements • Plate tectonics • Rocks, minerals • Solar system • Stars, galaxies, and the universe • Water cycle • Weather and climate • Weathering and erosion

	ACT College and Career Readiness Standards—Writing		
	Expressing Judgments	**Focusing on the Topic**	**Developing Ideas**
3–4	Show a little understanding of the persuasive purpose of the task but neglect to take or to maintain a position on the issue in the prompt Generate reasons for a position that are irrelevant or unclear	Maintain a focus on the general topic in the prompt throughout most of the essay	Offer little development in support of ideas; attempt to clarify ideas by merely restating them or by using general examples that may not be clearly relevant Show little or no movement between general and specific ideas and examples
5–6	Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt Generate reasons for a position that are vague or simplistic; show a little recognition of the complexity of the issue in the prompt by • briefly noting implications and/or complications of the issue, and/or • briefly or unclearly responding to counterarguments to the writer’s position	Maintain a focus on the general topic in the prompt throughout the essay	Offer limited development in support of ideas; clarify ideas somewhat with vague explanation and the use of general examples Show little movement between general and specific ideas and examples
7–8	Show clear understanding of the persuasive purpose of the task by taking a position on the issue in the prompt and offering some context for discussion Generate reasons for a position that are relevant and clear; show some recognition of the complexity of the issue in the prompt by • acknowledging implications and/or complications of the issue, and/or • providing some response to counterarguments to the writer’s position	Maintain a focus on the specific issue in the prompt throughout most of the essay Present a thesis that establishes focus on the topic	Provide adequate development in support of ideas; clarify ideas by using some specific reasons, details, and examples Show some movement between general and specific ideas and examples
9–10	Show strong understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion Generate thoughtful reasons for a position; show recognition of the complexity of the issue in the prompt by • partially evaluating implications and/or complications of the issue, and/or • anticipating and responding to counterarguments to the writer’s position	Maintain a focus on discussing the specific issue in the prompt throughout the essay Present a thesis that establishes a focus on the writer’s position on the issue	Provide thorough development in support of ideas; extend ideas by using specific, logical reasons and illustrative examples Show clear movement between general and specific ideas and examples
11–12	Show advanced understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion Generate insightful reasons for a position; show understanding of the complexity of the issue in the prompt by • examining different perspectives, and/or • evaluating implications and/or complications of the issue, and/or • anticipating and fully responding to counterarguments to the writer’s position	Maintain a precise focus on discussing the specific issue in the prompt throughout the essay Present a critical thesis that clearly establishes the focus on the writer’s position on the issue	Provide ample development in support of ideas; substantiate ideas with precise use of specific, logical reasons and illustrative examples Show effective movement between general and specific ideas and examples

ACT College and Career Readiness Standards—Writing (continued)

	Organizing Ideas	Using Language
3–4	Provide a discernible organizational structure by grouping together a few ideas Use transitional words and phrases that are simple and obvious, or occasionally misleading Present a minimal introduction and conclusion	Show limited control of language by • correctly employing some of the conventions of standard English grammar, usage, and mechanics, but with distracting errors that sometimes significantly impede understanding • choosing words that are simplistic or vague • using only simple sentence structure
5–6	Provide a simple organizational structure by logically grouping some ideas Use simple and obvious transitional words and phrases Present an underdeveloped introduction and conclusion	Show a basic control of language by • correctly employing some of the conventions of standard English grammar, usage, and mechanics, but with distracting errors that sometimes impede understanding • choosing words that are simple but generally appropriate • using a little sentence variety
7–8	Provide an adequate but simple organizational structure by logically grouping most ideas Use some appropriate transitional words and phrases Present a somewhat developed introduction and conclusion	Show adequate use of language to communicate by • correctly employing many of the conventions of standard English grammar, usage, and mechanics, but with some distracting errors that may occasionally impede understanding • choosing words that are appropriate • using some varied kinds of sentence structures to vary pace
9–10	Provide a coherent organizational structure with some logical sequencing of ideas Use accurate and clear transitional words and phrases to convey logical relationships between ideas Present a generally well-developed introduction and conclusion	Show competent use of language to communicate ideas by • correctly employing most conventions of standard English grammar, usage, and mechanics, with a few distracting errors but none that impede understanding • generally choosing words that are precise and varied • using several kinds of sentence structures to vary pace and to support meaning
11–12	Provide a unified, coherent organizational structure that presents a logical progression of ideas Use precise transitional words, phrases, and sentences to convey logical relationships between ideas Present a well-developed introduction that effectively frames the prompt's issue and writer's argument; present a well-developed conclusion that extends the essay's ideas	Show effective use of language to communicate ideas clearly by • correctly employing most conventions of standard English grammar, usage, and mechanics, with just a few, if any, errors • consistently choosing words that are precise and varied • using a variety of kinds of sentence structures to vary pace and to support meaning

Chapter 4
Technical Characteristics of the ACT Tests

This chapter discusses the technical characteristics—the score scale, norms, equating, and reliability—of the tests in the ACT. The data come from two sources: one special study and one set of operational data drawn as six 2,000-person samples from the six national test dates in the 2011-2012 testing year (September through August). Data from the special study, in 1995, were used for scaling and norming the ACT tests. The special study was conducted to examine the ACT score scale created in 1988, to update the nationally representative norms, and to investigate the impact of allowing the use of calculators on the ACT Mathematics Test. (The use of calculators was first permitted on the ACT Mathematics Test in October 1996.) This study and the processes of scaling, equating, and norming, are described below. For a discussion of validity issues, see Chapter 5.

Norming and Score Scale Data

In October 1988, ACT conducted a national study involving more than 100,000 high school students (ACT, 1997). This study, called the Academic Skills Study, provided the data that ACT used to revise the ACT score scales and to provide nationally representative norms. In October 1995, ACT conducted another national study, this one involving over 24,000 high school students. Data from the 1995 study were used to examine the score scale and to update the national norms given the use of calculators on the ACT Mathematics Test. The 1995 study is discussed in this manual mainly in regard to updating the norms for the ACT tests. The 1995 study data were also used to examine the score scale for the ACT given the addition of calculators. More detailed information regarding the scaling part of the study appears in Harris (1997).

Sampling for the 1995 Study

In the sample used for obtaining new norms for the ACT, one form of the calculator-not-permitted ACT and two forms of the calculator-permitted ACT were administered to twelfth graders. All three forms were administered at each school to randomly equivalent groups of examinees, using spiraling. The booklets were spiraled within classroom, meaning that some students were allowed to use a calculator on the Mathematics Test while other students were not.

Sample design and data collection. The target population consisted of students enrolled in twelfth grade in schools in the United States. The target population included students in both private and public schools. The sample size was chosen with the goal of achieving a precision level that would enable estimating any probability to within .05 with probability .95. The sample was explicitly stratified by region and school size. It was further implicitly stratified by affiliation and the percentage of minority students. A systematic sample was selected from each stratum. (Harris, 1997, offers more information on the sampling).

In anticipation that some schools would not participate in the study, many more schools were invited to participate than were required to achieve the targeted precision. During the recruitment the number of participating schools in each stratum was carefully monitored, so as to maintain the representativeness of the sample with respect to the stratification variables. In addition, a backup sample was chosen so that additional schools could be chosen from strata for which there were too few schools agreeing to participate. Schools were asked to test all students in each grade. A few schools were allowed to administer the spiraled test batteries to randomly selected subsamples of their students. Makeup testing for students who were absent was strongly encouraged.

Response rates. One type of nonresponse in this study was among schools: not every school invited to participate did so. Attempts were made to choose the replacement schools from the same strata as the schools they were replacing so that the obtained sample would be representative with respect to the stratification variables. Nevertheless, it is conceivable that a school's willingness to participate in this study could be related to their students' academic development, independently of these variables. If this were true, then the nonresponse among schools would introduce a bias in the results. It is not believed the selection of schools had any significant biasing effect in computing the norms.

A second type of nonresponse was among students within a participating school. One source of student nonresponse was absenteeism (schools were encouraged to retest students who were absent). Within-school student participation rates were monitored, and those schools with response rates less than 50% were contacted by phone. If there was not a reasonable justification for the less-than-50% response rate—such as that the school choose to test only a randomly selected subsample of students—the school was eliminated from further analyses. Four schools were deleted for this reason. It is believed that for the sample as a whole, student nonresponse did not have any important biasing effect.

Data editing. Data from two schools were eliminated due to irregularities in the administration of the tests. From the 67 remaining schools, examinees with problematic records were excluded (e.g., grade level not determinable, test form not determinable, zero raw score on one of the four tests, over two-thirds of the items omitted on any of the four tests). A minimal number of returned answer sheets were excluded. Final sample sizes for all examinees (national) and the subset of examinees who indicated they were college-bound are shown in Table 4.1. A college-bound student was defined as a student who indicated he or she was planning to attend a two- or four-year college or university after high school graduation.

Table 4.1
Examinee Sample Sizes for Updating the Norms (1995 Study)

Grade	National	College-Bound
12	2,981	2,356

Weighting. For the norming process, individual examinee records were multiplied by weights. Weighting is an adjustment performed to match the characteristics of the sample to that of the target population. This is done by either increasing or decreasing the importance of a particular observation, depending on the stratum where the observation is located. The result of this process is that the weighted sample will have proportions in each stratum equal to the proportions in each stratum in the population. For purposes of weighting and calculating standard errors, any stratum with fewer than two schools was combined with another stratum. In addition, weights were truncated. This was done so that no one school or student score would have an undue influence on the results. Harris (1997) provides details on the procedure used to determine the weights.

Sample representativeness. The representativeness of the sample is a consequence of the relative levels of success in recruiting schools of different sizes and from different parts of the country, and having these schools test their entire twelfth-grade class. One way to determine the character and extent of sample bias is to compare the demographic characteristics of the sample of examinees with the U.S. statistics for various demographic variables presented in Table 4.2. Precisely comparable U.S. data for the population of interest were not available. However, the data shown allow for a general examination of the representativeness of the sample with respect to the demographic variables.

As indicated in Table 4.2, the weighted sample appears to be reasonably representative of the national population. The actual discrepancy between African American students and male students is probably considerably less than appears in the table, for two reasons. First, some students did not respond to the question concerning racial/ethnic background, or chose "other" or "prefer not to respond" as their response. Second, the U.S. percentages in Table 4.2 are based on students in Grades K–12, not just Grade 12. To the extent that African American students and male students drop out at higher rates than other students, the U.S. percentage will be overstated. Even though region was used as a stratification variable, these percentages are also slightly different from the national percentages. This is due to the truncation of the weights previously mentioned.

Obtained precision. The targeted precision level was to estimate any probability to within .05 with probability .95. The actual obtained level of precision for the norms was estimation of any probability to within .12 with probability .95. This is far from the targeted value for two reasons. First, fewer schools were available for analysis than had been targeted. Second, among those schools that did participate, there was an unusual amount of homogeneity within a school. That is, the students within a school were far more similar than was expected: students in a given school who all did well or all did poorly. This phenomenon reduced the efficiency of the sample.

Table 4.2
Selected Demographic and Educational Characteristics for the 1995 Norming Study Sample

Category identifier used in study	Weighted sample proportion Grade 12	U.S. proportion[a]	U.S. category identifier
Gender			
Female	.55	.49	Female
Male	.45	.51	Male
Racial/Ethnic Origin			
African American/Black	.12	.17	Black
American Indian, Alaska Native	.01	.01	Indian
Caucasian American/White	.70	.66	White
Mexican American/Chicano	.03	.13	Spanish Origin
Puerto Rican, Cuban, Other Hispanic	.03	—	—
Asian American/Pacific Islander	.02	.04	Asian
Multiracial	.01	—	—
Other, Prefer Not to Respond, Blank	.06	—	—
School Affiliation			
Private	.05	.08	Private
Public	.95	.92	Public
Geographic Region			
East	.38	.44	East
Midwest	.28	.19	Midwest
Southwest	.16	.13	Southwest
West	.18	.24	West

[a] U.S. proportions obtained from United States Department of Education, *Digest of Education Statistics 1996* (pp. 23 and 60).

Scaling the Multiple-Choice Tests

Scale scores are reported for the ACT English, Mathematics, Reading, and Science Tests, and for the Usage/Mechanics, Rhetorical Skills, Pre-Algebra/ Elementary Algebra, Intermediate Algebra/Coordinate Geometry, Plane Geometry/Trigonometry, Social Studies/Sciences, and Arts/Literature subscores. A Composite score, calculated by rounding the unweighted average of the four test scores, is also reported. The rounding is done such that 0.50 or greater rounds up. Because subscores and test scores were scaled separately, there is no arithmetic relationship between subscores and the test score. For example, the Usage/Mechanics and Rhetorical Skills subscores will not necessarily sum to the English Test score.

The score scale. The range of the test and Composite scores on the ACT is 1 to 36. The range of the subscores is 1 to 18. The target means of the ACT score scales were 18 for each of the four tests and the Composite and 9 for the seven subscores among students at the beginning of twelfth grade, nationwide in 1988, who reported that they were planning to attend a two- or four-year college. Scale score properties for the ACT are summarized in Table 4.3.

Although the score scale for the current ACT (administered beginning in October 1989) and the score scale for the original ACT (from its inception in 1959 through all administrations prior to October 1989) have the same score range, scale scores on these two assessments are not directly comparable due to changes in the internal structure of the tests and the methodology used for scaling.

Table 4.3
Properties of the Score Scale for the ACT

- Scores on the current ACT (introduced in October 1989) and the original ACT (from its inception in 1959 through all administrations prior to October 1989) are not directly comparable.
- Range of scores is 1–36 on all multiple-choice tests and the Composite, and 1–18 for subscores.
- Test means are approximately 18 and subscore means are approximately 9 for twelfth-grade U.S. students in the fall of 1988 who reported they planned to attend college.
- The average standard error of measurement is approximately 2 points for each test score and subscore, and 1 point for the Composite score.
- The conditional standard error of measurement is approximately equal along the score scale.
- Occurrences of gaps (unused scale score units) and multiple raw scores converting to the same scale score were minimized in constructing the raw-to-scale score transformation.

For the current ACT, the standard error of measurement was targeted at approximately 2 scale score points for each of the subject-area test scores and subscores and 1 scale score point for the Composite. In addition, the scales for the ACT were constructed using a method described by Kolen (1988) to produce score scales with approximately equal standard errors of measurement along the entire range of scores. Without nearly equal standard errors of measurement, standard errors of measurement at different score levels would need to be presented and considered in score interpretation (see AERA, APA, & NCME, 1999, p. 31). Given the properties just described, and the assumption that the distribution of measurement error is approximated by a normal distribution, an approximate 68% confidence interval can be constructed for any examinee by adding 2 points to and subtracting 2 points from his or her reported scale score for any of the ACT tests or subscores. An analogous interval for the Composite score can be constructed by adding 1 point to and subtracting 1 point from the reported Composite score.

In thinking about standard errors and their use, note that the reported scale score (i.e., the obtained score) for an examinee is only an estimate of that examinee's true score. The true score can be interpreted as the average reported score obtained over repeated testings under identical conditions. If 1 standard error of measurement were added to and subtracted from each of these reported scores, about 68% of the resulting intervals would contain the examinee's true score. (This statement assumes a normal distribution for measurement error.)

Another way to view 68% intervals is in terms of groups of examinees. Specifically, if 1 standard error of measurement were added to and subtracted from the reported score of each examinee in a group of examinees, the resulting intervals would contain the true score for approximately 68% of the examinees. To put it another way, about 68% of the examinees would be mismeasured by less than 1 standard error of measurement. Again, such statements assume normal distribution. Also, these statements assume a constant standard error of measurement, which is a designed characteristic of ACT score scales. Consequently, it is relatively straightforward to interpret scale scores in relation to measurement error.

Scaling process. The data used in the scaling process were collected in the fall of 1988 as part of the Academic Skills Study, which provided nationally representative samples of examinees for the scaling of the ACT. In that study, data from twelfth-grade college-bound examinees were used in scaling the ACT. A detailed discussion of the data used in scaling the ACT is given in Kolen and Hanson (1989).

The scaling process for the ACT consisted of three steps. First, weighted raw score distributions for both national and college-bound groups of examinees from the Academic Skills Study were computed, with the weighting based on the sample design. Second, the weighted raw score distributions were smoothed in accordance with a four-parameter beta compound binomial model (Lord, 1965; Kolen, 1991; Kolen & Hanson, 1989). Finally, the smoothed raw score distributions for twelfth-grade college-bound examinees were used to produce the score scales.

Smoothing the raw score distributions is done to produce distributions that are easier to work with and that are better estimates of population distributions. Kolen (1991) and Hanson (1990) have shown that smoothing techniques have the potential to improve the estimation of population distributions. Overall, the smoothing process resulted in distributions that appeared smooth without departing too much from the unsmoothed distributions. In addition, the first three central moments (mean, standard deviation, skewness) of the smoothed distributions were identical to those of the original distributions. The fourth central moments of the smoothed distributions (kurtosis) were either identical or very close to those of the original distributions.

The first step in constructing the score scales was to produce initial scale scores with a specified mean for twelfth-grade college-bound examinees from the Academic Skills Study and a specified standard error of measurement that was approximately equal for all examinees. The means and standard errors of measurement specified for each test score and subscore were those given in Table 4.3. The process used was based on Kolen (1988) and described in detail by Kolen and Hanson (1989). These initial scale scores were rounded to integers ranging from 1 to 36 for the tests and 1 to 18 for the subscores. Some adjustment of the rounded scale scores was performed to attempt to meet the specified mean and standard error of measurement and to avoid gaps in the score scale (scale scores that were not used) or to avoid having too many raw scores converting to a single scale score. This process resulted in the final raw-to-scale score conversions.

In the 1995 special study, the score scale was reexamined under the condition of allowing calculators on the ACT Mathematics Test. In this study, the ACT Mathematics Test with calculators was quasi-equated to the ACT Mathematics Test without calculators permitted. It was determined from the results obtained that the score scale created in 1988 would continue to have the same meaning with or without the allowance of calculators on the Mathematics Test.

Scale score statistics for the 1995 nationally representative sample. Scale score summary statistics, average standard errors of measurement (SEMs), and reliabilities for twelfth-grade examinees in the 1995 nationally representative sample are given in Table 4.4 for the test scores and the Composite score, and in Table 4.5 for the subscores. Scale score statistics are reported for all examinees (national) and those examinees who indicated they planned to attend a two- or four-year college (college-bound). The mean scale scores for college-bound students in Tables 4.4 and 4.5 were, in all cases, within 0.01 of the score scale target values given in Table 4.3. The Composite score mean is somewhat higher than 18 due to the rounding rule used to form the Composite score from the test scores. The variation in the standard errors of measurement among the various test scores and subscores occurred as a result of differences in raw score means, reliabilities, and test lengths.

The statistics reported in Tables 4.4 and 4.5 are for those examinees who were allowed to use calculators on the Mathematics Test.

Procedures described by Kolen, Hanson, and Brennan (1992) were used to compute the scale score average standard errors of measurement and scale score reliabilities reported in Tables 4.4 and 4.5. The data used for the results in Tables 4.4 and 4.5 were weighted using the weighting procedure described on page 39. The standard errors of measurement and reliabilities are an average of the values over two test forms. The method used to compute the standard errors of measurement and reliabilities (Kolen, Hanson, & Brennan, 1992) could only be applied to the two forms separately; it could not be applied across forms.

Scale score statistics for the 2011–2012 academic year. The scale score summary statistics for examinees testing on the six national ACT administrations in 2011-2012 are given in Table 4.6 (for the test scores and the Composite score), and in Table 4.7 (for the subscores). The average SEMs and reliabilities presented in Tables 4.6 and 4.7 are the median average SEMs and median reliabilities across the six national administrations. The data in Tables 4.6 and 4.7 are based on systematic samples of 2,000 examinees per administration who took the ACT in the 2011–2012 school year.

Table 4.4
Scale Score Summary Statistics for the ACT Tests for 1995 Nationally Representative Sample of Twelfth-Grade Students (Mathematics Test administered with calculators)

Statistic	English	Mathematics	Reading	Science	Composite
			National (N = 2,981)		
Mean	17.17	17.93	17.59	17.08	17.58
SD	5.96	4.54	6.44	4.72	4.83
Skewness	0.42	0.82	0.68	0.58	0.69
Kurtosis	2.47	3.30	2.81	3.27	2.90
SEM[a]	1.65	1.41	2.23	1.84	0.90
Reliability	.92	.90	.88	.85	.97
			College-Bound (N = 2,356)		
Mean	18.05	18.54	18.39	17.69	18.30
SD	5.95	4.60	6.54	4.76	4.87
Skewness	0.30	0.72	0.55	0.54	0.57
Kurtosis	2.38	2.99	2.60	3.14	2.71
SEM[a]	1.65	1.43	2.24	1.84	0.91
Reliability	.92	.90	.88	.85	.97

[a] Standard error of measurement

Table 4.5
Scale Score Summary Statistics
for Subscores of the ACT for
1995 Nationally Representative Sample for Twelfth-Grade Students
(Mathematics Test administered with calculators)

Statistic	Usage/ Mechanics	Rhetorical Skills	Pre-Algebra/ Elementary Algebra	Intermediate Algebra/ Coordinate Geometry	Plane Geometry/ Trigonometry	Social Studies/ Sciences	Arts/ Literature
National (N = 2,981)							
Mean	8.30	8.92	8.84	8.70	9.07	8.71	8.70
SD	3.75	3.07	3.30	2.92	3.03	3.67	4.25
Skewness	0.45	0.40	0.40	−0.04	−0.02	0.40	0.45
Kurtosis	2.36	2.64	2.57	3.18	3.11	2.72	2.30
SEM[a]	1.34	1.13	1.33	1.72	1.71	1.75	1.94
Reliability	.87	.86	.84	.65	.68	.77	.79
College-Bound (N = 2,356)							
Mean	8.83	9.35	9.30	9.03	9.40	9.15	9.18
SD	3.77	3.07	3.29	2.88	3.04	3.71	4.32
Skewness	0.31	0.30	0.29	−0.04	−0.06	0.31	0.32
Kurtosis	2.23	2.56	2.49	3.17	3.06	2.63	2.15
SEM[a]	1.35	1.12	1.33	1.65	1.65	1.72	1.93
Reliability	.87	.87	.84	.66	.70	.78	.80

[a] Standard error of measurement

Table 4.6
Scale Score Summary Statistics for the ACT Tests
for 2011-2012 Test Dates

Statistic	English	Mathematics	Reading	Science	Composite
Mean	21.24	21.64	21.85	21.26	21.61
SD	6.04	5.08	6.00	4.92	4.94
Skewness	0.04	0.40	0.26	0.07	0.18
Kurtosis	2.60	2.45	2.39	3.12	2.44
SEM	1.72	1.50	2.09	2.06	0.93
Reliability	0.92	0.91	0.88	0.83	0.96

Table 4.7
Scale Score Summary Statistics for Subscores of the ACT Tests for 2011–2012 Test Dates

Statistic	Usage/ Mechanics	Rhetorical Skills	Pre-Algebra/ Elementary Algebra	Intermediate Algebra/ Coordinate Geometry	Plane Geometry/ Trigonometry	Social Studies/ Sciences	Arts/ Literature
Mean	10.71	10.89	11.28	11.02	10.83	11.18	11.08
SD	3.75	3.24	3.47	2.77	2.91	3.44	3.65
Skewness	0.05	-0.17	0.08	-0.21	-0.15	0.08	0.00
Kurtosis	2.34	2.53	2.24	3.13	2.99	2.29	2.19
SEM	1.29	1.16	1.41	1.39	1.43	1.52	1.67
Reliability	0.88	0.87	0.84	0.74	0.75	0.81	0.79

Scaling the Writing Test

Prior to the ACT Writing Test becoming operational (February 2005), a sample of ACT testing centers was invited to participate in a special scaling study that would help to establish the combined English/Writing Test score scale. More than 3,800 students from 38 ACT national testing sites completed the ACT Writing Test as part of their operational test administration in September 2003. The responses from 3,503 students were scored in December 2003.

A Combined English/Writing score scale was created by standardizing the English scores (1–36) and the Writing scores (2–12) for these students, weighting them 2/3 and 1/3, respectively, and using a linear transformation to map these combined scores onto a scale that ranged from 1 through 36. These transformed scores were then rounded to integers to form the reported score scale. This approach resulted in a single conversion table that is used for all ACT English form/Writing form combinations (Table 4.8). The optimal transformation methodology was a linear transformation. The arcsine and normalized transformations of the raw scores compressed score distances in the middle of the distribution and expanded distances at the extremes. Under the linear transformation, there are no gaps or clumping in the combined scaled scores.

Norms for the National Sample

The norms for the ACT are intended to represent the national population of twelfth-grade students and the national subpopulation of twelfth-grade students who report that they plan to attend a two- or four-year college when tested at the beginning of twelfth grade. The norms were obtained from the 1995 nationally representative sample using the weighting procedures described on page 39. All nonexcluded examinees in the 1995 nationally representative sample who were allowed to use a calculator on the Mathematics Test were used to produce the norms.

Data from the national sample were used to develop cumulative percentages (percents-at-or-below) for each ACT test score, the Composite score, and the subscores. The percent-at-or-below corresponding to a scale score is defined as the percentage of twelfth-grade examinees with scores equal to or less than that scale score.

Tables 4.9 and 4.10 contain percents-at-or-below for the four ACT test scores and the Composite score for twelfth-grade college-bound and national examinees, respectively. Tables 4.11 and 4.12 contain percents-at-or-below for the seven ACT subscores for twelfth-grade college-bound and national examinees, respectively.

Calculators were allowed on the Mathematics Test beginning on the October 1996 test date. The norms reported in Tables 4.9 through 4.12 for the Composite scores, Mathematics Test scores, and Mathematics Test subscores are not appropriate for the ACT taken prior to October 1996.

(*Text continues on p.* 50.)

Table 4.8
Conversion Table for the ACT Combined English/Writing Scale Scores

English Test score	Writing Test score										
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1	2	3	4	5	6	7	8	9	10	11
2	2	3	4	5	6	6	7	8	9	10	11
3	2	3	4	5	6	7	8	9	10	11	12
4	3	4	5	6	7	8	9	10	11	12	13
5	4	5	6	7	8	9	10	11	12	12	13
6	5	6	7	7	9	9	10	11	12	13	14
7	5	6	7	8	9	10	11	12	13	14	15
8	6	7	8	9	10	11	12	13	14	15	16
9	7	8	9	10	11	12	13	13	14	15	16
10	8	9	9	10	11	12	13	14	15	16	17
11	8	9	10	11	12	13	14	15	16	17	18
12	9	10	11	12	13	14	15	16	17	18	19
13	10	11	12	13	14	14	15	16	17	18	19
14	10	11	12	13	14	15	16	17	18	19	20
15	11	12	13	14	15	16	17	18	19	20	21
16	12	13	14	15	16	17	18	19	20	20	21
17	13	14	15	16	16	17	18	19	20	21	22
18	13	14	15	16	17	18	19	20	21	22	23
19	14	15	16	17	18	19	20	21	22	23	24
20	15	16	17	18	19	20	21	21	22	23	24
21	16	17	17	18	19	20	21	22	23	24	25
22	16	17	18	19	20	21	22	23	24	25	26
23	17	18	19	20	21	22	23	24	25	26	27
24	18	19	20	21	22	23	23	24	25	26	27
25	18	19	20	21	22	23	24	25	26	27	28
26	19	20	21	22	23	24	25	26	27	28	29
27	20	21	22	23	24	25	26	27	28	28	29
28	21	22	23	24	24	25	26	27	28	29	30
29	21	22	23	24	25	26	27	28	29	30	31
30	22	23	24	25	26	27	28	29	30	31	32
31	23	24	25	26	27	28	29	30	30	31	32
32	24	25	25	26	27	28	29	30	31	32	33
33	24	25	26	27	28	29	30	31	32	33	34
34	25	26	27	28	29	30	31	32	33	34	35
35	26	27	28	29	30	31	31	32	33	34	35
36	26	27	28	29	30	31	32	33	34	35	36

Table 4.9
ACT Norms
for College-Bound High School Students
(Cumulative Percentages for Test Scale Scores
Based on the 1995 Norming Study)

Scale score	Percent at or below				
	English	Mathematics	Reading	Science	Composite
1	01	01	01	01	01
2	01	01	01	01	01
3	01	01	01	01	01
4	01	01	01	01	01
5	01	01	01	01	01
6	01	01	01	01	01
7	01	01	01	01	01
8	03	01	02	01	01
9	05	01	04	01	01
10	10	01	08	03	01
11	16	01	14	07	04
12	20	06	21	11	09
13	26	09	29	23	17
14	32	19	34	28	26
15	37	30	39	38	34
16	43	40	45	43	42
17	49	49	50	51	50
18	56	58	57	61	56
19	62	64	60	69	62
20	66	70	66	74	68
21	71	76	71	78	74
22	75	81	73	83	80
23	79	83	77	88	84
24	83	87	81	91	88
25	86	90	83	95	91
26	90	93	86	96	94
27	93	95	90	97	96
28	96	97	92	98	97
29	97	98	94	99	98
30	98	99	95	99	99
31	99	99	97	99	99
32	99	99	97	99	99
33	99	99	98	99	99
34	99	99	99	99	99
35	99	99	99	99	99
36	99	99	99	99	99

Table 4.10

ACT Norms
for National High School Students
(Cumulative Percentages for Test Scale Scores
Based on the 1995 Norming Study)

Scale score	Percent at or below				
	English	Mathematics	Reading	Science	Composite
1	01	01	01	01	01
2	01	01	01	01	01
3	01	01	01	01	01
4	01	01	01	01	01
5	01	01	01	01	01
6	01	01	01	01	01
7	02	01	01	01	01
8	04	01	03	01	01
9	08	01	05	02	01
10	14	01	09	04	02
11	20	02	17	10	05
12	25	07	25	15	13
13	31	13	34	26	23
14	39	24	39	33	33
15	44	35	45	43	41
16	50	46	51	49	49
17	56	56	56	56	57
18	62	64	62	66	62
19	68	69	65	73	68
20	71	75	70	78	73
21	76	79	75	82	78
22	79	84	77	86	83
23	83	86	80	90	87
24	86	89	84	92	90
25	89	92	86	95	93
26	92	94	88	97	95
27	94	96	91	97	97
28	96	97	93	98	98
29	98	98	95	99	98
30	99	99	96	99	99
31	99	99	97	99	99
32	99	99	98	99	99
33	99	99	98	99	99
34	99	99	99	99	99
35	99	99	99	99	99
36	99	99	99	99	99

Table 4.11
ACT Norms
for College-Bound High School Students
(Cumulative Percentages for Subtest Scale Scores Based on the 1995 Norming Study)

	Percent at or below						
Scale score	Usage/ Mechanics	Rhetorical Skills	Pre-Algebra/ Elementary Algebra	Intermediate Algebra/ Coordinate Geometry	Plane Geometry/ Trigonometry	Social Studies/ Sciences	Arts/ Literature
1	01	01	01	01	01	01	01
2	01	01	01	02	02	02	04
3	05	01	02	02	02	05	08
4	14	03	06	07	08	10	14
5	22	09	12	15	08	15	23
6	32	19	22	15	15	24	32
7	40	30	32	27	26	37	41
8	51	43	44	38	38	45	49
9	59	56	56	61	49	58	57
10	67	65	64	69	68	67	64
11	75	77	74	83	76	73	70
12	80	82	82	88	84	82	75
13	86	89	89	95	92	87	80
14	91	95	93	97	95	90	84
15	95	97	96	99	98	93	90
16	98	99	98	99	99	96	93
17	99	99	99	99	99	99	97
18	99	99	99	99	99	99	99

Table 4.12
ACT Norms
for National High School Students
(Cumulative Percentages for Subtest Scale Scores Based on the 1995 Norming Study)

	Percent at or below						
Scale score	Usage/ Mechanics	Rhetorical Skills	Pre-Algebra/ Elementary Algebra	Intermediate Algebra/ Coordinate Geometry	Plane Geometry/ Trigonometry	Social Studies/ Sciences	Arts/ Literature
1	01	01	01	01	01	01	01
2	02	01	01	03	03	03	04
3	07	02	03	03	03	07	09
4	18	04	08	09	09	13	16
5	27	12	16	18	09	18	26
6	38	24	27	18	17	29	36
7	47	36	38	30	31	42	47
8	57	50	51	43	43	51	55
9	65	62	62	66	54	63	62
10	72	70	69	74	72	72	68
11	79	80	78	86	79	77	74
12	84	85	85	90	86	85	79
13	88	90	91	96	94	89	83
14	93	96	94	97	96	92	87
15	96	98	97	99	99	94	91
16	98	99	99	99	99	96	94
17	99	99	99	99	99	99	98
18	99	99	99	99	99	99	99

(*Text continued from p. 45.*)

An examinee's standing on different tests should be compared by using the percents-at-or-below shown in the norms tables (Tables 4.9–4.12) rather than by using scale scores. The score scales were not constructed to ensure that, for example, a scale score of 16 on the English Test is comparable to a 16 on the Mathematics, Reading, or Science Tests. In contrast, examinee percents-at-or-below on different tests indicate standings relative to the same comparison group.

Even comparison of percents-at-or-below do not permit comparison of standing in different skill areas in any absolute sense. The question of whether a particular examinee is stronger in science than in mathematics, as assessed by the corresponding tests, can be answered only in relation to reference groups of other examinees. Whether the answer is "yes" or "no" can depend on the group.

User Norms

In addition to nationally representative norms, user norms are provided for the ACT and are the norms reported on score reports. User norms summarize the test scores and subscores, including Writing and Combined English/Writing scores, of recent high school graduates who took the ACT as tenth-, eleventh-, or twelfth-grade students and are not intended to represent the performance of twelfth-grade students nationwide. The norms reported each year are based on the scores of ACT-tested students from the three most recent high school graduating classes.

Because user norms are updated each year, they are not included in this manual. Instead, they are available at http://www.actstudent.org/scores/norms.html.

Equating

Several new forms of each of the ACT tests are developed each year. Even though each form is constructed to adhere to the same content and statistical specifications, the forms may differ slightly in difficulty. To control for these differences, subsequent forms are equated, and the scores reported to examinees are scale scores that have the same meaning regardless of the particular form administered to examinees. Thus, scale scores are comparable across test forms and test dates.

A carefully selected sample of examinees from one of the six national test dates each year is used as an equating sample. The examinees in this sample are administered a spiraled set of "n" forms—the new forms ("n – 1" of them) and one anchor form that has already been equated to previous forms. (The anchor form is the form used initially to establish the score scale.) The use of randomly equivalent groups is an important feature of the equating procedure and provides a basis for confidence in the continuity of scales. More than 2,000 examinees take each form.

Scores on the alternate forms are equated to the score scale using equipercentile equating methodology. In equipercentile equating, a score on Form X of a test and a score on Form Y are considered to be equivalent if they have the same percentile rank in a given group of examinees. The equipercentile equating results are subsequently smoothed using an analytic method described by Kolen (1984) to establish a smooth curve, and the equivalents are rounded to integers. The conversion tables that result from this process are used to transform raw scores on the new forms to scale scores.

The equipercentile equating technique is applied to the raw scores of each of the four multiple-choice tests for each form separately. The Composite score is not directly equated across forms. It is, instead, a rounded arithmetic average of the scale scores for the four equated tests. The subscores are also separately equated using the equipercentile method. Note, in particular, that the equating procedure does not lead to a reported score for a test being equal to some prespecified arithmetic combination of subscores within that test.

As specified in the Standards for Educational and Psychological Testing (AERA, APA, NCME, 1999), ACT conducts periodic checks on the stability of the ACT scores. The results appear reasonably stable to date.

Reliability, Measurement Error, and Effective Weights

The potential for some degree of inconsistency or error is contained in the measurement of any cognitive characteristic. An examinee administered one form of a test on one occasion and a second, parallel form on another occasion may earn somewhat different scores on the two administrations. These differences might be due to the examinee or the testing situation, such as differential motivation or differential levels of distractions on the two testings. Alternatively, these differences might result from attempting to infer the examinee's level of skill from a relatively small sample of items.

Reliability coefficients are estimates of the consistency of test scores. They typically range from zero to one, with values near one indicating greater consistency and those near zero indicating little or no consistency.

The standard error of measurement (SEM) is closely related to test reliability. The standard error of measurement summarizes the amount of error or inconsistency in scores on a test. As described previously in this manual, the score scales for the ACT were developed to have approximately constant standard errors of measurement for all true scale scores (i.e., the conditional standard error of measurement as a function of true scale score is approximately constant). This statement implies, for example, that the standard error of measurement for any particular ACT test score or subscore is approximately the same for low-scoring examinees as it is for high-scoring examinees. As discussed more fully in the score scale section, which begins on page 40, if the distribution of measurement error is approximated by a normal distribution, about two-thirds of the examinees can be expected to be mismeasured by less than 1 standard error of measurement.

Figure 4.1 (pages 54–55) presents the conditional standard errors of measurement for the four multiple-choice tests as a function of true scale score for the six national ACT administrations in the 2011-2012 school year. Conditional standard errors of measurement for the English, Mathematics, and Reading subscores are presented in Figures 4.2 through 4.4, respectively. The data used to produce Figures 4.1 through 4.4 are systematic samples of 2,000 examinees per national administration in the 2011-2012 school year. The conditional standard error of measurement functions were computed using methods presented in Kolen, Hanson, and Brennan (1992). The minimum scale scores plotted were chosen such that only an extremely small proportion of examinees are expected to have a true scale score lower than the minimum plotted score for each test and subscore for each administration.

For most of the true scale score range, the scale score standard error of measurement is reasonably constant. Some deviations occur at higher true scale scores. Some of these deviations are due to gaps in the raw–to–scale-score conversion at the high end of the scale for certain forms (for some forms certain scale scores cannot be obtained at the high end of the scale). For all tests the standard error of measurement is smaller at very high scores. The primary reason for the conditional standard error of measurement being smaller at higher true scale scores is that the conditional standard error of measurement must be zero for the maximum true scale score and be near zero for true scale scores near the maximum. The method used to produce the score scales cannot guarantee a completely constant standard error of measurement for all true scale scores.

The proportion of examinees with true scale scores at the extreme high end of the score scale, where the deviations from a constant conditional standard error of measurement are most apparent in Figures 4.1 through 4.4, is small. For example, the average standard errors of measurement for the English Tests reported in Table 4.13 (page 61) range from 1.65 to 1.79 across the six forms. The average standard errors of measurement, which are the averages of the conditional standard errors of measurement given in Figure 4.1 over the distribution of true scale scores, are approximately equal to the corresponding conditional standard error of measurement at true scale scores in the middle of the scale. This is a reflection of most of the true scale score distribution being in the middle of the score range, and very little of the true scale score distribution being in the extremes of the score range where the conditional standard errors of measurement deviate. Thus, the constant conditional standard error of measurement property is, for practical purposes, reasonably well met for the six forms.

Assuming the measurement errors on the four tests are independent, the conditional standard error of measurement of the unrounded Composite score is

$$s_c(\tau_e, \tau_m, \tau_r, \tau_s) = \frac{\sqrt{\sum_i s_i^2(\tau_i)}}{4},$$

where $s_i(\tau_i)$ is the conditional standard error of measurement for test i at true scale score τ_i, where i = e, m, r, s for English, Mathematics, Reading, and Science, respectively. The functions $s_i(\tau_i)$ are plotted in Figure 4.1. The conditional standard error of measurement for the Composite score depends on four variables—the true scale scores for the four tests. To facilitate presentation of the conditional standard errors of measurement for the Composite score, the conditional standard errors are plotted as a function of the average of the true scale scores for the four tests. In other words, $s_c(\tau_e, \tau_m, \tau_r, \tau_s)$ is plotted as a function of $\frac{(\sum_i \tau_i)}{4}$. A particular value of the average of the true scale scores on the four tests can be obtained in a variety of ways (i.e., different combinations of true scale scores on the individual tests could produce the same true Composite score). Consequently, each true Composite score value may correspond to several different values of the conditional standard error of measurement depending on the combination of true scores on the four tests that produced the true Composite score value.

To produce plots of the conditional standard errors of measurement of the Composite score, the observed proportion-correct scores (the number of items correct divided by the total number of items) of the examinees on the four tests were treated as true proportion-correct scores at which the conditional standard errors were calculated. For each test the conditional standard error of measurement was computed for each examinee using the observed proportion-correct score as the true proportion-correct score in the formula for the conditional standard error of measurement (Equation 8 in Kolen, Hanson, & Brennan, 1992). In addition, for each test the true scale score corresponding to the observed proportion-correct score (treated as a true proportion-correct score) was computed (Equation 7 in Kolen, Hanson, & Brennan, 1992). The resulting conditional standard errors of measurement for the four tests were substituted in the equation given above to compute a value of the conditional standard error of measurement of the Composite score. This is plotted as a function of the average of the true scale scores across the four tests. This procedure was repeated for each of the 2,000 examinees for each national test date. Figure 4.5 presents plots of the conditional Composite score standard errors of measurement versus the averages of the true scale scores for six test forms. Values for examinees who received proportion-correct scores of 0 or 1 on any of the four tests are not plotted in Figure 4.5; while observed proportion-correct scores of 0 and 1 are possible, true proportion-correct scores of 0 and 1 are unrealistic.

