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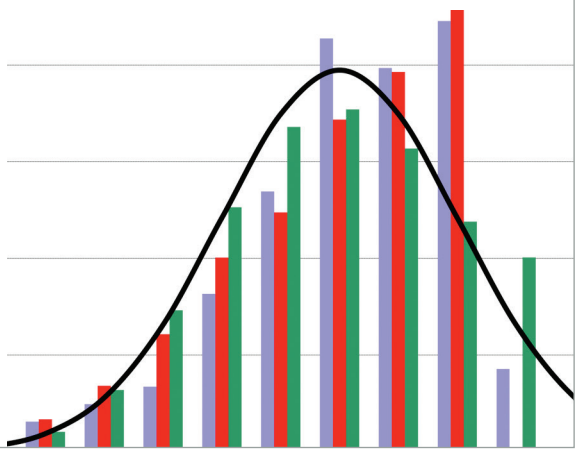

Updating the ACT College Readiness Benchmarks

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Abstract

The ACT College Readiness Benchmarks are the ACT® College Readiness Assessment scores associated with a 50% chance of earning a B or higher grade in typical first-year credit-bearing college courses. The Benchmarks also correspond to an approximate 75% chance of earning a C or higher grade in these courses. There are four Benchmarks, corresponding to the four ACT subject area test scores linked to common first-year courses: ACT English/English Composition I, ACT Mathematics/College Algebra, ACT Reading/social science courses, and ACT Science/Biology.

This report updates the Benchmarks, first established in 2005, with more current data. We found no change in the English and Mathematics Benchmarks; the Reading Benchmark increased from 21 to 22; and the Science Benchmark decreased from 24 to 23.

The ACT College Readiness Benchmarks are applicable to 11th and 12th grade students who take the ACT. ACT Explore® (grade 8 and 9) and ACT Plan® (grade 10) Benchmarks are the scores associated with a 50% chance of meeting the ACT Benchmarks. In this study, we also updated the Explore and Plan Benchmarks.

This report describes potential uses of the Benchmarks, including 1) targets for monitoring K-12 academic progress, 2) indicators of academic readiness within multiple-measure systems for college course placement and intervention, and 3) indicators to monitor educational progress at the local, district, state, and national levels.

Acknowledgements

I thank Chrys Dougherty, Julie Noble, Justine Radunzel, Richard Sawyer, and Jim Sconing for their review and suggestions for improving a previous version of this paper. Thanks also to Richard Sawyer, Karen Zimmerman, and others who have worked to maintain the ACT Course Placement Research Data Archive.

Updating the ACT College Readiness Benchmarks

Introduction

The ACT® College Readiness Assessment is designed to measure the academic skills obtained throughout students' K-12 education that are necessary for success in the first year of college (ACT, 2007). Students typically take the ACT in grades 11 and 12. The content specifications describing the knowledge and skills measured by the ACT are determined by curriculum frameworks for grades 7-12; state-approved course textbooks for grades 7-12; and responses from a national survey of elementary, secondary, and postsecondary educators on the importance of specific knowledge and skills (ACT, 2007; ACT, 2013).

Research has consistently demonstrated that ACT scores are predictive of college outcomes, including enrollment (ACT, 2012a), success in first-year courses (Noble, 1991; Allen & Sconing, 2005), first-year grade point average (GPA) (Radunzel & Noble, 2012a; Sawyer, 2013), retention (ACT, 2012b), semester-specific GPA through year 4 (Westrick, 2012), collegiate mathematics and writing proficiency (ACT, 2008), timely degree attainment (Radunzel & Noble, 2012a; Allen & Robbins, 2010; Radunzel & Noble, 2012b), and GPA at graduation (Radunzel & Noble, 2012a; ACT, 2008). For example, Sawyer (2013) reported a median correlation of .44 between ACT Composite score and first-year college GPA across 192 4-year institutions. Westrick, Le, Robbins, Radunzel, and Schmidt (2013) reported a mean correlation of .51, adjusted for restriction of range, across 50 4-year institutions.

Reflective of this research, ACT scores are used by postsecondary institutions to inform admissions decisions, help place students in courses appropriate to their achievement level, identify students needing academic support, and award scholarships, among other uses. While the full continuum of ACT scores contains more information than any dichotomization of scores,

simple criterion-referenced indicators of readiness are useful guideposts for postsecondary personnel. For example, readiness indicators can be used to help identify students needing supplemental instruction or other forms of academic support.

Beyond its uses at the postsecondary level, the ACT and aligned assessments for earlier grade levels are used by K-12 educators as indicators of college readiness. Recent initiatives, such as the Common Core State Standards, Race to the Top, the ESEA Flexibility Waiver, and several state-level reforms hold college and career readiness as the goal for students exiting secondary education. ACT scores signaling college readiness are useful within K-12 assessment systems, providing an anchor point for score trajectories across grade levels indicating students are on target for college readiness (c.f., Furgol, Fina, & Welch, 2011).

In 2005, ACT established College Readiness Benchmarks representing the ACT scores associated with a 50% chance of earning a B or higher grade in common first-year credit-bearing courses at a typical postsecondary institution (Allen & Sconing, 2005). The Benchmarks are subject to change over time. Some of the possible reasons for this include change in college grading standards, aggregate change in college student performance, and change in the level of alignment of secondary and postsecondary course content. Therefore, in this study we update the Benchmarks using more recent data. Updated Benchmarks are also reported for the ACT Explore and ACT Plan assessments, spanning grades 8 through 10.

Methods

Data Sources

ACT data were matched to course grade data provided by postsecondary institutions. To estimate the ACT Explore and ACT Plan Benchmarks, student records from these tests were matched to data from the ACT. We describe the data sources in greater detail below.