The conditional standard errors of measurement, as presented in Figure 4.5, vary not only across average scale scores but also within each average scale score. Different standard errors of measurement are possible for each particular value of the average scale score because more than one combination of the four test scores can produce the same average score. The general trend in the plots is for the conditional standard errors to be fairly constant as a function of average true scale score in the middle of the scale and to be lower for moderately high scores. This trend is similar to the trend in Figure 4.1 for the conditional standard errors of measurement for the four tests. As for the four test scores, it is concluded that the conditional standard error of measurement of the Composite score is, for practical purposes, reasonably constant across the score scale.

A limitation of the approach used in producing estimates of the conditional standard error of measurement of the Composite score presented in Figure 4.5 is that standard errors of measurement of the unrounded average of the four test scores are computed rather than the standard errors of measurement of the rounded average of the four test scores (the rounded average is the score reported to examinees).

It is not a problem that the observed scores of the examinees are used in producing the plots because it is standard errors *conditional* on average true scale score that are being plotted, and the observed scores for the examinees are only used to determine the specific average true scale scores at which to plot the standard errors. One effect of using observed scores as the true score values at which to plot the conditional standard errors of measurement is that many points at the extremes of the scale in Figure 4.5 may not represent realistically obtainable average true scale scores (the probability of observing examinees with these values of average *true* scale score is extremely small).

Summary statistics, based on the six national ACT administrations in 2011-2012, for scale score reliability coefficients and average standard errors of measurement for the ACT tests and subscores are given in Table 4.13. The data used to produce Table 4.13 are systematic samples of 2,000 examinees per national administration who took the ACT in the 2011-2012 school year. Scale score average standard errors of measurement were estimated using a four-parameter beta compound binomial model as described in Kolen, Hanson, and Brennan (1992). The estimated scale score reliability for test i (REL_i) was calculated as

$$REL_i = 1 - \frac{SEM_i^2}{S_i^2} ,$$

where SEM_i is the estimated scale score average standard error of measurement and S_i^2 is the observed scale score variance for test i.

The estimated average standard error of measurement for the Composite (SEM_c) was calculated as

$$SEM_c = \frac{\sqrt{\Sigma_i SEM_i^2}}{4} ,$$

where the summation is over the four tests. The estimated reliability of the Composite (REL_c) was calculated as

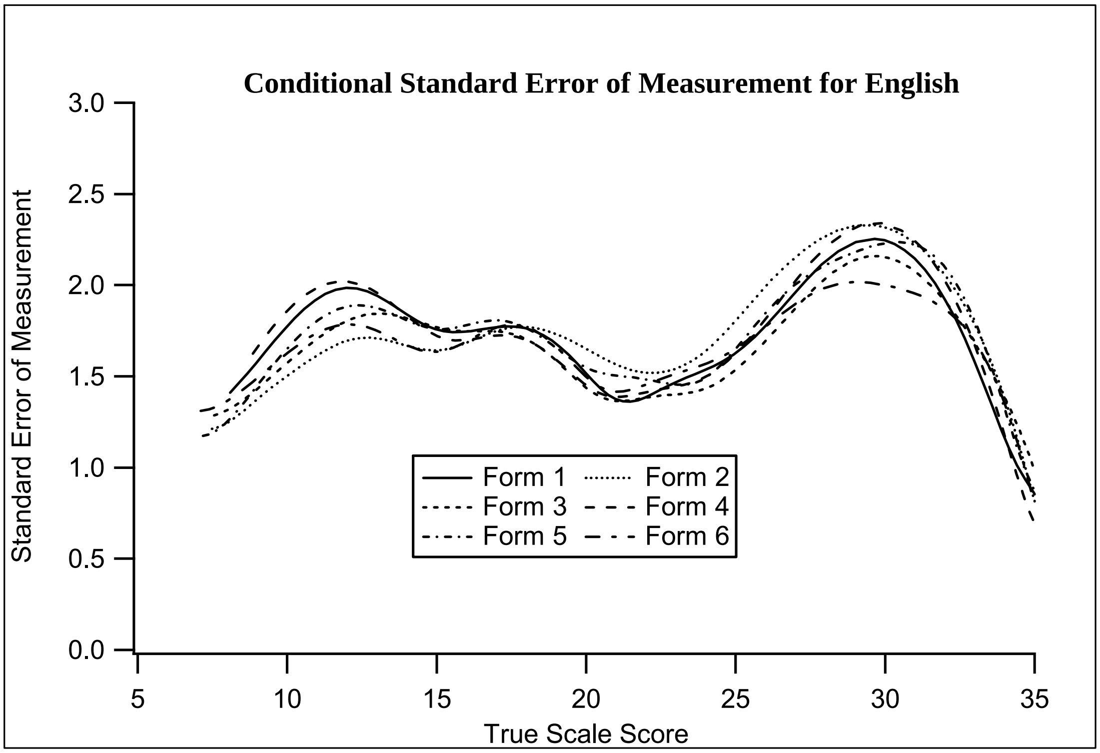
$$REL_c = 1 - \frac{SEM_c^2}{S_c^2} ,$$

where S_c^2 is the observed Composite score variance.

Prior to the ACT Writing Test becoming operational, a special administration of the Writing Test was conducted to collect data on score reliability. Two forms of the Writing Test were administered to students at an ACT national testing site. The forms were administered under standardized and secure conditions on consecutive days. The two forms were counterbalanced in order to control for order effects. Rater-agreement reliability was estimated using multiple pairs of raters and ranged from .92 to .94. Generalizability theory was also used to estimate score reliability, and to study the contributions of prompts, raters, and students to the variance of Writing scores. The variance component for students (analogous to true score variance in classical test theory) represented 63% of the total score variance. Prompts and raters contributed negligible amounts to the total variance, which means the level of student achievement, not the particular prompts asked or the particular raters doing the scoring, is what most strongly determines the reported score. The generalizability coefficient (a reliability-like estimate of score consistency) was .64, which is very high for a writing assessment. The standard error of measurement was 1.23. The reliability for the Combined English/Writing score was .91 with a standard error of measurement of 1.67.

Scale scores from the four multiple-choice tests are summed and divided by 4 in the process of calculating the Composite score. This process suggests that, in a sense, each multiple-choice test is contributing equally to the Composite score. (Writing Test scores—and whether a student did or did not take the Writing Test—have no bearing on the Composite score.) The weights used (.25 in this case) are often referred to as *nominal weights*.

(*Text continues on p.* 61.)



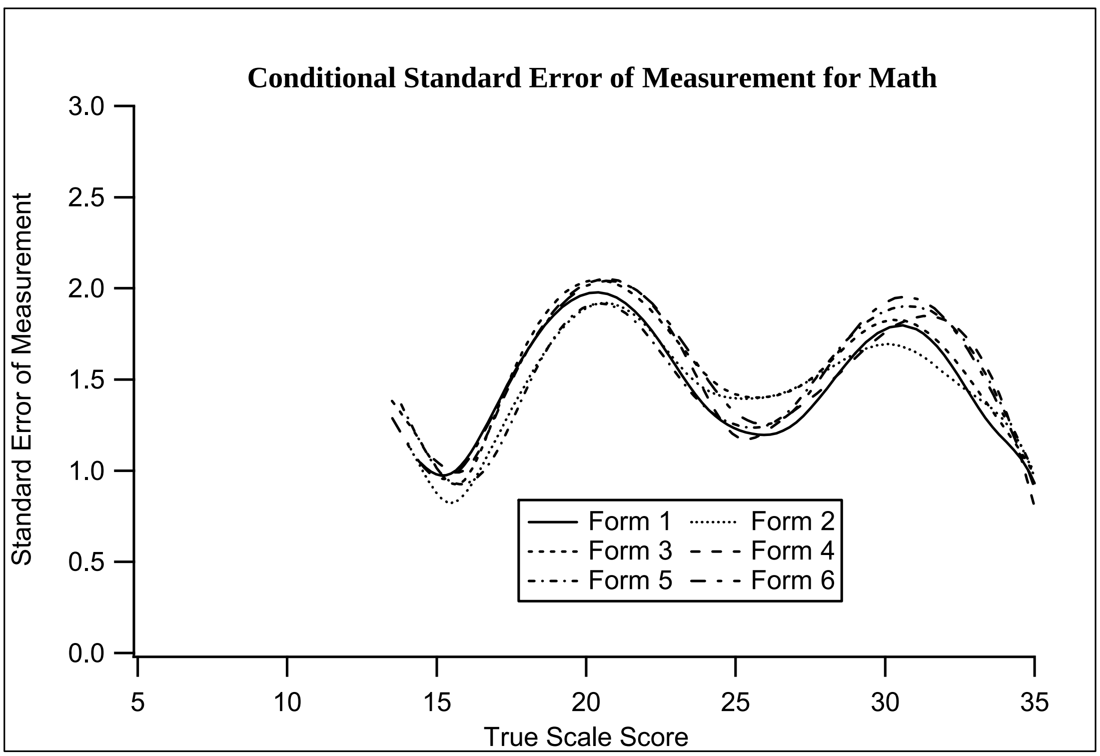
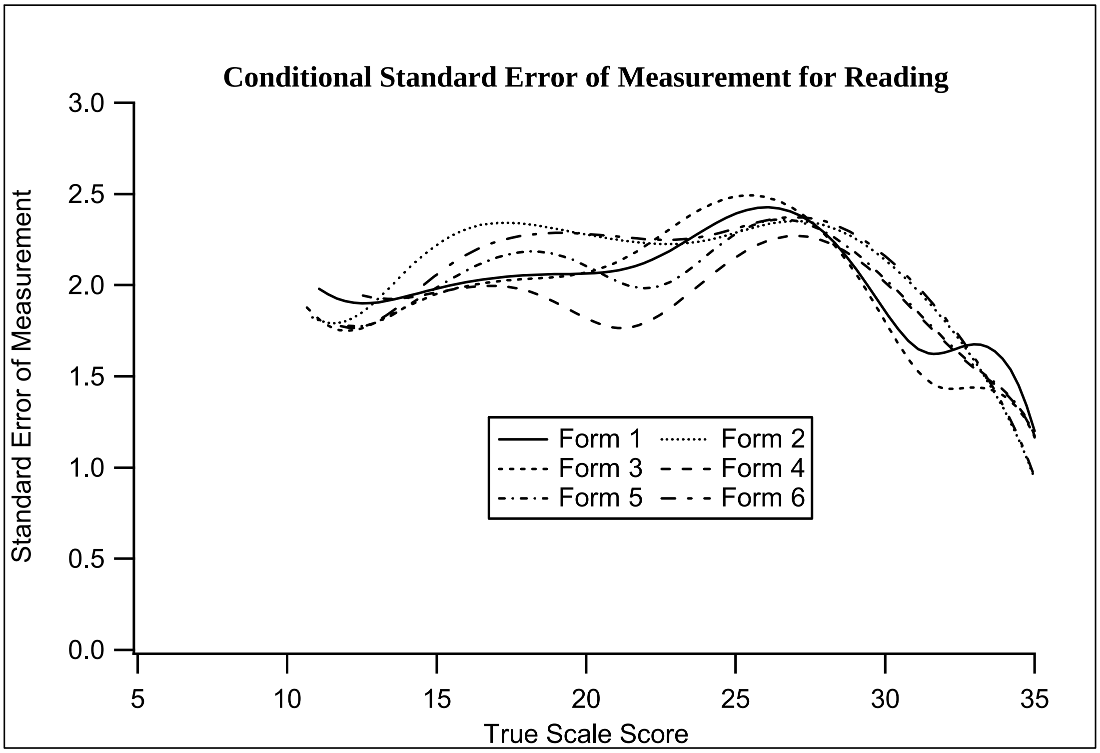


Figure 4.1. Estimated conditional standard errors of measurement for the four tests of the six national ACT administrations in 2011–2012 (*figure continues*).



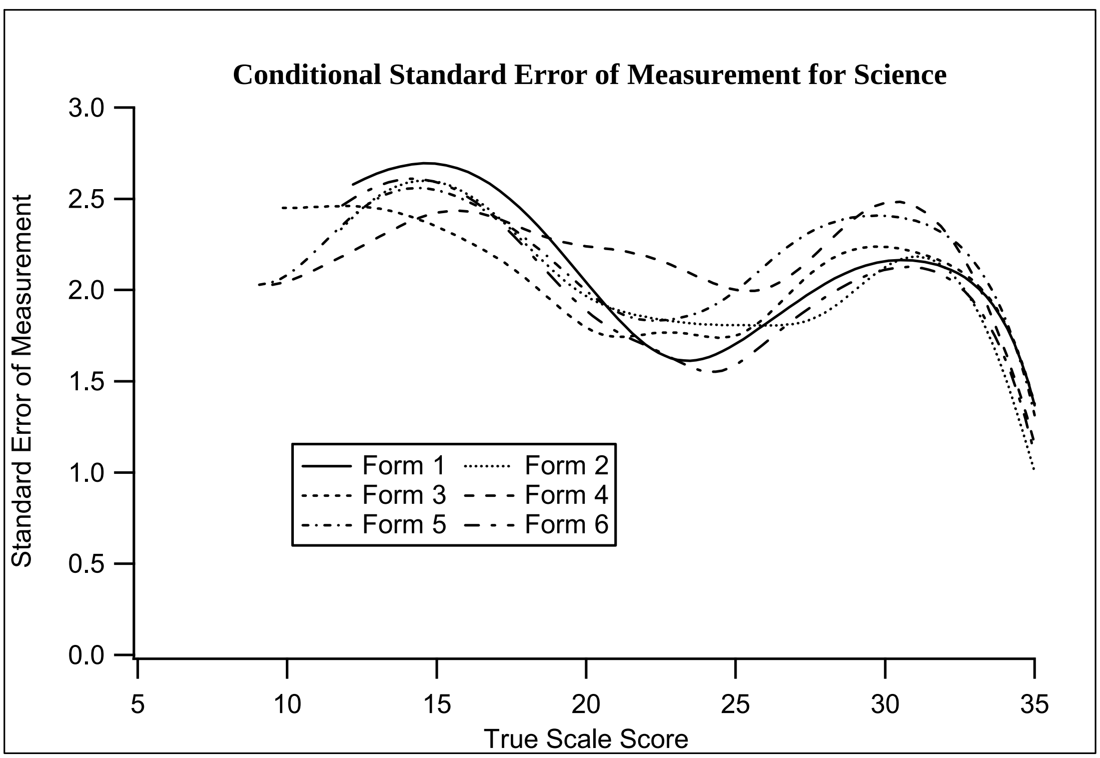
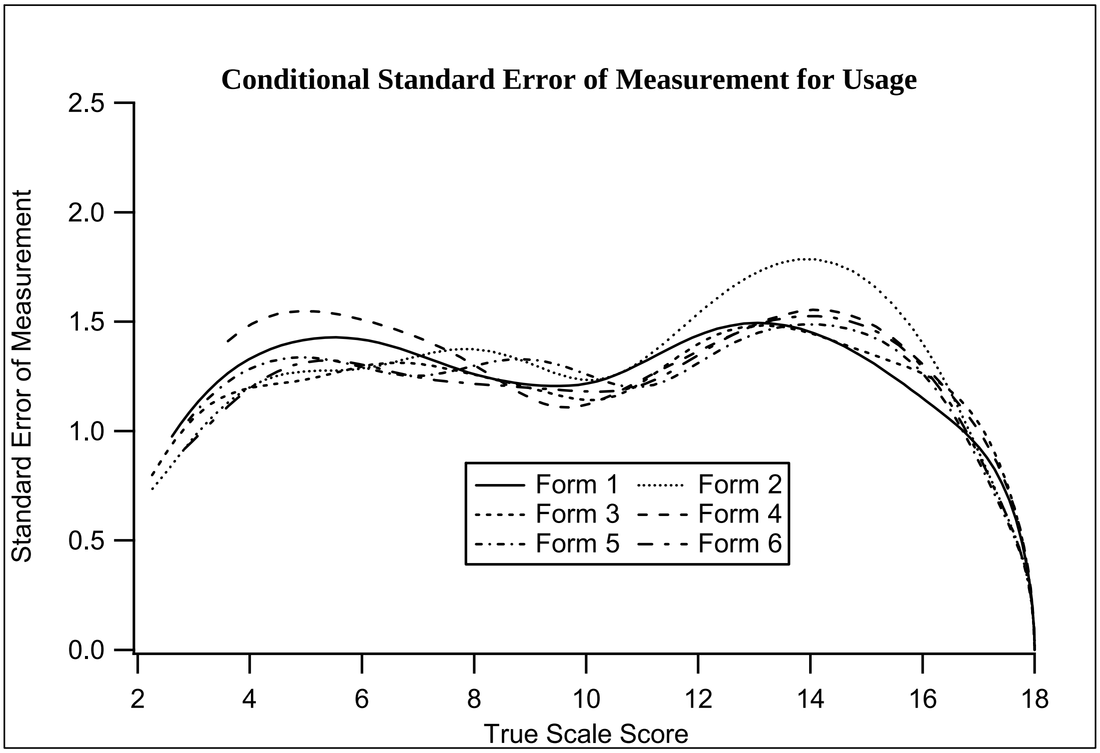


Figure 4.1 (*continued*)**.** Estimated conditional standard errors of measurement for the four tests of the six national ACT administrations in 2011–2012.



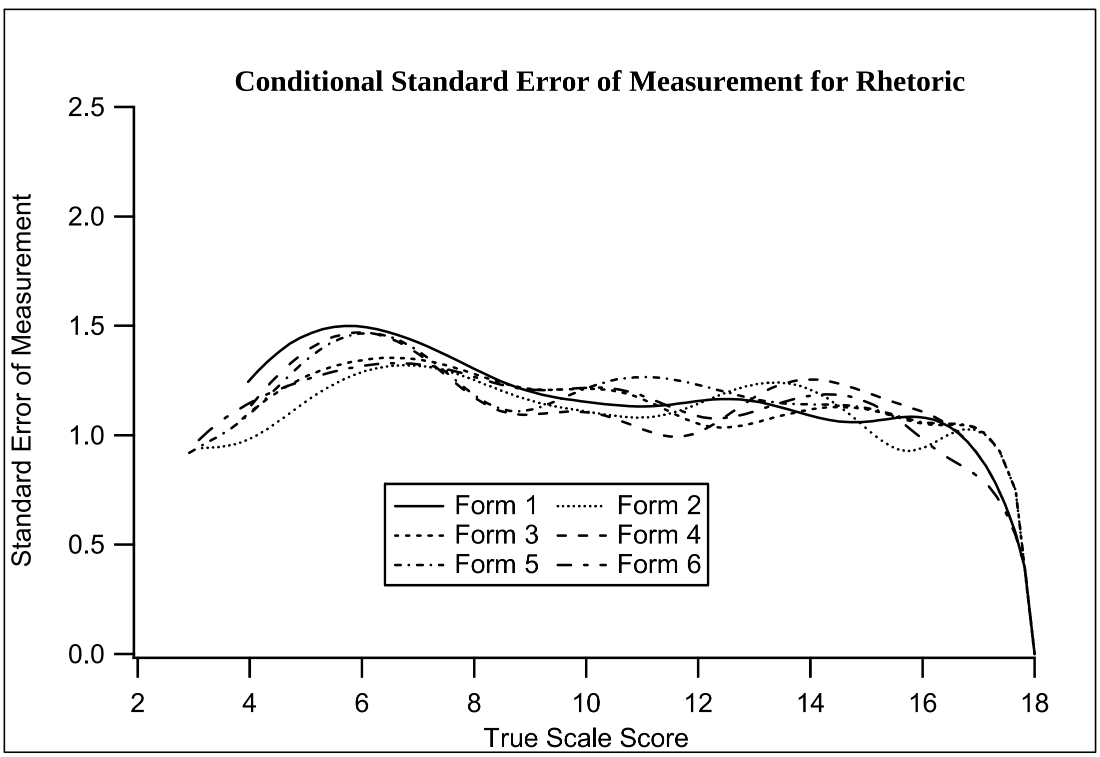
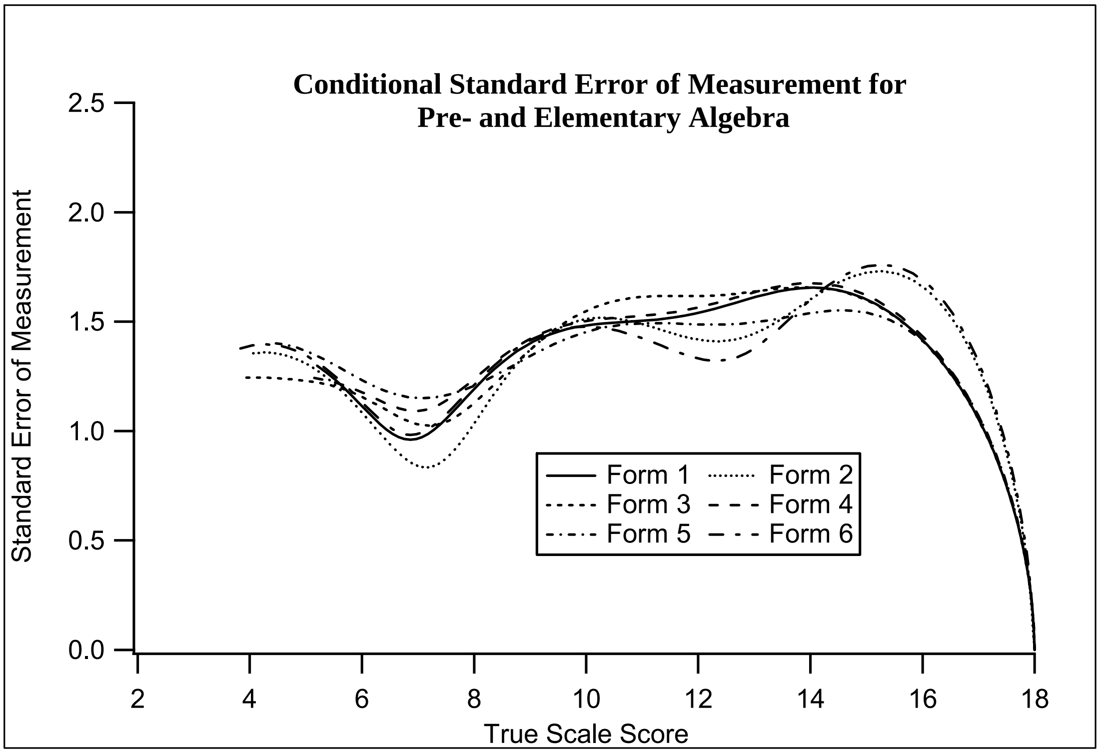


Figure 4.2. Estimated conditional standard errors of measurement for the English subscores of the six national ACT administrations in 2011–2012.



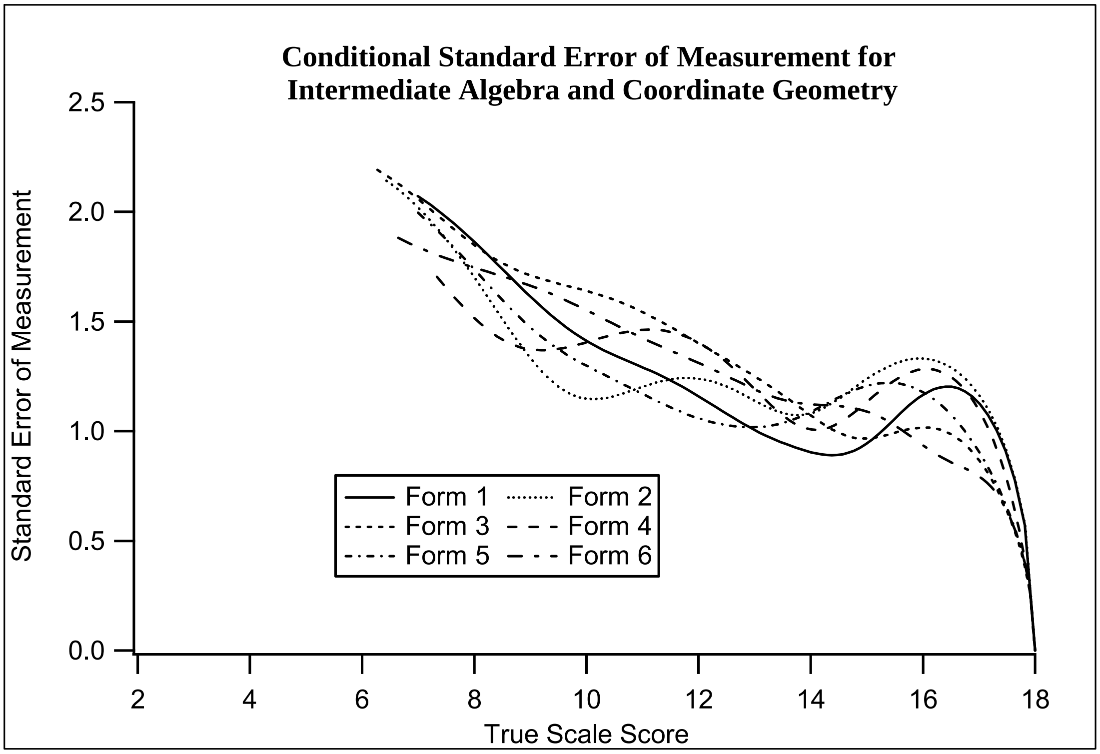


Figure 4.3. Estimated conditional standard errors of measurement for the Mathematics subscores of the six national ACT administrations in 2011–2012 (*figure continues*).

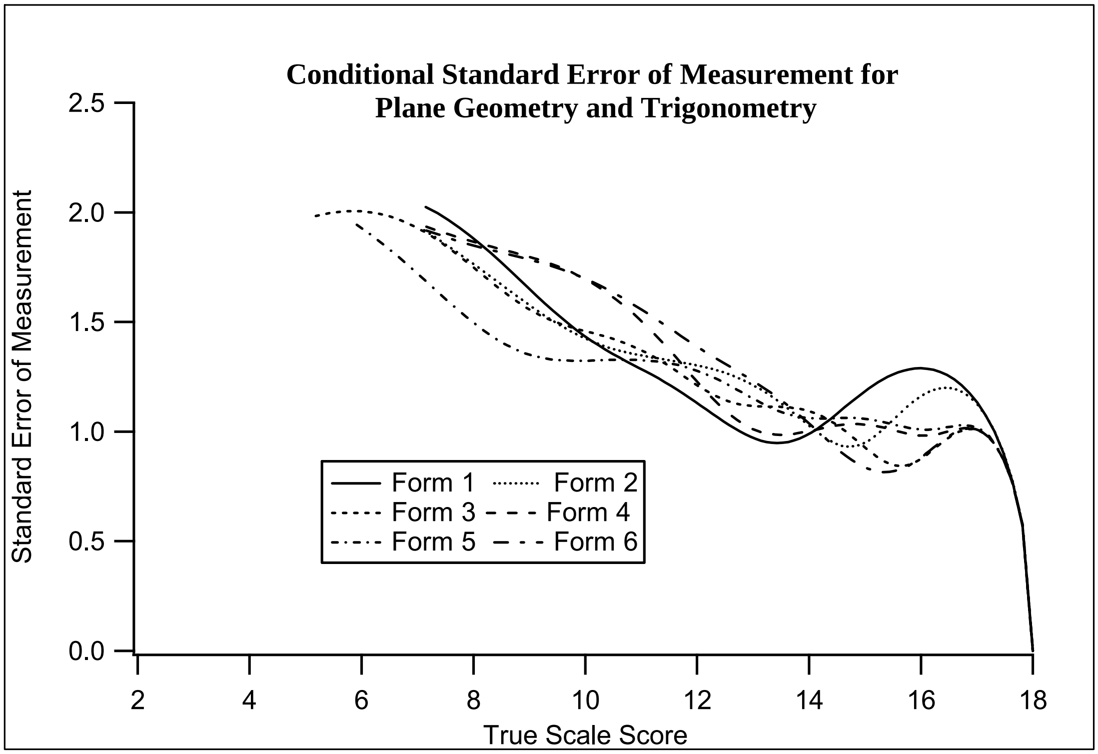
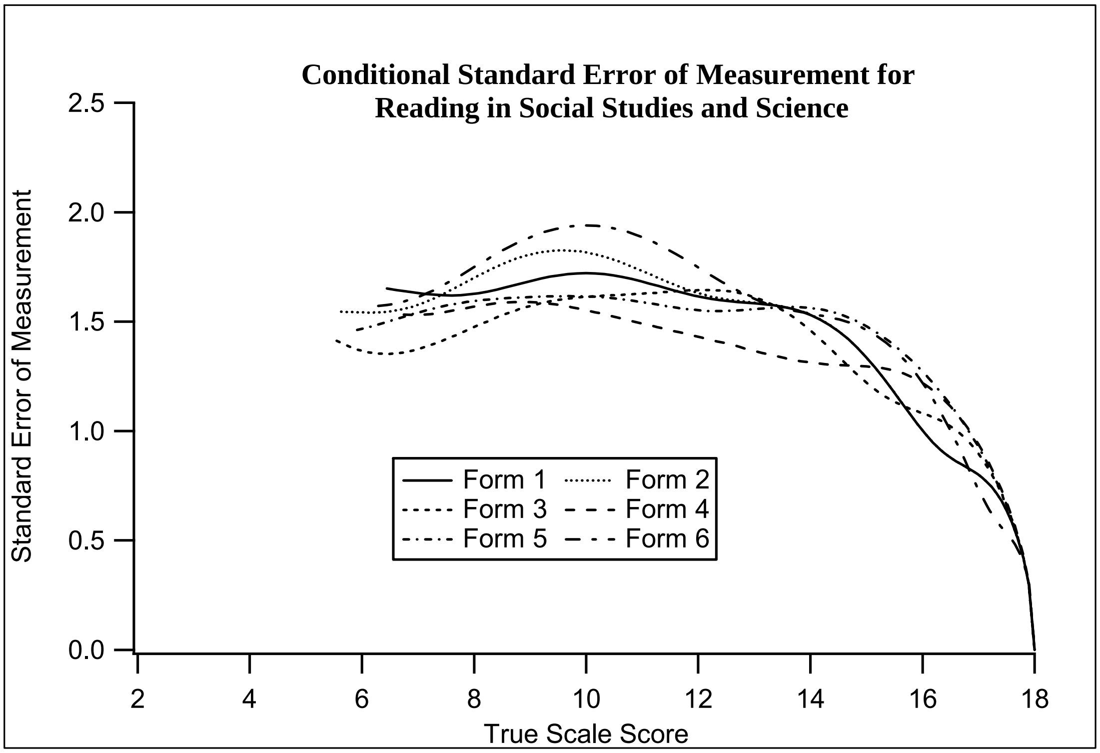


Figure 4.3 (*continued*). Estimated conditional standard errors of measurement for the Mathematics subscores of the six national ACT administrations in 2011–2012.



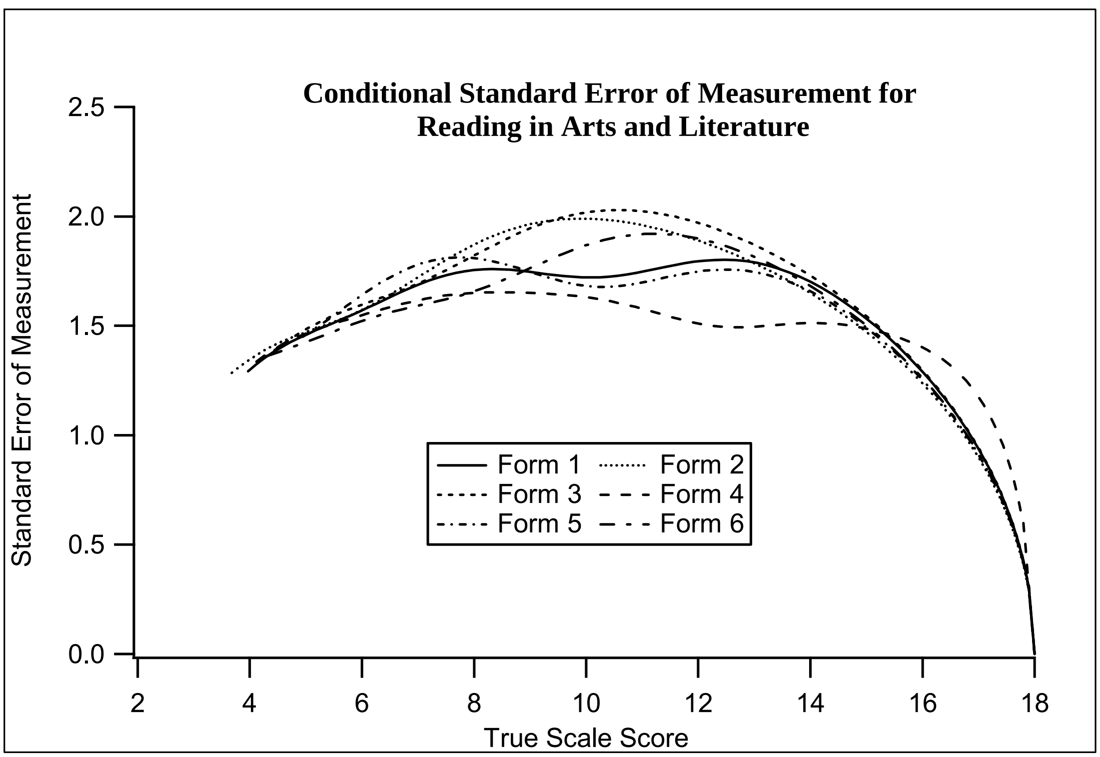
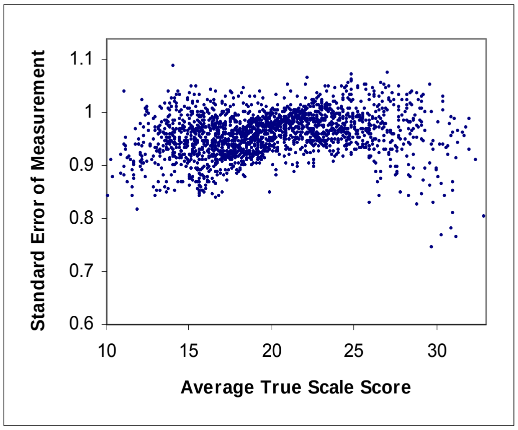
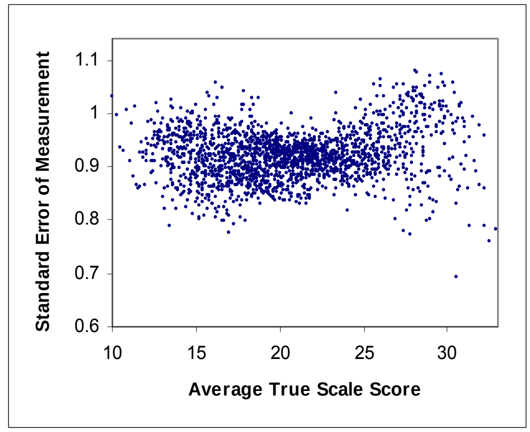


Figure 4.4. Estimated conditional standard errors of measurement for the Reading subscores of the six national ACT administrations in 2011–2012.

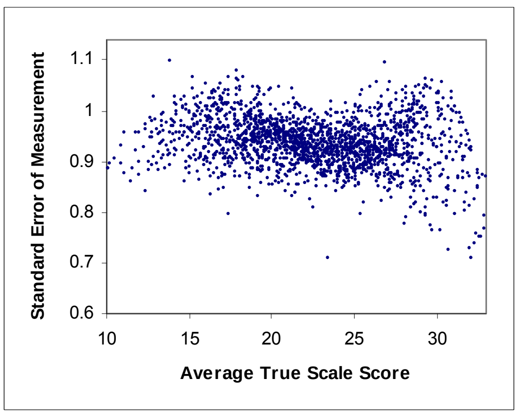
Form A



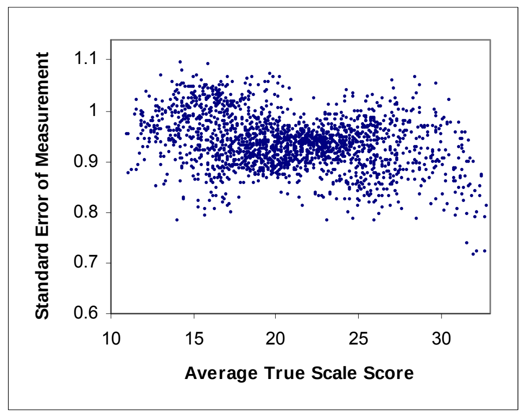
Form B



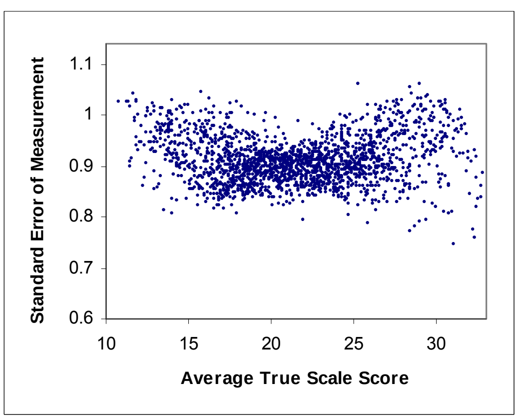
Form C



Form D



Form E



Form F

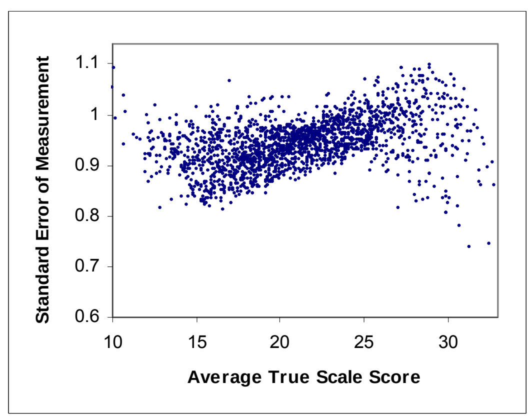


Figure 4.5. Conditional standard errors of measurement for the Composite scores of six national ACT administrations.

Table 4.13
Scale Score Reliability and
Average Standard Error of Measurement Summary Statistics for the
Six National ACT Administrations in 2011–2012

	Scale score reliability			Average SEM		
Test/Subtest	**Median**	**Minimum**	**Maximum**	**Median**	**Minimum**	**Maximum**
English	.92	.92	.93	1.72	1.66	1.74
Usage/Mechanics	.88	.87	.89	1.29	1.27	1.38
Rhetorical Skills	.87	.86	.88	1.16	1.16	1.20
Mathematics	.91	.90	.92	1.50	1.43	1.60
Pre-Algebra/Elementary Algebra	.84	.83	.85	1.41	1.35	1.44
Intermediate Algebra/Coordinate Geometry	.74	.72	.77	1.39	1.33	1.46
Plane Geometry/Trigonometry	.75	.71	.80	1.43	1.34	1.60
Reading	.88	.86	.90	2.09	1.95	2.21
Social Studies/Sciences	.81	.77	.82	1.52	1.46	1.67
Arts/Literature	.79	.77	.82	1.67	1.55	1.77
Science	.83	.80	.85	2.06	1.95	2.24
Composite	.96	.96	.97	0.93	0.92	0.95

(*Text continued from p.* 53.)

Other definitions of the contribution of a test score to a composite score may be more useful. Wang and Stanley (1970) described *effective weights* as an index of the contribution of a test score to a composite score. Specifically, the effective weight is defined as the covariance between a test score and the composite score. These covariances can be summed over tests and then each covariance divided by their sum (i.e., the composite variance) to arrive at *proportional effective weights*. Proportional effective weights are referred to as effective weights in the remainder of this discussion.

The covariances and effective weights are shown in Table 4.14 for the 1995 nationally representative sample (results for the 1995 sample are based on the scores achieved by examinees who were allowed to use calculators). Covariances and effective weights are presented for all twelfth-grade examinees (national) and for college-bound examinees. The values in the diagonals that are not in brackets are the observed scale score variances (the diagonal values in brackets are the true scale score variances). With nominal weights of .25 for each test, the effective weight for a test can be calculated by summing the values in the appropriate row that are not in brackets and dividing the resulting value by the sum of all covariances among the four tests using the formula

$$\text{(effective weight)}_i = \frac{\sum_j \text{cov}_{ij}}{\sum_i \sum_j \text{cov}_{ij}} \, ,$$

where cov_{ij} is the observed covariance of test scores corresponding to row i and column j for each form. Effective weights for true scores, shown in brackets in Table 4.14, are calculated similarly, with the true score variance $[S_i^2 \cdot \text{REL}_i]$ used in place of the observed score variance.

The effective weights for the English and Reading Tests are the largest of the effective weights. They are relatively high because the English and Reading Tests had the largest scale score variances and because their covariances with the other measures tended to be the highest. These effective weights imply that the English and Reading Tests are more heavily weighted (relative to Composite score variance) in forming the Composite score than are the Mathematics and Science Tests. Note that these effective weights are for the nationally representative samples and that the weights might differ considerably from those for other examinee groups.

Table 4.15 shows the range of effective weights for the six national ACT administrations in 2011-2012. The data in Table 4.15 are based on systematic samples of approximately 2,000 examinees per national administration who took the ACT in the 2011-2012 school year. Table 4.15 shows that the effective weights differ from the nominal weights of .25 per test in a manner similar to the effective weights reported in Table 4.14 and that they remain fairly stable across test dates.

Table 4.16 shows the strength of the relationships among scale scores for the four tests. These median correlations are based on the 2,000-examinee samples from the 2011-2012 national administrations.

Table 4.14

Scale Score Covariances, Effective Weights, and Reliability Coefficients by Test for the 1995 Nationally Representative Sample

(Numbers in brackets relate to true scores.)

	English	Mathematics	Reading	Science
Number of items	75	60	40	40
Proportion of total items	.35	.28	.19	.19
National scale score				
English	42.49 [39.24]	23.14	37.41	25.62
Mathematics	23.14	23.89 [21.60]	22.21	18.61
Reading	37.41	22.21	52.24 [46.00]	29.30
Science	25.62	18.61	29.30	30.78 [26.25]
Effective weight	.28 [.28]	.19 [.19]	.31 [.30]	.23 [.22]
Reliability	.92	.90	.88	.85
College-Bound scale score				
English	41.13 [37.82]	22.19	36.93	24.67
Mathematics	22.19	24.45 [22.13]	21.61	18.43
Reading	36.93	21.61	53.65 [47.43]	29.32
Science	24.67	18.43	29.32	30.60 [26.02]
Effective weight	.27 [.28]	.19 [.19]	.31 [.31]	.23 [.22]
Reliability	.92	.91	.88	.85

Note. Values are based on one form only.

Table 4.15

Range of Effective Weights for the Six National ACT Administrations in 2011-2012

Test	Range of effective weights
English	.28–.29
Mathematics	.22–.23
Reading	.27–.28
Science	.21–.23

Table 4.16

Median Correlations Among Test Scale Scores for the Six National ACT Administrations in 2011-2012

	English	Mathematics	Reading	Science
English	1.00	.74	.80	.75
Mathematics		1.00	.66	.77
Reading			1.00	.74
Science				1.00

Chapter 5
Validity Evidence for the ACT Tests

Overview

According to the *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 1999), "validity refers to the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests" (p. 9). Arguments for the validity of an intended inference made from a test may contain logical, empirical, and theoretical components. A distinct validity argument is needed for each intended use of a test.

The potential interpretations and uses of ACT scores are numerous and diverse, and each needs to be justified by a validity argument. In this chapter, validity issues are discussed for five of the most common interpretations and uses: measuring college-bound students' educational achievement in particular subject areas, making college admissions decisions, making college course placement decisions, evaluating the effectiveness of high school college-preparatory programs, and evaluating students' probable success in the first year of college and beyond.

Measuring Educational Achievement

Content Validity Argument for ACT Scores

The ACT tests are designed to measure students' problem-solving skills and knowledge in particular subject areas. The usefulness of ACT scores for this purpose provides the foundation for validity arguments for more specific uses (e.g., course placement).

The guiding principle underlying the development of the ACT is that the best way to predict success in college is to measure as directly as possible the degree to which each student has developed the academic skills and knowledge that are important for success in college. Tasks presented in the tests must therefore be representative of scholastic tasks. They must be intricate in structure, comprehensive in scope, and significant in their own right, rather than narrow or artificial tasks that can be defended for inclusion in the tests solely on the basis of their statistical correlation with a criterion. In this context, content-related validity is particularly significant.

The ACT tests contain a proportionately large number of complex problem-solving exercises and few measures of narrow skills. The tests are oriented toward major areas of college and high school instructional programs, rather than toward a factorial definition of various aspects of intelligence. Thus, ACT scores, subscores, and skill statements based on the ACT College and Career Readiness Standards are directly related to student educational progress and can be readily understood and interpreted by instructional staff, parents, and students.

As described in Chapter 2, the test development procedures include an extensive review process with each item being critically examined at least sixteen times. Detailed test specifications have been developed to ensure that the test content is representative of current high school and university curricula. All test forms are reviewed to ensure that they match these specifications. Hence, there is an ongoing assessment of the content validity of the tests during the development process.

The standardization of the ACT tests is also important to their proper use as measures of educational achievement. Because ACT scores have the same meaning for all students, test forms, and test dates, they can be interpreted without reference to these characteristics.[1] The courses students take in high school and the grades they earn are also measures of educational achievement, but these variables are not standardized measures. They cannot be standardized because course content varies considerably among schools and school districts, and grading policies certainly vary among instructors. Therefore, while high school courses taken and grades earned are measures of educational achievement, their interpretation should properly take into account differences in high school curricula and grading policies. ACT scores, because they are standardized

[1] ACT scores obtained before October 1989, however, are not directly comparable to scores obtained in October 1989 or later. A new version of the ACT was released in October 1989 (the "enhanced" ACT). Although scores on the current and former versions are not directly comparable, approximate comparisons can be made using a concordance table developed for this purpose (American College Testing Program, 1989).

measures, are more easily interpreted than are courses taken and grades earned.

Comparison of Groups Differing in Educational Background

Table 5.1 provides information from the 1988 nationally representative sample of ACT-tested students (ACT, 1997) about the relationship among scores, academic level, and educational plans. In this table, the means for the college-bound group are higher than the means for the national group for all four test scores, seven subscores, and the Composite score. This finding indicates that, as expected, ACT scores are related to educational plans: Students with higher educational aspirations earn higher scores. Also as expected, ACT scores are related to grade level: Examinees in higher grades earn higher test scores.

Groups of examinees who were presumed to differ in their educational achievement for reasons other than grade level were also compared. Examinees in the Academic Skills Study were asked to indicate the number of high school English and mathematics courses they had taken and/or planned to take. For first-semester seniors, this information should provide fairly accurate indications of how many courses they had taken or were enrolled in (as contrasted to how many courses they planned to take). Of the 5,058 twelfth-grade examinees, only 50 had invalid or missing responses to the item concerning English courses, and only 63 had invalid or missing responses to the item concerning mathematics courses. For each item, the remaining examinees were grouped into three categories: those who had taken and/or planned to take 3½ or more years of the subject, those who had taken and/or planned to take 2½ or 3 years of the subject, and those who had taken and/or planned to take 2 years or less of the subject.

Table 5.2 displays the ACT scale score means and standard deviations for the three groups of twelfth-grade students by years of English and mathematics coursework taken/planned to take. For the ACT English Test, the largest score differences are, not unexpectedly, between those who have taken and/or are planning to take at least 3½ years of English and those who have taken and/or are planning to take 2 years or less. Those who have taken and/or are planning to take between 2½ and 3 years performed more similarly to the 2-year-or-less group than to the 3½-or-more group. This pattern is also true for the ACT Mathematics Test. Results are presented in more detail in Harris and Kolen (1989).

These findings—that students who have taken and/or plan to take more English and mathematics courses (and in the fall of twelfth grade, students can plan for only one semester of courses at most) have higher English and Mathematics Test scores and subscores—support the interpretation that the ACT is a curriculum-based test. However, it is also conceivable that able examinees take more English and mathematics classes and score higher on all types of English and mathematics tests. This hypothesis is examined later in this chapter.

Table 5.1
Scale Score Means and Standard Deviations of ACT Tests by Grade Level for the 1988 Nationally Representative Sample

Test/Subtest	Number of items	Grade 10 Mean	Grade 10 SD	Grade 11 Mean	Grade 11 SD	Grade 12 Mean	Grade 12 SD
National							
English	75	15.27	4.42	16.24	4.82	17.18	5.30
Usage/Mechanics	40	7.29	2.94	7.90	3.14	8.50	3.42
Rhetorical Skills	35	7.56	2.48	8.08	2.72	8.56	2.98
Mathematics	60	15.68	2.86	16.63	3.58	17.44	4.45
Pre-Algebra/Elementary Algebra	24	7.45	2.65	8.07	2.90	8.56	3.31
Intermediate Algebra/Coordinate Geometry	18	7.88	2.14	8.25	2.38	8.77	2.73
Plane Geometry/Trigonometry	18	7.76	2.36	8.41	2.56	8.73	2.85
Reading	40	14.94	5.33	16.17	5.89	17.18	6.42
Social Studies/Sciences	20	7.61	2.70	8.14	2.98	8.66	3.22
Arts/Literature	20	7.03	4.02	7.86	4.34	8.40	4.52
Science	40	16.31	3.71	16.91	3.93	17.48	4.34
Composite		15.67	3.51	16.61	3.99	17.45	4.54
College-Bound							
English	75	15.86	4.44	16.91	4.84	18.01	5.27
Usage/Mechanics	40	7.65	2.97	8.29	3.18	9.01	3.40
Rhetorical Skills	35	7.89	2.48	8.47	2.71	9.00	2.98
Mathematics	60	16.00	2.92	17.05	3.67	18.00	4.56
Pre-Algebra/Elementary Algebra	24	7.78	2.67	8.44	2.90	9.00	3.32
Intermediate Algebra/Coordinate Geometry	18	8.01	2.11	8.40	2.41	9.00	2.78
Plane Geometry/Trigonometry	18	7.85	2.39	8.59	2.60	9.02	2.87
Reading	40	15.59	5.38	16.92	5.93	18.01	6.47
Social Studies/Sciences	20	7.84	2.77	8.40	3.06	8.98	3.30
Arts/Literature	20	7.52	4.06	8.45	4.35	9.00	4.53
Science	40	16.72	3.74	17.36	3.98	17.99	4.41
Composite		16.17	3.54	17.18	4.02	18.13	4.56

Table 5.2
Means and Standard Deviations for ACT Scores and Subscores: Grade 12 National Groups by Years of English and Mathematics Coursework Taken and/or Planned to Take

	ACT Test/Subtest																
Years of course-work		English		Usage/ Mechanics		Rhetorical Skills			Mathematics		Pre-Algebra/ Elementary Algebra		Intermediate Algebra/ Coordinate Geometry		Plane Geometry/ Trigonometry	
	N[a]	Mean	SD	Mean	SD	Mean	SD	N[a]	Mean	SD	Mean	SD	Mean	SD	Mean	SD
≤ 2	126	13.3	3.28	6.0	2.26	6.6	1.86	758	14.6	2.37	6.3	2.12	7.7	2.16	7.4	2.13
2½–3	221	14.6	4.06	7.0	2.70	7.1	2.40	1,642	16.1	2.98	7.7	2.61	8.1	2.19	8.0	2.44
≥ 3	4,661	17.5	5.32	8.7	3.44	8.7	3.00	2,595	19.4	4.91	10.0	3.41	9.6	2.95	9.7	2.99

[a]N-counts are actual numbers of examinees; means and standard deviations are computed on weighted data.

Statistical Relationships Between ACT Scores and High School Coursework and Grades

The ACT tests are oriented toward the general content areas of high school and college curricula. Students' performance on the ACT should therefore be related to the high school courses they have taken and to their performance in these courses.

The Course/Grade Information Section (CGIS) of the ACT collects information about 30 high school courses in English, mathematics, social studies, natural sciences, languages, and arts. Many of these courses form the basis of a high school college-preparatory curriculum and are frequently required for college admission or placement. For each of the 30 courses, students indicate whether they have taken or are currently taking the course, whether they plan to take it, or do not plan to take it. If they have taken the course, they indicate the grade they received (A–F). Self-reported coursework and grades collected with the CGIS have been found to be accurate relative to information provided on student transcripts (Sawyer, Laing, & Houston, 1988; Valiga, 1986).

ACT's recommended college preparatory core curriculum is defined as at least four years of English and at least three years each of mathematics, social studies, and natural sciences. As shown in Table 5.3, students who have taken or plan to take the core curriculum tend to achieve higher ACT scores than those who have not completed the core curriculum (ACT, 2013a). From 2008–2009 through 2012–2013, the ACT Composite scores of students who completed the core curriculum averaged between 2 to 3 scale score points higher than the scores of those who did not. Table 5.4 shows that those students who have higher course grades also tend to achieve higher ACT scores.

Noble, Davenport, Schiel, and Pommerich (1999a) showed that, in general, coursework and high school grades are strongly associated with performance on the ACT. In this study, the researchers investigated the relationships between the noncognitive characteristics, high school coursework and grades, and test scores of ACT-tested students.

Data. The data consisted of a stratified random sample of high school juniors and seniors who registered for the ACT either in April 1996 or October 1996. Stratification variables included school size and geographic region; only those schools for which at least 60 students registered for either of the two ACT test dates were included. All students tested within the selected schools were sent a questionnaire four weeks after the ACT was administered. The questionnaire was designed to collect information about students' attitudes and behaviors in several noncognitive areas including (a) reasons for attending college; (b) attitudes toward self, school, friends and family; (c) activities and interests; and (d) educational and family background. Of the original sample, 5,489 students from 106 schools completed and returned the questionnaire, for a response rate of 60%.

Method. Stepwise multiple regression was used to model five ACT test scores (English, Mathematics, Reading, Science, and Composite) using high school coursework and grades and noncognitive variables. Independent variables were grouped in blocks (see

Table 5.5 for the various block groupings denoted in bold font) and were allowed to differ across ACT score models. In order to be retained in the models, variables within the blocks were required to be statistically significant ($p < .01$) and noncollinear. Upon entry, each variable block was evaluated relative to the blocks preceding it; this procedure continued until all of the blocks were evaluated. Weighted analyses were utilized to correspond with the sampling design. For a more comprehensive description of the methods and questionnaire used in this study, see ACT Research Report Nos. 99-4 and 99-6 (Noble et al., 1999a,b).

Results. Multiple regression statistics for modeling ACT scores are reported in Table 5.5. Regression coefficients, total R^2, and standard errors of estimate (SEE) are reported by model for each ACT score. High school grade point average (GPA) was associated with a large percentage of the variance explained by the high school coursework blocks (25% to 38%). Of the 23 courses entered into the model, only mathematics, chemistry, and physics courses accounted for a statistically significant proportion of the variance in any of the ACT scores. This is not to say that other coursework taken, including English and social studies courses, was unrelated to ACT performance. In general, the other courses taken were collinear with mathematics and science courses, or they were either mostly taken or not taken by these students. High school GPA and coursework taken, in combination, explained between 30% and 55% of the variance in ACT scores. The models for the ACT Mathematics score and Composite score showed the greatest prediction accuracy, based on the total R^2 (.65 and .63, respectively; see also Figures 5.2 and 5.3).

The individual unstandardized regression coefficients reported in Table 5.5 can be interpreted as the average change (increase or decrease) in ACT scores associated with a one-unit change in an independent variable, given the other variables in the model. For example, as shown in Table 5.5, taking trigonometry was associated with an average ACT test score increase of more than 1.0 scale score point for each ACT test. Over and above the other variables in the models, taking a calculus course was associated with average ACT score increases of more than 2.0 scale score points on all ACT tests except Science. Taking chemistry was statistically significant ($p < .01$) only for the ACT Science score; taking physics was statistically significantly related to ACT Mathematics, Science, and Composite scores.

Summary. High school coursework, GPA, and high school attended were strongly associated with most ACT scores. In particular, whether students had or had not taken specific mathematics or science courses appeared to result in sizable mean ACT score differences. English and social studies courses were excluded from the models because of the limited variability in students' course taking in these subject areas and their collinearity with other variables, such as coursework taken in mathematics and science. The findings from this study are consistent with other studies (Noble & McNabb, 1989; Schiel, Pommerich, & Noble, 1996) that examined coursework, grade, and ACT score relationships.

Table 5.3

Average ACT Scores by Academic Preparation, 2009–2013

Academic preparation	Reference year	N	ACT score: English	Mathematics	Reading	Science	Composite
Core curriculum[a] or more completed	2008–09	1,039,502	21.7	21.9	22.3	21.7	22.0
	2009–10	1,118,639	21.6	21.9	22.2	21.7	22.0
	2010–11	1,202,164	21.5	21.8	22.0	21.6	21.9
	2011–12	1,259,744	21.3	21.8	22.0	21.6	21.8
	2012–13	1,322,739	21.2	21.7	22.0	21.5	21.7
Core curriculum[a] not completed	2008–09	391,458	18.3	18.9	19.4	19.2	19.1
	2009–10	397,685	18.1	18.9	19.2	19.0	18.9
	2010–11	366,518	18.3	19.0	19.3	19.0	19.0
	2011–12	355,849	18.3	19.1	19.4	19.1	19.1
	2012–13	396,592	17.8	18.9	19.0	18.8	18.7

[a] Core curriculum is defined here as four or more years of high school English and three or more years each of high school mathematics, social studies, and natural sciences.

Table 5.4

Average ACT Score by High School GPA Ranges, 2012–2013

Group	N	English Mean	English SD	Mathematics Mean	Mathematics SD	Reading Mean	Reading SD	Science Mean	Science SD	Composite Mean	Composite SD
All students	1,799,243	20.2	6.5	20.9	5.3	21.1	6.3	20.7	5.3	20.9	5.4
HS GPA:											
3.50–4.00	626,008	24.4	5.8	24.4	5.0	24.8	5.8	23.9	4.8	24.5	4.8
3.00–3.49	433,214	19.6	5.4	20.2	4.3	20.6	5.4	20.3	4.5	20.3	4.3
2.50–2.99	257,138	17.0	5.0	18.1	3.6	18.3	5.0	18.3	4.3	18.1	3.8
2.00–2.49	146,003	15.2	4.7	16.8	3.0	16.6	4.7	16.9	4.2	16.5	3.5
1.99 and below	65,943	13.7	4.4	16.0	2.5	15.3	4.4	15.7	3.9	15.3	3.2

Table 5.5
Weighted Regression Statistics for Modeling ACT Scores

	ACT score				
	English	**Mathematics**	**Reading**	**Science**	**Composite**
Intercept	5.11	9.28	8.64	10.81	8.03
High school GPA in 4 core areas[a]	3.27	2.63	3.24	2.39	2.93
Core courses (taken/not taken)					
Algebra 2	0.87	0.95	0.94	–	0.86
Geometry	1.38	1.13	–	0.87	0.79
Trigonometry	1.25	1.97	1.09	1.08	1.38
Calculus	2.04	3.48	2.27	1.77	2.39
Other math beyond Algebra 2	0.51	1.26	0.71	0.55	0.77
Chemistry	–	–	–	0.82	–
Physics	–	0.99	–	0.76	0.66
Education-related factors					
College-prep curriculum (taken/not taken)	1.13	0.46	1.05	0.62	0.80
Need help with math skills (yes/no)	–	–1.43	–	–0.39	–
Need help with reading (yes/no)	–1.70	–	–2.66	–1.03	–1.35
Need help with writing skills (yes/no)	–0.77	–	–	–	–0.31
Activities (hours per week)					
Educational activities	1.62	–	2.45	–	1.07
Quadratic term	–0.51	–	–0.65	–	–0.29
Homework	–	–	–1.12	–	–
Quadratic term	–	–	0.18	–	–
Background variables					
Parents' level of education	0.28	0.20	0.28	0.21	0.24
Primary language at home is English (yes/no)	1.94		1.91	1.12	1.20
Background variables					
Perception of self – General anxiety	–0.71	–0.49	–1.01	–0.68	–0.74
Total R^2	.52	.65	.47	.50	.63
SEE	2.09	1.64	2.45	1.80	1.59

Note. Regression coefficients for all achievement and noncognitive variables were statistically significant ($p < .01$).
[a]Average of course grades in 23 core courses in English, mathematics, natural sciences, and social studies.

Coursework Associated With Longitudinal Educational Achievement, as Measured by ACT Plan and ACT Scores

ACT research has shown that taking rigorous, college-preparatory mathematics courses is associated with higher ACT Mathematics and Composite scores. (e.g., ACT, 2005a; Noble, Davenport, & Sawyer, 2001; Noble, Roberts, & Sawyer, 2006). Schiel, Pommerich, and Noble (1996) statistically controlled for prior achievement using ACT Plan scores and found substantive increases in average ACT Mathematics and Science scores associated with taking upper-level mathematics and science courses. In a recent study (Noble & Schnelker, 2007; ACT, 2005b) researchers examined the effects of taking specific high school course sequences on students' ACT performance in English, Mathematics, and Science based on data for students who had taken both ACT Plan and the ACT.

Data and method. Data for 403,381 students representing 10,792 high schools were analyzed. The ACT Plan/ACT cohort file for the 2003 graduating class contained matched records of students who completed ACT Plan during their sophomore year (2000–2001) and the ACT during their junior or senior year, prior to graduating in 2003. If students took the ACT more than once, only the most recent ACT record was used. Each record included ACT Plan and ACT scores (in English, Mathematics, and Science), race/ethnicity, grade level at the time of taking the ACT, self-reported coursework information from the CGIS, and high school attended. Dummy variables were used to represent specific course sequences; the course sequences were based on previous research (ACT, 2004; Noble et al., 1999a,b) and were constructed such that the incremental benefit of specific courses could be determined.

Hierarchical regression modeling was used to examine the effects of taking specific high school course sequences on students' ACT scores. Hierarchical regression models account for variability in regression coefficients across schools in order to draw correct conclusions about predictor-outcome relationships. In these analyses, student-level regression coefficients were allowed to vary across high schools.

All effects were examined in the context of the high schools students attended, and prior achievement (i.e., ACT Plan scores) and students' grade level at the time of ACT testing were statistically controlled in the models. A more detailed discussion concerning the data and methods used, including a more in-depth discussion of hierarchical regression, is in Noble and Schnelker (2007).

Results. Pearson correlation coefficients between pairs of ACT Plan and ACT scores ranged from .56 (ACT Plan Reading–ACT Math) to .88 (ACT Plan–ACT Composites). These statistics are reported in Table 5.6 and suggest that students with high ACT Plan scores tend also to have high ACT scores, on average.

The results of the hierarchical linear regression models are shown in Table 5.7. The table includes the unstandardized regression coefficients for each variable in each model; all regression coefficients were statistically significant ($p < .01$) unless otherwise noted. Overall, about .60 of the variance in students' ACT English scores, between .50 and .60 of the variance in students' ACT Mathematics scores, and between .30 and .50 of the variance in students' ACT Science scores were explained by the models. High school attended explained .16 to .25 of the variance across ACT scores (intraclass correlations; Noble & Schnelker, 2007).

For all models, ACT Plan scores were positively related to ACT scores. A 1-point increase in ACT Plan English score corresponded to about a 1.0-point increase in ACT English score, and a 1-point increase in ACT Plan Mathematics or Science score corresponded to about a 0.8-point increase in ACT Mathematics or Science score, respectively. Moreover, high school seniors, on average, scored about 0.3 points higher on ACT English, about 0.5 to 0.7 points lower on ACT Mathematics, and about 0.1 to 0.5 points lower on ACT Science than did juniors.

Taking one or more foreign languages, over and above English 9–11, increased students' ACT English score, on average, by 1.1 score points, compared to taking only English 9–11. Taking Algebra 1, Algebra 2, and Geometry was associated with an average ACT Mathematics score increase of about 1.1 score points, compared with taking less than these three courses. Taking either Trigonometry or Other Advanced Mathematics, over and above these three courses, resulted in an average increase in ACT Mathematics score of 1.0 to 1.5 score points. Taking Other Advanced Mathematics and Trigonometry, or Trigonometry and Calculus, increased ACT Mathematics scores, on average, by more than 2.0 score points. The greatest average score increase associated with mathematics coursework resulted from taking Other Advanced Mathematics, Trigonometry, and Calculus, in addition to Algebra 1, Geometry, and Algebra 2 (3.2 score points).

Compared with taking General Science only, taking General Science and Biology, or Biology alone, resulted in an average ACT Science score increase of about 0.5 points. Taking Biology and Chemistry, or Biology, Chemistry, and Physics, was associated with an average ACT Science score increase of 1.3 and 2.4 score points, respectively, compared to taking Biology only.

Summary. These results indicate that, in a typical high school, students who take upper-level mathematics or science courses (e.g., trigonometry, calculus, chemistry, or physics) can expect, on average, to earn meaningfully higher ACT Mathematics and Science scores than students who do not take these courses. The benefits of coursework taken in high school for increasing ACT performance depend on the high school students attend, regardless of prior achievement and grade level at testing. The relationships between coursework taken and ACT performance are also influenced by the characteristics of schools. A detailed description of these results is provided in Noble and Schnelker (2007).

Table 5.6
Correlation Coefficients
Among ACT Scores and ACT Plan **Scores**
(Based on data pooled over high schools, N = 403,381)

	ACT score				
ACT Plan **score**	**English**	**Mathematics**	**Reading**	**Science**	**Composite**
English	.81	.65	.73	.67	.80
Mathematics	.67	.82	.61	.72	.78
Reading	.68	.56	.71	.61	.72
Science	.62	.65	.60	.67	.71
Composite	.82	.78	.78	.78	.88

Table 5.7
Hierarchical Linear Regression Coefficients
for Modeling ACT Scores

		Regression coefficient				
Model	**Coursework comparison**	**Intercept**	**ACT Plan score**	**Grade level**	**Course-work**	**Level 1 R^2**
ACT English score						
1	English 9–11 & 1 or more foreign languages vs. English 9–11	1.33	0.99	0.32	1.12	.60
ACT Mathematics score						
1	Algebra 1, Algebra 2, and Geometry vs. less than these courses	5.03	0.75	−0.45	1.07	.52
	Algebra 1, Algebra 2, and Geometry vs.					
2	Algebra 1, Algebra 2, Geometry & Other Advanced Math	5.65	0.79	−0.66	1.01	.52
3	Algebra 1, Algebra 2, Geometry & Trig	5.63	0.79	−0.70	1.52	.59
4	Algebra 1, Algebra 2, Geometry, Trig & Other Advanced Math	5.91	0.78	−0.72	2.02	.60
5	Algebra 1, Algebra 2, Geometry, Trig & Calculus only	5.84	0.78	−0.62	2.91	.60
6	Algebra 1, Algebra 2, Geometry, Other Advanced Math, Trig & Calculus	5.90	0.77	−0.62	3.16	.63
ACT Science score						
1	Biology vs. General Science	4.70	0.78	−0.07*	0.46	.28
	Biology vs.					
2	Biology & Chemistry	4.26	0.83	−0.43	1.29	.37
3	Biology, Chemistry & Physics	4.23	0.84	−0.48	2.41	.47

*p > .01.

Differential Performance by Racial/Ethnic and Gender Groups

The issues of equity and fairness are important concerns of educators. Researchers have examined the relative effects of coursework, course grades, student and high school characteristics, and educational plans on ACT performance by race/ethnicity and/or gender (e.g., Noble, Crouse, Sawyer, & Gillespie, 1992; Noble & McNabb, 1989; Chambers, 1988). Their findings suggest differential performance may be largely attributable to differential academic preparation across racial/ethnic or gender groups.

Table 5.8 shows, by racial/ethnic group, the percentage of 2012–2013 ACT-tested high school graduates who completed a college-preparatory core curriculum, the percentage who had high school GPAs of 3.0 or higher, and the average ACT Composite scores for core completers and noncompleters. Students for whom the core indicator was missing were excluded from the calculations presented in the table. The results indicate that relatively higher ACT Composite scores are associated with students who completed a core curriculum, regardless of their race/ethnicity. For these students, mean ACT Composite scores ranged from 17.5 (for African American/Black students) to 24.1 (for Asian students). For students who did not complete a core curriculum, mean ACT Composite scores ranged from 15.6 (for African American/Black students) to 21.5 (for Asian students). The ACT Composite means of males and females for six years are displayed in Figure 5.1. ACT Composite averages were slightly higher for males than for females for most years; averages for both groups are relatively stable across years.

Results from a study by Noble, Davenport, Schiel, and Pommerich (1999b; see also pages 67–68 in this manual for a description of the study) supported the hypothesis that differential performance on the ACT results from differential academic preparation, regardless of race/ethnicity or gender. This study investigated the extent to which noncognitive characteristics explained differential ACT performance of racial/ethnic and gender groups, over and above high school grades, courses taken, and high school attended.

In this study, about 50% to 65% of the variability in ACT scores was attributable to specific coursework taken and grades earned in high school, education-related factors, educational activities, background characteristics, perception of self, high school attended, and race/ethnicity or gender (see Figures 5.2 and 5.3; variables were entered into each model in the order specified in the figure legends). About 30% to 55% of the variability in ACT scores was attributable to specific coursework taken and the high school GPA in 4 core areas. As illustrated in Figures 5.2 and 5.3, high school GPA contributed substantially to the explained variance. The additional explained variability resulted from background characteristics, educational-related factors and activities, perception of self (5%–13%), and high school attended (4%–7%). No more than 2% of additional variability was associated with race/ethnicity or gender (Table 5.9).

Table 5.8
Descriptive Statistics for ACT Composite Scores by Racial/Ethnic Group, 2012–2013

Ethnic group	% with core or more	% with HS GPA ≥ 3.0	Average Composite score: Core or more	Average Composite score: Less than core
Black/African American	69	48	17.5	15.6
American Indian/Alaska Native	62	55	19.1	16.5
White	76	75	22.9	20.0
Hispanic/Latino	72	63	19.5	17.2
Asian	81	87	24.1	21.5
Native Hawaiian/Other Pac. Isl.	71	66	20.5	17.5
Two or more races	74	68	21.9	19.2

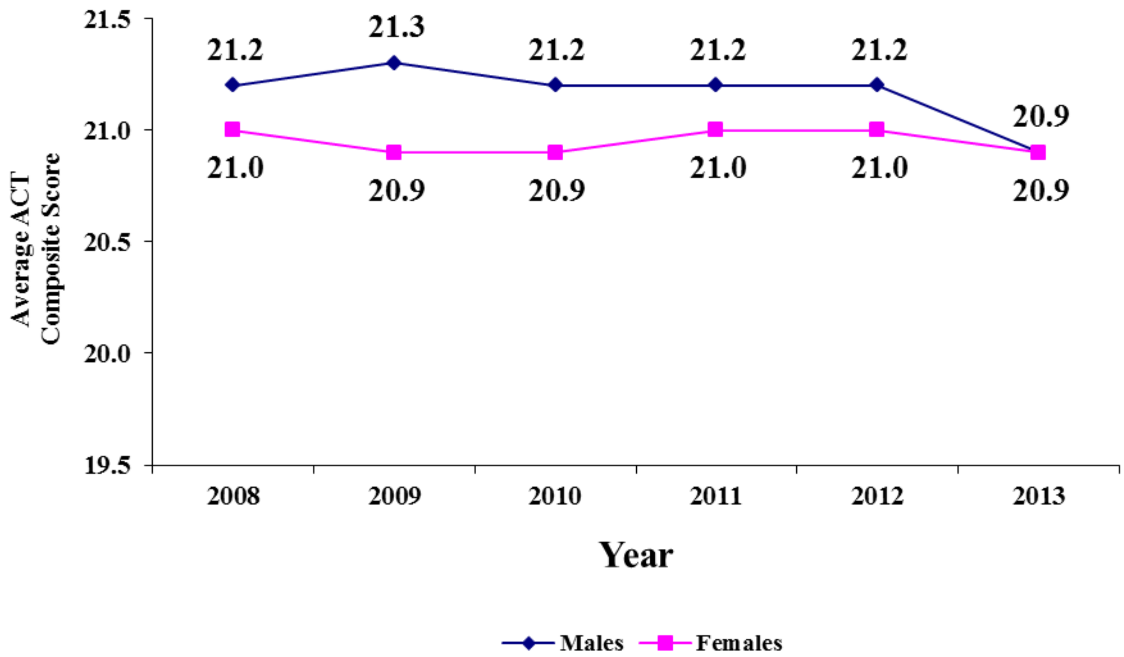


Figure 5.1. Average ACT Composite scores by gender, 2008–2013.

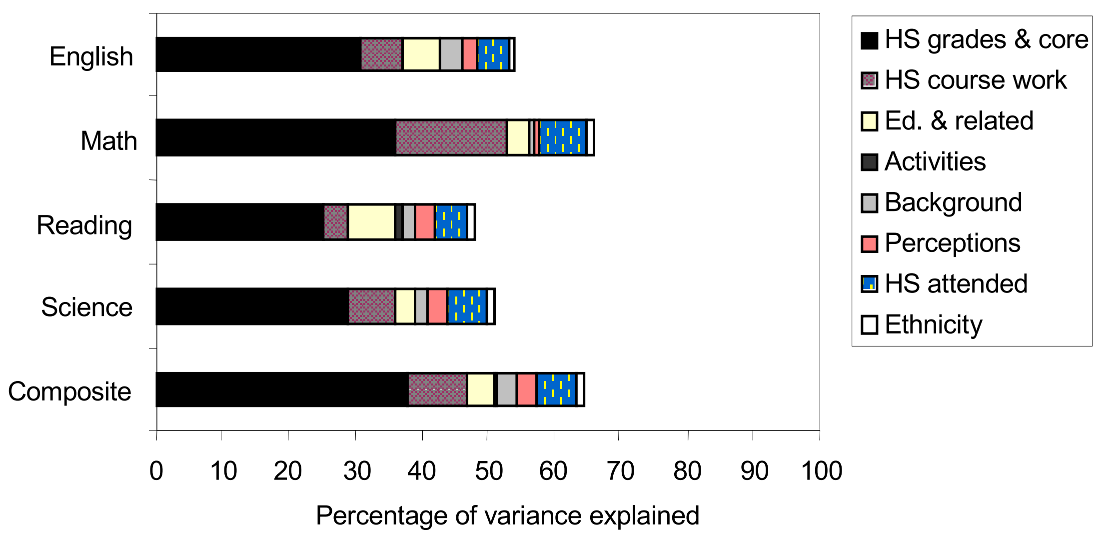


Figure 5.2. Percentage of variance in ACT scores associated with high school GPA in four core areas, high school coursework taken, education-related factors, educational activities, background characteristics, perception of self, high school attended, and race/ethnicity.

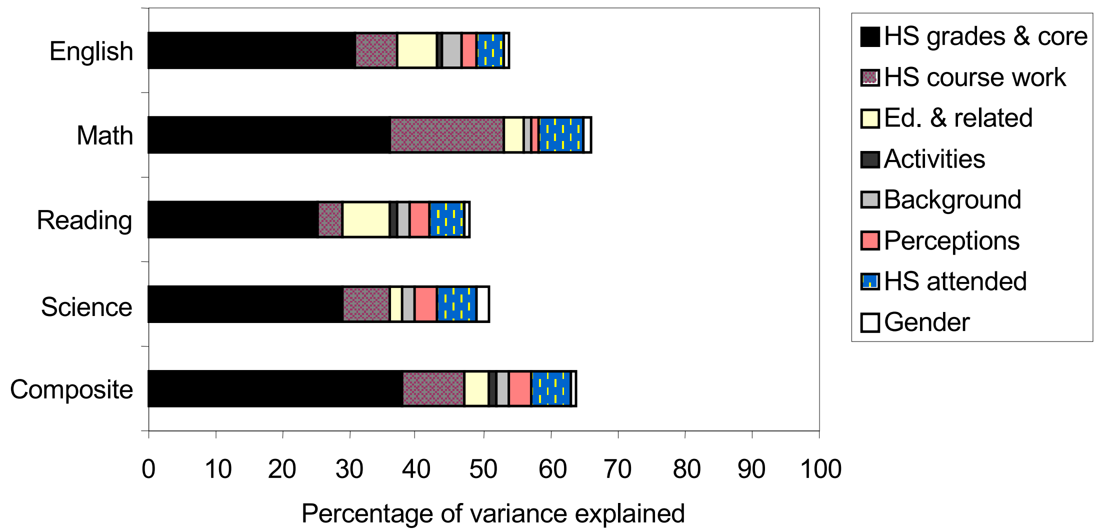


Figure 5.3. Percentage of variance in ACT scores associated with high school GPA in four core areas, high school coursework taken, education-related factors, educational activities, background characteristics, perception of self, high school attended, and gender.

Table 5.9
Weighted Regression Statistics for Race/Ethnicity and Gender From ACT Score Models

	ACT score				
Regression coefficient	**English**	**Mathematics**	**Reading**	**Science**	**Composite**
Race/Ethnicity					
African American vs. Caucasian American	–1.90	–1.49	–2.22	–1.54	–1.81
Hispanic/Native American vs. Caucasian American	–0.68	–0.80	–0.18*	–0.80	–0.57
Asian American vs. Caucasian American	–0.71*	0.54	–0.76*	–0.49*	–0.28*
Other vs. Caucasian American	–0.91	–0.42*	–1.02	–0.91	–0.85
Increase in Total R^2 for Race/Ethnicity	.01	.01	.01	<.01	.01
Gender					
Female vs. Male	0.36	–1.11	0.08*	–1.50	–0.57
Increase in Total R^2 for Gender	<.01	.01	<.01	.02	<.01

Note. Regression coefficients for race/ethnicity and gender were statistically significant ($p < .05$) unless marked with an asterisk (*). Adjustment was made for cognitive and noncognitive factors shown in Table 5.5 that were statistically significant ($p < .01$). Race/ethnicity and gender were evaluated in separate models.

Table 5.9 presents the individual unstandardized regression coefficients for each racial/ethnic group compared to Caucasian American students and for females compared to males, after adjusting for the other significant achievement and noncognitive factors (presented in Table 5.5). Statistically controlling for these other variables resulted in substantial reductions in mean ACT score differences among racial/ethnic groups: mean score differences between African American students and Caucasian American students were reduced by 58% (Reading) to 69% (Mathematics), mean differences between Hispanic/Native American students and Caucasian American students were reduced by 39% (Mathematics) to 87% (Reading), and mean differences between the Other racial/ethnic group and Caucasian American students were reduced by 40% (Science) to 55% (English). Although Asian American students had an unadjusted mean Mathematics score more than 2.0 scale score units higher than that of Caucasian American students, this difference was reduced by 75% when adjusted for the variables in the model. For gender, unadjusted mean ACT Mathematics, Science, and Composite scores of females were statistically significantly ($p < .05$) lower than those of males. However, when adjusted for the variables shown in Table 5.5, these mean differences were reduced by 20%, 2%, and 14%, respectively.

Longitudinal performance. A study by Schiel, Pommerich, and Noble (1996) found that ACT score differences for selected population groups were reduced when ACT Plan scores, coursework taken, majority/minority ethnic group membership, and family income were statistically controlled. This study focused on cohort achievement and specific course-taking patterns using longitudinal student data (i.e., students who had taken both ACT Plan and the ACT). Data for 73,818 students representing 1,174 high schools were analyzed. Each student record contained ACT Plan scores earned in fall 1991 and ACT scores earned during the student's junior or senior year, prior to graduating in 1994. Regression models (in which the five ACT scores were each regressed on the corresponding ACT Plan Composite, English, Mathematics, Reading, and Science scores) were developed using data pooled across all schools. English and social studies coursework taken were minimally related to ACT English and Reading scores, over and above ACT Plan Composite scores, primarily because nearly all students had taken the English courses and selected social studies courses. In the case for ACT-tested juniors, they would not have taken twelfth-grade English and social studies courses by the time they took the ACT. Therefore, only ACT Plan Composite was included as the independent variable in the models for ACT English and Reading. Because the effect of the independent variables varied across schools, all regression models were developed within schools. Regression coefficients were then summarized across schools using median values. For further details concerning the methodology, see the full research report (Schiel et al., 1996).

Gender. Table 5.10 shows regression coefficients for gender and majority/minority ethnic group membership when these variables were used singly to model ACT scores, and when they were included with other independent variables. The regression coefficients associated with gender reflect the typical adjusted mean difference in the ACT scores between males and females, when all other variables were statistically controlled. The sign (–) of the regression coefficient for gender simply reflects its arbitrary coding (females = 1, males = 0). Males, on average, had higher mean ACT Mathematics, Science, and Composite scores than did females when ACT Plan score, coursework, family income, and majority/minority ethnic group membership were statistically controlled. Median average score differences for these models ranged from 0.60 (Composite) to 1.51 scale score points (Science). ACT Reading scores of males were also higher than those of females when ACT Plan score, family income, and majority/minority ethnic group membership were statistically controlled. Females, however, typically had higher average ACT English scores than did males when ACT Plan score, family income, and majority/minority ethnic group membership were statistically controlled (median average score difference = 0.53).

Gender differences in performance were, in fact, reduced when other background and coursework variables were statistically controlled. As shown in Table 5.10, when gender was included as the only independent variable in the ACT Mathematics model (i.e., ACT Plan score, background variables, and coursework variables were not statistically controlled), the median regression coefficient associated with this variable was relatively large (1.58 vs. 0.64). In other words, the typical ACT Mathematics mean for males was 1.58 scale score points higher than that for females when ACT Plan score, background variables, and coursework variables were not statistically controlled. When these variables were statistically controlled, this difference decreased to 0.64 scale score point.