Course grade data. Through their participation in research services offered by ACT, postsecondary institutions provide ACT with course grade data on first-year students.[1] In addition, ACT has collected course grade data through research partnerships with other institutions and groups of institutions.

Typically, institutions provide course grade data coded on the usual 0.00-4.00 scale, with additional indicators for course withdrawals and incompletes. Institutions also provide the course title and a course content code[2], which is used to classify courses across institutions. Table A1 of the appendix provides a full listing of courses studied in ACT's postsecondary research. The ACT College Readiness Benchmarks are based on a subset of these courses, as shown in Table 1 below. These courses were chosen because they represent common first-year credit-bearing courses, cover a diverse set of content, and require a wide variety of knowledge and skills. Each course is paired with the ACT subject area test that is most closely aligned in content.

Table 1

Courses used for ACT College Readiness Benchmarks

College Course Type	ACT Subject Area Test
English Composition I	English
College Algebra	Mathematics
Social Science American History Other History Psychology Sociology Political Science Economics	Reading
Biology	Science

[1] For a description of ACT's research services, including the Course Placement Service and Prediction Service, please see http://www.act.org/research-policy/research-survey-services.

[2] When institutions do not provide course content code, ACT research staff assign a code based on the course name and course description information from course catalogs.

For each student, we retained course grade records corresponding to the course content codes of interest. Many students had multiple records for social science courses. When multiple course grades were available for a student, we chose one record at random. Therefore, each student is represented at most once for each course type.[3]

ACT College Readiness Assessment and student background data. Student background data, including gender, race/ethnicity, and grades earned in high school courses, were obtained from students' ACT test records. Later, we describe how these data were used to develop the ACT College Readiness Benchmarks. We matched students' ACT scores from their last ACT testing to the course grade data.

Explore and Plan data. Many schools and districts across the country use ACT's Explore and Plan tests as part of their longitudinal assessment system. Explore is typically administered to students in grades 8 and 9, while Plan is typically used in grade 10. The design specifications of Explore and Plan are similar to those of the ACT, but cover content appropriate for students in grades 8, 9, and 10 (ACT, 2011a; ACT, 2011b). Explore, Plan, and the ACT include subject area tests in English, Mathematics, Reading, and Science. The assessments use a common scale, with Explore scores ranging from 1-25, Plan scores ranging from 1-32, and ACT scores ranging from 1-36.

Grade 8 and grade 9 Explore scores were matched to students' last ACT test record. Matching was based on student name, date of birth, district code, and student ID number (when available). The same procedure was used for matching grade 10 Plan scores to students' last ACT test record. For updating the Explore and Plan Benchmarks, we retained student records for schools that tested at least 50% of their student body with the two tests in question (Explore

[3] One record per student and course simplifies the analysis because within-student correlation does not need to be accounted for.

and the ACT or Plan and the ACT)**.** This was done to make the samples more representative of the general population of high school students.

Sample

Postsecondary institutions. For each college course, course data for each institution cohort[4] were retained if they met the following criteria: 1) N≥10 of students with valid course grade data[5]; 2) availability of institutional data, including type (2-year or 4-year), admissions policy (open, liberal, traditional, selective, or highly selective), and control (public or private) through ACT's Institutional Data Questionnaire; and 3) percentage of students earning a B or higher grade of at least 20% but less than 80%.[6] Because we wanted to study current data, student cohorts from 2005 and later years were used. The previous Benchmarks study (Allen & Sconing, 2005) used data for student cohorts from 1995 through 2002.

The resulting sample of institutions for each college course is summarized in Table 2. The number of institutions ranged from 90 for Biology to 136 for English Composition I. There was a relatively even split among 2-year and 4-year institutions, with the greatest disparity observed for the social science courses and College Algebra, with 42% 2-year institutions. Most of the 4-year institutions in each sample were less selective and the samples included relatively few private institutions. Later, we examine how similar the student samples are to the population of ACT-tested college enrollees with respect to institution type.

[4] Cohort defined as year of high school graduation.
[5] Valid course grade data were coded as 0.00 (F) though 4.00 (A), or coded as a withdrawal. Incompletes were not counted.
[6] This criterion was imposed to increase the stability of the analyses. Groups with very high (or very low) success rates are rare but could have a large influence on the distribution of scores associated with a 0.50 probability of success. Such groups are less likely to have an optimal cutoff score (a score associated with a 0.50 probability of success).

Table 2

Types of Institutions in Samples

Characteristic	College Course			
	English Comp. I	College Algebra	Social Science	Biology
N (Institutions)	136	125	129	90
Type				
2-year	68 (50%)	53 (42%)	54 (42%)	40 (44%)
Less selective 4-year	58 (43%)	60 (48%)	63 (49%)	41 (46%)
More selective[7] 4-year	10 (7%)	12 (10%)	12 (9%)	9 (10%)
Control				
Public	119 (88%)	115 (92%)	119 (92%)	78 (87%)
Private	17 (13%)	10 (8%)	10 (8%)	12 (13%)

Across the four courses, the total number of institutions represented was 214. Figure 1 maps the number of institutions by state (categories of 0, 1-5, or 6 or more institutions per state). There is a heavier concentration of institutions in the Midwest and south-central United States, with fewer institutions sampled from the East and Western regions.

[7] Admission policy was reported by institutions according to the high school class ranks of their accepted freshmen: the majority of freshmen at *highly selective* schools are in the top 10%, *selective* in the top 25%, *traditional* in the top 50%, and *liberal* in the top 75% of their high school class. Institutions with *open* admissions policies accept all high school graduates to limit of capacity. For our analysis, we classified 4-year institutions as more selective (*selective* or *highly selective*) or less selective.