Table 5.10
Median Regression Coefficients for Gender and Majority/Minority Ethnic Group Membership

ACT score	Median regression coefficients: Gender only	Gender, given coursework taken,[a] majority/minority membership, family income, & ACT Plan score	Majority/minority membership only	Majority/minority membership, given coursework taken,[a] family income, & ACT Plan score
English	0.57	0.53	2.52	0.48
Mathematics	−1.58	−0.64	2.14	0.42
Reading	−0.07	−0.11	2.81	0.36
Science	−1.56	−1.51	2.48	0.67
Composite	−0.67	−0.60	2.42	0.48

[a] Coursework variables were not included in ACT English and Reading models.

Findings for ACT Science and Composite models, summarized in Table 5.10, indicated that gender differences in performance were somewhat reduced by statistically controlling for ACT Plan score and background and coursework variables. The same was true for ACT English scores when statistically controlling for ACT Plan score and background variables. The reductions for these three models were much smaller than that for the Mathematics model, however. Findings for the Reading model, on the other hand, indicated a very slight increase in average score differences by gender when ACT Plan score and background variables were statistically controlled.

Race/ethnicity and income. Caucasian American/White students typically had higher mean ACT scores than did racial/ethnic minority students when ACT Plan score, coursework taken (ACT Mathematics, Science, and Composite models only), gender, and family income were statistically controlled. The median differences in average score ranged from 0.36 (Reading) to 0.67 (Science) scale score points (see Table 5.10). When majority/minority ethnic group membership was used singly to model ACT scores, typical average ACT score differences were considerably larger, ranging from 2.14 (Mathematics) to 2.81 (Reading) scale score points. This suggests that the other variables included in the models played a significant role in diminishing the effects of differential ACT performance between majority and minority ethnic groups.

Family income level contributed very little to average ACT performance differences when ACT Plan score, coursework taken, gender, and majority/minority ethnic group membership differences were statistically controlled. Typical average ACT score differences between family income levels did not exceed 0.08 scale score point in any of the models.

Summary. The models examined in this study (Schiel et al., 1996) provide some insight into differences in ACT performance for different population groups. The results show that ACT performance differences, particularly on the Mathematics Test, are reduced for males and females when ACT Plan score, coursework taken, majority/minority membership, and family income are considered. Similarly, ACT score differences between Caucasian American/White students and racial/ethnic minority students are considerably reduced when ACT Plan score, coursework taken, gender, and family income are considered. It is likely that other important, noncognitive variables could reduce these differences further.

Family income level contributed minimally to average ACT performance differences when controlling for ACT Plan score, coursework taken, and background variables. This suggests that most of the sources of ACT performance differences among students with varying income backgrounds were identified in this study through other independent variables.

Statistical Relationships Between ACT Scores and Student Profile Section Items

Students are asked to provide information about their background, interests, needs, and plans in the Student Profile Section (SPS) of the ACT. Correlations were calculated between selected variables and ACT scores for the 2013 ACT-tested graduating class. As shown in Table 5.11, students with higher ACT scores tended to describe their high school curriculum as college-preparatory in nature ($r = .30$ to $.35$), and to aspire to higher educational levels ($r = .30$ to $.35$). Those who reported needing help with their reading ($r = .02$ to $.19$), study skills ($r = .07$ to $.09$), and math skills ($r = .09$ to $.27$) tended to have lower ACT scores.

The correlation between family income and the ACT scores ranged from .34 to .41. However, ACT research (e.g., Noble et al., 1992; Schiel et al., 1996) found that family income was associated with less than 1% of the explained variance in the ACT scores when coursework taken, grades, high school attended, and background characteristics were statistically controlled. These results support the hypothesis that variation in scores by family income reflects differences in the quality of education, type of school, and other related variables.

Statistical Relationships Between ACT Scores and Noncognitive Factors

A study by Noble, Davenport, Schiel, and Pommerich (1999a,b; see also pages 67–68 in this manual) examined the relationships between a comprehensive set of students' noncognitive characteristics, high school coursework taken and grades earned, and ACT scores, with emphasis on students' attitudes and perceptions and their contribution to explaining ACT performance.

Data. Measures of students' attitudes and behavior included the following: (a) attitudes toward self, school, friends, and family, (b) activities and interests, and (c) educational and family background. Self-perception encompassed a general self-confidence factor, a healthy living habits factor, a general anxiety factor, a school value factor and a positive attribution factor. The school value factor appeared to measure a student's belief that participation in school tasks is important, relevant, and valuable. Attitudes toward school, friends, and family were summarized by the following five factors: a "perception of teachers" factor, a "perception of counselors" factor, a "perception of parental attitudes" factor, a "perception of friends' attitudes" factor, and a factor reflecting perceptions of parental pressure to participate in school athletics. The activities-related variables described the typical amount of time the student participated in various activities, such as work, athletics, watching TV, and studying. Background characteristics

Table 5.11

Correlations Among ACT Scores and Background Characteristics

	Educational needs, plans, and courses taken				
			Need for help in[c]		
ACT Score	College-preparatory curriculum[a]	Educational plans[b]	Reading	Study skills	Mathematics
English	.34	.33	.14	.08	.12
Mathematics	.32	.33	.02	.09	.27
Reading	.30	.31	.19	.07	.09
Science	.30	.30	.09	.08	.18
Composite	.35	.35	.13	.09	.18

Note. All p-values ≤ .0001.

[a] Responses were coded 1 (college preparatory) and 0 (business or commercial, vocational-occupational, other or general).

[b]Responses were coded 1 to 5 (voc-tech program, associate degree, bachelor degree, 1 to 2 years of grad program, professional degree).

[c]Responses were coded 1 (do not need assistance) and 0 (need assistance).

included information about the total number of children and of adults living in the student's home, information about the educational backgrounds of students' parents/guardians, and the number of negative situations in the home, such as serious health problems, family discord, and financial difficulty.

Results. The four sets of noncognitive variables (education-related factors, activities, background characteristics, and perceptions of self) together accounted for 5% to 13% of the variance in ACT scores, over and above the variance accounted for by high school grades and high school coursework taken (shown in Figures 5.2 and 5.3 and Table 5.5). None of the variables pertaining to perceptions of school or perceptions of home and friends met the criteria for inclusion in the final models. The education-related factors that were found to be related to ACT performance included being enrolled in a college-preparatory curriculum and needing help with mathematics skills, reading skills, or writing skills. Students indicating a need for help with mathematics skills, reading skills or writing skills tended to have lower ACT scores, on average, than those not needing help, as indicated by the negative regression coefficients. Hours spent on educational activities and hours spent on homework were the only activity variables that met the criteria for inclusion in any of the models. Though the relationship between ACT scores and educational activities was moderately positive for students spending 0 to 10 hours per week on educational activities, ACT scores tended to decline for students spending more than 10 hours on educational activities, thereby necessitating the inclusion of a quadratic term. Among the family background variables, parents' level of education and whether English was the primary language in the home explained only 1% to 3% of the variance in ACT scores, over and above the other variables in the models. Perceived general anxiety was the only perception variable that appeared related to all ACT scores, over and above other variables in the model. It accounted for 1% to 3% of the variance in ACT scores. As perceived anxiety increased by 1 unit, ACT scores decreased, on average, by 0.5 to 1.0 scale score points.

Summary. The contribution of selected noncognitive variables for explaining ACT performance, relative to coursework taken, grades, and high school attended was small (i.e., less than 15%). However, by themselves students' noncognitive characteristics explained 12% to 31% of the variance in high school GPA and coursework taken (for further details, see ACT Research Report No. 99-4, Noble et al., 1999a). These results suggest that noncognitive characteristics influence students' choices of high school coursework and the grades they earn in those courses, which, in turn, are strongly related to ACT scores.

Validity Evidence for ACT's College Readiness Benchmarks

In the spring of 2003, a study by Allen and Sconing (2005) was conducted to establish readiness benchmarks for common first-year college courses based on ACT scores. Benchmarks were developed for four courses: English Composition, using the ACT English score; College Algebra, using the ACT Mathematics score; Social Science courses, using the ACT Reading score; and Biology, using the ACT Science score. The ACT College Readiness Benchmarks were updated in 2013 using data from more recent high school graduates (Allen, 2013).

Data and method. Data for the most recent study came from colleges or groups of colleges that had participated in ACT's research services, including the Course Placement Service and Prediction Service. Results were based on 96,583 students from 136 colleges for English Composition, 70,461 students from 125 colleges for College Algebra, and 41,651 students from 90 colleges for Biology. Six different courses were considered for the Social Science analyses: American History, Other History, Psychology, Sociology, Political Science, and Economics. Results for the social science courses were based on 130,954 students from 129 colleges.

Success in a course was defined as earning a grade of B or higher in the course. Hierarchical logistic regression was used to model within each college the probability of success in a course as a function of ACT test score. The student-level data was weighted to make the sample more representative of all ACT-tested students. For each course within each college, a cutoff score was chosen such that the probability of success (i.e., the probability of earning a B or higher grade in the course) was at least .50. According to Sawyer (1989), this score point most accurately classifies the group into those who would be successful and those who would not. The individual cutoff scores per college were weighted to make the sample more representative of all colleges with respect to institution type (2-year, 4-year less selective, 4-year more selective). The Benchmarks were determined based on the median cutoff scores across colleges. For further details concerning the research methods, see the full ACT Research Report (Allen, 2013).

Results. Table 5.12 gives the median ACT cutoff scores across colleges, along with the first and third quartiles. The scores of 18 for English, 22 for College Algebra, 22 for Social Science, and 23 for Biology represent ACT Benchmarks that would give a student at a typical college a reasonable chance of success in these courses; that is, at least a 50% chance of earning a B or higher grade. Moreover, these cutoff scores were also associated with a 73 to 79% chance of earning a C or higher grade.

For the 2013 ACT-tested graduating class, 64% of the students met the ACT English Benchmark, 44% met the ACT Mathematics Benchmark, 44% met the ACT Reading Benchmark, and 36% met the ACT Science Benchmark (Table 5.13; ACT, 2013a). The corresponding percentages for full-time college-enrolled ACT-tested freshmen in 2012-2013 were higher by 11 to 14 percentage points (ACT, 2013b).

Summary. Students, parents, and counselors can use the Benchmarks to determine the academic areas in which students are ready for college coursework, and areas in which they may need more work. Although the Benchmarks are useful predictors of success in first-year college courses, ACT scores above the cutoffs do not guarantee success since factors other than academic preparedness, such as motivation and good study habits, are also important to success in college (Robbins et al., 2004).

High School Coursework Associated With ACT College Readiness Benchmarks

A study by Noble and Schnelker (2007; ACT, 2005b; see page 70 of this manual) examined the contribution of specific high school course sequences to college readiness in English Composition, College Algebra, and Biology.

Data and method. Data for 403,381 students representing 10,792 high schools were analyzed. The ACT Plan/ACT cohort file for the 2003 graduating class contained matched records of students who completed ACT Plan during their sophomore year (2000–2001) and the ACT during their junior or senior year, prior to graduating in 2003. Students' readiness for college coursework in a subject area was defined by whether the relevant ACT Benchmark (Allen & Sconing, 2005) had been met or not. Hierarchical logistic regression was used to model the probability of a student meeting or exceeding the English Composition, Algebra, or Biology readiness Benchmark as a function of courses taken in high school, while statistically controlling for the relevant ACT Plan score (as a measure of students' prior achievement) and student grade level at the time of taking the ACT (junior or senior). High school attended was also accounted for in the models by allowing the student-level regression coefficients to vary across high schools.

Results. In this study, 74% of the students met the ACT English Benchmark, 44% met the ACT Mathematics Benchmark, and 30% met the ACT Science Benchmark. Table 5.14 gives the unstandardized logistic regression coefficients for each variable from each model; all regression coefficients were statistically significant ($p < .01$) unless otherwise noted. The odds ratios for the coursework comparisons are also reported in Table 5.14. Compared to taking only English 9–11, the odds of meeting the ACT English Benchmark for students also taking one or more foreign languages was 2 times greater. Moreover, taking at least one foreign language was typically associated with a 9% increase in students' chances of meeting the Benchmark, compared to taking only English 9–11.

Figure 5.4 illustrates students' chances of meeting the College Algebra Benchmark associated with taking various mathematics course sequences. Taking Algebra 1, Geometry, and Algebra 2 was typically associated with a 22% chance of meeting the Benchmark (an increase of 12% over that for students taking less than Algebra 1, Geometry, and Algebra 2). Taking upper-level mathematics courses beyond Algebra 2 was associated with substantial increases in students' chances of meeting the College Algebra Benchmark, compared to taking less than Algebra 1, Geometry, and

Table 5.12
College Readiness Benchmarks, by Subject Area

Course	ACT Test	Median[a]	1st Quartile/3rd Quartile
English Composition	English	18	16/20
College Algebra	Mathematics	22	21/24
Social Science	Reading	22	20/24
Biology	Science	23	22/25

[a] The College Readiness Benchmarks were determined based on the median cutoff scores across colleges.

Table 5.13
Percentage of Students Meeting the ACT College Readiness Benchmarks, 2012–2013

ACT Benchmark	High school graduating class	Enrolled college freshmen[a]
English	64	78
Mathematics	44	56
Reading	44	55
Science	36	47

[a] Represents students that participating institutions nationwide identified as enrolled full-time.

Table 5.14
Hierarchical Logistic Regression Coefficients for Modeling the Probability of Students' Meeting or Exceeding ACT College Readiness Benchmarks

Model	Coursework comparison	Regression coefficient: Intercept	ACT Plan score	Grade level	Course-work	Odds ratio
College English Benchmark						
1	English 9–11 & 1 or more foreign languages vs. English 9–11	− 8.04	0.49	0.02*	0.68	1.97
College Algebra Benchmark						
1	Algebra 1, Algebra 2, and Geometry vs. less than these courses	−10.29	0.47	−0.37	0.91	2.48
	Algebra 1, Algebra 2, and Geometry vs.					
2	Algebra 1, Algebra 2, Geometry, & Other Advanced Math	−9.18	0.46	−0.40	0.63	1.88
3	Algebra 1, Algebra 2, Geometry, & Trig	−8.91	0.44	−0.43	0.90	2.46
4	Algebra 1, Algebra 2, Geometry, Trig, & Other Advanced Math	−8.86	0.44	−0.42	1.15	3.16
5	Algebra 1, Algebra 2, Geometry, Trig, & Calculus only	−9.01	0.45	−0.40	1.66	5.26
6	Algebra 1, Algebra 2, Geometry, Other Advanced Math, Trig, & Calculus	−8.96	0.44	−0.40	1.76	5.81
College Biology Benchmark						
	Biology vs.					
1	Biology & Chemistry	−10.97	0.48	−0.29	0.71	2.03
2	Biology, Chemistry, & Physics	−10.24	0.44	−0.30	1.31	3.71

*p < .01

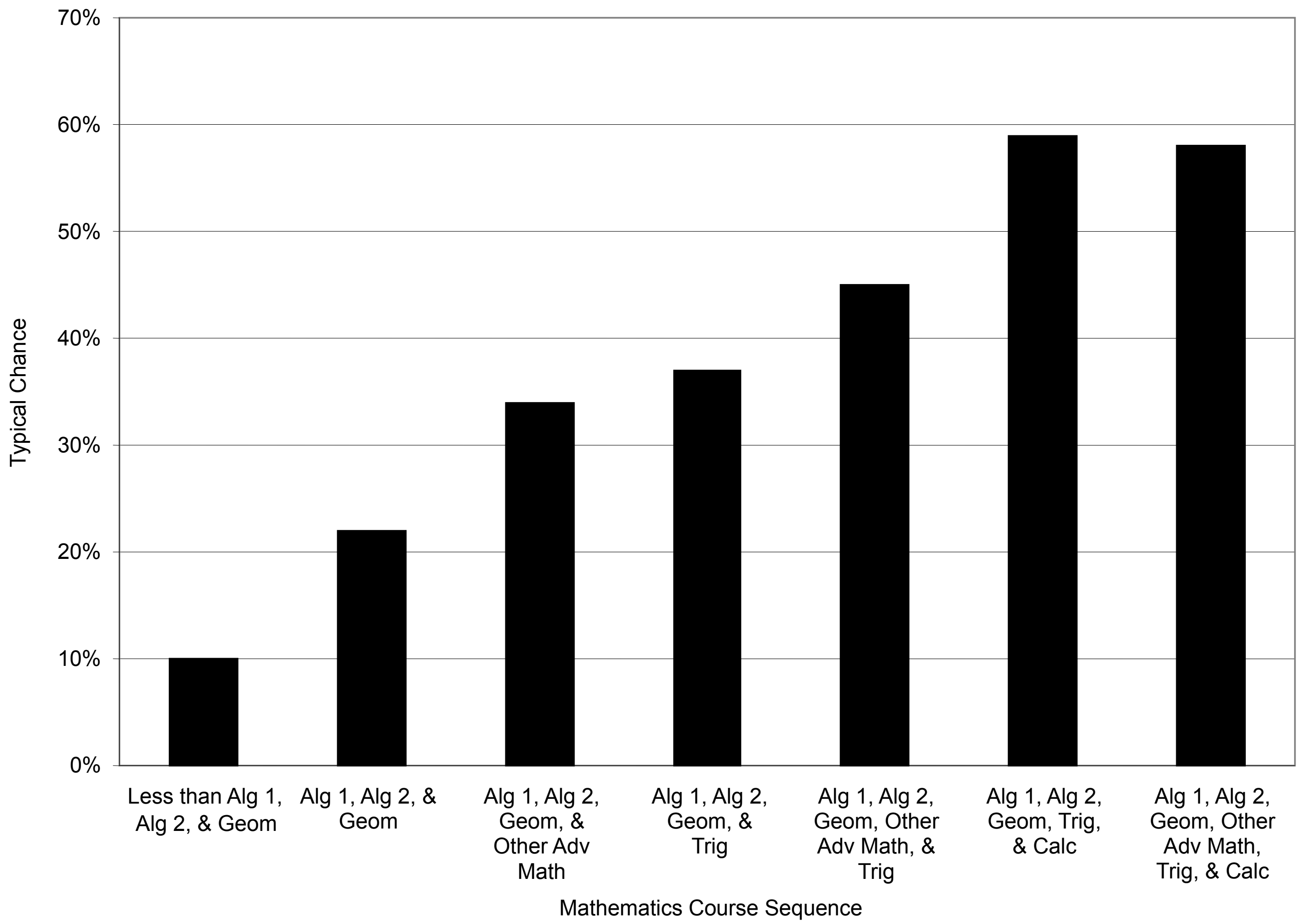


Figure 5.4. Typical chances of meeting the College Readiness Benchmark for College Algebra by specific mathematics coursework.

Algebra 2. Chances ranged from 34% (other advanced mathematics) to 58% (other advanced mathematics, Trigonometry, and Calculus), compared to 10% for those taking less than Algebra 1, Geometry, and Algebra 2.

Compared to students taking Biology only, the odds of meeting the ACT Science Benchmark were 2 times greater for students taking Biology and Chemistry and were nearly 4 times greater for students taking Biology, Chemistry, and Physics. Taking Biology and Chemistry was typically associated with a 19% chance of meeting the College Biology Benchmark, compared to a 10% chance for students taking Biology only. Students taking Biology, Chemistry, and Physics typically had a 29% chance of meeting the Benchmark.

Summary. The findings from this study indicate that some courses and course sequences better prepare students for postsecondary-level work than others. Each incremental college-preparatory course taken, particularly in mathematics and science (e.g., Trigonometry beyond Algebra 2, Physics beyond Chemistry), added to readiness more than did the number of courses in a discipline alone. A more detailed description of these results is provided in the full ACT Research Report (Noble & Schnelker, 2007).

Test Preparation and Maximizing ACT Performance

Given the content and philosophy of the ACT, the approach that is most likely to increase ACT scores is rigorous high school coursework, because much of the knowledge and many of the skills that are taught in high school are being measured on the ACT. It would stand to reason that long-term learning in school, rather than cramming and short-term preparation that reviews test format and/or test-taking skills, would be the best form of test preparation for the ACT. To understand better the relationship between short-term preparation and ACT scores, several studies were conducted between the early 1990s and 2003 to examine score increases attributable to short-term test preparation activities using repeat test takers and cross-sectional samples of students. Results from two studies are summarized below and compared to those resulting from longer-term preparation.

Scholes and Lain (1997) examined test preparation activities of two large samples of ACT-tested students (first-time and repeat test takers) and the impact of these activities on ACT scores. Scholes and McCoy (1998) studied the effects of specific short-term test preparation activities on ACT Composite scores for first-time ACT test takers.

First-time ACT test takers. Scholes and Lain (1997) found that first-time test takers who used only practice tests had only slightly higher mean ACT Composite scores than first-time test takers who did not engage in test preparation activities (21.2 vs. 20.8, respectively), after adjusting for high school GPA and grade level. However, the adjusted means for students who used workbooks, took a prep course, or did any type of preparation were actually lower than the adjusted means of those who did not participate in such activities. While the results from this study were based on a large number of first-time ACT test takers (~69,000 students), the study was limited with regard to the general nature of the test preparation activities studied: the authors could not examine the specific type of activity or the specific content of the test preparation activity in which students participated. Therefore, the purpose of the follow-up study (Scholes & McCoy, 1998) was to examine the effects of specific short-term test preparation activities on ACT Composite scores.

Data and method. October 1997 ACT-tested high school students comprised the population for this study. Students who tested under special testing conditions were excluded. Of these 134,000 first-time test takers, 51,000 had indicated that they had participated in certain types of test preparation activities. Of these examinees, a random sample of 15,000 students was selected to complete a questionnaire inquiring about their involvement in test preparation activities. To ensure a comparison group, 5,000 students who did not indicate any test preparation activity were also sent the questionnaire. The response rate for both groups was 33% (N = 4,856 "test prep" students and N = 1,646 "no prep" students). Students with a significant portion of missing data on the questionnaire were eliminated, leaving a sample of 5,929 students. The sample was 65% female, 74% Caucasian American/White, and 67% high school seniors.

The questionnaire consisted of 45 possible activities, listed under six major areas of test preparation: test preparation courses offered by high school/local college or university, commercial test preparation courses (e.g., Kaplan and Princeton Review), test preparation computer software, test preparation workbooks with software, test preparation workbooks (such as *Preparing for the ACT*), and test preparation websites (i.e., ACT home page, Kaplan, and Princeton Review). To examine the effect of test preparation activities on ACT Composite scores, a one-way ANOVA was performed for each type of test preparation activity, while statistically controlling for the effects of high school GPA.

Results. Table 5.15 presents group mean ACT Composite scores, mean ACT Composite scores adjusted for high school GPA, and adjusted mean differences between those who had prepared and those who had not for each type of test preparation. The results showed that, on average, students who reported using selected commercial software and those who used commercial workbooks had higher adjusted mean ACT Composite scores (by 1.5 and 1.2 scale score points, respectively) than those who did not participate in short-term test preparation activities. The adjusted mean score difference between those who took a commercial test preparation and the "no prep" group was 0.9 scale score points. The difference in means for those who did any type of preparation solely or in combination compared to those who did not was only 0.1 scale score point. All of these differences were statistically significant ($p < .05$).

Repeat test takers. Scholes and Lain (1997) also examined the effects of test preparation activities on increasing ACT scores from first to second testing.

Data and method. Students who had taken the ACT two or more times between October 1, 1994, and September 20, 1995, comprised the sample (N = 178,278). Students who tested under special testing conditions were eliminated, as were students with invalid or missing data. To avoid possible confounding effects, students who had engaged in test preparation activities before their first testing were also eliminated. These procedures yielded a sample of 126,253 repeat testers. Of the sample, 59% were female and 72% were Caucasian American/White.

A one-way ANOVA was performed for each type of test preparation activity, while statistically controlling for the effects of GPA and grade level. The dependent variable for all analyses was the mean ACT Composite score increase from first to second testing.

Results. Table 5.16 presents means for first and second ACT Composite scores, gain score means from first to second testings, and gain score means adjusted for GPA and grade level. The mean gain score for students who did not prepare was 0.6. In comparison, the mean gain scores for practice tests, workbooks, and any type of preparation group was 0.8; the mean gain score for the prep course group was the same as that for the no-preparation group. Thus, students who used practice tests, workbooks, or engaged in any type of preparation gained, on average, 0.2 ACT Composite score units more than those who did not prepare, regardless of GPA and grade level. Although the differences in means between those who engaged in one of these three types of preparation activities and those who did not prepare were statistically significant ($p < .0001$), the magnitudes of the differences were minimal (effect size < 0.1). Results of two-way ANOVAs, where GPA and grade level were statistically controlled, showed that the impact of test preparation activities on mean ACT Composite gain scores did not differ significantly by race/ethnicity, gender, and family income (data not shown).

Long-Term Test Preparation. ACT research has continually demonstrated the benefits of taking upper-level college-preparatory coursework for increasing ACT scores, regardless of students' prior achievement in high school (see page 67). In Figure 5.5, average ACT Composite score increases associated with short-term test preparation activities (Scholes & McCoy, 1998) are compared to the average score increases associated with college-preparatory courses in high school. For example, average ACT Composite scores of students taking/planning to take the ACT-recommended core curriculum (i.e., 4 years of English, 3 years each of mathematics, science, and social studies) were 2.3 score points higher than those of students taking less than core. Increases in average ACT Composite scores for students taking/planning to take upper-level mathematics and science coursework compared to those who did not were even greater than 2.3 score points. The largest increases were those associated with additional mathematics coursework over and above Algebra 1, Algebra 2, and Geometry (Figure 5.5).

Table 5.15

Mean ACT Composite Scores,
Adjusted Mean ACT Composite Scores, and Difference Scores
Between Type of Test Preparation and No Preparation

Group	N	ACT Composite score		Adjusted ACT Composite score[a]	Difference from no-prep group mean
		M	SD	M	
Courses Offered by High School/Local College or University only	221	21.6	4.7	21.1	0.3
Courses Offered by High School/Local College or University and ACT's *Preparing for the ACT*	663	21.9	4.5	21.5	0.7
Commercial Test Prep Courses Only	68	22.2	4.2	21.7	0.9
Commercial Test Prep Software	141	23.2	4.4	22.3	1.5
ACT-Offered Test Prep Workbooks	485	22.1	4.5	21.7	0.9
Selected Commercial Test Prep Workbooks	194	22.6	4.3	22.0	1.2
Any Preparation[b]	3,336	21.1	4.6	20.9	0.1
No Preparation	2,593	21.0	4.5	20.8	N/A

[a]Means are adjusted for the effects of GPA and grade level.
[b]Consists of students who participated in one or more types of preparation.

Table 5.16

Mean 1st and 2nd ACT Composite Scores, Gain Scores from 1st to 2nd Testing, and Adjusted Gain Scores for Repeat Testers

Group	N	1st ACT Composite score M	1st ACT Composite score SD	2nd ACT Composite score M	2nd ACT Composite score SD	Gain score M	Gain score SD	Adjusted gain score[a] M	Difference over no-prep gain[b]
Practice Tests	8,922	20.5	4.4	21.4	4.5	0.9	1.6	0.8	0.2
Workbooks	3,974	20.2	4.5	21.0	4.6	0.8	1.6	0.8	0.2
Prep Course	3,071	20.7	4.3	21.3	4.5	0.7	1.6	0.6	0
Any Preparation[c]	64,757	19.6	4.3	20.3	4.5	0.8	1.6	0.8	0.2
No Preparation	61,496	20.7	4.4	21.2	4.5	0.6	1.6	0.6	N/A

[a]Means are adjusted for the effects of GPA and grade level.
[b]Type of preparation gain score minus the no-preparation gain score.
[c]Consists of students who participated in one or more types of preparation.

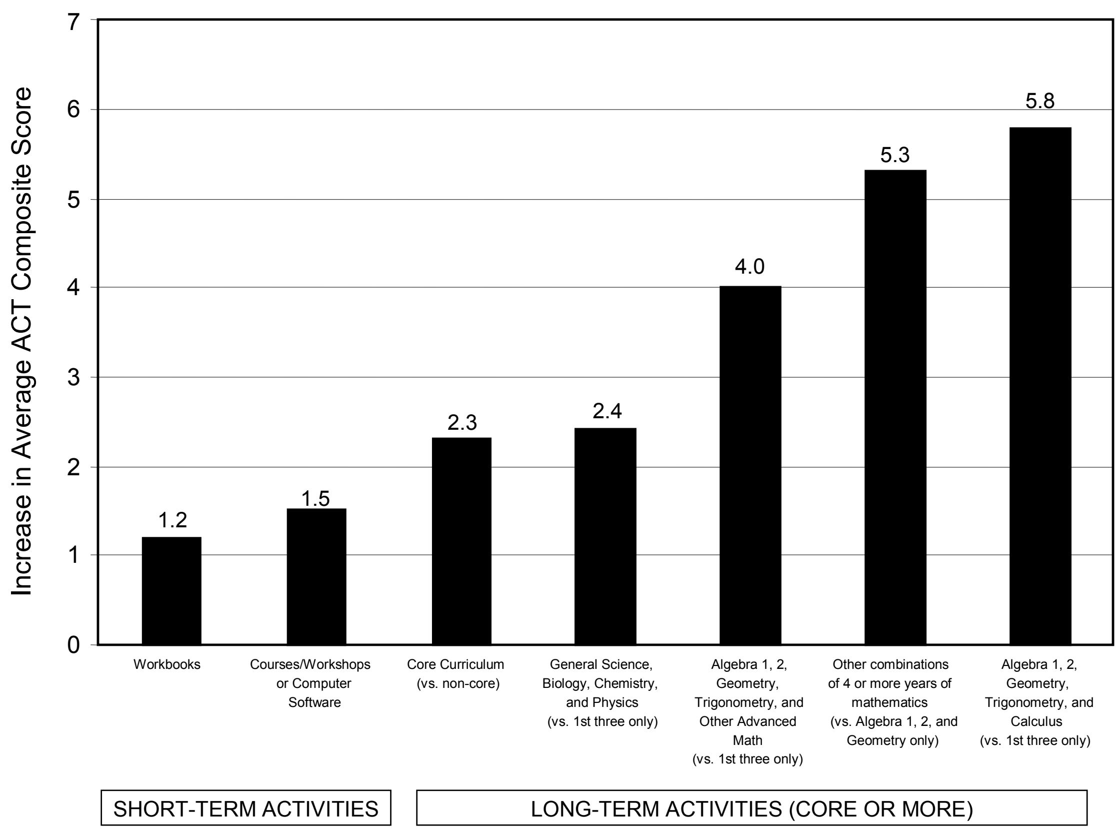


Figure 5.5. Effect of selected test preparation activities on ACT Composite score.

Summary. Increases in average ACT Composite score associated with high school coursework are substantially larger than those associated with short-term test preparation activities, regardless of the type of activity. These results suggest that the courses taken in high school matter much more than short-term test preparation activities.

In general, the types of short-term test preparation activities studied have relatively small effects on first-time test takers' performance on the ACT. Certain types of preparation activities such as using commercially available computer software or workbooks had, on average, larger positive effects on ACT Composite scores than did other types of preparation activities. In addition, the results suggest that the test preparation activities studied here have only a minimal effect, on average, on increasing second ACT scores beyond the gains that can occur from simply retaking the test. The types of short-term test preparation activities studied here were limited; the activities were not differentiated by duration of activity or quality of content. Further research with more detailed test preparation information is planned.

Statistical Relationships Among ACT Explore, ACT Plan, and the ACT and High School Grades

As described in Chapter 1, ACT has an integrated series of assessment programs that includes ACT Explore, ACT Plan, and the ACT. All three are designed to measure educational achievement appropriate to their administration grade. Each comprises four multiple-choice tests: English, Mathematics, Reading, and Science. Each of the four tests has an associated score, and there is a fifth Composite score equal to the average of the four multiple-choice test scores. The subject-area tests are each scored on a common score scale ranging from 1 (lowest) to 25 for ACT Explore, 32 for ACT Plan, and 36 for the ACT. The three testing programs form a developmental score scale for educational achievement. Relationships among the three testing programs and with high school grade point average (HSGPA) were examined in this study.

Data and method. The data included high school students who graduated in 2002, 2003, or 2004, and who took ACT Explore, ACT Plan, and the ACT. If students took the ACT more than once, only their most recent score was included in the analysis. Self-reported high school course grades from the CGIS (see page 67 for details concerning CGIS) were used to calculate HSGPAs in English, mathematics, social science, natural science, and an overall HSGPA. These HSGPAs were examined in relation to English, Mathematics, Reading, Science, and Composite scores, respectively.

Results. Table 5.17 presents the means for the five different test scores comprising each of the three testing programs and the correlations between them and with the corresponding subject-area HSGPAs.

Even though the time between different testing program administrations ranges from one to four years, the correlations ranged from .62 to .88. The largest correlation coefficient was between ACT Plan and the ACT test scores for each subject area and for the Composite score.

ACT test scores had a slightly stronger linear relationship (as measured by the correlation coefficient) with HSGPA than did ACT Explore and ACT Plan test scores. The correlations between Composite scores and overall HSGPA were slightly larger than the corresponding subject-area correlations. The correlations between the subject-area test scores and HSGPAs were likely smaller than the intertest correlations due to the variability in grading standards among teachers and schools (see page 92 for a discussion of Validity of High School Course Grades for Measuring High School Achievement). The strength of the relationships among the three testing programs and HSGPAs provide evidence for the construct and criterion validity of the three tests.

Scores on the ACT Explore, ACT Plan, and the ACT allow for the measurement of growth in educational achievement across the secondary school grades. Figure 5.6 displays the means of the test scores of the three testing programs for each subject-area score and for the Composite score. The average increase in scores ranged from 1.4 to 2.5 points from Grade 8 to Grade 10 (ACT Explore to ACT Plan) and from 2.3 to 3.6 points from Grade 10 to Grade 11 or 12 (ACT Plan to ACT). The smallest increases were in average Science scores. Growth in average scores was fairly linear for English and Mathematics. Reading growth was slightly nonlinear in that the ACT Plan to ACT growth is steeper than the ACT Explore to ACT Plan growth.

Summary. During these years students are acquiring knowledge and skills at a rapid rate. The large intertest correlations and the increases in the average scores indicate ACT Explore, ACT Plan, and the ACT are measuring educational achievement as students progress through the grades.

Table 5.17
Means and Correlations for ACT Explore, ACT Plan, and the ACT

English (N = 212,805)

	Means	Correlation		
		ACT Explore	ACT Plan	ACT
ACT Explore	16.5	1.00		
ACT Plan	19.0	.74	1.00	
ACT	21.6	.75	.81	1.00
HSGPA	3.30	.44	.46	.50

Mathematics (N = 210,651)

	Means	Correlation		
		ACT Explore	ACT Plan	ACT
ACT Explore	16.6	1.00		
ACT Plan	18.9	.74	1.00	
ACT	21.2	.74	.82	1.00
HSGPA	3.12	.45	.49	.55

Reading (N = 210,666)

	Means	Correlation		
		ACT Explore	ACT Plan	ACT
ACT Explore	16.4	1.00		
ACT Plan	18.4	.64	1.00	
ACT	22.0	.67	.71	1.00
HSGPA	3.40	.40	.39	.42

Science (N = 210,493)

	Means	Correlation		
		ACT Explore	ACT Plan	ACT
ACT Explore	17.8	1.00		
ACT Plan	19.2	.62	1.00	
ACT	21.5	.65	.67	1.00
HSGPA	3.25	.41	.39	.43

Composite (N = 211,603)

	Means	Correlation		
		ACT Explore	ACT Plan	ACT
ACT Explore	17.0	1.00		
ACT Plan	19.0	.84	1.00	
ACT	21.7	.83	.88	1.00
HSGPA	3.27	.54	.55	.58

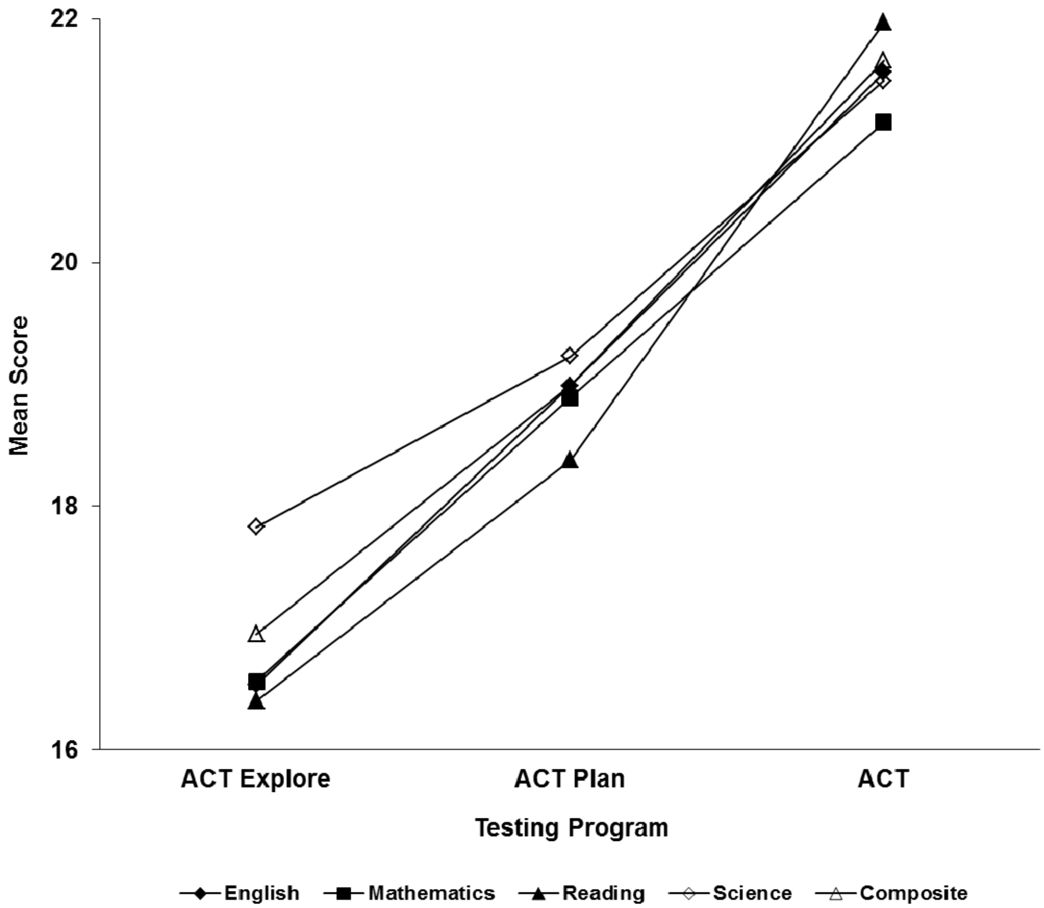


Figure 5.6. Increase in mean scores from ACT Explore to ACT Plan to ACT in each subject area and for the Composite.

Retesting With the ACT

Increasing numbers of students are taking the ACT more than once. But, what are the typical score gains to students who retest with the ACT?

Lanier (1994) conducted an investigation of score gains with the ACT Composite score and focused on how likely students are to obtain or exceed a specific ACT Composite score on retesting given their initial score. In this investigation, the mean gain on retesting was found to be 0.8 scale score point. A follow-up study (Andrews & Ziomek, 1998) extended this research by describing typical ACT Composite score changes from first to second, second to third, and third to fourth testing, conditioned on first test score.

Data and method. Data for the study by Andrews and Ziomek (1998) included 875,603 students from the graduating class of 1993 who took the ACT. Of these students, 311,729 (35.6%) took the ACT on more than one occasion. Among the retesting students, 15,528 had one or more of their test administrations at some time or location other than a national test date and site. These circumstances included international testing, administrations under some special test administration conditions (both timed and extended time), residual testing (scored locally or at ACT), and state testing.

The summary of patterns of score changes on retesting presented here is intended to describe retesting for students who tested at the national test dates and sites. It is based on only those students with all test administrations at national test dates and sites (296,201 students). Consequently, the summary information provided here may not accurately describe changes on retesting for a student who, for example, initially tested on a national test date, and then retested under extended-time conditions.

Results. Figures 5.7 and 5.8 illustrate the results of retesting. Figure 5.7 presents the average gains in the ACT score obtained on retesting; gains are presented from first to second (N = 296,201), second to third (N = 67,410), and third to fourth (N = 15,833) testings. For each retesting analysis, 93% or more of students retesting had a first score in the score scale range of 13 to 28. Summary results in this range may therefore be taken to be representative of nearly all students who retest.

As shown in Figure 5.7, students with lower scores on previous testings had the greatest average gains and those scoring near the maximum score of 36 actually had score decreases. In the range of scores from 13 through 28, however, the average gain in Composite score was fairly stable at 0.75 scale score point. The average gain decreased slightly, but not dramatically, across this range. Because ACT scores are reported as whole numbers, the average gain would be 1 scale score point.

The second consideration of note is that the greatest gains were made from first to second testing. At any first score, the average gain was less for second to third or third to fourth testing than it was for first to second testing. As already noted, the average gain from first to second testing was 0.75 scale score point. The average gain from second to third testing was 0.59 scale score unit, and from third to fourth testing the average gain was 0.51 scale score point.

Average gains across a large number of persons suggest, but do not guarantee, the amount of gain that might be expected by an individual should he or she decide to retest. Figure 5.8 summarizes the percentage of students retesting who maintained or increased their score on retesting. These results are presented from first to second, second to third, and third to fourth testings.

As scores increased from 13 to 28, the percentage of students who maintained or increased their score decreased. From first to second testing, approximately 80% of students at the score of 13 and approximately 70% of students at the score of 28 maintained or increased their score. The patterns of percentages of students who maintained or increased scores was somewhat more erratic from second to third and from third to fourth testing. Again, however, within the range of first scores of 13 to 28, the percentage of students who maintained or increased their score remained between 70% and 80%. Although patterns for second to third and third to fourth testings were not as smooth, the differences in likelihood of maintaining or increasing scores were not large enough to suggest that the decision to retest should be based on different information each time retesting was considered.

Summary. Two pieces of information that are relevant to the decision to retest are the likelihood of maintaining or increasing test score on retesting and the expected gain that may result. Approximately 95% of all students have a 70% to 80% chance of maintaining or increasing their score on retesting. The percentage of examinees maintaining or increasing their score, as well as the amount of the average gain, decreased with each additional testing. The average gain on retesting is 0.75 scale score point.

Irrespective of these statistics, students should consider retesting if they believe their test scores do not accurately reflect their skills and knowledge. Test performance can be influenced by conditions prior to and during testing, including physical illness, temporary physical disabilities (e.g., broken arm), stress, or trauma.

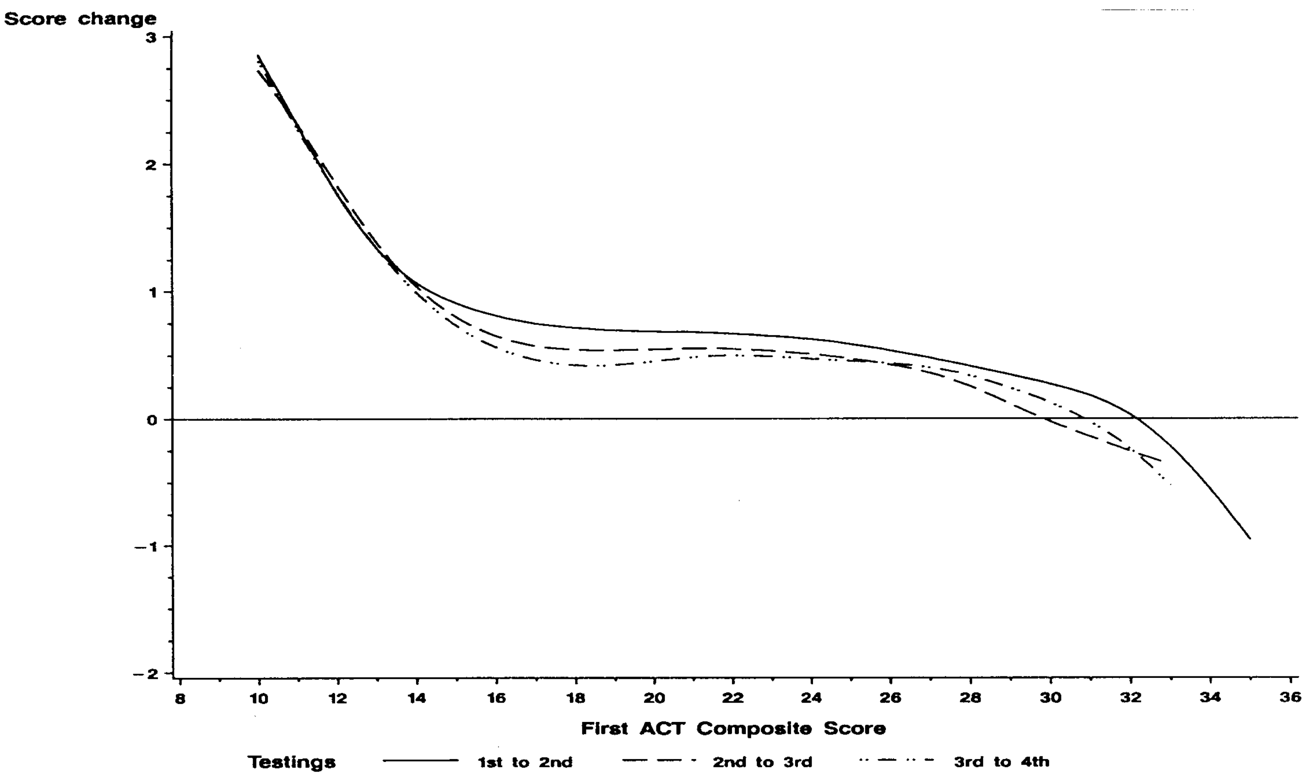


Figure 5.7. Changes in Composite test scores from 1st to 2nd, 2nd to 3rd, and 3rd to 4th testings.

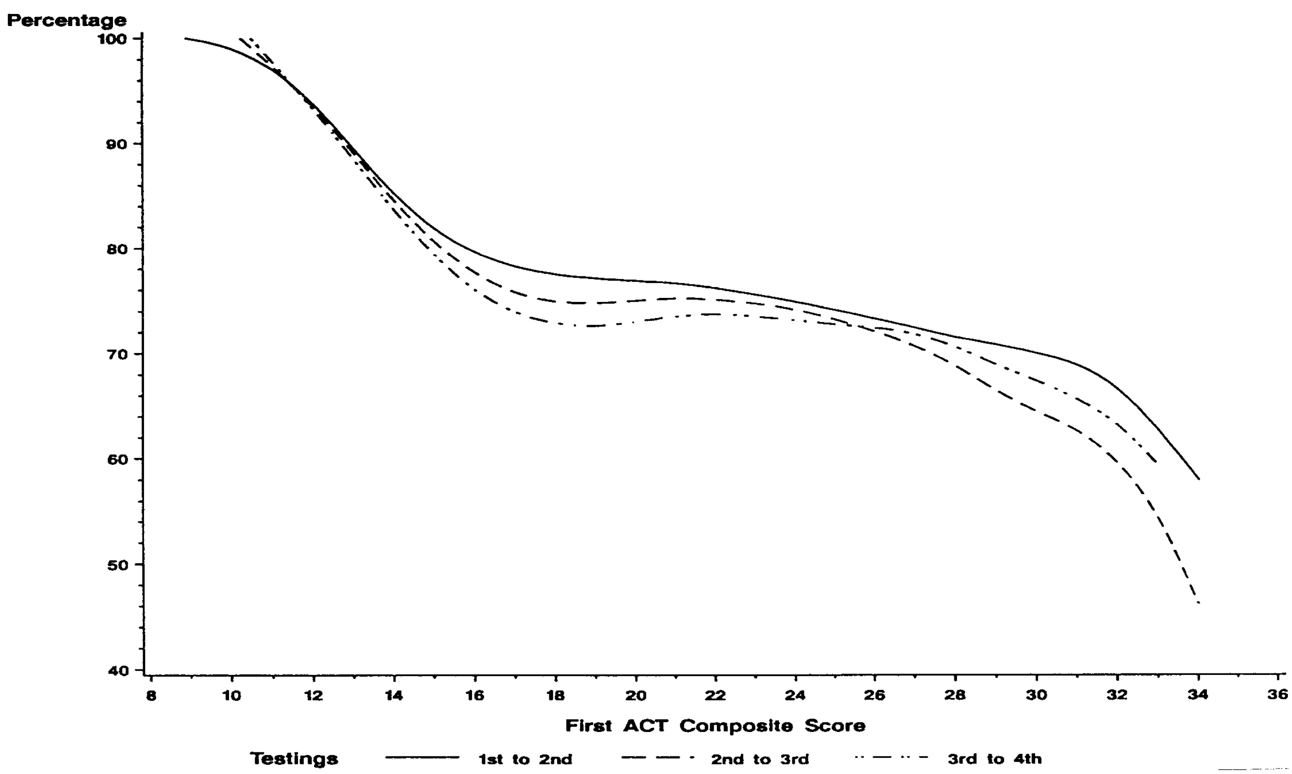


Figure 5.8. Percentage of students maintaining or increasing score from 1st to 2nd, 2nd to 3rd, and 3rd to 4th testings.

Validity of High School Course Grades for Measuring High School Achievement

The accuracy of the high school course and grade information students provide in the ACT registration folder within CGIS is a focus of continuing research at ACT. Sawyer, Laing, and Houston (1988) concluded that the accuracy of student-supplied course and grade information was "sufficiently high to be useful in many contexts" (page 12). More specifically, these researchers found that 71% of student-reported course grades were identical to those obtained from student transcripts and that 97% of student-reported course grades were within one grade of those obtained from transcripts. The tendency of students to over-report grades was also documented in that the average difference between transcript-obtained and self-reported course grades was 0.23.

ACT scores are statistically associated with high school grades, but are different measures. To the extent that grades measure educational achievement, there will be a strong statistical relationship between grades and ACT scores. However, research has shown that high school grades are of limited validity as indicators of academic achievement. They are more subjective than standardized test scores because of the differing standards and purposes teachers associate with grades (Pilcher, 1994; Brookhart, 1993; Stiggins, Frisbie, & Griswold, 1989). Within a given school, teachers may differ in the criteria they use to judge student achievement. Effort and reward are often confounded with academic accomplishment in assigning course grades (Pilcher, 1994). Grading practices also vary across schools; an "A" in one school may be equivalent to a "C" in another school (United States Department of Education, 1994). As such, the interpretation of high school grades should take into account differences across high schools in their curricula and grading standards. Grade inflation also adversely affects the validity of high school grades.

Grade inflation. Grade inflation is present when grades increase over time without a concomitant increase in achievement. A study by Woodruff and Ziomek (2004a) investigated inflation in high school grade point average (HSGPA); this study was a follow-up to an earlier study by Ziomek and Svec (1995). The latter study examined ACT Composite scores and HS overall GPAs from 1990 to 1994 and found evidence for modest grade inflation.

Data and method. The data for the Woodruff and Ziomek (2004a) study consisted of students who graduated from public high schools between 1991 and 2003, and who took the ACT in the eleventh or twelfth grade of high school. If a student took the ACT more than once then only the student's scores from the most recent testing were included. Overall HSGPA was based on the students' self-reported grades in 23 of the 30 courses from the CGIS (see page 67 for details concerning the CGIS); grades in foreign language and art courses were not included.

Results. Table 5.18 contains sample sizes, means, standard deviations, and correlations for overall HSGPA and ACT Composite score by year. While overall HSGPA means increased steadily from year to year (by 0.26 from 1991 to 2003), ACT Composite means increased from 1991 to 1998, except in 1992, and then started to decrease (increase of 0.3 from 1991 to 2003). However, since the two measures are on different scales, it is more appropriate to compare the effect sizes of the changes (i.e., mean difference divided by the standard deviation) than the mean increases. The effect size for HSGPA was 0.43, compared to 0.062 (only 14% of that for overall HSGPA) for the ACT Composite score.

Figure 5.9 contains 13 curves, one for each of the 13 years, with the bottom curve being for 1991 and the top curve being for 2003. Each dot represents the mean overall HSGPA for all students with a specific ACT Composite score value. Overall grade inflation from 1991 to 2003 varied between 0.21 and 0.29 units (indicated by the distance between the curves) for ACT Composite scores between 13 and 27, with a substantial proportion occurring between 1991 and 1995. ACT Composite score values outside the range 13 to 32 did not have sufficient sample sizes for stable year-to-year results.

Summary. The results from this study suggest that the increase in overall HSGPA over time was largely attributable to grade inflation since the average HSGPA increase was not accompanied by a correspondingly large increase in mean ACT scores. However, the grade inflation that occurred did not seem to decrease the correlation between overall HSGPA and ACT Composite score (last column in Table 5.18). This study also evaluated grade inflation by subject area; for further details, see the full ACT Research Report (Woodruff & Ziomek, 2004a).

Table 5.18
Sample Sizes, Means, Standard Deviations, and Correlations Between Overall HSGPA and ACT Composite Score for 1991 to 2003

Year	N	HSGPA mean	ACT mean	HSGPA SD	ACT SD	Correlation
1991	637,261	2.94	20.6	0.63	4.40	.58
1992	700,869	3.00	20.6	0.61	4.42	.57
1993	721,963	3.02	20.7	0.61	4.44	.57
1994	733,320	3.05	20.7	0.60	4.51	.57
1995	778,594	3.09	20.7	0.60	4.51	.57
1996	756,678	3.11	20.8	0.60	4.54	.57
1997	781,080	3.13	20.8	0.60	4.59	.57
1998	725,375	3.14	21.1	0.60	4.58	.57
1999	725,724	3.16	21.0	0.60	4.56	.57
2000	781,460	3.17	21.0	0.59	4.56	.57
2001	762,793	3.18	21.0	0.59	4.58	.56
2002	702,397	3.19	21.0	0.59	4.58	.57
2003	706,978	3.20	21.0	0.59	4.58	.57

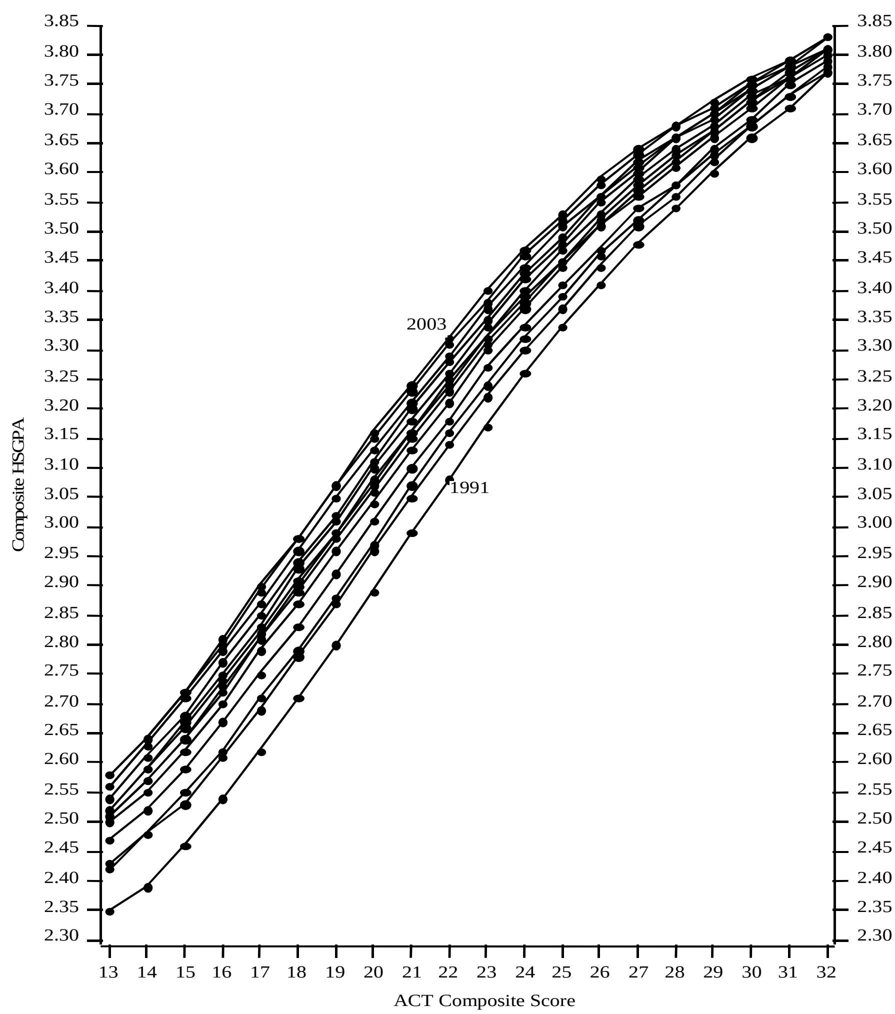


Figure 5.9. Plot of HS overall GPA by ACT Composite score, 1991 to 2003.

Differential grading standards. Another study by Woodruff and Ziomek (2004b) was designed to assess how grading standards vary across high schools.

Data and method. The data included students who graduated from public high schools in the spring of 1998, 1999, 2000, 2001, and 2002, and took the ACT in the eleventh or twelfth grade in high school. For each high school, the mean ACT Composite score was computed for each year. Only schools with at least 30 students were included. The schools were then divided into quintiles (i.e., five groups) based on the school means for each of the five years. The schools included in the analysis were those that remained in the 1st quintile group (bottom 20% of schools) and those that remained in the 5th quintile group (top 20% of schools) on the ACT Composite score for all five years. The number of schools in the 1st quintile group and the 5th quintile group were 664 and 573, respectively. Although the same schools were used for all five years, the graduating class of students in those schools changed from year to year. The hypothesis investigated was that schools within the 1st quintile group used more lenient grading standards than the schools within the 5th quintile group. HSGPA was regressed on ACT score within each quintile group for each year. In all cases, regression diagnostics suggested that linear models were appropriate for the data. If the schools in the 1st and 5th quintile groups are using the same grading standards, then it is reasonable to expect the HSGPA on ACT score regressions in the two quintiles to be equal, that is, have the same intercept and slope.

Results. Table 5.19 contains relevant statistics from the linear regression analyses. The results are similar for all five years. The two quintile groups have essentially equal slopes. Mean differences in grading practices between the two groups of schools equal the differences between their linear regression intercepts. The 1st quintile groups' mean leniency in grading ranged from a high of 0.19 in 1998 to a low of 0.12 in 2002; each was statistically significant ($p < .01$). In addition, the correlations between overall HSGPA and ACT Composite score were slightly higher for the 5th quintile group.

Figure 5.10 displays the regression lines between overall HSGPA and ACT Composite score in 2000 for the 1st and 5th quintile groups. From the figure, it is clear that for students with the same ACT Composite score, the 1st quintile group had a higher mean overall HSGPA than the 5th quintile group.

Summary. The results of this study imply that grades are more of a relative standard in that they can vary from school to school. This study also evaluated differential grading standards by subject area; for further details, see the full ACT Research Report (Woodruff & Ziomek, 2004b).

Grade inflation and differential grading standards introduce additional variability into high school grades, allowing them to differ in value from year to year and school to school. In contrast, the ACT is carefully constructed to measure the same content and have the same statistical properties from year to year, and its administration does not vary from school to school. Hence, the validity of high school grades is improved by combining them with ACT scores to predict readiness for college.

Identifying Students for Gifted and Talented Programs

ACT scores have, over the years, been used successfully by national talent search programs to identify academically talented youth. Talent search programs provide these individuals with such services as advanced-level course materials, recognition ceremonies, and special residential programs. In a typical talent search program, seventh- or eighth-grade students who score very high (e.g., top 3%) on in-school standardized achievement tests are invited by the program to take the ACT. Those applicants earning very high ACT scores are then invited to participate in a special residential program or recognition program.

Figure 5.11 displays two ACT Composite score cumulative distributions, one representing the scores of 2006 high school graduates and the other representing the scores of a group of talent search applicants. The score distribution for the 2006 high school graduates (N = 1,206,455) in this figure was based on students who took the ACT on national test dates during their sophomore, junior, or senior year, and who graduated from high school in the spring of 2006. Only the most recent ACT score of each high school student was retained for analysis. The score distribution for talent search applicants was based on data from 39,784 students who took the ACT during 6th, 7th, or 8th grade in 2005 and sent their scores to a particular national talent search program.

Figure 5.11 shows that the cumulative distribution for the 2006 ACT-tested graduating class is shifted slightly to the right of the cumulative distribution for the talented search students who took the ACT in 6th, 7th, or 8th grade (average ACT Composite score: 21.1 vs. 17.9, respectively). This figure suggests that ACT scores appear to have sufficient floor and ceiling to measure the relatively greater educational development of academically talented students.

Table 5.19

Coefficients for the HSGPA on ACT Score Regressions for the First and Fifth Quintile in Each of the Five Years

Year	Quintile	N	Correlation	Slope	Intercept	Difference between intercepts
1998	Q1	53,939	.48	0.076	1.60	0.19
	Q5	96,586	.60	0.076	1.41	
1999	Q1	55,013	.49	0.077	1.60	0.16
	Q5	94,235	.60	0.076	1.44	
2000	Q1	59,434	.48	0.075	1.63	0.14
	Q5	101,833	.59	0.074	1.49	
2001	Q1	56,668	.47	0.075	1.66	0.14
	Q5	98,136	.59	0.073	1.52	
2002	Q1	52,997	.47	0.075	1.68	0.12
	Q5	86,536	.59	0.073	1.56	

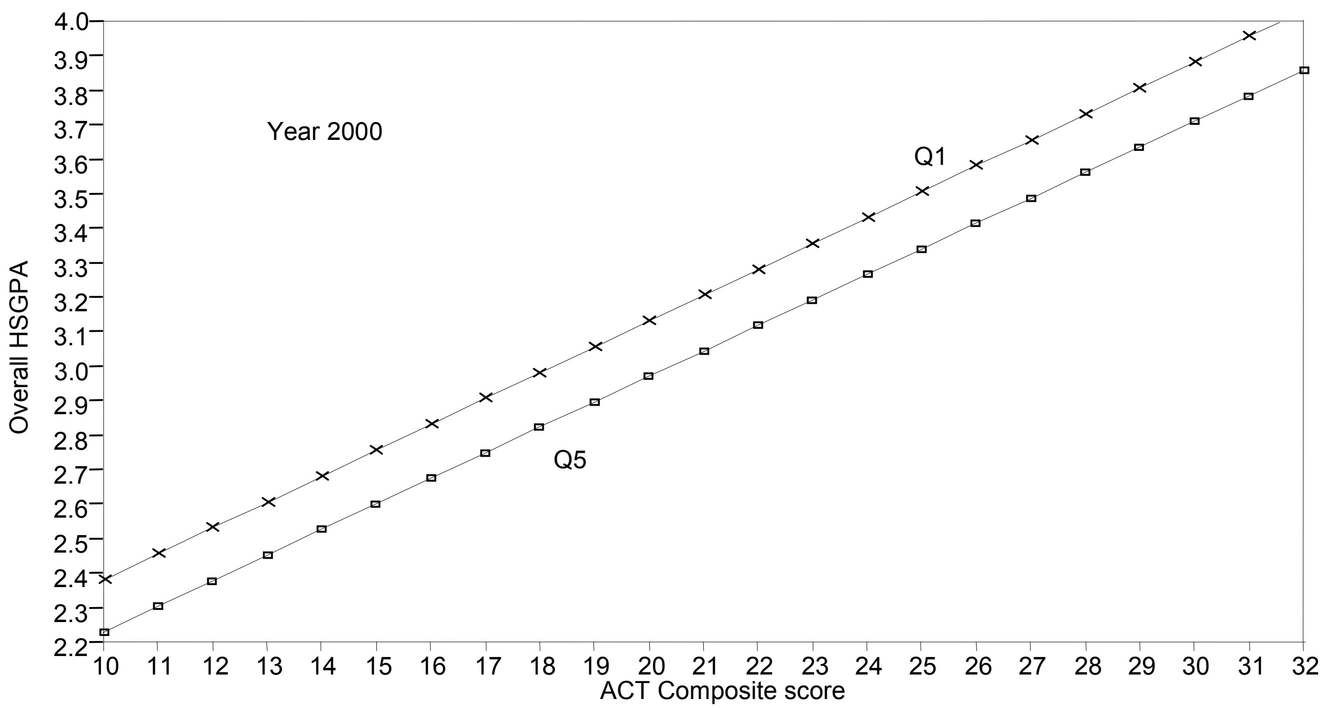


Figure 5.10. Plot of the year 2000 linear regressions of overall HSGPA on ACT Composite score.

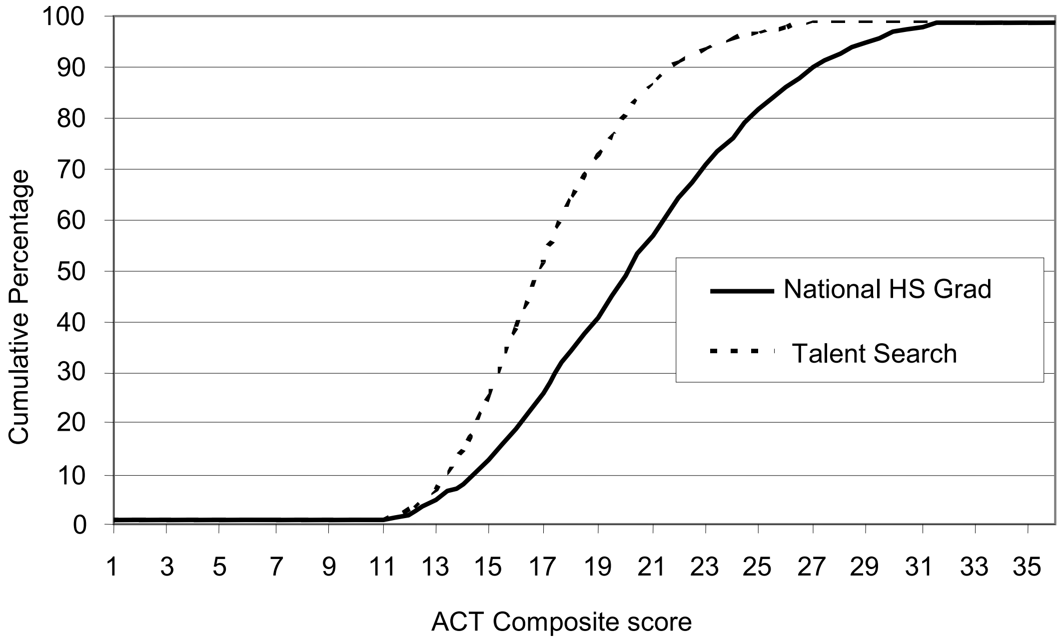


Figure 5.11. ACT Composite cumulative percentages for 2006 ACT-tested high school graduates and talent search 6th-, 7th-, and 8th-grade students.

A study by Schiel (1998) examined the academic benefits in high school of an intensive summer program for academically talented seventh graders. The results of the study suggested that participation in Summer Residential Programs is positively related to academically talented students' subsequent academic performance in high school. For more details, see the full ACT Research Report (Schiel, 1998).

Making Admissions Decisions

Postsecondary institutions want to admit students who will be academically successful. Because attending college requires a significant investment of time, money, and other resources by students and parents, as well as by the institutions, it is in their common interest that the investment succeed. Admission therefore involves decisions made by students, counselors, and parents (all of whom may participate in selecting the institutions to which students apply), as well as decisions made by institutions.

One important aspect of success in college is academic achievement, and one critical determinant of academic achievement is academic preparation. In any postsecondary academic curriculum, a certain minimum level of academic skill is required for success; beyond the minimum required level, better academic preparation usually results in greater academic success. Therefore, it is appropriate to take into account students' academic preparation when making admissions decisions.

Academic success during a student's college career requires at least a minimal level of academic success in the first year. Some students have significant academic difficulties in their first year, but later go on to have satisfactory levels of achievement in subsequent years. Nevertheless, students whose academic difficulties in their first year cause them to leave college obviously cannot be considered academically successful overall. Thus, the likelihood of academic success in the first year is a reasonable factor to consider when making admissions decisions. Because the ACT tests are designed to measure the academic skills needed to succeed in typical first-year college curricula, they are appropriate for use in admission.

One should keep in mind that although the ACT tests measure important academic skills needed for success in college, they do not measure all relevant academic skills; no practically feasible test is ever likely to do so. Therefore, it is advisable to supplement ACT scores with other academic information, such as courses taken and grades earned in high school, when making admissions decisions. The High School Course/Grade Information Section (CGIS) of the ACT was developed to provide such information.

Moreover, academic preparation is only one determinant of academic success in college (albeit an important one). Nonacademic characteristics, such as motivation, interests, and goals can also influence academic success. Therefore, admissions decisions should take into account students' noncognitive characteristics, as well as their academic skills. The Student Profile Section and the Interest Inventory of the ACT provide information on students' background characteristics, goals, and vocational interests.

Finally, there are other outcomes of postsecondary education (e.g., students' appreciation of culture, their intellectual curiosity, their ability to work with people holding differing opinions) that are not strictly academic in nature, but that may be important goals of an institution. If an institution is able to define and defend its nonacademic goals, and is able to collect information on student characteristics related to them, then such information could also be used in making admissions decisions. Of course, using nonacademic characteristics to predict the achievement of nonacademic goals needs to be validated, just as using test scores to predict the achievement of academic goals must be validated.

Statistical Relationships Between ACT Scores and First-Year College Grades and GPAs

If the ACT test measures characteristics important to success in the first year of college, and if first-year grades are reliable and valid measures of educational achievement, then there should be a statistical relationship between ACT scores and first-year grades. Therefore, a crucial aspect of any validity argument for using ACT scores in making admissions decisions is the strength of the statistical relationships between the test scores and first-year grades.

Traditional validity statistics. The Pearson correlation coefficient measures the strength of the linear statistical relationship between two variables, such as a college GPA and a test score. The absolute value of the correlation coefficient ranges between 0 and 1, with 0 indicating no relationship and 1 indicating a perfect linear relationship. Correlations near 0 are usually interpreted to mean that the correspondence between college coursework and test content is insufficient for the test to be used for college admissions.

As shown in Table 5.20, ACT scores are, according to correlational indices, valid predictors of overall first-year GPA in college (ACT, 1998). These statistics are based on the 291 institutions that participated in the Prediction Research Service during the 1997–98 academic year. For these institutions, the median multiple correlation for the regression of college GPA on the four ACT scores was .42. The median multiple correlation for the regression of college GPA jointly on the four ACT scores and the four high school subject area averages (in English, mathematics, social studies, and natural sciences, as measured by the CGIS) was .53.

It is likely that the magnitudes of these observed correlations are significantly affected by the restriction of range caused by prior selection of students on the basis of their ACT scores or their scores on other college admissions tests. If a college did not use test scores or other measures of applicants' academic skills in making admissions decisions, then applicants with low test scores, as well as those with high test scores, could enroll. In this situation, the correlation between the students' test scores and their grades would most likely be higher than if the college used test scores in making admissions decisions (Whitney, 1989). Therefore, a correlation between test scores and college grades estimated from enrolled students whose academic skills were considered in admitting them will understate the theoretical correlation in the entire applicant population. This statistical problem exists at all postsecondary institutions whose admissions decisions take into account applicants' academic skills.

Furthermore, the correlation between a test score and course grade or GPA cannot exceed the square root of the product of the reliabilities of the two measures. For example, the reliability of the ACT Composite score is approximately .96 (see Table 4.13), but the reliability of first-year college GPA has been estimated to range from .69 to .81 (Etaugh, Etaugh, & Hurd, 1972). Therefore, the correlation between the ACT Composite score and college GPA will not exceed .81 to .88. This result is consistent with the results shown in Table 5.20.

Table 5.20
Correlational Validity Indices for First-Year College GPA
Using Four ACT Scores Alone and
Four ACT Scores and Four High School Subject Area GPAs Combined

Predictors	Minimum R	25th percentile	Median R	75th percentile	Maximum R
Four ACT scores	<.29	.35	.42	.50	>.65
Four ACT scores and four high school subject area GPAs	<.29	.47	.53	.60	>.70

Decision-based statistics. The correlation coefficient is probably used more often than any other statistic to summarize the results of predictive validity studies. As an index of the strength of the linear statistical relationship between first-year college grades or GPAs and admissions or placement measures, a correlation coefficient can lend credibility to a validity argument based on content fit. It does not, however, directly measure the degree to which admissions or placement measures correctly identify students who are academically prepared for college coursework.

The correlation coefficient is an indicator of the average accuracy of prediction across all values of the predictor variables. Of more direct interest to educators who must evaluate admissions or placement systems is the correctness of the decisions made about individual students. Suppose "success" in the first year of college can be defined in terms of some measurement that is obtainable for each student; for example, success might be defined as a student's completing the first year with a GPA of C-or-higher in a common subset of first-year courses. Then, there are four possible results (outcomes) of the admissions decision for a particular student:

A. True positive: the student is permitted to enroll in the college and is successful there. (Correct decision)
B. False positive: the student is permitted to enroll in the college and is not successful there. (Incorrect decision)
C. True negative: the student is not permitted to enroll in the college, and would have been unsuccessful if he or she had enrolled. (Correct decision)
D. False negative: the student is not permitted to enroll in the college, and would have succeeded if he or she had enrolled. (Incorrect decision)

The sum of the proportions of students associated with outcomes A and C is the proportion of correct admissions decisions.

Note that outcomes A and B can be directly observed in existing admissions systems, but outcomes C and D cannot. In principle, the proportions associated with all four outcomes could be estimated by collecting admissions measures (e.g., admissions test scores) on every student, while permitting everyone to enroll in the college, regardless of test score. Some of these students would be successful in the college and others would not; the relationship between the probability of success and the admissions measures could then be modeled using statistical methods. From the estimated conditional probabilities of success for given values of the admissions measures, estimates of the probabilities of the outcomes A–D could be calculated.

In most institutions, of course, this kind of experimentation is not done, because students with low probabilities of success are generally not admitted to or do not select the college. Therefore, first-year outcomes are not available for these students, and the relationship between their probability of success and their admissions measures must be estimated by extrapolating relationships estimated from the data of students who actually enrolled in the college. Research at ACT has shown that accurate extrapolations can usually be made from moderately truncated data (Houston, 1993; Schiel & Harmston, 2000; Schiel & Noble, 1992).

It is possible to relate a correlation coefficient to the conditional probability of success function, but a number of strong statistical assumptions are required. A more straightforward way to estimate the probability of success is to dispense with correlation coefficients altogether and to model it directly. For example, one could use the logistic regression model:

$$\hat{P}[W = 1 \mid X = x] = \frac{1}{1 + e^{-\hat{a} - \hat{b}x}} \qquad (1)$$

where W = 1, if a student is successful in college
= 0, if a student is not successful in college, and
X is the student's admissions test score.

An example of an estimated logistic function is the curve labeled "Probability of C-or-higher" in Figure 5.12. Note that the probability of C-or-higher ranges from .05 to .99, depending on the test score. Note that this particular curve is S-shaped, and that its maximum slope occurs at the test score of 20. In logistic regression, the point at which the maximum slope occurs is called the "inflection point," and the slope of the curve at this point is proportional to the coefficient $\hat{b}$ in Expression (1). Therefore, larger values of $\hat{b}$ in logistic regression curves correspond to steeper slopes, and to better identification of the students who will succeed.

The estimated weights $\hat{a}$ and $\hat{b}$ in Expression (1) can be calculated by iterative least squares procedures. Given the previous discussion, the coefficient $\hat{b}$ should be both positive and statistically significant. A coefficient near zero would result in a flat curve for the conditional probability of success.

Once estimates $\hat{a}$ and $\hat{b}$ have been obtained, estimated probabilities for the four outcomes can easily be calculated. For example, if 16 is the cutoff score on X for being admitted to an institution, then the probability of a true positive (outcome A on page 98) can be estimated by:

$$\hat{P}[A] = \frac{\sum_{x \geq 16} \hat{P}[W = 1 \mid X = x]\, n(x)}{N}, \qquad (2)$$

where $\hat{P}[W = 1 \mid X = x]$ is Expression (1) calculated from the estimates $\hat{a}$ and $\hat{b}$, $n(x)$ is the number of students whose test score is equal to x, and N is the total number of students in the sample. At institutions with existing admissions systems, the conditional probabilities $\hat{P}[W = 1 \mid X = x]$ in Expression (1) are calculated from data for students who enrolled in the institution. The probability $\hat{P}[A]$ in Expression (2), however, is calculated from the test scores of all students, both those who were admitted and those who were not admitted. The probabilities for outcomes B, C, and D can be estimated in a similar way.

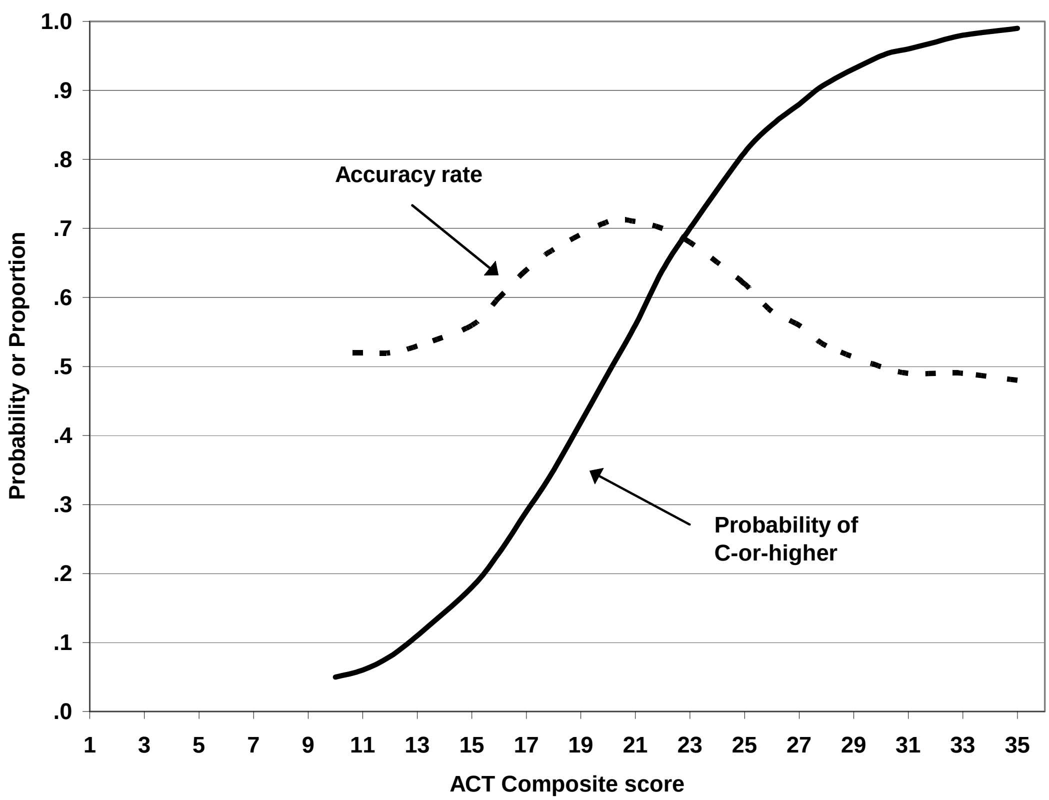


Figure 5.12. Probability of C-or-higher first-year college GPA and accuracy rate.

It should be noted that admissions decisions are usually made on the basis of several measures. For the purpose of illustrating how the accuracy of admissions decisions can be estimated, the example uses a simplified model based on a cutoff score on a single admissions test. Students scoring at or above the cutoff score would be admitted; students scoring below the cutoff score would not be admitted. ACT does not advocate making admissions decisions solely on the basis of a single measure; this example is for illustration only. Results are shown later in this chapter that illustrate how the logistic regression model may be generalized to multiple measures.

Once the estimates $\hat{P}[A]$ and $\hat{P}[C]$ are obtained, the percentage of correct admissions decisions ("accuracy rate") is estimated as $\hat{P}[A] + \hat{P}[C]$, multiplied by 100. An illustration of estimated accuracy rates for different test scores is given in Figure 5.12 as a proportion. Note that the maximum accuracy rate (.71) occurs at the inflection point in the graph of the probability of success, i.e., near a score of 20. This score is referred to as the optimal cutoff score, the score that maximizes the percentage of correct admissions decisions.

The accuracy rate value corresponding to the lowest obtained test score represents the overall percentage of students who would succeed in college without using the test for admissions. The difference ("increase in accuracy rate") between the maximum accuracy rate and the accuracy rate for the lowest test score is an indicator of the effectiveness of the test for making admissions decisions. This statistic shows the increment in the percentage of correct admissions decisions due to the use of the test. Large increases in accuracy rate correspond to a greater contribution by the test in increasing the rate of correct admissions decisions.

The ratio of true positives, $\hat{P}[A]$, to the sum of true positives and false positives, $\hat{P}[A] + \hat{P}[B]$, multiplied by 100, shows the estimated percentage of students who would be successful, of those who would be admitted using particular admissions criteria. This ratio is called the "success rate." Like the probability of success, the success rate should increase as scores on the admissions measure increase.

Admissions validity evidence. Tables 5.21 and 5.22 summarize the admissions validity evidence for a large sample of institutions and students (Noble & Sawyer, 2002). This study examined the accuracy of ACT Composite scores for predicting successive levels of first-year college GPA. The levels considered were first-year GPAs of 2.00, 2.50, 3.00, 3.25, 3.50, and 3.75.

Data. The analyses were based on data from 84 institutions that had participated in ACT's Prediction Research Service in 1996–97 (58,482 enrolled and 186,029 nonenrolled students). Nonenrolled students included those students who had requested that their ACT scores be sent to at least one of the 84 institutions. These students, plus those who actually enrolled in an institution and completed their first year comprised the "applicant pool" for that institution.