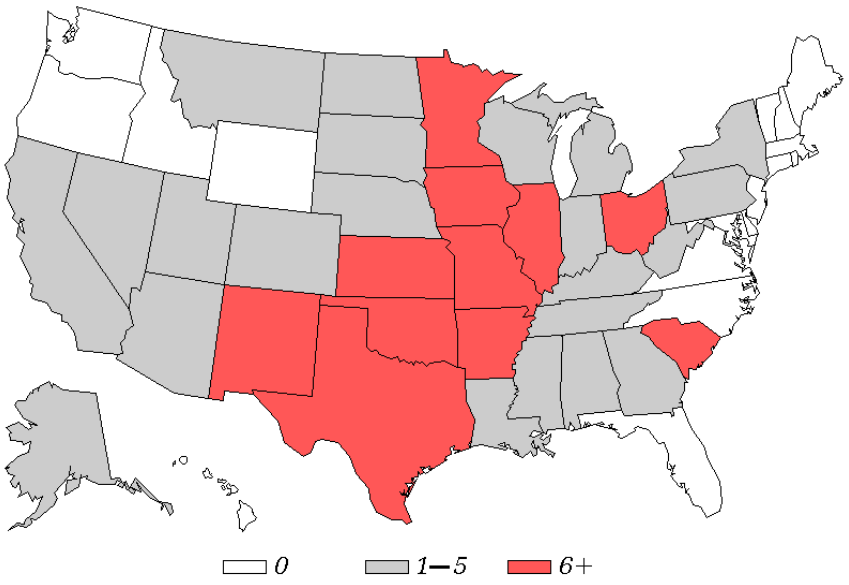

Figure 1. Number of Institutions by State

Student Samples by Course. The student sample sizes were approximately 97 thousand for English Composition I, 70 thousand for College Algebra, 131 thousand for Social Science, and 42 thousand for Biology. For each course, we summarize students' gender, race/ethnicity, and postsecondary institution type (Table A2 of the appendix) and their ACT Composite score and high school GPA levels (Table A3). For comparison, we provide relative frequencies for the population of ACT-tested high school graduates of 2012 from states where at least 50% took the ACT**.**

Relative to the ACT-tested high school graduate population, the samples have fewer African American, Hispanic, and male students (Table A2 of the appendix). Relative to the population, the samples have fewer students in the most extreme ACT Composite score levels (Table A3 of the appendix). A possible explanation for this is that students with very low ACT scores are less likely to enroll and more likely to require developmental instruction and so are less likely to take credit-bearing college courses as first-year students. The same explanation

applies to the lower levels of high school GPA[8], where we see fewer students in the samples than in the population. Students with very high ACT scores may be more likely to forego standard credit-bearing college courses as first-year students, opting instead for honors courses. Students with higher ACT scores are also more likely to have completed Advanced Placement or dual credit coursework in high school (Crouse & Allen, in press; ACT, in press), which could contribute to lower participation in standard credit-bearing courses as first-year students.

Comparing the samples to the population of ACT-tested college enrollees, we see there is less representation of students at more selective 4-year institutions, and greater representation of students at less selective 4-year institutions (Table A2 of the appendix). The greatest disparity is for the English Composition I sample: 40% of the population of ACT-tested enrolled students was enrolled at a more selective 4-year college, compared to 11.2% for the English Composition I sample.

To address the disparities between the sample and population frequency distributions, we applied weights based on ACT Composite score level, high school GPA level, race/ethnicity, and institution type. The weights were applied in two stages. In the first stage, student weights were applied based on the population to sample ratio of the relative frequency of ACT Composite score level, high school GPA level, and race/ethnicity. In the second stage, institution weights were applied based on the population to sample ratio of frequency of students at each institution type (2-year, less selective 4-year, or more selective 4-year).

Student Samples for Explore and Plan Benchmarks. The student sample sizes, in thousands, were approximately 425 for the Explore grade 8 / ACT sample, 210 for the Explore grade 9 / ACT sample, and 1,513 for the Plan grade 10 / ACT sample. The number of high

[8] High school GPA is based on student-report grades earned in 23 core high school courses.

schools in which students were enrolled when they took the ACT was 1,520 (for Explore grade 8 to the ACT), 620 (for Explore grade 9 to the ACT), and 4,111 (for Plan grade 10 to the ACT).

For each sample, we report distributions of ACT Composite score level and race/ethnicity (Table A4 of the appendix). For comparison, we provide relative frequencies for the ACT-tested high school graduate population. Each sample was similar to the population in terms of ACT Composite score level. For race/ethnicity, the largest differences between sample and population percentages were observed for the Explore grade 8 and Plan grade 10 samples. Relative to the population, each sample had more White students and fewer African American and Hispanic students. Because the differences were small, weights were not applied to the data used to develop the Explore and Plan Benchmarks.

Statistical Methods for ACT Benchmarks

Choice of 50% chance of B or higher criterion. For each course and institution, we determined the ACT score associated with a 50% chance of earning a B or higher course grade. The reasons for studying the B or higher course grade criterion include: 1) Grades of D and F are uncommon, thus the parameters from a model for a C or higher criterion are less precise, 2) Anecdotally, grades of A and B are viewed as successes, while a C grade is viewed as satisfactory or "just getting by", and 3) Students who earn first-year grades of B or higher, on average, are much more likely to complete a postsecondary degree.[9] The 50% chance threshold was chosen because 1) Course placement accuracy rates are maximized at the score associated with a 0.50 probability of success (Sawyer, 1996) and 2) If used as course placement cutoff scores, the 0.50 probability criterion would lead to the least-qualified student in the course

[9] Among 4-year students who earned a first-year GPA of at least 3.00 (B or higher grades, on average), 64% earned a Bachelor's degree within six years, versus just 27% for 4-year students whose first-year GPA was less than 3.00. Similarly, among 2-year students who earned a first-year GPA of at least 3.00, 51% earned an Associate's or Bachelor's degree within six years, versus just 19% for 2-year students whose first-year GPA is less than 3.00. The degree completion percentages are obtained from the data set described in a published study (Radunzel and Noble, 2012b).

having a 50% percent chance of earning a C or lower grade, which is a reasonable degree of confidence in success. As is noted later, a 50% chance of a B or higher grade corresponds approximately to a 75% chance of a C or higher grade.