Method. Mean ACT Composite scores and mean high school GPAs were computed by institution. Means were calculated for enrolled students, as well as for students in the entire applicant pool. Mean first-year GPAs were calculated by institution for students who completed the first year of college. Distributions of the means of these variables were then summarized across institutions using minimum, median, and maximum values.

The distributions of descriptive statistics across the 84 institutions are summarized in Table 5.21. For both enrolled students and the applicant pool, median, minimum, and maximum numbers of students, mean ACT Composite scores, high school GPAs, and first-year college GPA (enrolled students only) are reported.

As expected, the institutions' mean ACT Composite scores and high school GPAs were typically higher among enrolled students than among the students in the entire applicant pool. The corresponding standard deviations were smaller for enrolled students. Mean ACT Composite scores for enrolled students were typically lower than those for first-year college students nationally (mean ACT Composite = 21.7; ACT, 1998). Mean high school GPAs were similar to those for first-year college students nationally (mean high school GPA = 3.23; ACT, 1998).

We then estimated three validity statistics:

a. the maximum percentage of correct classifications (accuracy rate [AR]),
b. the percentage of successful students among those who would be expected to be successful (success rate [SR]), and
c. the increase in the percentage of correct classifications over expecting all applicants to be successful (increase in accuracy rate [ΔAR]).

Table 5.21
Distributions, Across Institutions, of Means and Standard Deviations of ACT Composite Scores, High School GPA, and First-Year College GPAs, by Applicant/Enrollment Status

		N		Mean		SD	
Enrollment status	**Predictor variable**	**Med.**	**Min./Max.**	**Med.**	**Min./Max.**	**Med.**	**Min./Max.**
Base year							
Applicant pool	ACT Composite	1,183	219/19,675	20.6	17.5/26.0	3.97	3.35/4.81
	HS GPA			3.10	2.76/3.65	0.59	0.37/0.71
Enrolled students	ACT Composite	388	50/3,319	21.4	17.9/26.0	3.79	3.02/4.69
	HS GPA			3.18	2.70/3.65	0.57	0.37/0.76
	First-year college GPA			2.63	2.30/3.13	0.90	0.55/1.28

Correct classifications include students scoring above a cutoff score who were successful and students scoring below the cutoff who would have not been successful, if they had been selected. The "optimal" cutoff score is that for which the percentage of correct classifications (AR) is highest.

If there were no selection procedure (i.e., if all students were selected, regardless of their ACT Composite scores), a certain percentage of students would be successful. This percentage is referred to as the "baseline" accuracy rate. The arithmetic difference between the maximum accuracy rate and the baseline accuracy rate represents the increase in accuracy rate (ΔAR) that results from using ACT Composite scores.

Logistic regression models were constructed based on ACT Composite score for predicting first-year success. The success criteria included first-year college GPAs of 2.00, 2.50, 3.00, 3.25, 3.50, and 3.75 or higher. The logistic regression weights from each model were applied to the ACT Composite scores of all students at each institution with valid predictor data (i.e., the applicant pool), resulting in estimated probabilities of success for each student and model.

For each institution and success criterion, an optimal cutoff was identified. It can be shown that optimal cutoffs also correspond to a .50 probability of success for a given model. ARs, SRs, and ΔARs were then estimated for each optimal cutoff. All statistics were calculated from the conditional probabilities of each outcome for individual students in the applicant pool, as estimated by the regression models (Sawyer, 1996). In reporting maximum accuracy rates for all criterion levels, the probability distributions for each institution were required to cross .50. For comparison purposes, median baseline accuracy rates (the percentages of all enrolled students with GPAs at or above each criterion level) were also reported. Distributions of these statistics were summarized across institutions using minimum, median, and maximum values.

Results. For the 2.00 criterion level, there were only 58 institutions and 39,925 enrolled and 166,583 nonenrolled students for which ACT Composite score models could be developed. Therefore, results for the 2.00 success criterion cannot be directly compared to the results for other criterion levels.

Table 5.22 shows median baseline accuracy rates, optimal cutoff scores, estimated accuracy rates (ARs), estimated increases in accuracy rates (ΔARs), and estimated success rates (SRs) for the 84 institutions for which validity statistics could be calculated.

As one would expect, median optimal ACT Composite cutoffs increased across criterion levels from 2.00 to 3.75. For example, the median optimal ACT Composite score for a GPA level of 2.50 or higher was 18; the corresponding optimal cutoff scores for the other criterion levels were 22, 25, 27, and 30, respectively. Correspondingly, median baseline accuracy rates (median percentages of students with GPAs at or above each criterion level) decreased across all criterion levels. A relatively high percentage of students (median = 75%) had GPAs of 2.00 or higher.

Table 5.22
Medians, Across 84 Institutions, of Base-Year Logistic Regression Statistics

Success criterion level	Baseline accuracy rate	Optimal ACT Composite cutoff	Accuracy rate (AR)	Increase in accuracy rate (ΔAR)	Success rate (SR)
2.00 or higher GPA[a]	75	14	76	0	77
2.50 or higher GPA	61	18	69	7	70
3.00 or higher GPA	39	22	71	31	65
3.25 or higher GPA	25	25	79	54	63
3.50 or higher GPA	17	27	84	67	61
3.75 or higher GPA	7	30	93	85	57

[a] All 2.00 models are based on 58 institutions for which the base-year fitted probability distributions based on ACT Composite scores crossed 0.50.

Accuracy rates increased across successive GPA levels from 2.50 to 3.75, and ranged from 69 to 93. Corresponding ΔARs also increased, from 7 to 85. The median success rates indicated that, if institutions used their optimal ACT Composite cutoff scores for admissions (the Composite score associated with the maximum accuracy rate), of the students who enrolled, typically 77% of the students who were admitted would achieve a C or higher first-year college GPA. Using the B or higher success criterion, 65% of the students who were admitted would achieve a B or higher GPA. Higher cutoff scores would result in higher success rates, but would also probably result in lower accuracy rates.

Summary. Postsecondary institutions seek high achievement for their students, and want to admit students who have a good chance of being successful in college. The results from this study suggest that ACT Composite scores provide differentiation across levels of achievement in terms of students' probable success during their first year in college. This study also evaluated the effectiveness of high school GPA for predicting different levels of first-year college GPA. For a detailed description of these results, see the next section or the full research report (Noble & Sawyer, 2002).

Incremental Validity of ACT Test Scores and High School Grades

A majority of postsecondary institutions now use standardized test scores in combination with high school grades or rank for making admissions decisions and some form of course placement (Breland, Maxey, Gernand, Cumming, & Trepani, 2002). This has largely been the result of (a) research supporting the use of multiple measures for making college admission and placement decisions (e.g., Ang & Noble, 1993; Noble, Crouse, & Schulz, 1995; Whitney, 1989) and (b) a content perspective that no test can measure all of the skills and knowledge needed for success in college. Using multiple measures probably increases content coverage and, as a consequence, increases the accuracy of admissions and placement decisions over that obtained by using test scores alone.

A study was conducted to compare the accuracy of admissions decisions based on ACT Composite scores and/or high school averages (Noble & Sawyer, 2002). The study also examined whether prediction accuracy was consistent across successive levels of first-year college GPA. Furthermore, the study determined the cross-validated accuracy of prediction equations and cutoffs based on ACT Composite score, high school average, and both variables in combination.

Data. The analyses were based on data from institutions that had participated in ACT's Prediction Research Service in both 1996–97 and 1997–98. The resulting analysis files therefore consisted of data from 216 institutions: The base-year file consisted of records for 164,436 enrolled students and 528,082 nonenrolled students, and the cross-validation-year file consisted of records for 166,126 enrolled students and 539,241 nonenrolled students.

Method. Logistic regression models were constructed based on (a) ACT Composite score, (b) high school GPA, and (c) ACT Composite score and high school GPA used jointly for predicting first-year college success. The success criteria included first-year college GPAs of 2.00, 2.50, 3.00, 3.25, 3.50, and 3.75 or higher. The logistic regression weights from each model were applied to the ACT Composite scores and/or high school GPAs of all students at each institution with valid predictor data (i.e., the applicant pool), resulting in estimated probabilities of success for each student and model.

For each institution and success criterion, optimal base-year cutoffs were identified for the three types of predictor models a.–c. For the two-predictor model, combinations of ACT Composite score and high school GPA cutoffs corresponding to a probability of success of .50 were identified. ARs, SRs, and ΔARs were then estimated for each predictor (or predictor combination) and optimal cutoff. All statistics were calculated from the conditional probabilities of each outcome for individual students in the applicant pool, as estimated by the regression models (Sawyer, 1996). Distributions of these statistics were summarized across institutions using minimum, median, and maximum values.

Of the 216 institutions for which data were available for both 1996–97 and 1997–98, logistic regression models could be developed for all institutions and for all criterion values, with the exception of one institution for the 3.75 criterion. (For this institution, all students with a GPA of 3.75 or higher had high school GPAs of 4.00.) Different criterion levels resulted in different numbers of institutions for which the fitted probability curves crossed .50.

For the 2.50 to 3.50 criterion levels, the final sample consisted of 84 institutions with 58,482 enrolled and 186,029 nonenrolled students for which all models and criterion levels could be evaluated. For the 2.00 criterion level, there were 58 institutions and 39,925 enrolled and 166,583 nonenrolled students for which all models could be developed. For the 3.75 criterion level, there were only 15 institutions for which a high school GPA model could be developed. In comparison, ACT Composite and joint models could be developed for all 84 institutions. High school GPA results are therefore not reported for the 3.75 criterion level. Results for all three models for the 2.00 success criterion can be compared with each other, but they cannot be directly compared to the results for other criterion levels.

The accuracy of predictions based on the base-year ACT Composite score and high school average logistic regression models was assessed using the cross-validation-year data. The logistic regression weights from each base-year model were applied to the ACT Composite scores and high school GPAs of all applicants to each institution, resulting in estimated probabilities of success for each student and model. The *base-year* optimal cutoffs for each institution were then applied to the corresponding cross-validation-year probability distributions, and cross-validated ARs, SRs, and ΔARs were calculated (see page 100 for descriptions of these statistics). For the two-predictor model, the logistic regression coefficients developed from the base year were applied to the cross-validation-year applicant pool data to estimate probabilities of success. These probability "scores" were then used to calculate ARs, SRs, and ΔARs using a cutoff value of .50. Distributions of all cross-validated statistics were summarized across institutions using minimum, median, and maximum values.

Results. Figures 5.13 and 5.14 show the median probabilities corresponding to all six criterion levels for ACT Composite score (Figure 5.13) and high school GPA (Figure 5.14) models. The probabilities were summarized across the 216 institutions (215 institutions for the 3.75 criterion level) for which all three models could be developed.

As shown in Figure 5.13, the median probability distributions for all criterion levels ranged from near zero for an ACT Composite score of 1 to between .83 and .98 for an ACT Composite score of 36. A student with an ACT Composite score of 21 (the approximate median mean ACT Composite score across the 84 institutions) would typically have a .81 probability of earning a 2.00 first-year college GPA or higher. The corresponding probabilities for the other criterion levels would be .62 (2.50), .36 (3.00), .20 (3.25), .11 (3.50), and .04 (3.75), respectively.

As shown in Figure 5.14, the median probability distributions for high school GPA ranged from near 0 (high school GPA = 0) to between .29 and .93 (high school GPA = 4.00). A student with a high school average of 2.00 would typically have a .48 probability of a 2.00 or higher first-year college GPA, and a .21 probability of a 2.5 or higher first-year college GPA. The corresponding median probabilities for the other criterion levels would be .05 or lower. In comparison, a student with a high school GPA of 3.2 (the approximate median mean high school GPA across the 84 institutions) would typically have a .83 probability of a 2.00 or higher first-year GPA. The corresponding median probabilities for the other criterion levels would be .64 (2.50), .37 (3.00), .19 (3.25), .11 (3.50), and .03 (3.75), respectively.

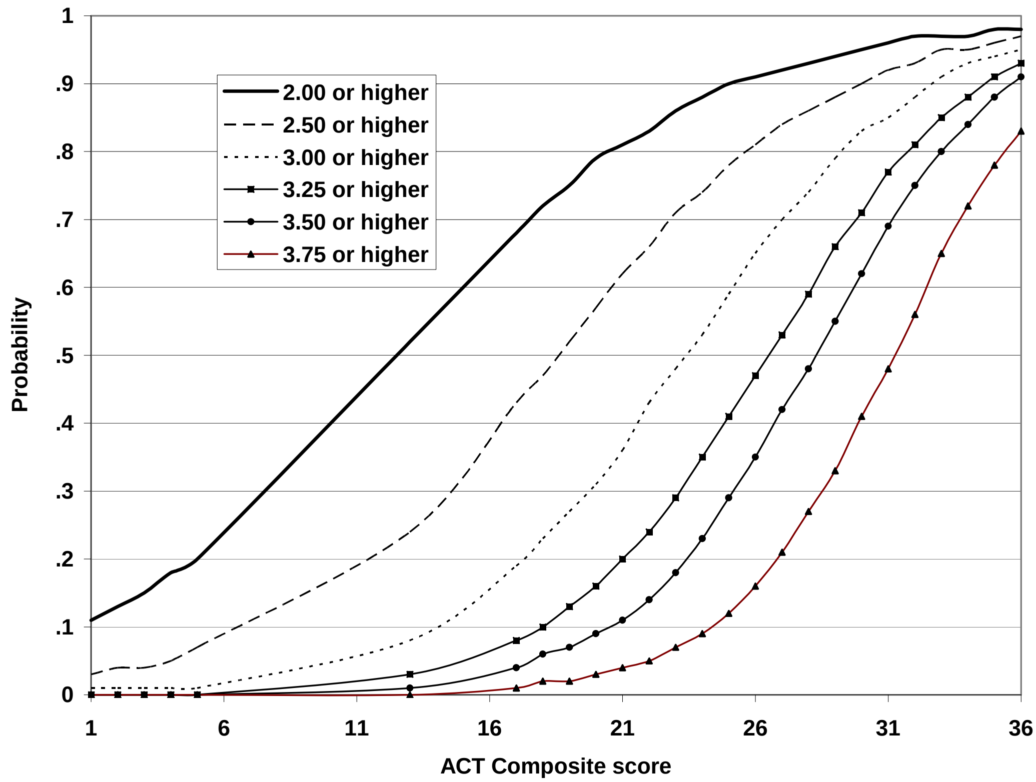


Figure 5.13. Median probabilities of 2.00, 2.50, 3.00, 3.25, 3.50, and 3.75 or higher first-year college GPA, based on ACT Composite score.

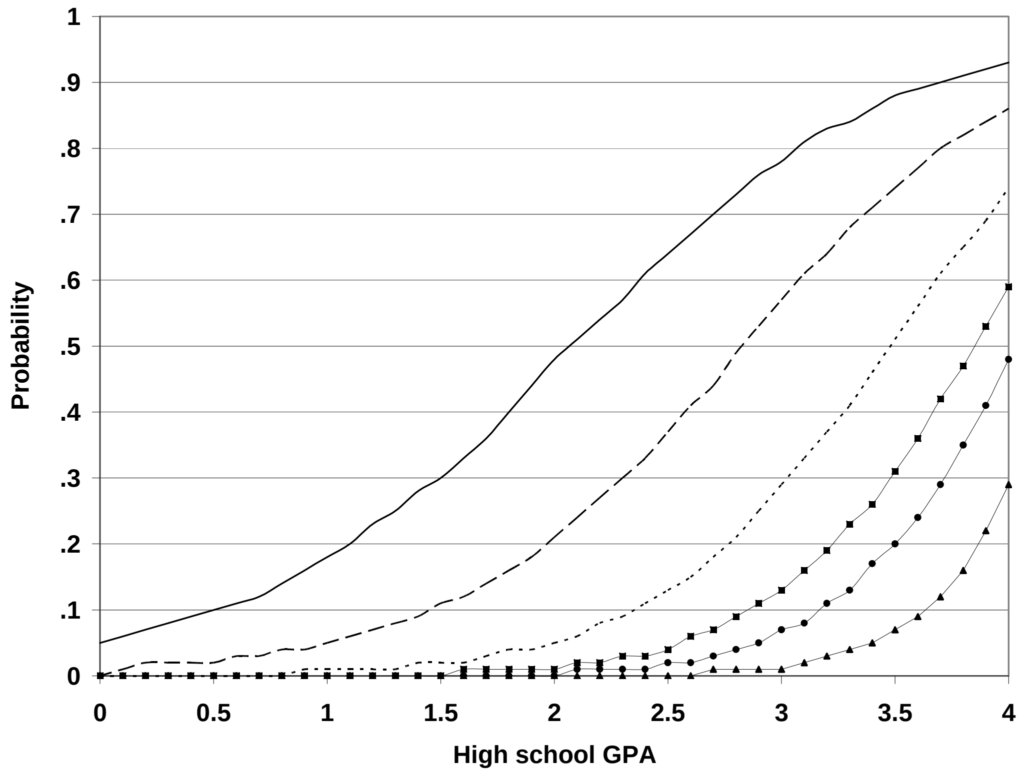


Figure 5.14. Median probabilities of 2.00, 2.50, 3.00, 3.25, 3.50, and 3.75 or higher first-year college GPA, based on high school GPA.

Note that for the criterion levels of 3.50 and 3.75, a high school GPA of 4.00 corresponded to a median probability of success of less than .50. Moreover, for the criterion levels of 2.50 and 3.00, there was little difference in the median probabilities for high school GPAs of less than 2.00. Similarly, for high school GPAs of 2.50 for the 3.00, 3.25, 3.50, and 3.75 criterion levels, there was little difference in the corresponding median probabilities. Any substantive differentiation among students' probabilities across all criterion levels therefore appeared to occur between high school GPAs of 3.0 and 4.0.

Table 5.23 shows median baseline accuracy rates, optimal cutoff scores, estimated accuracy rates (ARs), estimated increases in accuracy rates (ΔARs), and estimated success rates (SRs) for the 84 institutions for which validity statistics could be calculated.[2] As one would expect, median optimal ACT Composite and high school average cutoffs increased across criterion levels from 2.00 to 3.75. For example, the median optimal ACT Composite score for a GPA level of 2.50 or higher was 18; the corresponding optimal cutoff scores for the other criterion levels were 22, 25, 27, and 30, respectively. Note, however, that statistics could not be calculated for the high school GPA model for the 3.75 criterion level, due to the substantial number of institutions where the probability of a 3.75 or higher college GPA for students with a 4.00 high school GPA was less than .50. (The probability distributions did not cross .50 for 69 of the 84 institutions; a probability distribution is required to cross .50 for there to be a maximum accuracy rate.)

[2] The accuracy rates for ACT Composite scores were previously shown in Table 5.22, but are also presented in Table 5.23 for ease of comparison to the accuracy rates for high school GPA and those based on the ACT Composite and high school GPA joint models.

Correspondingly, median baseline accuracy rates (median percentages of students with GPAs at or above each criterion level) decreased across all criterion levels. A relatively high percentage of students (median = 75%) had GPAs of 2.00 or higher.

For criterion levels of 2.00, 2.50, and 3.00, the median ARs and ΔARs indicated that the high school GPA models were somewhat more accurate than the ACT Composite models. However, for criterion levels of 3.25 and 3.50, the median ARs for the ACT Composite equaled and then exceeded those for high school GPA. (The corresponding median ΔARs were both somewhat higher for the ACT Composite models.) For the 3.75 model, the median ARs for the ACT Composite model and the joint model were identical, reflecting the small contribution of high school GPA to the joint model. For all criterion levels except the 2.00 level, the median ARs and ΔARs for the ACT Composite and high school GPA joint model exceeded those for the single-predictor ACT Composite and high school GPA models.

Median SRs showed a similar result: For criterion levels of 2.00 and 2.50, median SRs for the high school GPA model were higher than those for the ACT Composite model. For all other criterion levels, the median SRs for ACT Composite were higher than those for high school GPA. For all criterion levels, median SRs for the joint model exceeded those for the separate high school GPA and ACT Composite models.

For all criterion levels except 2.50 or higher, median baseline accuracy rates were slightly higher for the cross-validation year than for the base year. The cross-validated ARs and ΔARs were very similar to those for the base year: Differences between base-year and cross-validated median AR did not exceed 2% for all three models. Differences between base-year and cross-validated median ΔARs for all three models were 4% or less across all criterion levels.

Summary. An important finding of this study is the apparent inability of high school GPA to predict high levels of academic achievement during the first year of college. The ACT Composite scores provide greater differentiation across levels of achievement than do high school GPAs in terms of students' probable success during their first year in college.

Table 5.23

Medians, Across 84 Institutions, of Base-Year Logistic Regression Statistics for Predicting First-Year College GPA Levels

Success criterion level	Baseline accuracy rate	Predictor variable	Optimal cutoff	Accuracy rate (AR)	Increase in accuracy rate (ΔAR)	Success rate (SR)
2.00 or higher GPA[a]	75	ACT Composite	14	76	0	77
		High school GPA	2.21	76	2	80
		ACT Composite & high school GPA[c]		79	2	81
2.50 or higher GPA	61	ACT Composite	18	69	7	70
		High school GPA	2.78	71	9	73
		ACT Composite & high school GPA[c]		74	11	75
3.00 or higher GPA	39	ACT Composite	22	71	31	65
		High school GPA	3.39	73	32	67
		ACT Composite & high school GPA[c]		76	36	70
3.25 or higher GPA	25	ACT Composite	25	79	54	63
		High school GPA	3.73	79	52	60
		ACT Composite & high school GPA[c]		81	57	67
3.50 or higher GPA	17	ACT Composite	27	84	67	61
		High school GPA	3.91	83	65	55
		ACT Composite & high school GPA[c]		86	69	64
3.75 or higher GPA[b]	7	ACT Composite	30	93	85	57
		High school GPA				
		ACT Composite & high school GPA[c]		93	86	59

[a] All 2.00 models are based on 58 institutions for which the base-year fitted probability distributions based on ACT Composite scores crossed .50.

[b] High school GPA prediction statistics could be calculated for only 15 of the 84 institutions.

[c] A range of optimal combinations of ACT Composite score and high school GPA correspond to a probability of .50 for the joint model.

Differential Prediction

A study by Noble (2003) investigated differential prediction for racial/ethnic groups and the differential effects on African American, Hispanic, and Caucasian American students of using ACT Composite scores, high school GPAs, or both for making non-race-based admissions decisions. Differential prediction, prediction accuracy, and percentage admitted were compared across subgroups.

Data and method. The data for this study consisted of the background characteristics, high school grades, ACT scores, and college grades for 219,954 first-year students from 311 colleges. The applicant pool for each institution was limited to students with ACT Composite scores and high school GPAs (and first-year college GPAs, for enrolled students who had taken the ACT within two years of enrolling in college). The applicant pool also included nonenrolled students who had requested that their ACT scores be sent to at least one of the 311 institutions. The applicant pools for the institutions in this study approximate actual applicant pools. Students may send their ACT scores to any number of institutions, but actually apply only to a subset of them. The converse is also true.

A minimum sample size of 40 enrolled students for each racial/ethnic group was used to help insure accurate and stable predictions. Analyses were carried out separately for the African American/Caucasian American sample and for the Hispanic/Caucasian American sample. Probabilities of obtaining a college GPA of 2.5 or higher were estimated by racial/ethnic group and institution using ACT Composite, high school GPA, and joint predictor logistic regression models. Similarly, ACT Composite, high school GPA, and joint predictor logistic regression models were developed for all students, by institution. The total group included all students from each institution with an ACT Composite score and high school GPA, regardless of race/ethnicity. The regression weights from these models were then used to estimate probabilities of success for all students in the applicant pool, by racial/ethnic group and overall for the total sample. These probabilities were summarized across institutions by model and racial/ethnic group using median, minimum, and maximum values. Then, based on the models using the total group of students, optimal ACT Composite score and high school GPA cutoffs were identified (referred to here as total-group optimal cutoffs).

Optimal cutoffs correspond to a .50 probability of success for a given predictor or set of predictors, and maximize the estimated percentage of correct admission decisions (see Sawyer, 1996). In order to achieve reasonable predictions of first-year college GPA, there must be a sufficient number of students with GPAs above and below a given GPA threshold. Institutions for which this was not the case were eliminated. Therefore, a success criterion of a 2.5 or higher GPA was selected to maximize the number of institutions in both samples for which models could be developed. The final samples upon which all results were based consisted of 262,553 students from 43 institutions for the African American/Caucasian American sample and 174,890 students from 25 institutions for the Hispanic/Caucasian American sample. The optimal cutoffs were then used to show the effect of using non-race-based admissions criteria on African American, Hispanic, and Caucasian American students.

Results. In general, enrolled students had higher ACT Composite scores and slightly higher high school GPAs than did the entire applicant pool. For both enrolled students as well as the entire applicant pool, African American and Hispanic students typically had lower mean ACT Composite scores and high school GPAs than did Caucasian American students. African American and Hispanic students also had lower mean first-year college GPAs than did Caucasian American students.

Figures 5.15 and 5.16 give the median estimated probabilities of a college GPA of 2.5 or higher given ACT Composite score or high school GPA by race/ethnicity. African American and Hispanic students typically had a lower probability of obtaining a 2.5 or higher GPA, relative to Caucasian American students with the same score or high school GPA.

The logistic regression statistics in Table 5.24 reflect the effect of imposing the total-group optimal cutoff for each institution on each racial/ethnic group. This approach illustrates the effects of using a common selection rule for the applicant pool based on total-group optimal ACT Composite scores and high school GPA. Median probabilities of success for African American and Hispanic students corresponding to the total-group optimal cutoff were lower than were those for Caucasian American students for all three predictor models. The differences between racial/ethnic groups in median probabilities of success associated with the total-group optimal cutoffs were smallest for the ACT Composite model and largest for the high school GPA model. In addition, median increases in accuracy rates (i.e., the increases in the percentages of correct admission decisions over admitting all applicants) for all three models were higher for African American and Hispanic students than Caucasian American students. However, in general, a smaller percentage of African American and Hispanic students than Caucasian American students would be admitted under a total-group cutoff, using any of the three models (that is, total-group predictions overestimated the first-year college performance of African American and Hispanic students, relative to that of Caucasian American students).

Summary. The findings from this study suggest that if admission decisions are based on test scores or high school GPAs, and if race/ethnicity is not considered, a smaller percentage of African American and Hispanic students than Caucasian American students would be admitted to college. This result is true of both test scores and high school GPAs. In addition, by not using standardized test scores with other information for college admissions, institutions run the risk of admitting African American and Hispanic students who are underprepared for college-level work. This study also investigated the relative contribution of other student information to making admission decisions for African American and Hispanic students (for further details, see the full ACT Research Report [Noble, 2003]).

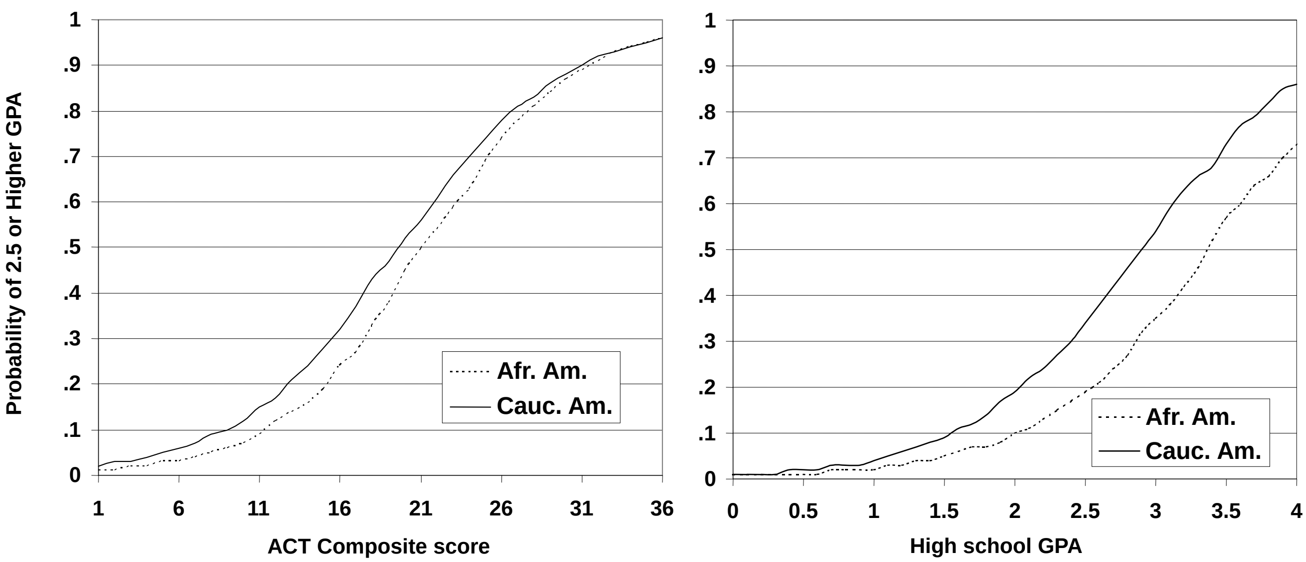


Figure 5.15. Median within-racial/ethnic group probabilities of 2.5 or higher first-year college GPA, using ACT Composite score or high school GPA (Caucasian American students and African American students).

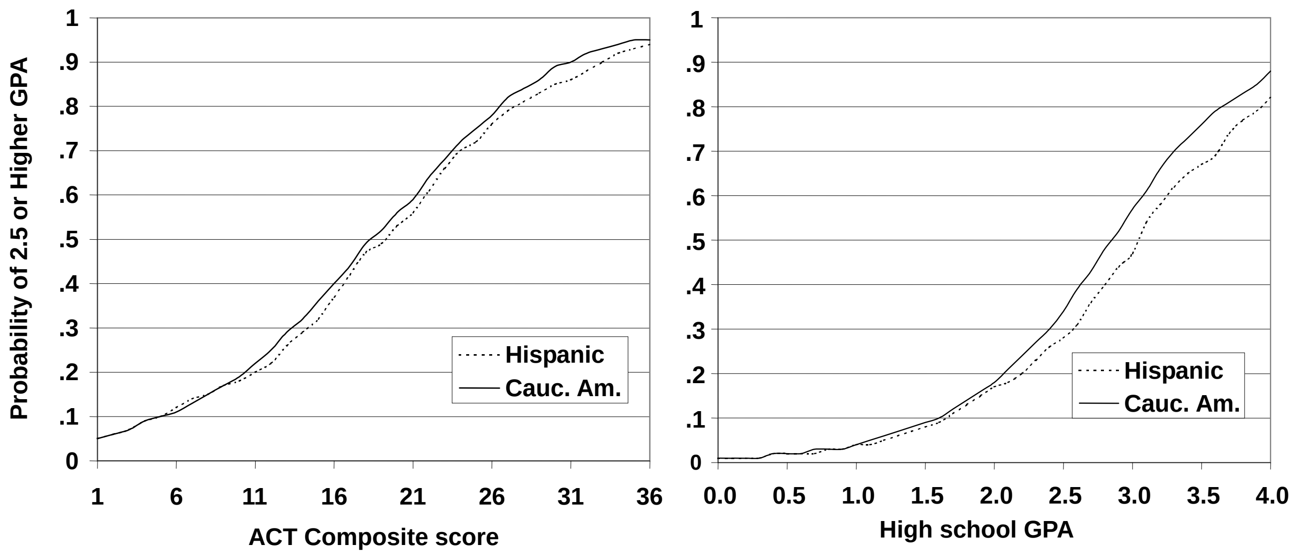


Figure 5.16. Median within-racial/ethnic group probabilities of 2.5 or higher first-year college GPA, using ACT Composite score or high school GPA (Caucasian American students and Hispanic students).

Table 5.24
Within-Group Regression Statistics, Across Institutions Using Total-Group Optimal Cutoffs

		Probability of success at total-group cutoff		Estimated accuracy rate		Estimated increase in accuracy rate		% Admitted	
Predictor variable	**Group**	**Med.**	**Min./Max.**	**Med.**	**Min./Max.**	**Med.**	**Min./Max.**	**Med.**	**Min./Max.**
African American and Caucasian American students									
ACT Composite	Caucasian Am.	.55	.49/.68	66	60/84	9	0/33	56	31/93
	African Am.	.45	.29/.68	71	58/82	41	8/62	18	15/70
HS GPA	Caucasian Am.	.52	.50/.61	70	62/83	12	0/30	59	37/96
	African Am.	.35	.17/.49	69	59/80	37	0/57	37	14/96
ACT Composite & HS GPA	Caucasian Am.	.49	.43/.59	71	63/83	14	1/36	55	36/89
	African Am.	.37	.14/.57	74	65/86	45	10/65	24	7/67
Hispanic and Caucasian American students									
ACT Composite	Caucasian Am.	.52	.48/.56	67	59/84	4	0/23	77	31/100
	Hispanic	.48	.20/.64	63	53/75	7	0/43	57	8/98
HS GPA	Caucasian Am.	.51	.50/.70	70	62/83	9	0/26	68	24/96
	Hispanic	.42	.27/.60	66	56/79	15	1/42	59	16/97
ACT Composite & HS GPA	Caucasian Am.	.50	.28/.58	72	64/84	12	1/29	67	31/97
	Hispanic	.41	.12/.60	68	59/83	21	2/47	55	14/90

Differential Validity

Validity evidence for using ACT test scores for predicting first-year college GPAs of different population groups was developed using data for ACT-tested first-year students from colleges that participated in the ACT Prediction Research Service for two consecutive years (1992–1993 and 1993–1994). The number of institutions and student records included in the analyses are listed in Table 5.25. Average ACT Composite scores and average first-year college GPAs are also listed in the table for both groups of students by reference group: total group, males, females, Caucasian American/White students, and African American/Black students. In general, first-year college students in each of the groups had earned higher average ACT Composite scores than the ACT-tested high school graduates of the preceding year (American College Testing Program, 1991, 1992).

Multiple regression equations were developed, by institution, for each reference group in the 1992–1993 sample that contained at least 50 students. Regression statistics, summarized across the 263 institutions, for the linear regression equation based on the four ACT test scores (T-index) are shown in Table 5.26. Results are given in the table for the first (Q1), second (Q2), and third (Q3) quartiles and mean values of the multiple correlations, summarized across all eligible institutions. The median (Q2) multiple correlation for predicting first-year college GPA for the total group was .46. In general, the typical multiple correlation was slightly higher for females than for males, regardless of racial/ethnic background. Further, first-year college GPA was predicted somewhat more accurately for Caucasian American/White students than for African American/Black students. These findings are consistent with other research on this issue (Sawyer, 1985; Linn, 1982).

Table 5.26 also provides summary validity statistics for the TH-index, which is the linear regression equation based on the four ACT test scores and four high school GPAs (e.g., English, mathematics, social studies, and natural sciences). The high school grades were taken from the CGIS. As shown in the table, the median multiple correlation was .58. Comparison of the T-index and TH-index results shows that using both high school grades and test scores significantly improved the typical multiple correlation for all reference groups over using ACT test scores alone.

Cross-validation statistics. An ACT regression equation (T-index) and an ACT and high school GPA regression equation (TH-index) were developed for each institution using a random half of the 1992–1993 sample (base-year sample). Cross-validation statistics were developed for the other random half (cross-validation across samples). In addition, the 1992–1993 half-sample regression equation for each institution was also used to develop cross-validation statistics for the 1993–1994 sample at the same colleges (cross-validation over time). These results are shown in Table 5.27.

Three different cross-validation statistics are reported in the table. They include:

MAE = Mean absolute error (the mean of the absolute value of the difference between earned and predicted first-year college GPA).

P20 = The proportion of students for which the predicted first-year college GPA was within 0.20 of the earned first-year college GPA, which represents a high level of accuracy.

cvr = The cross-validated correlation between predicted and earned first-year college GPA.

For the T-index model, the typical MAE for any of the reference groups was between 0.5 and 0.6 grade units. About 20% of the predicted GPAs were within 0.20 of the actual GPAs for all the reference groups, and the cross-validated multiple correlations were only slightly less than the multiple correlations developed from the original regression model. The cross-validation statistics across samples and over time for the T-index show very little loss in prediction accuracy over time, and provide supportive evidence for the use of ACT test scores for predicting first-year college GPAs for these reference groups.

Table 5.27 also contains the cross-validation statistics for each reference group based on the TH-index regression model (ACT test scores and high school GPAs). The median (Q2) MAE was smaller, the median P20 was larger, and the median cross-validated correlation was higher for most reference groups than those based on ACT test scores alone. Further, the loss in prediction accuracy across samples and over time (i.e., one year) was minimal. These results provide supportive evidence that ACT test scores and high school grades combined can be used effectively to predict first-year college GPAs for these reference groups. Another study by Noble (2003) also provides validity evidence for using ACT test scores for predicting first-year college GPAs of different population groups (see previous section and Table 5.24).

Table 5.25
Differential Validity Study: Stratification of the Sample and Summary Statistics

Characteristic	Reference group				
	Total group	Males	Females	Caucasian American/ White students	African American/ Black students
1992–1993 first-year college students					
Number of students:					
99 or fewer	74	171	132	83	253
100–199	81	58	79	80	22
200–299	46	26	27	45	13
300–499	36	35	35	30	4
500–999	41	33	41	44	2
over 1,000	56	9	18	49	0
Total number of colleges	334	332	332	331	294
Total number of students	161,662	70,719	90,943	148,173	13,489
ACT Composite score					
Mean	21.5	21.8	21.3	21.9	17.7
SD	4.2	4.4	4.0	4.1	3.4
First-year college GPA					
Mean	2.58	2.47	2.66	2.62	2.13
SD	0.81	0.83	0.79	0.80	0.82
1993–1994 first-year college students					
Number of students:					
99 or fewer	34	110	86	44	196
100–199	63	62	61	59	22
200–299	38	18	30	37	13
300–499	41	28	25	36	4
500–999	33	31	39	36	3
over 1,000	52	12	19	46	0
Total number of colleges	261	261	260	258	238
Total number of students	149,443	66,010	83,433	136,039	13,404
ACT Composite score					
Mean	21.5	21.9	21.2	21.9	17.6
SD	4.2	4.4	4.0	4.1	3.3
First-year college GPA					
Mean	2.58	2.47	2.67	2.63	2.14
SD	0.83	0.84	0.80	0.81	0.83

Table 5.26

Summary of Differential Validity Statistics for ACT Scores Alone (T-index) and ACT Scores and High School GPAs Combined (TH-index) (1992–1993 First-year college students)

Groups	Number of colleges	Number of students	Multiple R			
			Q1	Q2	Q3	Mean
T-index						
Total group						
Total	263	79,127	.41	.46	.55	.48
Male	150	30,914	.37	.44	.52	.46
Female	188	46,296	.43	.49	.57	.51
Caucasian American/White						
Total	250	72,257	.39	.45	.53	.47
Male	149	28,692	.37	.43	.51	.45
Female	184	37,981	.42	.49	.57	.50
African American/Black						
Total	37	4,530	.35	.41	.52	.44
Male	9	864	.33	.44	.48	.40
Female	27	2,388	.36	.48	.54	.48
TH-index						
Total group						
Total	254	73,951	.51	.58	.64	.58
Male	150	28,904	.48	.54	.62	.56
Female	188	39,383	.53	.59	.67	.61
Caucasian American/White						
Total	239	67,396	.51	.57	.64	.58
Male	140	26,510	.48	.54	.62	.56
Female	175	35,585	.53	.59	.66	.60
African American/Black						
Total	34	3,989	.44	.51	.59	.52
Male	9	762	.44	.54	.60	.53
Female	24	2,070	.45	.56	.64	.55

Table 5.27
Summary of Cross-Validation Statistics for First-Year College GPA Using ACT Scores Alone (T-index) and ACT Scores and High School GPAs Combined (TH-index)

Group	Cross-validation statistic	1992–1993 Sample[a]			1993–1994 Sample[b]		
		Q1	Q2	Q3	Q1	Q2	Q3
T-index							
Total group	MAE	.51	.57	.63	.53	.58	.64
	P20	.20	.22	.26	.19	.22	.24
	Cvr	.37	.44	.51	.35	.42	.49
Male	MAE	.54	.61	.66	.55	.61	.68
	P20	.20	.23	.27	.18	.21	.23
	Cvr	.31	.40	.46	.31	.38	.46
Female	MAE	.48	.54	.60	.50	.56	.62
	P20	.20	.24	.27	.19	.23	.26
	Cvr	.39	.47	.53	.38	.44	.50
Caucasian American/White	MAE	.50	.56	.62	.52	.58	.64
	P20	.20	.23	.26	.19	.22	.24
	Cvr	.35	.42	.50	.34	.41	.48
African American/Black	MAE	.56	.59	.64	.58	.63	.66
	P20	.18	.22	.24	.18	.20	.24
	Cvr	.26	.32	.37	.22	.35	.38
TH-index							
Total group	MAE	.48	.54	.59	.50	.55	.60
	P20	.21	.24	.27	.21	.24	.26
	Cvr	.45	.53	.59	.44	.50	.57
Male	MAE	.51	.57	.63	.54	.58	.64
	P20	.19	.23	.26	.19	.22	.25
	Cvr	.39	.47	.53	.40	.47	.53
Female	MAE	.45	.52	.58	.47	.54	.60
	P20	.21	.25	.29	.21	.24	.28
	Cvr	.46	.54	.60	.42	.52	.58
Caucasian American/White	MAE	.48	.53	.58	.49	.54	.60
	P20	.21	.24	.28	.21	.24	.27
	Cvr	.45	.53	.58	.43	.51	.57
African American/Black	MAE	.54	.58	.64	.57	.61	.65
	P20	.18	.21	.24	.19	.22	.24
	Cvr	.30	.38	.44	.28	.38	.45

[a] The 1992–1993 cross-validation sample consisted of one-half of the student records. The second half of the sample was used to develop the regression models.

[b] The regression equation developed on a random half of the 1992–1993 student records was used to predict GPA for the 1993–1994 sample within each college.

Scores of Students Testing Under Special Conditions

The number of students who elect to take the ACT under special conditions continues to grow. Accommodations for eligible students with disabilities include but are not limited to the following:

- large-type edition
- Braille edition
- audio DVD edition
- extended time
- reader administration

Average scores for those tested in 2005–2006 are shown in Table 5.28. Generally, students in the reference groups hearing disabilities, math and other developmental disorders, and other psychiatric disorders tend to earn lower scores than students with other types of disabilities. Students with anxiety disorders tend to earn scores comparable to those of the regular ACT–tested population.

ACT has data through its Prediction Research Services to examine the utility of ACT scores for predicting the academic success of students with different types of disabilities. However, the number of students with a specific disability enrolled at a specific college in any one year is usually too small to develop a group-specific model for predicting college GPAs from ACT scores. A study was conducted by Ziomek and Andrews (1996) to examine this issue.

Data and method. In order to have sufficient sample sizes, first-year college GPAs for students with disabilities were aggregated over three academic years (1992–1993 through 1994–1995). The data available for special-tested students with one or more diagnosed disabilities included type of disability, test package, and extended-time information. A total of 2,959 special-tested students with earned college grades were identified for the study. Three groups of diagnosed disabilities had sufficient number of students to warrant further analyses: Attention Deficit Disorder (N = 480); Developmental Reading Disorder (Dyslexia) (N = 526); and Learning Disabled (N = 1,258). Data were also analyzed for three groups of students with extended testing time:

- Up to double time on the English and Mathematics Tests and up to triple time on each of the Reading and Science Tests (N = 1,127)
- Up to triple time per test (N = 476)
- Up to three hours per test (N = 1,353)

Finally, two test packages that had a sufficient number of students were regular print (N = 173) and audiocassette with regular print (N = 938).

Table 5.28
Average ACT Scores for Students Tested Under Special Conditions in 2005–2006

Reference group	Number of students	Average ACT score: English	Mathematics	Reading	Science	Composite
Developmental disorders						
Arithmetic	618	13.6	14.8	16.0	14.8	14.9
Reading	9,075	14.1	16.4	17.2	17.0	16.3
Writing	160	17.4	19.2	18.8	19.4	18.8
Other	4,919	13.3	15.6	16.0	15.7	15.3
Physical disabilities						
Hearing	792	12.8	16.1	16.1	16.8	15.5
Motor	94	19.1	17.7	22.2	19.2	19.7
Visual	468	19.0	18.4	21.9	19.6	19.9
Other	419	18.0	18.0	21.0	19.1	19.2
Psychiatric disorders						
ADD/ADHD	3,011	17.1	17.7	19.5	18.5	18.3
Anxiety	93	20.4	18.8	21.7	20.0	20.3
Other	1,892	13.4	15.4	16.0	15.6	15.2
Regular ACT-tested graduates, 2006	1,206,455	20.6	20.8	21.4	20.9	21.1

Results. The mean error of prediction (e.g., actual GPA minus predicted GPA) for the total group of students was −0.04, a negligible overprediction. The predicted GPAs of special-tested students tended to be slightly higher, on average, than their actual GPAs. The correlation between predicted first-year college GPA and actual GPA for all special-tested students was .42, as compared to .52 for students tested on national test dates.

Summary. The researchers concluded that, based on the limited data available, ACT scores can be used to help make admissions and course placement decisions for first-year college students with special needs.

Course Placement Decisions

The ACT tests were expressly designed to facilitate placement in first-year college courses. This section summarizes research conducted during 1990–2003 on the effectiveness of ACT scores for this use.

At many postsecondary institutions, there are two levels of first-year courses: "standard" courses in which most students enroll, and "remedial" or "developmental" courses for students who are not academically prepared for standard courses. At some institutions, there may also be "advanced" or "honors" courses for students who are exceptionally well prepared.

One can, in all these cases, think of placement as making a decision on whether to recommend that a student enroll in an "upper-level" or a "lower-level" course. The names "upper-level" and "lower-level" may refer variously to standard and remedial or developmental courses, or to advanced and standard courses. Placement systems typically identify students who have a small chance of succeeding in the upper-level course, and recommend that they enroll in the lower-level course.

Placement Validity Argument Based on ACT Content

A straightforward way to construct a validity argument for a placement test is on the basis of subject matter content. The ACT test battery is intended to measure academic skills and knowledge that are acquired in typical college-preparatory curricula in high school and that are essential for academic success in the first year of college. The content specifications of the ACT are based on the recommendations of nationally representative panels of secondary and postsecondary educators. Determining the content "fit" between ACT scores and a particular course at a given postsecondary institution must, of course, be done by faculty at the institution who know the course content. ACT therefore recommends that faculty and staff review the ACT test specifications to determine their relationship to the first-year curriculum as a preliminary step in deciding whether to use the ACT for first-year course placement.

Given that the contents of the ACT are related to the skills and knowledge required for success in a particular college course, and given that course grades are reliable and valid measures of educational performance in the course, there should be a statistical relationship between test scores and course grades. If the fit of ACT tests to the college course is good, then it is reasonable to expect that students with higher ACT scores will be more successful than students with lower ACT test scores. If this expectation of ACT scores is borne out in empirical studies, then it is appropriate to consider using the tests for course placement.

As noted previously, it is unlikely that ACT scores will measure all aspects of students' readiness for all first-year college courses. Therefore, it is advisable to consider using additional measures, such as high school coursework and grades, scores on locally developed placement tests, or noncognitive measures, in addition to ACT scores in making placement decisions. Two key issues in deciding whether and how to use additional measures of academic skills for course placement are feasibility and cost.

Statistical Relationships Between ACT Scores and Course Grades

ACT has collected course grades from postsecondary institutions specifically to examine the effectiveness of the current version of the ACT tests for placement.

Data. The grades are from entry-level courses at over 100 institutions and include several different course types. Most of the institutions were participants in the ACT Course Placement Service (CPS) either during its pilot phase, the operational phase, or in special studies (e.g., statewide placement studies) prior to 2007. Nearly all the institutions had existing course placement systems. The results of all these analyses were summarized across institutions by course type. This information provides validity evidence for using ACT scores for placement.

Method. Logistic regression models were used to calculate estimated probabilities of success for each course provided by each institution. Course success was predicted from the relevant ACT score; success was defined as receiving a B-or-higher grade in the course. At each ACT score, the probabilities were used to estimate the success rate, accuracy rate, and percentage of students who would be placed in the lower-level course (see pages 98–100 for descriptions of these statistics). These decision-based statistics were then summarized across institutions by course type. Courses that had at least 40 students who had completed the appropriate ACT test and had obtained a course grade were included in the analysis.

To show validity evidence, accuracy rates were summarized at the institution-specific optimal cutoff score. When examined across a range of cutoff scores for a given institution, the accuracy rate will typically peak at a specific cutoff score and then decrease as the cutoff score increases further. This maximum value, which occurs at a probability of success of .50, corresponds to the "optimal" cutoff score for a given course.

There are three reasons why success was defined as a grade of B or better. First, grades below C are fairly uncommon in most courses. The statistical model used will be unstable if either a success or a failure happens only rarely. Second, if the optimal cutoff score is used, the least-qualified student would have about a 50% chance of being unsuccessful. If success is defined as a grade of C or better, that means that the least-qualified student would have about a 50% chance of getting a grade of D or F. It would seem poor policy to place a student into a class with that large a chance of needing to repeat the class due to poor grades. Third, the success criterion of B or better results in grade distributions that more closely follow those currently found in colleges.

Results. Table 5.29 provides the summarized information for 13 course types. For all courses, the median accuracy rate at the optimal cutoff score exceeded 64%. Consequently, a typical institution using the ACT optimal cutoff score from their data could expect that 64% or more of the placement decisions that are made would be correct decisions. Differentiating by course type shows that psychology courses had the lowest median accuracy rate (64%) and calculus and statistics/probability courses had the highest (75%).

Although the magnitude of the accuracy rates might be used as evidence of placement validity, one needs to compare the maximum accuracy rate at the optimal cutoff score to the accuracy rate that would result without placement (i.e., the accuracy rate at the lowest possible ACT score). The difference between these two values for each course represents the increase in the accuracy rate resulting from using ACT scores for placement. For example, the median optimal ACT Mathematics cutoff score for college algebra was 22 (see also the discussion of the ACT College Readiness Benchmarks, page 80), the median accuracy rate was 71%, and the median increase in accuracy rate was 24%. Thus, if no cutoff score were used and all students were allowed into the course, then the expected accuracy rate would be 47%. Typically, use of the optimal ACT Mathematics cutoff score for placement into intermediate algebra would substantially increase the percentage of correct decisions (24%) over what would be expected without using the scores for placement.

Mathematics courses tended to show higher increases in accuracy rate than did English courses. Results from the ACT Course Placement Service suggest this phenomenon occurs regardless of the placement variable (e.g., standardized tests, high school grades, locally developed placement tests, or performance assessments).

The median success rates at the optimal cutoff score ranged from 61% in chemistry courses to 70% in advanced composition courses. This suggests that an institution using its optimal ACT cutoff score typically could expect that at least 61% of the students who were placed in the standard course would obtain a grade of B-or-higher.

ACT Writing scores. Using the methodology described above, the statistical relationships between ACT Writing scores and college course grades were also examined. Prior to the ACT Writing Test becoming operational (February 2005), ten institutions participated in a special study. The ACT English and Writing tests were given during the first two weeks of the semester to college students in English Composition. Course grades were collected at the end of the semester.

Table 5.30 shows the results, based on course outcomes of a B-or-higher grade. Statistics for the ACT English, Writing and English/Writing scores are reported (the English/Writing score is a weighted combination of the ACT English and Writing scores).The median accuracy rates for all three scores ranged from 65 to 69%. As expected, the English/Writing score had the highest accuracy rate. This score is based on more information (i.e., a combination of two scores) and can place students more accurately. The median increases in accuracy rate and success rates for the three scores ranged from 5 to 7% and 66 to 69%, respectively.

Table 5.29

ACT Cutoff Scores and Decision-Based Validity Statistics for Course Placement

(Success criterion = B-or-higher grade)

Course type	ACT score	Number of institutions	Median cutoff score	Maximum accuracy rate			Increase in accuracy rate			Success rate		
				Q_1	Med.	Q_3	Q_1	Med.	Q_3	Q_1	Med.	Q_3
English courses												
Standard composition	English	157	18	63	67	73	1	5	13	63	66	73
Advanced composition		25	20	66	71	75	1	6	13	66	70	74
Literature		11	20	67	69	71	5	9	18	64	69	70
Mathematics courses												
Intermediate algebra	Mathematics	44	21	66	69	75	14	25	35	64	66	71
College algebra		123	22	65	71	76	13	24	41	62	66	70
Statistics/Probability		8	23	70	75	79	15	34	49	65	69	71
Pre-Calculus		32	26	68	72	78	19	38	51	59	64	67
Trigonometry		29	25	63	72	76	13	32	47	60	62	68
Calculus		50	27	67	75	84	25	46	57	59	62	66
Social science courses												
American history	Reading	49	22	63	67	71	6	21	37	60	63	66
Psychology		44	20	62	64	68	2	7	22	61	64	68
Natural science courses												
Biology	Science	53	24	64	69	74	15	30	42	60	62	65
Chemistry		40	23	62	66	73	12	26	42	58	61	64

Note. Placement analyses that did not yield an optimal cutoff score (i.e., the logistic function did not include a probability of .50) were not summarized in this table. Results based on ACT research services data prior to 2007 and the 2013 release of the updated ACT College Readiness Benchmarks.

Table 5.30

Course Placement Validity Statistics
for ACT Writing, English, and English/Writing Scores in English Composition
(Success criterion = B-or-higher grade)

ACT score	Number of institutions	Median cutoff score	Maximum accuracy rate			Increase in accuracy rate			Success rate		
			Min.	Med.	Max.	Min.	Med.	Max.	Min.	Med.	Max.
Writing	10	6	59	65	73	2	7	25	59	66	73
English		18	59	67	74	0	5	24	58	67	75
English/Writing		17	62	69	74	0	6	20	60	69	77

Differential Prediction/Impact by Ethnic and Gender Groups in Course Placement

The studies described in the previous section provided the data and the method to determine the impact of placement decisions on students from specific population groups. Using logistic regression and decision-based statistics, the practical implications of course placement decisions based on ACT scores and high school subject GPAs for females, males, African American/Black students, and Caucasian American/White students were examined.

Although previous research had shown that using ACT scores in combination with HS GPA results in slight differential prediction of first-year college GPAs (Sawyer, 1985), no research had previously compared the differential impact of using high school subject GPAs in course placement with that of using test scores. Therefore, ACT scores and high school subject GPA were used separately as predictor variables, and the differential impact on course placement decisions was compared.

To help insure statistical stability and consistency of population groups across institutions, minimum sample size requirements were made. Only data for courses that had sample sizes of at least 50 students and subgroup (e.g., gender) sample sizes of at least 25 students were used. The sample for each course was also limited to students with the relevant ACT score (ACT English for English courses, and ACT Mathematics for mathematics courses), high school subject area GPA (English GPA for English courses and mathematics GPA for mathematics courses), and the college course grade. These sample size constraints restricted the number of course types and racial/ethnic groups that could be examined. For the gender analyses, four courses were investigated: English composition, intermediate algebra, college algebra, and calculus. For the racial/ethnic analyses, English composition and college algebra were the only course types for which there were sufficient numbers of African American/Black students and Caucasian American/White students within each institution.

Descriptive statistics, calculated for each institution by course type and group, were summarized across institutions. The minimum, median, and maximum values of these statistics are reported in Table 5.31. The number of courses was included with the number of institutions for each course type, as some institutions provided grades from multiple courses of the same type. (For example, there were grades from 47 English composition courses but these grades came from 40 institutions.) The median ACT scores for males were slightly higher than those for females except for the ACT English Test (largest difference = 0.8), and the median ACT scores for Caucasian American/White students were higher than those for African American/Black students (largest difference = 2.9). For the high school subject GPAs and college course grades, females and Caucasian American/White students had higher median values, respectively, than did males and African American/Black students for all course types. Racial/ethnic differences were larger than the gender differences.

Differential prediction. For each course type, group-specific probabilities of success (B-or-higher) were calculated using a group-specific ACT score or high school subject GPA prediction model. The logistic regression weights from the models were applied to the ACT scores or high school subject GPA of all students at each institution with valid predictor data (i.e., the group of students for whom placement decisions needed to be made), resulting in an estimated probability of success for each student. Then, for each course type, a mean between-group difference in probability of success was computed. The difference at each ACT score or high school subject GPA was weighted by the number of females (in the gender analysis) or African American/Black students (in the racial/ethnic analysis) with that score or average in the placement group for the course. The minimum, median, and maximum mean differences across institutions, within course type, were calculated.

The results are reported in Table 5.32. For every course type, females had a slightly higher median probability of success than males, based either on ACT scores (.08 to .10) or on high school subject GPA (.02 to .06). The range of gender differences in probability of success across institutions was larger for all course types when based on high school subject GPA than on ACT score.

The results by racial/ethnic group showed that African American/Black students had a lower median probability of success than Caucasian American/White students for both course types, whether based on ACT scores (–.08,–.05, respectively) or high school subject GPA (–.12,–.08, respectively).

Table 5.31

Descriptive Statistics for Differential Impact Study Groups

Course type	No. of inst./ no. of courses	Group	Mean ACT subject area score			Mean HS subject area GPA			Mean course grade			Percentage with B-or-higher grade		
			Min.	Med.	Max.	Min.	Med.	Max.	Min.	Med.	Max.	Min.	Med.	Max.
English composition	40/47	Females	14.1	**20.3**	25.7	2.61	**3.18**	3.56	2.07	**2.70**	3.54	27	**65**	95
		Males	14.1	**19.7**	24.7	2.29	**2.88**	3.28	1.70	**2.40**	3.42	22	**51**	89
Intermediate algebra	13/13	Females	16.0	**19.1**	20.0	2.13	**2.72**	2.90	1.39	**2.13**	3.20	20	**39**	82
		Males	17.2	**19.5**	21.1	2.18	**2.53**	2.84	0.88	**1.94**	3.03	13	**35**	78
College algebra	22/25	Females	18.2	**20.9**	25.4	2.46	**3.14**	3.60	1.05	**2.28**	2.78	18	**46**	65
		Males	18.8	**21.7**	25.2	2.30	**2.97**	3.41	0.83	**2.08**	2.76	13	**41**	64
Calculus	12/16	Females	20.2	**26.2**	30.0	2.89	**3.64**	3.83	1.96	**2.53**	3.00	36	**52**	74
		Males	20.4	**26.7**	30.8	2.62	**3.50**	3.77	1.88	**2.43**	3.03	27	**51**	70
English composition	8/11	Afr. Am.	13.2	**17.8**	20.9	2.24	**2.82**	3.24	1.47	**2.27**	2.82	17	**46**	61
		Cau. Am.	17.8	**20.7**	22.9	2.65	**3.00**	3.37	2.11	**2.60**	3.18	43	**60**	79
College algebra	6/6	Afr. Am.	18.8	**19.5**	20.9	2.76	**2.88**	3.07	1.32	**1.76**	2.29	25	**27**	41
		Cau. Am.	21.2	**22.0**	22.7	2.88	**3.15**	3.21	1.74	**2.33**	2.63	39	**47**	59

Table 5.32

Differences in Probability of Success Using B-or-Higher Success Criterion (Female probability minus male probability, African American students minus Caucasian American students)

Group	Course type	Weighted average gender difference in probability of success: ACT score			High school subject area GPA		
		Min.	Med.	Max.	Min.	Med.	Max.
Gender	English composition	−.04	**.08**	.26	−.08	**.06**	.27
	Intermediate algebra	.02	**.10**	.18	−.03	**.05**	.17
	College algebra	−.03	**.08**	.22	−.17	**.03**	.17
	Calculus	−.07	**.08**	.17	−.20	**.02**	.16
Racial/Ethnic	English composition	−.15	**−.08**	.06	−.19	**−.12**	−.01
	College algebra	−.17	**−.05**	.03	−.15	**−.08**	.06

Differential impact. For each group within course type and institution, two optimal cutoff scores were identified—one based on the prediction model for all students (total group optimal cutoff score) and the other based on the group-specific prediction models (group-specific cutoff scores).

Using the two optimal cutoff scores for each course type and institution, the following statistics were estimated for each gender and racial/ethnic group: (a) the percentage of placement group students who would be placed into a lower-level course, (b) the percentage of successful students among those who would be placed into the course (success rate), and (c) the percentage of correct placement decisions (accuracy rate). Optimal cutoff scores and differential impact statistics were summarized across institutions using median, minimum, and maximum values.

Total group cutoff scores—gender. The gender results are reported in Table 5.33. For every course type except English composition, using a total group ACT cutoff score would generally result in a slightly higher percentage (median difference = 10% to 11%) of females than males placed into the lower-level course. For English composition courses, the median percentage placed into lower-level courses, based on an ACT English cutoff score of 17, was 35% for females and 46% for males. Using a total group high school subject GPA cutoff score would generally result in placing more males than females into both lower-level English and mathematics courses. The one exception was calculus, where slightly more females than males would be placed into lower-level courses.

Among students placed into a course using a total group ACT cutoff score, the typical percentage of females who would be successful (success rate) was 8% to 15% higher than that of males for all courses. The largest differences based on ACT scores were found for English composition (15%) and intermediate algebra (13%). The typical success rates based on total group high school subject area GPA cutoffs were also higher for females than for males for English composition (10%) and intermediate algebra (8%). Success rates of females in college algebra and calculus were higher than those of males, but the differences were small.

The differences in estimated percentages of males and females correctly placed (accuracy rate) based on total group ACT cutoff scores were relatively small and varied across course types. The differences between median accuracy rates were no greater than 3 percentage points. The accuracy rate differences based on high school subject area GPAs were very similar to those based on ACT scores.

Group-specific cutoff scores—gender. Compared to the total group optimal cutoff scores, gender-specific optimal cutoff scores across institutions using either ACT scores or high school subject area GPA were slightly lower for females and slightly higher for males for every course type except calculus, as shown in Table 5.33. Gender-specific ACT cutoff scores were generally 1–2 scale score units lower for females and 1–2 score units higher for males than the corresponding total group cutoff scores. For calculus, the median optimal ACT cutoff score for males was 1 scale score unit higher than the total group cutoff score; for females the two cutoffs were the same.

Using gender-specific ACT cutoff scores, rather than a total group ACT cutoff score, would generally decrease the percentages of females (9% to 13%) and increase the percentages of males (1% to 13%) placed in lower-level courses for all course types. In addition, it would decrease the typical success rates for females (1% to 7%) and slightly increase the success rates for males (4% to 6%) for all course types. Accuracy rates for gender-specific ACT cutoff scores were comparable to those obtained using a total group cutoff score for all course types.

Gender-specific high school subject area grade optimal cutoffs were generally lower by 0.2–0.3 grade units for females than for males for all course types except calculus. Using gender-specific cutoffs rather than total group cutoffs would result in an increase in the percentage of males (9%) and a decrease in the percentage of females (5%) placed into lower-level English courses. Success rates and accuracy rates would typically be comparable to those obtained using a total group high school subject GPA cutoff.

Total group cutoff scores—race/ethnicity. The racial/ethnicity results are reported in Table 5.34. For both course types, using a total group ACT cutoff score would generally result in a higher percentage of African American/Black students than Caucasian American/White students placed into the lower-level course (median difference = 30% for English composition, 27% for college algebra). The same would be true using a total group high school subject GPA cutoff score, although the median differences were smaller (19% and 15%).

Table 5.33

Differential Impact of Using Total Group or Group-Specific Cutoffs Across Gender Groups (Medians)

		ACT score				High school subject area GPA			
Course	Group	Optimal cutoff score	Percent placed in lower-level course	Success rate	Accuracy rate	Optimal cutoff score	Percent placed in lower-level course	Success rate	Accuracy rate
Total group cutoff									
English composition	Females	17	35	74	69	2.67	23	72	69
	Males		46	59	66		38	62	67
Intermediate algebra	Females	21	61	74	68	3.34	65	61	66
	Males		50	61	70		68	53	69
College algebra	Females	22	71	68	68	3.26	61	63	66
	Males		61	60	69		65	61	68
Calculus	Females	25	88	65	73	3.49	74	64	69
	Males		78	56	73		72	63	71
Group-specific cutoff									
English composition	Females	16	26	71	69	2.55	18	72	70
	Males	19	55	64	67	2.82	47	64	67
Intermediate algebra	Females	19	50	67	68	3.17	63	60	66
	Males	23	63	67	72	3.54	82	56	69
College algebra	Females	21	58	64	68	3.19	60	62	67
	Males	23	66	64	70	3.36	69	61	68
Calculus	Females	25	79	64	76	3.49	73	64	69
	Males	26	79	62	74	3.39	70	62	71

Table 5.34
Differential Impact of Using Total Group or Group-Specific Cutoffs Across Racial/Ethnic Groups
(Medians)

		ACT score				High school subject area GPA			
Course	Group	Optimal cutoff score	Percent placed in lower-level course	Success rate	Accuracy rate	Optimal cutoff score	Percent placed in lower-level course	Success rate	Accuracy rate
Total group cutoff									
English composition	African Amer.	17	50	58	62	2.46	45	52	61
	Cauc. Amer.		20	68	68		26	69	68
College algebra	African Amer.	22	77	50	72	3.14	78	47	72
	Cauc. Amer.		50	66	69		63	66	68
Group-specific cutoff									
English composition	African Amer.	19	59	61	63	2.76	63	62	63
	Cauc. Amer.	17	20	68	69	2.37	22	68	68
College algebra	African Amer.	24	92	61	76	3.72	91	59	78
	Cauc. Amer.	22	50	66	69	3.09	60	66	68

Among students placed into a course using a total group ACT cutoff score, the typical percentage of Caucasian American/White students who would be successful (success rate) was higher than that of African American/Black students for both courses (median difference = 10% and 16%). The typical success rates based on total group high school subject area GPA cutoffs were also higher for Caucasian American/White students than for African American/Black students. The median differences (17% and 19%) were slightly higher than the differences based on ACT scores.

The differences in estimated percentages of African American/Black students and Caucasian American/White students correctly placed (accuracy rate) based on total group ACT cutoff scores were relatively small. The accuracy rate for African American/Black students was 6% lower in English composition and 3% higher in college algebra than those for Caucasian American/White students. The accuracy rate differences based on high school subject area GPAs were very similar (7% and 4%) to those based on ACT scores.

Group-specific cutoff scores—ethnicity. Group-specific ACT cutoff scores for African American/Black students were slightly higher than the corresponding total group ACT cutoff scores in both courses. Compared to using a total group ACT cutoff score, using group-specific ACT cutoff scores would typically result in higher percentages of African American/Black students placed into lower-level courses (median difference = 9% and 15%), higher percentages of African American/Black students who would be successful (median difference = 3% and 11%), and slightly higher percentages of African American/Black students who would be correctly placed (median difference = 1% and 4%).

Median group-specific high school subject GPA cutoff scores were higher for African American/Black students than for Caucasian American/White students, and would result in correspondingly higher percentages of African American/Black students placed into lower-level courses (median difference = 18% and 13%). Using group-specific high school subject GPA cutoffs, rather than total group high school subject GPA cutoffs, would typically increase the percentages of correct placement decisions by 10% and 12%, respectively, for African American/Black students, and would slightly increase the percentages of African American/Black students who would be successful by 2% and 6%, respectively.

Summary. The results of this study were consistent with prior research (e.g., Sawyer, 1985), showing that both ACT scores and high school subject area GPAs slightly overpredict the college English composition and mathematics course grades of males relative to those of females, and overpredict the English composition and college algebra grades of African American/Black students relative to those of Caucasian American/White students. Differential prediction based on logistic regression was slight for both racial/ethnic and gender groups, corresponding to the difference between a B and a B– grade. This would seem to indicate that factors other than cognitive achievement (e.g., social support, family values concerning education, aspirations) contribute to differential performance. Further research on these factors would help in determining these relationships.

Both ACT scores and high school GPAs differentially predict college performance of racial/ethnic and gender groups to some degree but, from a practical perspective, the differences between groups are very small. Placement accuracy was fairly consistent across racial/ethnic and gender groups. Further, were institutions to move toward group-specific cutoffs, or toward adjusting their placement requirements to balance group representation on the basis of, for example, the percentages of students placed in the lower-level course, there would probably be consequences in terms of placement accuracy and the percentages of students placed into the course who would be successful.

Incremental Validity of ACT Scores and High School Grades in Course Placement

As described at the beginning of this section, using multiple measures could increase content coverage and, as a consequence, increase the accuracy of placement decisions. Consequently, the methods used to examine incremental validity in admissions decisions were applied to the course placement data described in the previous section to determine whether the accuracy of placement decisions would increase if ACT scores and high school subject GPA were used jointly.

Logistic regression analyses. Course grades in English composition, intermediate algebra, college algebra, and calculus; ACT English and Mathematics scores; and self-reported high school English and mathematics GPAs were used for this study. Three general logistic regression models were developed for predicting course grades of B-or-higher: (a) ACT score or high school subject GPA (one-predictor model), (b) ACT score and high school subject GPA (two-predictor model), and (c) ACT score, high school subject GPA, and their interaction (three-predictor model). Institutions were included as effect-coded variables. The utility of additional predictor variables was evaluated by the difference between the –2 log likelihood of the models ($\sim\chi^2$ with $p_i - p_j$ degrees of freedom, where p_i = number of parameters estimated by each model i). All analyses were carried out separately for each of the four courses.

The results showed that the one-predictor models were statistically significant ($p < .001$) for predicting course outcomes, and that the addition of a second predictor resulted in a statistically significant increase in the χ^2 ($p < .001$). Moreover, the increase in the χ^2 by adding an interaction term (score by GPA) was statistically significant for three of the four courses (calculus was the exception).

Comparing Accuracy Rates. Given the logistic regression results, joint ACT score and high school subject GPA models should improve the accuracy of institution-specific placement decisions over that obtained by using these variables alone. Further, increases in accuracy should depend on the ACT score or high school subject GPA value (i.e., interaction effect): improvement in accuracy is therefore a function of students whose predicted outcome changes from successful to unsuccessful, or vice versa, when the second predictor variable is considered. Thus, the change in students' positions rests on (a) the cutoff score for the first predictor variable, (b) the cutoff for the second predictor variable, and (c) the contribution of the second predictor variable to placement accuracy.

The one-predictor and two-predictor logistic regression models were developed for each institution. Table 5.35 shows median estimated accuracy rates (ARs), estimated increases in accuracy rates (ΔARs), and estimated success rates (SRs). For all four courses, the median accuracy rates and increases in accuracy rates for ACT scores alone and high school subject GPAs alone were very similar. The largest difference was in calculus, where the ARs and ΔARs for ACT Mathematics Test score were 2% higher than the ARs and ΔARs for high school math GPAs.

The results of using ACT scores and high school subject GPA in combination show that typically there was a moderate increase in the median accuracy rate (2%–5%) for all four courses. For example, a typical institution using ACT Mathematics scores and high school mathematics GPAs for placing students into college algebra could expect a maximum accuracy rate of 68%. This is a 2% increase in the percentage of correct decisions over that obtained with either ACT Mathematics score or high school mathematics GPA alone.

Table 5.35
Median Placement Statistics for ACT Scores and High School Subject Area GPA as Single Predictors, and Jointly

Course type	Number of institutions	Predictor variable	Accuracy rate (AR)	Increase in accuracy rate (ΔAR)	Success rate (SR)
English composition	66	ACT English	68	7	68
		High school English GPA	68	7	68
		ACT English & HS English GPA	71	10	71
Intermediate algebra	23	ACT Math	68	30	57
		High school Math GPA	67	29	52
		ACT Math & HS Math GPA	70	32	61
College algebra	44	ACT Math	66	21	63
		High school Math GPA	66	21	61
		ACT Math & HS Math GPA	68	23	65
Calculus	35	ACT Math	66	16	64
		High school Math GPA	64	14	63
		ACT Math & HS Math GPA	69	19	67

Two features of using two predictors for placement are noteworthy. First, the maximum accuracy rate was not associated with a single combination of ACT score and high school subject GPA. Instead, there was a cluster of combinations that was compensatory in nature and varied in size among the four courses. For example, in English composition, ACT English score and high school English GPA combinations of 17 and 2.5, 18 and 2.4, and 19 and 2.2 (and others) were associated with the highest median accuracy rate (68%). Allowing higher ACT scores to compensate for lower high school subject GPAs and vice versa contributed to the increase in the percentage of correct decisions.

Second, without careful selection of the cutoff combinations, the accuracy rate from using two placement variables could be lower than that obtained by using one placement variable. In calculus, the median accuracy rate for ACT Mathematics score or high school mathematics GPA alone was 66% and 64%. Combining the variables increased the accuracy rate to 69% (e.g., at ACT Mathematics score and high school GPA combinations of 24 and 3.6, and 27 and 3.0). However, if an institution were to use an ACT Mathematics score and high school mathematics GPA combination of 24 and 2.6 as cutoffs, the accuracy rate would be 3 percentage points lower (64%) than that using an ACT Mathematics score of 24 alone (67%). Students who were not academically prepared would be placed in calculus, thereby decreasing the percentage of correct decisions.

Success rates resulting from placement with ACT scores and high school subject GPAs followed the same pattern for all four courses: Success rates increased as the values of the two placement variables increased. At the optimal cutoff scores, the success rate equaled the maximum accuracy rate for English composition and was slightly lower for the mathematics courses. The success rates at the optimal cutoff using ACT scores and high school subject GPAs jointly were slightly higher than those using either variable alone (increase of 2%–9%). Thus, when using their optimal cutoff combinations for these courses, institutions could expect an increase in the percentage of students who would obtain a grade of B-or-higher of about 2%–9%.

Methods for Setting Cutoff Scores

Institutions have unique admissions and placement needs that require locally developed cutoff scores, rather than the median optimal cutoff scores shown in this section. There are a variety of ways to establish cutoff scores or decision zones for admissions or for placement of students into different courses. The procedures for setting cutoff scores include the use of logistic regression and decision-based statistics, as used by the ACT Course Placement Service, local score distributions, judgmental procedures based upon a content review of the items, and other comparison populations.

It is often advisable to interpret cutoff scores as guides rather than as rigid rules. One way to do this is to use decision zones. A decision zone is an interval around the cutoff score; students whose test scores (or other variable) are in a decision zone are encouraged to provide more information about their academic qualifications and skill levels. For example, it might be appropriate to identify an ACT English score range of 17–20 as a placement decision zone in Composition. Students whose scores are above 20 would be placed into Composition. Those whose scores are below 17 would be placed into a developmental writing course, one that prepares them for Composition. Students whose scores fall into the decision zone would be advised that their skills appear to be on the borderline of readiness for Composition. Their option, with the advice of an advisor, would be to enroll in a developmental course (or participate in other appropriate skill-building services) to improve skills prerequisite for Composition or to enroll directly in the Composition course, with full awareness that most of the other students will probably have a stronger base of skills in the prerequisite areas. To provide more information about their readiness for Composition, another test of writing skills could be administered to the students whose scores fall into the decision zone.

A course placement study generates the probability of success, accuracy rate, success rate, and percentage not placed in a lower-level course. If a test is effective for admissions or placement, then higher test scores should correspond to higher probabilities of success. Probability-of-success information can be used for advising individual students. It also serves as the basis for computing the group statistics used to validate tests and to select cutoff scores. Table 5.36 shows the relationship between students' ACT Mathematics Test scores and their probability of earning a grade of B-or-higher and a grade of C-or-higher in Mathematics 211. For example, the probability of earning a grade of C-or-higher corresponding to an ACT Mathematics score of 18 is .35; consequently, we would expect that about 35 out of 100 students with an ACT Mathematics score of 18 would achieve a C-or-higher grade in Mathematics 211. This information is also shown graphically in Figure 5.17.

Decision-based statistics provide information about how an admissions or placement system affects groups of students. Such group-level information is important in validating and selecting cutoff scores for admissions and placement. The percentage of students who would not be admitted or would be placed in lower-level courses is one important consideration. The availability of instructors, classrooms, and other resources affect how many students can be admitted or enrolled in either standard or lower-level courses. Moreover, if a test is effective for admissions or placement, then it should have a high estimated accuracy rate: whether a student is admitted, or placed in the standard course, or placed in a lower-level course, the decision for the student should be correct. Finally, using an effective admissions or placement test should also result in a high estimated success rate.

Table 5.36
Probability of Success in Math 211, Given ACT Mathematics Score

ACT Mathematics score	Probability of success (B-or-higher)	Probability of success (C-or-higher)
35	.93	.99
33	.88	.98
32	.84	.97
31	.79	.96
30	.74	.95
28	.60	.91
27	.52	.88
26	.44	.85
25	.37	.81
23	.24	.70
22	.18	.64
21	.14	.56
20	.11	.49
18	.06	.35
17	.04	.29
16	.03	.23
15	.02	.18
13	.01	.11
12	.01	.08
11	.01	.06
10	.01	.05

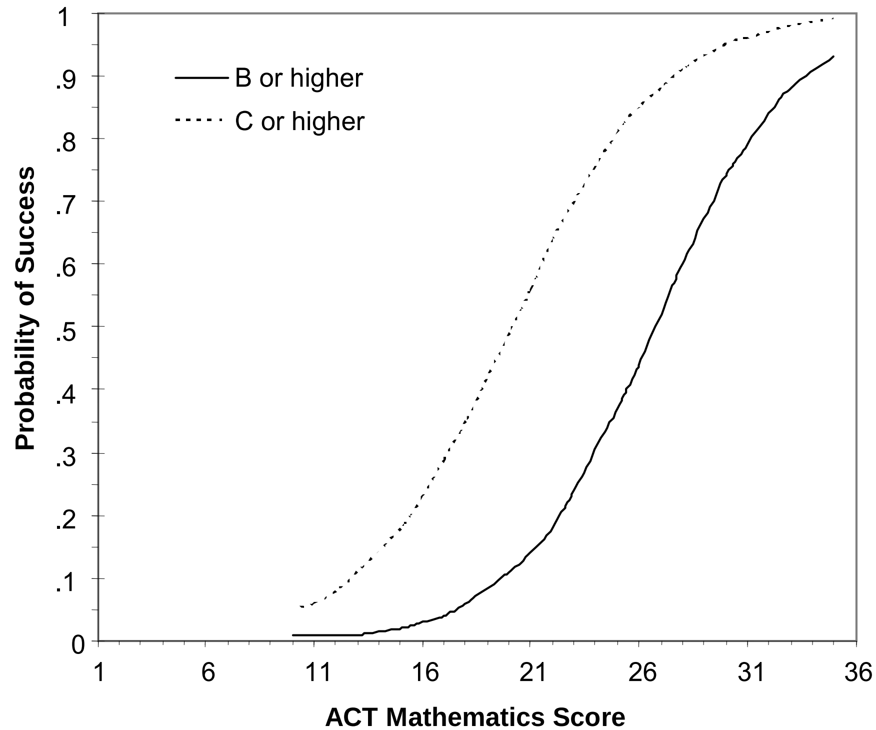


Figure 5.17. Probability of success in Math 211, given ACT Mathematics score.

Table 5.37 is provided as an example of these statistics. If the ACT Mathematics cutoff score for placement into Mathematics 211 were taken to be 18, then about 27% of the students would be placed into a lower-level course. With respect to the C-or-higher success criterion, about 67% of all the placement decisions (into either course) would be correct ones; of the students placed into Mathematics 211, about 63% of them would be successful.

The "optimal" cutoff score is a reasonable starting point and can be found by identifying the score that corresponds to a probability of success of about .50. In Table 5.37, the ACT Mathematics score of 21 is the cutoff score that would maximize the accuracy of placement in Mathematics 211 (71%) using the C-or-higher success criterion.

One should keep in mind, however, that the cutoff score that maximizes the accuracy rate may be associated with a success rate and a percentage of students not admitted (or placed in the lower-level course) that is not acceptable to an institution. In Table 5.37, using the optimal cutoff (ACT Mathematics score of 21) would place approximately 52% of the students into the lower-level course, and, with respect to the C-or-higher success criterion, about 74% of the students who would enroll in Mathematics 211 would be successful. A lack of resources may make it impossible for an institution to place 52% of their students into lower-level courses. A solution might be to use a cutoff score of 20. This would result in an accuracy rate nearly identical to the rate associated with a score of 21, but only 43% of the students would be placed into the lower-level course. The disadvantage of lowering the cutoff score would be that the percentage of students who would be successful in Mathematics 211 would decrease. The institution would need to consider the consequences of selecting alternative cutoff scores as they relate to resources, as well as to institutional goals and policies.

Table 5.37
Decision-Based Statistics for Placement Based on ACT Mathematics Score

		B-or-higher		C-or-higher	
ACT Mathematics score	Percent placed in lower-level course	Estimated accuracy rate (in percent)	Estimated success rate (in percent)	Estimated accuracy rate (in percent)	Estimated success rate (in percent)
35	100	82	93	48	99
33	100	82	89	49	98
32	99	82	87	49	98
31	99	82	84	49	97
30	98	83	81	50	96
28	94	84	69	53	93
27	91	84	63	56	92
26	87	83	57	58	90
25	82	82	51	62	87
23	68	76	40	68	81
22	60	70	36	70	77
21	52	65	32	71	74
20	43	57	29	71	70
18	27	44	24	67	63
17	19	36	22	64	59
16	12	30	21	60	57
15	6	24	19	56	54
13	1	20	19	53	52
12	1	20	19	52	52
11	1	20	19	52	52
10	1	20	19	52	52

Local score distributions. Institutional personnel are often required to establish cutoff scores on the basis of administrative considerations (e.g., availability of instructional staff and facilities). Score distributions can be used under these conditions to provide preliminary cutoff scores.

Cutoff scores based on score distributions are easy to communicate and to implement in an admissions or placement system. However, students' true abilities may be inconsistent with the selected cutoff score; that is, students who are underprepared for college may be incorrectly admitted or placed in the standard course. For more accurate decisions, ACT scores (or other variables) should be related to college and/or course outcomes.