Hierarchical logistic regression. For each course, we used hierarchical logistic regression to determine the ACT score at each institution associated with a 50% chance of earning a B or higher course grade. The logistic regression model relates ACT scores (X) to probability of course success (p) through Equation (1):

$$\ln\left(\frac{p}{1-p}\right) = \alpha + \beta X \quad (1)$$

The relationship between ACT subject test scores and the log-odds of success in equation (1) is specified as a simple intercept-slope model. In the hierarchical version of the model, the intercepts (α) and slopes (β) are treated as random effects, so that each parameter can vary by institution. The hierarchical model is appropriate because of the nesting of students within institutions (Raudenbush & Bryk, 2002). This model is the same as that used for the original Benchmarks study (Allen & Sconing, 2005). In addition to the models used for the B or higher criterion, we also fit models for the C or higher criterion.

Multiple social science courses were used to establish the ACT Reading Benchmark. Because the probability function could vary by institution and course, we allowed the intercepts and slopes to vary for each social science course within institution.

As described earlier, student weights were used to make the samples similar to the ACT-tested high school graduate population with respect to ACT Composite score, high school GPA, and race/ethnicity. The weights were applied to the hierarchical logistic regression models.

Calculating the Benchmarks. For each course, the hierarchical logistic regression model produced an estimated intercept and slope for each institution. (For the social science

courses, the model produced an estimated intercept and slope for each course and institution). For each institution, we then calculated the score associated with a 50% chance of success – we refer to these scores as the institution-specific cutoffs.[10] Weights were applied to the institution-specific cutoffs to make each sample similar to the ACT-tested college enrollee population with respect to institution type (2-year, less selective 4-year, and more selective 4-year). The ACT College Readiness Benchmarks were then calculated as the weighted median, across institutions, of the cutoffs. Thus, the Benchmarks represent the ACT scores associated with a 50% chance of earning B or higher grades in first-year courses at a typical college.

Statistical Methods for Explore and Plan Benchmarks

The Explore and Plan Benchmarks are defined as the scores associated with a 50% chance of meeting the ACT College Readiness Benchmark in the same subject area. Simple logistic regression models were used to relate Explore (Plan) subject area scores to the probability of meeting the associated ACT Benchmark. Separate models were fit for grade 8 (Explore), grade 9 (Explore), and grade 10 (Plan).[11] Using the intercepts and slopes estimated by the logistic regression model, the Benchmarks were calculated as the score associated with a 0.50 probability, rounded to the nearest integer.

Results

The overall success rates varied by course, ranging from 46.7% in Biology to 58.7% in English Composition I for the B or higher criterion; and ranging from 71.5% in College Algebra

[10] The cutoff score is calculated as the intercept divided by the slope, multiplied by -1, and then rounded to the next integer. For example, an intercept of -4.10 and slope of 0.20 would yield a 50% cutoff of 20.5 (21). For institutions with multiple social science courses, there is one cutoff per course. The institution's cutoff was obtained by taking the median across multiple social science course cutoffs.

[11] The intercept and slope estimates vary by the number of months elapsed between Explore (Plan) and the ACT. The Benchmarks are estimated with respect to 48 (Explore grade 8 to the ACT), 36 (Explore grade 9 to the ACT), and 24 (Plan grade 10 to the ACT) months elapsed between tests.

to 80.6% in English Composition I for the C or higher criterion (Table 3). Across all courses, B was the modal course grade.

Table 3

Success Rates by Course

	Relative Frequencies of Course Grades					Success Criteria	
College Course Type	A	B	C	D	F[12]	≥B	≥C
English Composition I	26.9%	31.8%	21.9%	6.6%	12.8%	58.7%	80.6%
College Algebra	23.7%	25.1%	22.6%	11.0%	17.6%	48.9%	71.5%
Social Science	25.3%	27.2%	23.3%	10.3%	13.9%	52.6%	75.8%
Biology	19.6%	27.1%	25.8%	12.0%	15.5%	46.7%	72.5%

ACT College Readiness Benchmarks

The results of the hierarchical logistic regression models are given in Table A5 of the appendix. The values in Table A5 represent estimates of the mean intercept and slope across institutions. The parameter estimates describe the relationship between ACT scores and course success at a typical institution.[13] The relationships are plotted in the figures below for both criterion levels (B or higher and C or higher).

[12] Includes students who withdrew from the course.

[13] Table A5 includes estimates (and standard errors) of the mean intercept and slope, as well as estimates (and standard errors) of the variance of intercepts and slopes.