Expert judgment. When expert judgment is used to establish cutoff scores, institutional personnel should conduct a thorough review of the test content. Based on this review, institutions may determine that a student correctly answering a certain percentage or more of the items has demonstrated sufficient knowledge of the subject to be admitted or placed in a particular course.

In establishing a cutoff score, there are various methods for determining the proportion of students with adequate skills. (For a description of some of these methods, see Cizek & Bunch, 2006.) These methods require content judges to decide how a "borderline" test taker, one whose knowledge and skills are on the decision borderline, would probably respond to the items on the examination. Since each of these methods relies on subjective judgment, inspection of actual performance data is also recommended.

Other comparison populations. Cutoff scores can also be set by using the scores from the ACT national norms or the Course Placement Service Summary Tables. This is particularly helpful when local normative data are not available. For example, the normative data provided in Table 4.10 might be used to set local cutoff scores based on the scores earned by a nationally representative sample of ACT–tested students. The normative distribution would be used in a manner similar to that described above for local score distributions. A student taking a specific test would be admitted or placed in a standard course if he or she scored at or above the scale score corresponding to a predetermined percentage. Users should note that local distributions of ACT scores and/or grades may differ markedly from national distributions. Therefore, cutoff scores derived from national data should be validated, and later should be adjusted as warranted as local data become available. The Course Placement Service provides a convenient way for institutions to validate and determine appropriate cutoff scores.

Monitoring Cutoff Scores

Once a procedure has been selected and used for establishing a cutoff score, it is essential that the effectiveness of the cutoff score be continually monitored by the institution. Experience may suggest adjusting established cutoff scores. By participating in the ACT Course Placement Service, institutions can use the results from the reports to develop score cutoffs and then can use future reports to validate these cutoffs. The tables from the report illustrate the effectiveness of the score cutoffs for course placement.

Using ACT Scores as Indicators of Educational Effectiveness of College-Preparatory Programs in High School

An argument for using the ACT in evaluating college-preparatory programs is that it measures important program outcomes. The ACT tests have been developed to measure academic skills and knowledge that are obtained in high school and are necessary for academic success in the first year of college. Validity evidence for using the ACT as a measure of educational development is documented at the beginning of this chapter.

Before using the ACT in program evaluation, a high school should conduct a content review to determine the extent to which the tests represent important outcomes the school wishes to measure. If there is a content match between the ACT and important local educational outcomes, the ACT may be considered as one component of a program evaluation system. ACT scores should not be relied on exclusively as evidence of program effectiveness, however. Rather, ACT scores should be considered with other indicators of program effectiveness routinely collected by schools.

Several cautions must be kept in mind when using the ACT for program evaluation. Results using ACT scores can be based on a unique subsample of each school's students: ACT–tested students may not represent all students enrolled in the school. Expectations of and conclusions drawn about a select group of students who complete the ACT will differ from those concerning a larger group of college-bound students, or those of the graduating class as a whole (college-bound and non-college-bound). Moreover, without some measure of student achievement earlier in high school, judgments about educational development and achievement during high school may be misleading. This issue can be addressed by using the ACT in conjunction with ACT Plan.

Using ACT Scores for Program Evaluation

ACT scores can be used in various ways for program evaluation. A school could establish expected levels of educational achievement for individual students, for the entire group of tested students, or for groups of students defined by common academic interests, high school coursework, or some other characteristic.

In establishing expected levels of achievement for groups of students, several factors need to be considered, including the availability or resources both within and external to the school, the social climate of the school, the nature of the students from the school who complete the ACT, and the level of student preparedness upon entering the school. Identification of ACT–tested students within a school may not be possible.

Using ACT and ACT Plan Scores for Program Evaluation

ACT scores may be used in concert with ACT Plan scores for program evaluation. ACT Plan includes academic tests in the same subject areas as the ACT—English, Mathematics, Reading, and Science. Content specifications for the ACT Plan tests were developed using procedures comparable to those used for the ACT (ACT, 1999). However, results based on both ACT Plan and ACT scores should not be used as sole indicators in program evaluation. They should be considered with other indicators of program effectiveness.

The ACT Plan and ACT tests were designed to be similar in their content and in their focus on higher-order thinking skills. Their scores are reported on a common scale. The ACT Plan and ACT tests, then, are conceptually and psychometrically linked. As shown earlier in this chapter (see pages 67–71), ACT and ACT Plan scores are highly correlated with each other and with high school coursework and grades. They are therefore appropriate for measuring student academic achievement over time.

Student progress within a school can be examined using the percentage of students meeting College Readiness Benchmark Scores on ACT Plan and the ACT (see Chapter 3 for a discussion of the ACT College Readiness Benchmarks). The ACT Plan College Readiness Benchmark Scores are based on the ACT College Readiness Benchmark Scores. They reflect students' expected growth from ACT Plan to the ACT and assume sustained academic effort throughout high school. The ACT Plan Benchmarks are 15 in English, 19 in Mathematics, 18 in Reading, and 20 in Science. ACT's PLAN/ACT Linkage Reports provides this information for students who have taken both ACT Plan and the ACT.

Evaluating Students' Probable College Success

This section describes three recent studies demonstrating the relationship between college readiness as measured by the ACT and students' success in the first year of college and beyond.

Statistical Relationships Between College Readiness and First-Year College Success

A study (ACT, 2010) examined the relationship between college readiness and first-year college success.

Data and method. College outcomes included enrollment into any college the fall following high school graduation, first-year college course grades, first-year college grade point average (GPA), remediation in English or mathematics, and retention to the same college in year two. College readiness was measured by ACT College Readiness Benchmark attainment (see Allen & Sconing, 2005).

College enrollment rates were based on approximately 1.3 million high school students who took the ACT and indicated that they would graduate from high school in 2007. Colleges included two-year and four-year institutions, as well as full- and part-time students. College retention rates were based on approximately 922,000 ACT-tested students from the 2007 graduating class who enrolled in a postsecondary institution the fall following high school graduation, according to the National Student Clearinghouse database. Remediation rates were based on data for students from three states whose postsecondary institutions participated in ACT's College Success Profile Service (approximately 92,500 students for remedial English and 101,500 students for remedial mathematics). Remediation rates were analyzed by state, due to differing remediation policies across states. Data for first-year college GPA included approximately 302,000 ACT-tested students from postsecondary institutions who participated in ACT's

High School Feedback Service. First-year course grades data spanned multiple years from various postsecondary institutions who participated in ACT's Course Placement Service. Approximately 99,000 students were included in the analysis for English Composition I; 10,000 for English Composition II; 6,500 for Intermediation Algebra; 17,500 for College Algebra; 7,500 for Pre-Calculus/Finite Math; 5,500 for Calculus; 6,500 for American History; 7,000 for Psychology; 4,000 for Biology and Chemistry.

Results. Students who met the ACT College Readiness Benchmarks were more likely than those who did not (a) to enroll in college the fall following high school graduation (Figure 5.18; by 15 to 22%); (b) to achieve a B-or-higher grade in first-year college courses (Figure 5.19; by 14 to 33%); (c) to earn a first-year college grade point average of 3.0 or higher (Figure 5.20; by 21 to 28%), and (d) to persist to the second year at the same institution (Figure 5.21; by 11 to 15%). In addition, students who met the English Benchmark were less likely to take remedial English (2 to 5% vs. 38 to 74%), and those who met the Mathematics Benchmark were less likely to take remedial mathematics (1% vs. 27 to 59%).

Summary. These findings indicate that the ACT College Readiness Benchmarks are good indicators of whether students have acquired the knowledge and skills to be successful in first-year college courses and show that students who are college-ready are more likely to immediately enroll in college, and once they enroll, tend to be more successful during their first year of college than are underprepared students.

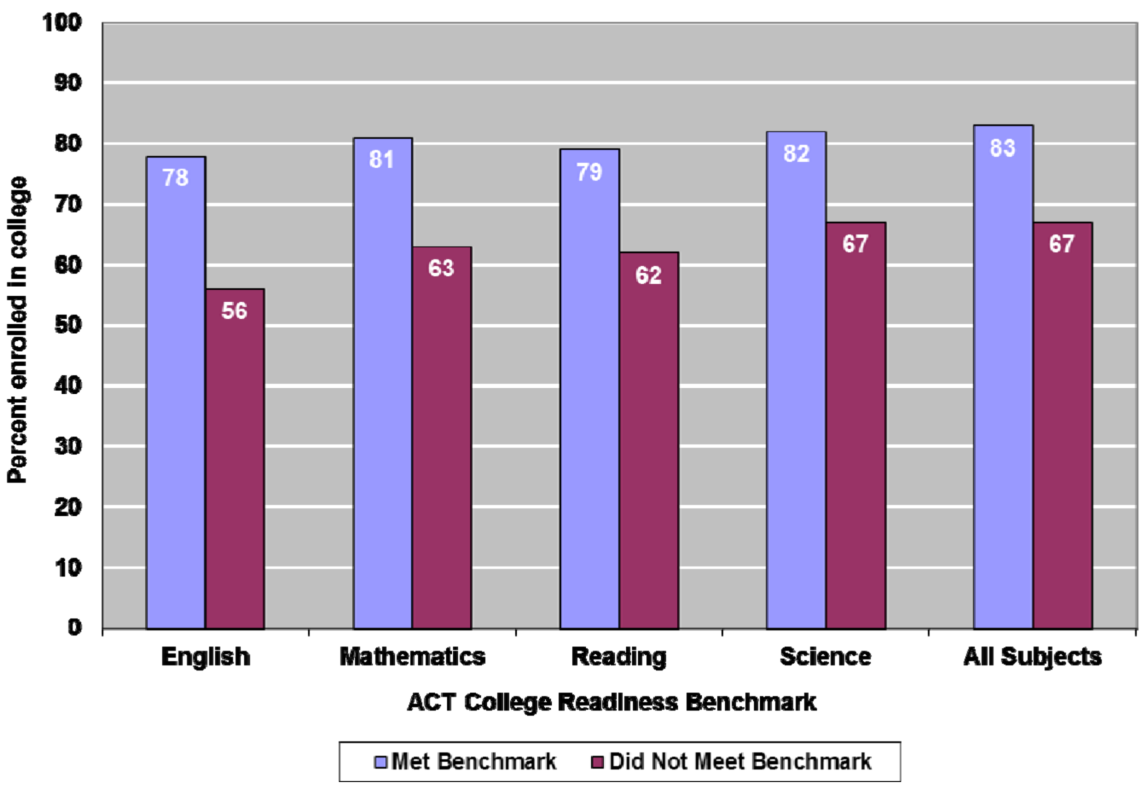


Figure 5.18. College enrollment rates by ACT College Readiness Benchmark attainment.

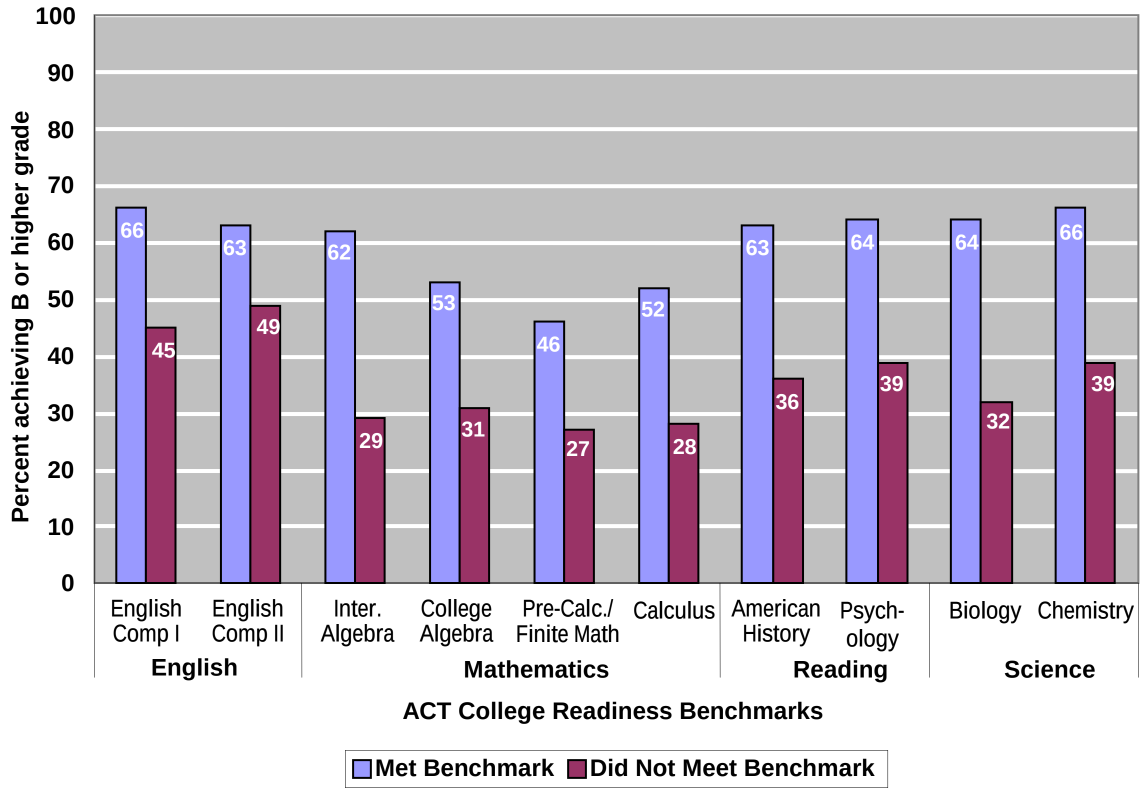


Figure 5.19. Achieving a B-or-higher grade in first-year college courses by ACT College Readiness Benchmark attainment.

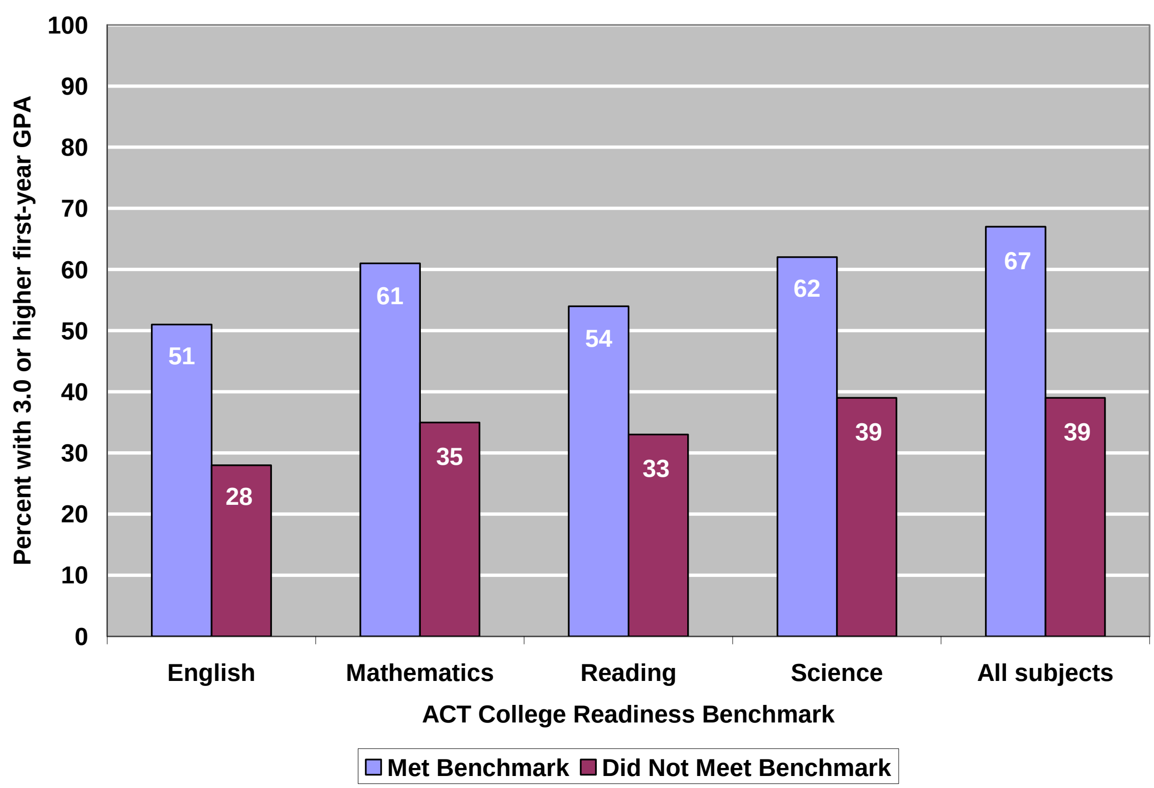


Figure 5.20. Achieving a 3.0 or higher first-year college grade-point average by ACT College Readiness Benchmark attainment.

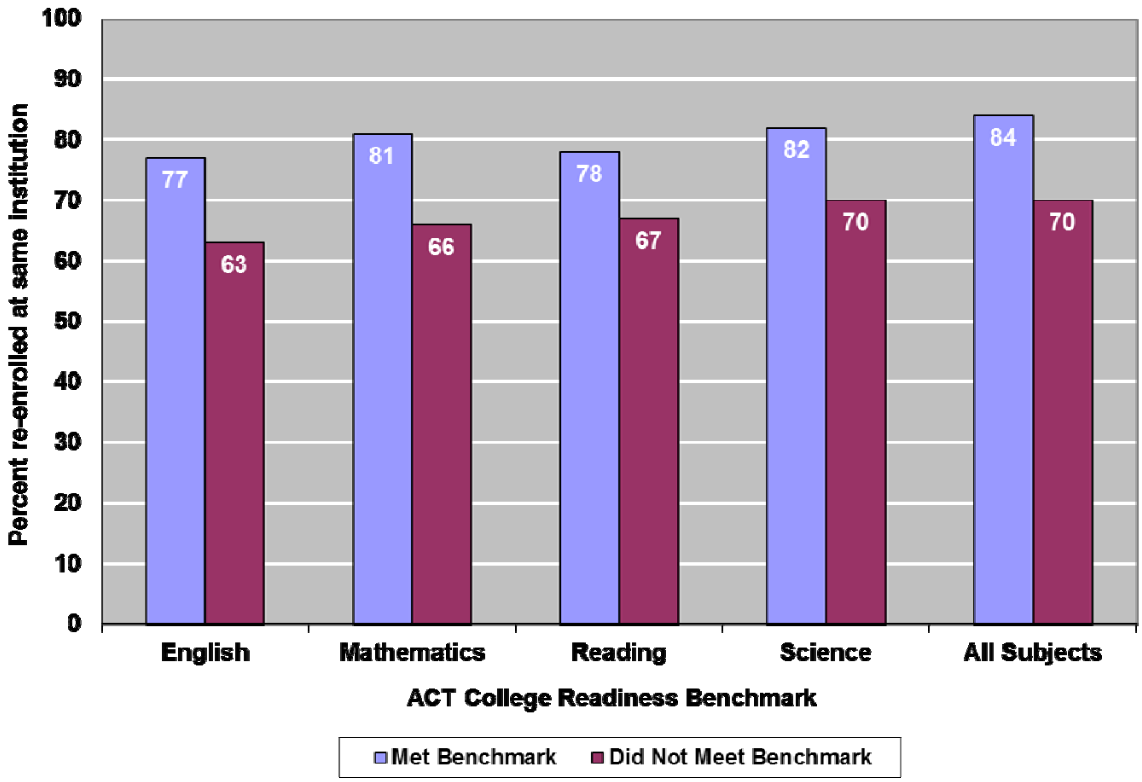


Figure 5.21. First-to-second-year college retention rates by ACT College Readiness Benchmark attainment.

Statistical Relationships Between ACT Scores and CAAP Scores

In the previous section, it was shown that college-ready students are more likely to be successful during their first year of college than are underprepared students. In this section, results from two different studies examine the statistical relationships between college readiness and college success beyond the first year.

In the first study, to better understand the relationship between college readiness and student academic success into the second year of college, we examined data from college students taking ACT's Collegiate Assessment of Academic Proficiency (CAAP) who had also participated in the ACT.

Data and method. The sample included over 62,000 second-year college students taking CAAP between the academic years of 2002–2003 and 2004–2005 who took the ACT in high school. Because of the modular nature of CAAP, not all students with ACT/CAAP matched records had all CAAP scores. The results for English/Writing were based on 38,441 ACT/CAAP-tested students. Results for the other subject areas were based on 39,010 students in mathematics, 34,683 students in reading, and 28,491 students in science. Self-reported cumulative college GPAs were also available to be used as an indicator of college achievement. College readiness was measured by ACT College Readiness Benchmark attainment (see Chapter 3 of this manual for a description of the Benchmarks).

Results. First, ACT scores were found to be strongly correlated with CAAP performance, even after at least two years of college coursework (Table 5.38). In addition, students meeting the ACT College Readiness Benchmarks had higher average CAAP scores than students not meeting the Benchmarks (Figure 5.22). This pattern was seen in all four content areas. The difference in average CAAP scores was as much as 6.1 points. Moreover, as shown in Figure 5.23, students with high college GPAs had met the ACT College Readiness Benchmarks at higher rates than students with low GPAs, regardless of content area.

Summary. These findings suggest that the use of ACT College Readiness Benchmarks can assist in determining who will succeed in college, even into the second year.

Table 5.38
ACT/CAAP Test Score Correlations

ACT/CAAP content area			
English/Writing Skills	**Mathematics/Mathematics**	**Reading/Reading**	**Science/Science**
.76	.71	.69	.66

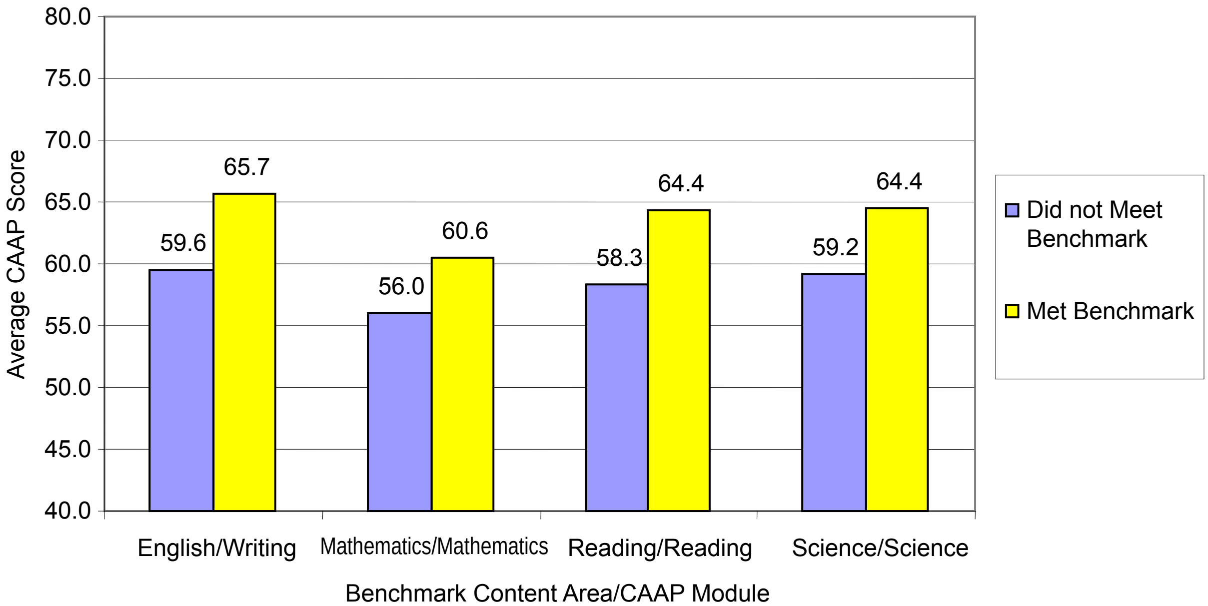


Figure 5.22. Average CAAP scores by ACT College Readiness Benchmark attainment.

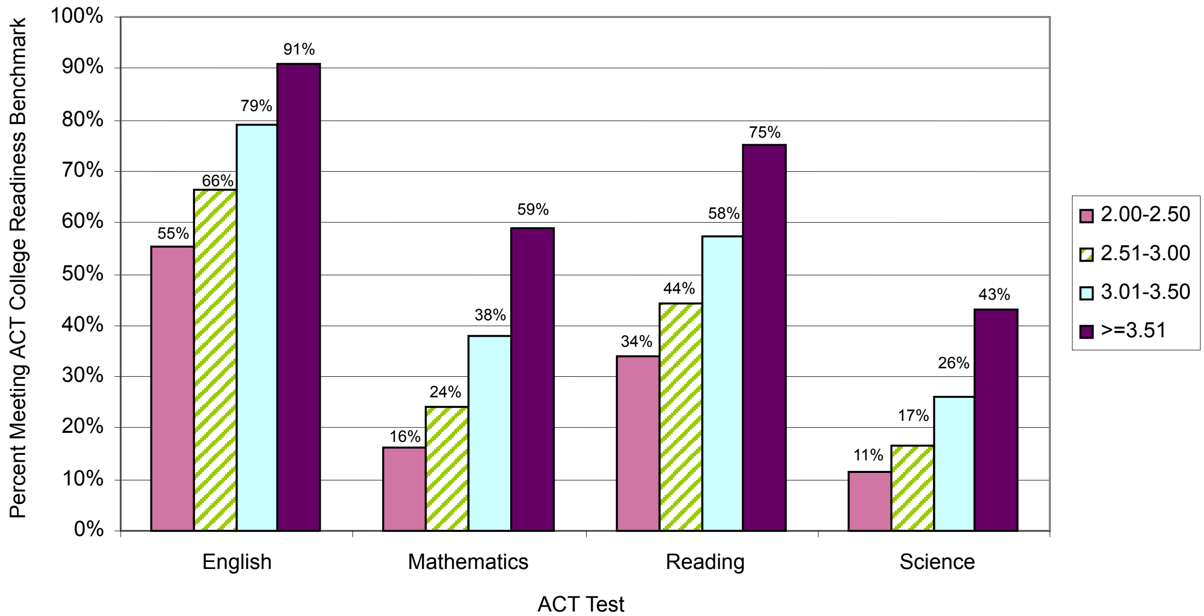


Figure 5.23. Percentages meeting ACT College Readiness Benchmarks by self-reported college cumulative grade point average range.

Statistical Relationships Between ACT Scores and Cumulative College GPAs

Another study (Tracey & Robbins, 2006) examined the relationships between performance on the ACT and cumulative college grade point average (GPA) across time.

Data and method. Enrollment information, including enrollment patterns, grades, and majors, were obtained from a total of 87 colleges and universities from four states. All colleges were bachelor's-level-degree-granting institutions. Some colleges provided only one semester of data, while others provided several years of college data. The data included first-time freshmen enrolled between 1994 and 2003; only students with valid ACT scores who had completed the ACT Interest Inventory were included in the analyses. The resulting sample size was 308,500 ACT-tested students who had at least first-year college enrollment data available.

College outcomes included cumulative college GPA at the end of the first academic year, at the end of the second academic year, and at graduation after five academic years. Hierarchical linear modeling (HLM) was used to examine the relationship between ACT scores and college GPA, while also accounting for the fact that students were nested within colleges. In the models, ACT scores were group-mean centered within institution.

Results. The results of the HLM analyses for college GPA are summarized in Table 5.39. In the table, the fixed effect columns refer to the relations of ACT scores to college GPA, while the random effect column refers to the variance across colleges associated with each variable. For each college GPA outcome, both the fixed effects and random effects were statistically significant ($p < .001$). Mean college GPAs varied significantly across colleges (the intercept) and ACT scores were significantly related to college GPA at various time points (the slope, labeled as ACT in table). For each model, the amount of within-college variance (labeled Level-1) accounted for ranged from .11 to .15.

Summary. The findings from this study suggest that performance on the ACT is predictive of cumulative college GPA across time. The researchers also examined how congruence measures between students' interests (as measured by the ACT Interest Inventory) and college major choice relate to college performance. For more details, see the full research article (Tracey & Robbins, 2006).

Table 5.39

Summary of Hierarchical Linear Modeling Regression on College GPA

Variable	Fixed effect: Coefficient	Fixed effect: Standard error	Random effect variance	R^2 explained
First-year college GPA (N = 72,648)				
Intercept	273.47*	2.78	341.69*	
ACT	6.55*	0.40	6.26*	
Level-1			5120.49	.11
Second-year college GPA (N = 51,012)				
Intercept	291.44*	2.89	243.38*	
ACT	6.49*	0.35	2.74*	
Level-1			2957.51	.15
Graduation college GPA (N = 15,882)				
Intercept	314.53*	1.49	106.54*	
ACT	5.34*	0.91	0.95*	
Level-1			1884.49	.15

Note. College GPA ranged from 0 to 425.
*p < .001.

Chapter 6
Other ACT Components

Unisex Edition of the ACT Interest Inventory (UNIACT)

Overview

The ACT Interest Inventory (UNIACT) helps students explore personally relevant career options (both educational and occupational) during the critical transition from high school to college. Using their UNIACT results, students can explore programs of study and occupations in line with their preferences for common, everyday activities involving data, ideas, people, and things. UNIACT provides scores on six scales paralleling Holland's (1997) six types of interests and occupations (see also Holland, Whitney, Cole, & Richards, 1969). Scale names (and corresponding Holland types) are Science & Technology (Investigative), Arts (Artistic), Social Service (Social), Administration & Sales (Enterprising), Business Operations (Conventional), and Technical (Realistic). Each scale consists of work-relevant activities (e.g., study biology, help settle an argument between friends, sketch and draw pictures) that are familiar to students, either through participation or observation. The activities have been carefully chosen to assess basic interests while minimizing the effects of sex-role connotations. Because males and females obtain similar distributions of scores on the UNIACT scales, combined-sex norms are used to obtain sex-balanced scores.

UNIACT is also a component of other ACT programs, some of which provide a comprehensive approach to career assessment. In these programs, UNIACT results are integrated with results for other work-relevant measures. Prediger and Swaney (1995) present a case study illustrating the interpretation of UNIACT results in the context of results for work-relevant experiences, work-relevant abilities, and job values. The World-of-Work Map (described below) provides the basis for this comprehensive approach.

Reporting Procedures

The World-of-Work Map. UNIACT results suggest 2–3 regions on the World-of-Work Map (Figure 6.1), the primary procedure used to link UNIACT scores to career options (ACT, 2009a). Holland's hexagonal model of interests and occupations (Holland, 1997; Holland et al., 1969) and the underlying Data/Ideas and Things/People work task dimensions (Prediger, 1996) form the core of the map. Holland's types and ACT career clusters appear on the periphery. Career Area locations on the map are empirically based, as determined from three databases: (a) expert ratings on Holland's (1997) six work environments for each of the 1,122 occupations in the U.S. Department of Labor's O*NET Occupational Information Network (Rounds, Smith, Hubert, Lewis, & Rivkin, 1998); (b) job analysis data for 1,573 recency-screened occupations in the *Dictionary of Occupational Titles* database update (U.S. Department of Labor, 1999); and (c) Holland-type mean interest scores for persons pursuing 640 (sometimes overlapping) occupations. See Prediger and Swaney (2004) for more information on the methods used to develop career area locations.

Student Report. The Student Report suggests Career Areas for exploration on the basis of World-of-Work Map regions. The Career Areas located in these regions are listed, and students are encouraged to visit **www.actstudent.org** to learn more about occupations in these career areas.

High School and College Reports. In addition to map regions, results for the six UNIACT scales are reported as normalized standard scores with a mean of 50 and a standard deviation of 10 (a *T* score). A percentile rank profile includes standard-error-of-measurement bands. Although most students will be satisfied with the suggestions in the Student Report, counselors may wish to use the six-score profile from the High School Report or College Report as a basis for more intensive self/career exploration.

Psychometric Support for UNIACT

The ACT Interest Inventory Technical Manual (ACT, 2009a) describes a wide range of information about UNIACT, including topics such as:

- Description of inventory items, scales, and interpretive aids
- Development of items and norms

- Reliability (internal consistency and test-retest stability)
- Validity (convergent and discriminant validity, item/scale structure, interest-environment fit and success outcomes)

UNIACT norms are based on a nationally representative sample of 257,567 students from 8,555 schools. Internal consistency reliability coefficients for the six 12-item scales range from .84 to .91 (median = .87). Validity evidence is extensive, including discriminant validity evidence based on score profiles for 648 career groups (*N*=79,040) and scale structure evidence based on multiple samples (*N* = 60,000). Readers are encouraged to review the full range of information on the ACT Interest Inventory. The ACT Interest Inventory Technical Manual is available at **http://www.act.org/research/researchers/pdf/ACTInterestInventoryTechnicalManual.pdf**.

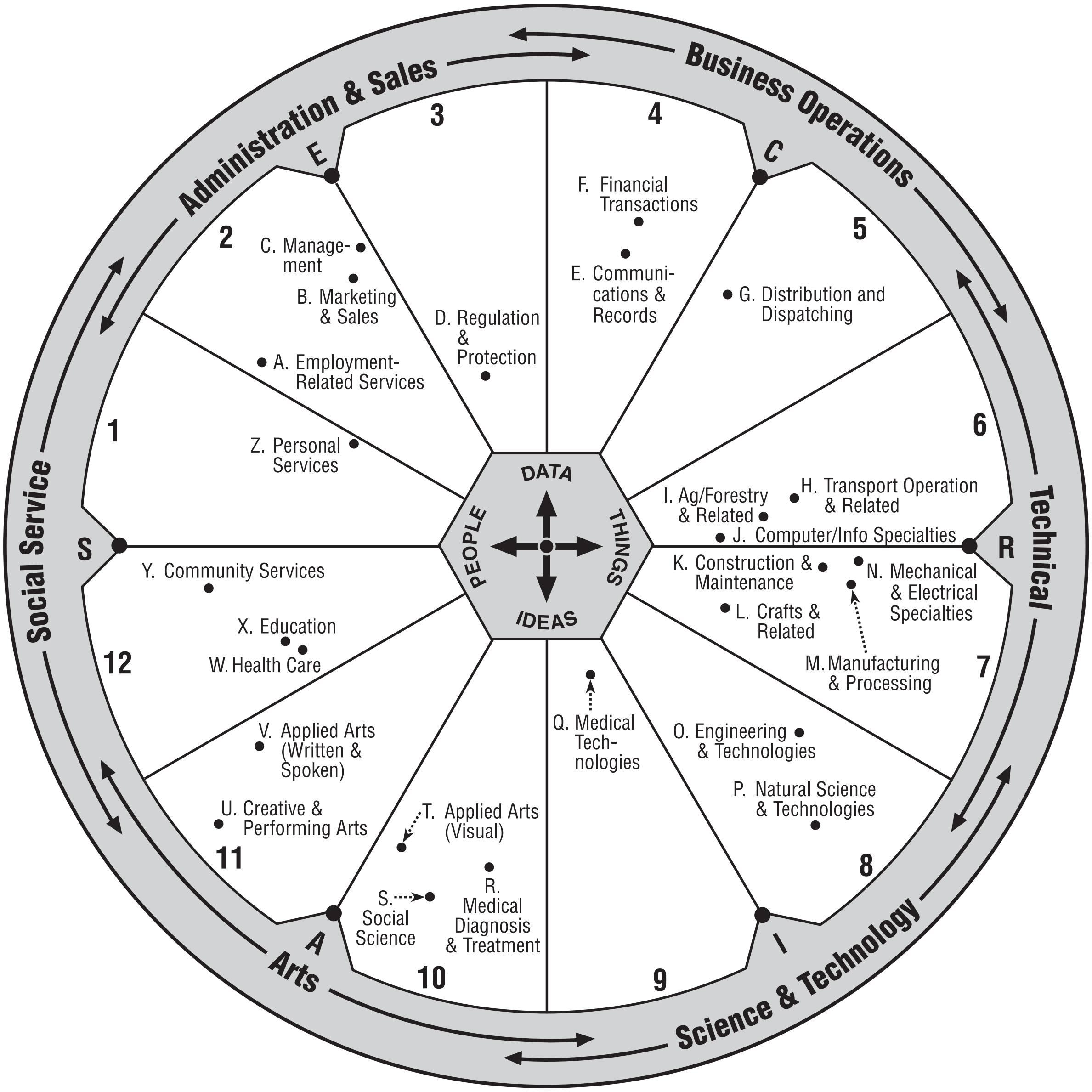


Figure 6.1. World-of-Work Map

The High School Course/Grade Information Section

Students registering for national test dates are asked to report the grades they earned in thirty different high school courses in six academic areas: English, mathematics, natural sciences, social studies, languages, and arts. Because high school grades depend on both academic aptitude and personal characteristics such as persistence and study habits, these self-reports provide useful estimates of future academic achievement. Prior to the 1985–86 academic year, students registering for the ACT were asked only to report grades earned in the last courses taken in English, mathematics, social studies, and natural sciences. Most colleges, universities, and state agencies, however, require information from applicants on performance in a larger number of high school courses. To meet this need, ACT, in consultation with a representative group of personnel from postsecondary educational institutions, developed the longer list of thirty courses. The self-reported grades collected by the ACT are reported to the postsecondary educational institutions of the student's choice on the College Report. Validity evidence for self-reported high school grades is discussed in Chapter 5 of this manual.

The Student Profile Section

In addition to measures of educational development and high school grades, other student information is collected as part of the ACT in order to broaden the information bases of both students and colleges. The development of the Student Profile Section (SPS) has been influenced by the educational context in which it evolved, as have other parts of the ACT. The chief assumption underlying development of the SPS is that the quality of education a college provides depends, in part, on the amount of relevant information its staff has about its students, and that educational quality rises when this information is available in systematic form prior to enrollment.

The SPS contains several subsections. The rationale underlying the development of each subsection is discussed below. The items of the SPS have been developed by ACT staff with input from personnel from a variety of postsecondary educational institutions. Items are revised from time to time as needs arise for these institutions to obtain different types of data.

Admissions and Enrollment Information

The questions in this section of the SPS are designed to yield two types of information. The first type is essential to planning by colleges since it includes the student's enrollment plans (full-time/part-time, day/evening, date of enrollment, preferred type of living accommodations, marital and residency status). The second type of information relates to the student's previous college credit, military service, and presence of a physical disability or learning disability. The instructions explicitly state that the latter information need not be supplied.

Educational Plans, Interests, and Needs

An assumption underlying the development of this subsection is that a student's entry into postsecondary education demands that the student make certain choices and decisions, even if these selections are tentative. Consequently, a narrowing of vocational choice occurs. Related factors such as educational and vocational aspirations also influence students' decisions about their future.

The SPS provides the opportunity for the student to indicate such information as intended college major, degree and occupational aspirations, estimated first-year grade point average, and extracurricular plans. Providing this information helps students examine their outlook and goals. The counselor also is provided with data that are useful in assisting students to evaluate the realism of their choices. Another reason for including this subsection is that it provides colleges with more time for planning educational programs than they would have if the data were not provided until students registered for the school.

Special Educational Needs, Interests, and Goals

With each new entering class, the college must be prepared to provide assistance for the special educational needs of its students. The list of needs includes advanced placement in specific areas of the curriculum, credit by examination, and assistance in improving specific skills. By providing such information, students are able to alert the college about their individual needs. At the same time, the process of responding to the list may well alert the student to options that had not previously been considered.

College Extracurricular Plans

To assist colleges in developing appropriate extracurricular programs, information about the prospective plans of their incoming students is valuable. From the students' viewpoint, presenting their extracurricular plans is yet another way of indicating their unique patterns of interests, needs, and skills. The information provided in this subsection of the SPS includes interest in social, political, and religious organizations, as well as the arts, athletics, and other activities.

Financial Aid

Questions about the student's plans for financing a college education make up this subsection of the SPS. The information in the responses to these questions can be useful to college financial aid officers. An estimate of the family's annual income is requested from the student. Other questions ask students to indicate if they intend to apply for financial aid and/or to work part-time while in college.

Background Information

Questions about distance from college, religious affiliation, language spoken in the home, and racial/ethnic background make up this subsection of the SPS. Several of these questions include the optional response "I prefer not to respond," to acknowledge that some individuals may prefer not to supply such information. The information collected from this subsection is intended to be used by the colleges in the planning process.

Factors Influencing College Choice

Information about how the student chooses a college can be of use to personnel responsible for planning. This subsection of the SPS contains questions about the type (public/private, coeducational or not, two-year/four-year), size, location, and maximum tuition that the student prefers in a college. The student is also asked to rank those factors, along with the curriculum, in order of importance to the student's decision.

High School Information

This subsection of the SPS asks the student to supply information about the type of high school attended (public/private, size). Additional information is requested about the student's own performance (overall average, rank) and program.

High School Extracurricular Activities

Students are asked to choose from a list those activities in which they participated in high school. Activities on the list represent such areas as athletics, drama, music, student government, student publications, and special-interest clubs.

Out-of-Class Accomplishments

Accomplishments (awards, election to offices, creative productions, etc.) in extracurricular activities while in high school are the focus of this subsection of the SPS. In conjunction with the questions in the previous subsection, these questions allow the student to report particular achievements as well as participation in a wide range of out-of-class activities.

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(Please note that in 1996 the corporate name "The American College Testing Program" was changed to "ACT.")

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