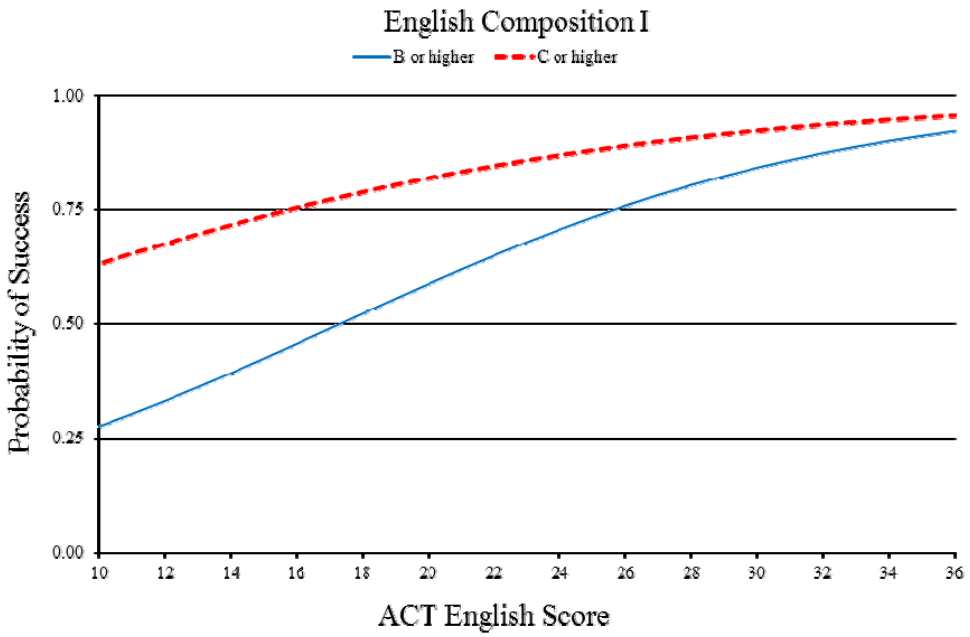

Figure 2: Probability of Success in English Composition I, by ACT English Score

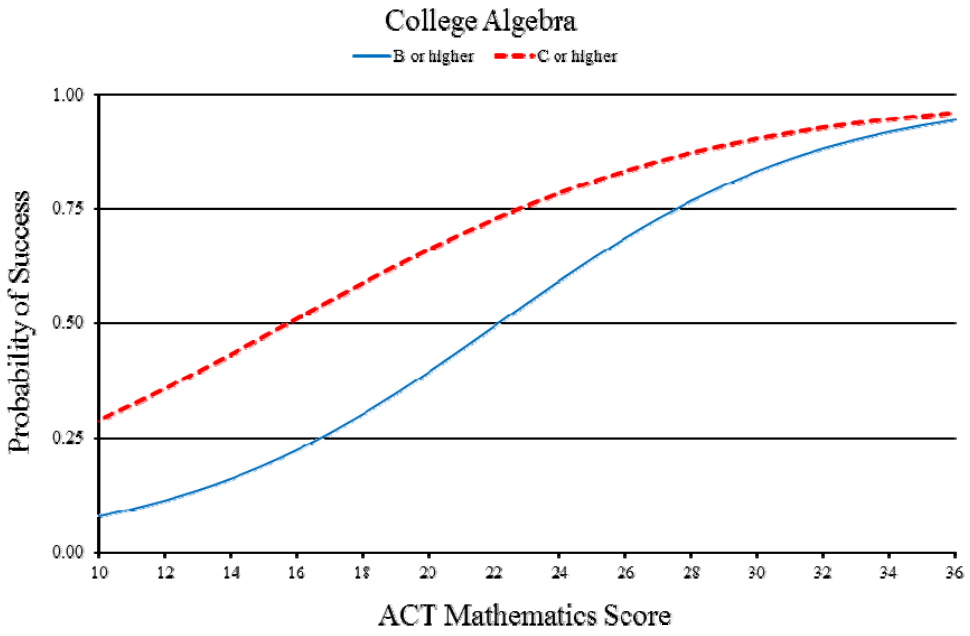

Figure 3: Probability of Success in College Algebra, by ACT Mathematics Score

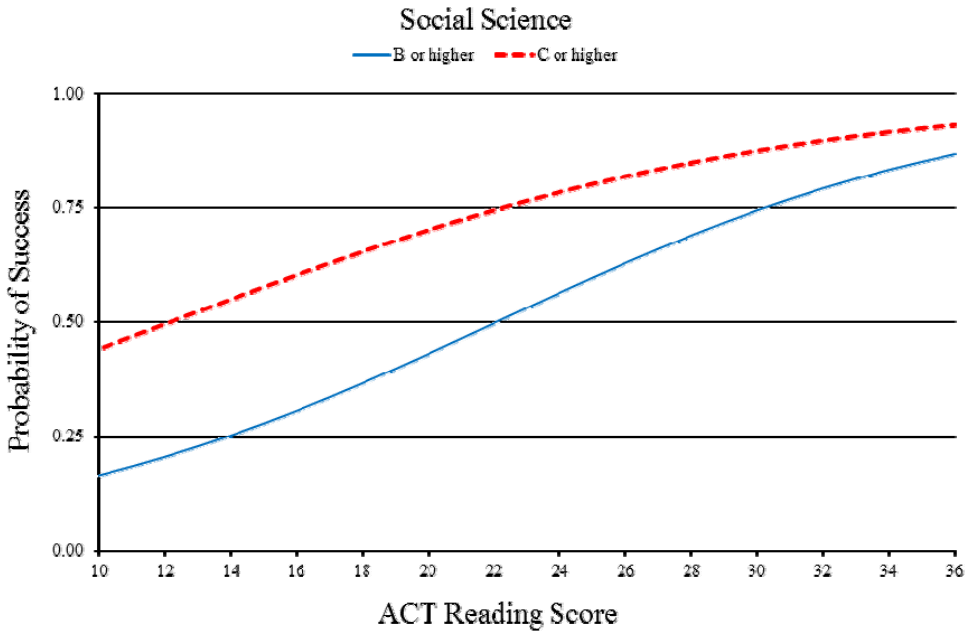

Figure 4: Probability of Success in Social Science, by ACT Reading Score

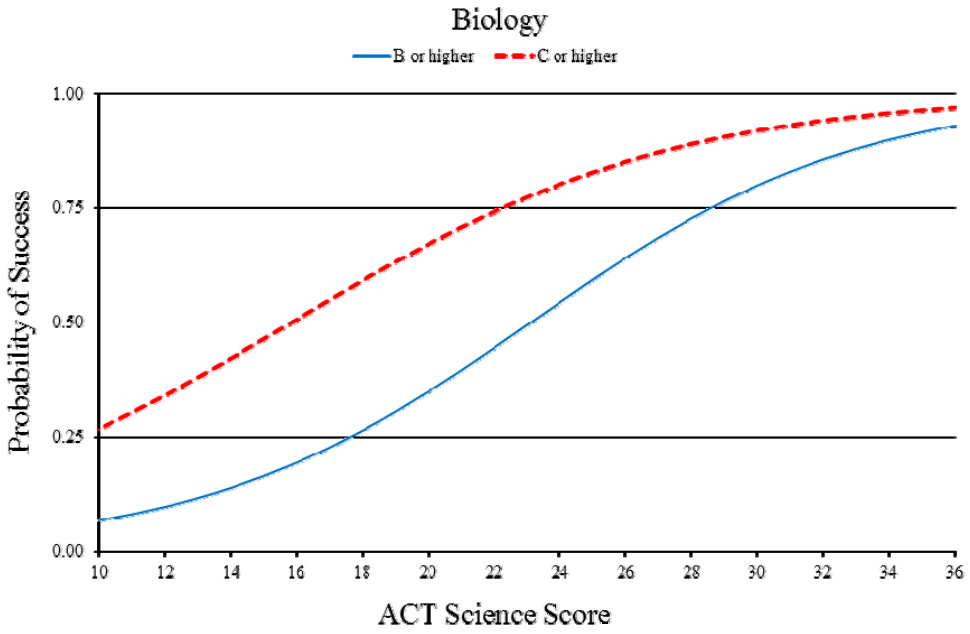

Figure 5: Probability of Success in Biology, by ACT Science Score

From Figures 2 through 5, we see that the probability of course success increases steadily with ACT scores. The slopes are greater for the B or higher criterion. This is consistent with

previous research that has shown that the predictive strength of ACT scores increases with the performance level defined by the criterion (Noble & Sawyer, 2002; Sawyer, 2013). The curves are steeper for College Algebra and Biology relative to English Composition I and the social science courses.

The distributions of institution-specific cutoff scores are summarized in Table 4. The median scores associated with a 50% chance of B or higher are 18, 22, 22, and 23 for the ACT English, Mathematics, Reading, and Science, respectively. These are the updated ACT College Readiness Benchmarks. There is variability in cutoffs across institutions, with interquartile ranges of 3 for the ACT Mathematics and Science tests, and 4 for English and Reading.

Table 4

Distributions of Institution-Specific Cutoffs

College Course and ACT Subject Area	1st Quartile	Median (Benchmark)	3rd Quartile
English Composition I (ACT English)	16	**18**	20
College Algebra (ACT Mathematics)	21	**22**	24
Social Science (ACT Reading)	20	**22**	24
Biology (ACT Science)	22	**23**	25

The Reading and Science Benchmarks differ from those established in the original Benchmarks study (Allen & Sconing, 2005): Reading increased by one score point, and Science decreased by one score point. The Benchmarks for English and Mathematics did not change.

Using the parameter estimates in Table A5 of the appendix, we estimate that the typical probabilities of earning a C or higher course grade for students at the ACT Benchmark scores are 0.79 (English Composition I), 0.73 (College Algebra), 0.74 (Social Science), and 0.77 (Biology). These probabilities are also displayed in Figures 2 through 5.

Explore and Plan Benchmarks

The results of the logistic regression models used to establish the Explore and Plan Benchmarks are given in Table A6 of the appendix. As would be expected given the alignment of Explore, Plan, and the ACT, Explore and Plan scores are strongly predictive of meeting the ACT Benchmark in the same subject area. The scores associated with a 50% chance of meeting the ACT Benchmarks are obtained from the intercept and slope estimates and are summarized in Table 5. The Explore and Plan Benchmarks for Reading and Science changed from those established based on the original ACT Benchmarks. The Reading Benchmarks changed from 15 to 16 for Explore grade 8, 16 to 17 for Explore grade 9, and 17 to 18 for Plan grade 10. The Science Benchmarks changed from 20 to 18 for Explore grade 8, 20 to 19 for Explore grade 9, and 21 to 20 for Plan grade 10. The Benchmarks for English and Mathematics did not change.

Table 5

Explore and Plan Scores Associated With 50% Chance of Meeting ACT Benchmark

Subject Area	Explore grade 8	Explore grade 9	Plan grade 10
English	13	14	15
Mathematics	17	18	19
Reading	16	17	18
Science	18	19	20

Discussion

Using the Benchmarks

We now discuss potential uses of the Benchmarks within K-12 education, postsecondary course placement and intervention, and educational research.

As targets for monitoring K-12 academic progress. With college and career readiness at the heart of educational reform, grade level-specific scores indicating that students are on track

for college readiness are needed. The ACT Benchmarks, along with Benchmarks for earlier grade levels, are useful for educational goal setting within K-12 assessment systems. In this study, we developed Benchmarks for ACT's Explore (grade 8 and 9) and Plan (grade 10) assessments. Future research will develop readiness benchmarks for earlier grade levels, including those covered by ACT Aspire.[14]

College readiness targets can help educators, students, and parents understand how far students need to progress to reach college readiness, as defined by having a 50% chance of earning a B or higher grade in credit-bearing college courses. This is especially important in the early grade levels, as research has demonstrated that very few students who are far off target are able to catch up (Dougherty & Fleming, 2012).

As indicators of academic readiness within multiple-measure systems. In most studies that examine predictors of college outcomes, ACT scores and high school grades (e.g., high school GPA or high school rank) are *jointly* predictive – meaning that each measure explains unique variance in the outcome. Importantly, models that use high school grades with ACT scores predict better than either measure used alone. Reflective of this research, college admissions personnel rank ACT/SAT scores behind only grades in college prep courses and strength of curriculum as factors of "considerable importance" in the admission decision (Clinedinst, Hurley, & Hawkins, 2011). In multiple-measure course placement systems, ACT scores, high school grades, and other measures are used together to provide more information about students' chances of success. For identifying students for intervention, the model can be extended further to include measures of motivation and social engagement (Robbins, Allen, Casillas, Peterson, & Le, 2006). Multiple-measures models such as these are more accurate than single-predictor models for estimating students' chances of success.

[14] For more information on ACT Aspire, see http://www.act.org/products/k-12-act-aspire.

The College Readiness Benchmarks represent a dichotomization of ACT scores, thus cannot contain as much information as the scores themselves. However, because the Benchmarks are anchored to a tangible criterion – a 50% chance of earning a B or higher grade in credit-bearing college courses – they are useful indicators of readiness. The Benchmarks can be used as initial estimates for course placement cutoff scores. Because of the variation in institution-specific cutoffs, postsecondary institutions should obtain more accurate estimates of the probability of success curve by studying their own data. The Benchmarks can also be used within multiple-measure systems for intervention. For example, students taking credit-bearing college courses that did not meet the College Readiness Benchmark but had acceptable high school grades might be considered candidates for extra academic support, such as tutoring or supplemental instruction.

In addition to the Benchmarks, it is possible to view readiness in terms of probabilities rather than as ready or not (Maruyama, 2012). The probabilities of success for each course for a "typical" institution are given in Figures 2 through 5, and are functions of the logistic regression parameters given in Table A5 of the appendix. For example, the probability of earning a B or higher in College Algebra is 0.19 for students with an ACT Mathematics score of 15, 0.39 for students with a score of 20, and 0.64 for students with a score of 25.

To monitor educational progress at the local, district, state, and national level. The Explore, Plan, and ACT College Readiness Benchmarks have been used in recent years to measure aggregate performance at all levels. For example, in the 2012 *Condition of College and Career Readiness* (ACT, 2012c), we presented the percentage of ACT-tested high school graduates meeting the ACT Benchmarks for each subject area, as well as the percentage meeting all four Benchmarks. Because the Benchmarks for Reading and Science have changed, it is

important for trend analyses to reflect the change, either by applying the new Benchmarks across all years or by noting the discontinuity in trend caused by the change in the Benchmark.

Because the Benchmarks are related to a tangible criterion – a 50% chance of earning a B or higher grade in credit-bearing college courses – they are appealing to use for aggregate reporting. However, interpretation of the percentage of students meeting the College Readiness Benchmarks should bear in mind the following caveats:

1) The Benchmark attainment rate (the percentage of students meeting the College Readiness Benchmark) is not equal to the average probability of success in the associated college course. For example, among ACT-tested high school graduates of 2012, 67% met the ACT English Benchmark, whereas the average probability of success in English Composition I was 0.59. For science, 38% met the Benchmark score of 23, while the average probability of success in Biology was 0.41. Students just below the Benchmark have a probability of success that is slightly below 0.50, but are counted as 0 in the computation of Benchmark attainment rates.
2) Benchmark attainment rates tend not to vary much from year to year.[15] Sustained school improvement should result in steady increases in college readiness rates (ACT, 2012d), but the increase may be small. Thus, state, district, and school improvement plans should set realistic and modest goals for improvements in College Readiness Benchmark attainment rates.

[15] Large year-to-year variations are more likely to be observed for schools, districts, and states with fewer students. Large variations can also be caused by changes in testing policies or changes in the student population. For example, states that adopt the ACT for all students tend to experience a decline in mean ACT scores and Benchmark attainment rates due to testing a more diverse population of students.

3) Benchmark attainment rates only reflect the aggregate achievement of a group of students at a single point in time. Attribution of student growth to specific teachers, schools, or programs cannot be based on a single Benchmark attainment rate.

Study Limitations

While the study employed a large sample of institutions for each college course, the samples were not drawn randomly from the population of all U.S. postsecondary institutions. In particular, the samples had relatively few private institutions, and mostly consisted of 2- and 4-year colleges and universities in the Midwestern and south-central United States. It is possible that data from a large random sample of postsecondary institutions would yield different results. Moreover, there was variation in results across institutions, suggesting that institution-specific models are needed for course placement and intervention identification.

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Appendix

Tables A1 through A 6

Table A1

Course Content Codes Used for ACT Postsecondary Research

COURSE CONTENT CODES		
English/Language Arts:	**Foreign Languages:**	**Mathematics:**
E1 - Grammar	**F1 -** Chinese	**M1 -** Arithmetic Skills
E2 - Reading	**F2 -** French	**M2 -** Elementary Algebra
E3 - Composition I (first writing course)	**F3 -** German	**M3 -** Intermediate Algebra
	F4 - Italian	**M4 -** College Algebra
E4 - Composition II (second writing course)	**F5 -** Japanese	**M5 -** Geometry
	F6 - Russian	**M6 -** Analytic Geometry
E5 - Literature	**F7 -** Spanish	**M7 -** Trigonometry
E6 - Speech/Rhetoric	**F8 -** Other (please specify)	**M8 -** Pre-calculus/Finite Math
E7 - Other (please specify)		**M9 -** Calculus
E8 – Film criticism / history		**M10-** Computer Science
		M11- Statistics/Probability
		M12- Logic
		M13- Other (please specify)
Social Studies:	**Natural Sciences:**	**Business:**
S1 - American History	**N1 -** General Science	**B1 -** Accounting
S2 - Other History (World, Western Civ., etc.)	**N2 -** Biology/Life Sciences	**B2 -** Introduction to Bus./Bus.
	N3 - General Chemistry	**B3 -** Management/Admin.
S3 - Psychology	**N4 -** Physics (without calculus)	**B4 -** Other (please specify)
S4 - Sociology	**N5 -** Physics (with calculus)	
S5 - Geography	**N6 -** Botany	**Fine Arts:**
S6 - Anthropology	**N7 -** Conservation/Ecology	**A1 -** Art
S7 - Archaeology	**N8 -** Engineering	**A2 -** Drama/Theater
S8 - Political Science	**N9 -** Zoology	**A3 -** General Humanities
S9 - Economics	**N10-** Anatomy/Physiology	**A4 -** Music
S10- Law	**N11-** Health Sciences	**A5 -** Other (please specify)
S11- Philosophy	**N12-** Astronomy	
S12- Religion	**N13-** Geology	**Miscellaneous:**
S13- Other (please specify)	**N14-** Meteorology	**X1 -** Agriculture
	N15- Other (please specify)	**X2 -** Architecture
		X3 - Military Science
		X4 - Research/Library Usage
		X5 - Study Skills
		X6 - Teacher Education
		X7 - Other (please specify)
		X8 - Communications / Media

Table A2

Demographics of Student Samples by College Course

Characteristic	College Course				ACT-tested high school population[16]
	English Comp. I	College Algebra	Social Science	Biology	
N (Students)	96,583	70,461	130,954[17]	41,651	
Gender					
Female	55.3%	54.6%	57.2%	60.2%	53.1%
Male	43.1%	44.2%	41.3%	38.6%	46.6%
Unknown	1.7%	1.3%	1.5%	1.2%	0.3%
Race/Ethnicity					
African American	12.4%	9.9%	10.5%	10.7%	15.0%
Asian American	1.9%	1.9%	2.5%	2.4%	2.6%
Hispanic	4.1%	3.6%	4.8%	3.9%	10.5%
Other	7.2%	6.3%	6.8%	6.1%	4.3%
White	69.5%	73.7%	70.3%	72.5%	62.7%
Unknown	4.9%	4.5%	5.2%	4.4%	4.8%
Institution Type					ACT-tested college population[18]
2-year	33.7%	18.0%	23.1%	22.0%	23.5%
Less selective 4-year	55.1%	58.1%	52.1%	49.7%	36.6%
More selective 4-year	11.2%	23.9%	24.7%	28.3%	40.0%

[16] ACT-tested high school graduates of 2012 from states where at least 50% took the ACT.
[17] The sample sizes by course are: 26,239 for American History; 15,278 for Other History; 57,384 for Psychology; 13,950 for Sociology; 15,302 for Political Science; and 2,801 for Economics.
[18] ACT-tested high school graduates of 2012 that enrolled in college in fall 2012. College enrollment data obtained through the ACT Class Profile Service and the National Student Clearinghouse.

Table A3

Aggregate Academic Achievement of Student Samples by College Course

Characteristic	College Course: English Comp. I	College Algebra	Social Science	Biology	ACT-tested high school population
N (Students)	96,583	70,461	130,954	41,651	
ACT Composite Score					
Mean	20.3	21.6	21.4	21.9	20. 7
Standard Deviation	3.7	3.7	4.3	4.2	5.1
Level					
01-15	8.6%	3.9%	7.6%	5.6%	17.1%
16-19	34.3%	25.0%	27.4%	24.9%	26.8%
20-23	37.8%	42.1%	34.5%	35.3%	27.0%
24-27	15.7%	22.6%	21.5%	24.0%	18.0%
28-36	3.5%	6.4%	9.1%	10.2%	11.1%
High School GPA					
Mean	3.23	3.38	3.36	3.44	3.17
Standard Deviation	0.55	0.49	0.53	0.51	0.65
Level					
0.00-1.99	1.5%	0.6%	1.1%	0.8%	4.1%
2.00-2.49	6.9%	3.9%	5.0%	3.8%	9.4%
2.50-2.99	15.7%	12.0%	12.6%	10.5%	15.8%
3.00-3.49	26.5%	26.9%	24.4%	23.2%	24.7%
3.50-3.74	13.8%	16.8%	15.3%	16.3%	13.1%
3.75-4.00	17.4%	24.7%	25.2%	30.8%	20.5%
Unknown	18.2%	15.1%	16.5%	14.5%	12.4%

Table A4

Student Samples for Explore and Plan Benchmarks

Characteristic	Explore 8	Explore 9	Plan 10	ACT-tested high school population
N (students)	424,677	209,641	1,513,061	
N (high schools)	1,520	620	4,111	
Median month span[19]	42	31	19	
ACT Composite Score				
Mean	20.6	20.7	20.8	20.7
Standard Deviation	5.3	5.3	5.2	5.1
Level				
01-15	19.1%	18.6%	17.0%	17.1%
16-19	26.6%	26.1%	26.3%	26.8%
20-23	25.6%	25.8%	26.7%	27.0%
24-27	17.2%	18.0%	18.3%	18.0%
28-36	11.4%	11.5%	11.7%	11.1%
Race/Ethnicity				
African American	11.0%	11.8%	10.5%	15.0%
Asian American	2.6%	3.0%	2.8%	2.6%
Hispanic	8.5%	14.7%	7.7%	10.5%
Other	3.4%	3.6%	3.4%	4.3%
White	68.4%	58.6%	69.3%	62.7%
Unknown	6.2%	8.3%	6.4%	4.8%

[19] This is the median number of months between the Explore or Plan test and the student's last ACT test.

Table A5

Parameter Estimates from Hierarchical Logistic Regression Models for Course Success

College Course	ACT Subject Test	Mean/ Variance	B or higher		C or higher	
			Intercept (SE)	Slope (SE)	Intercept (SE)	Slope (SE)
English Comp. I	English	Mean	-2.289 (0.094)	0.132 (0.004)	-0.434 (0.093)	0.097 (0.005)
		Variance	0.888 (0.148)	0.002 (0.0003)	0.785 (0.148)	0.002 (0.0004)
College Algebra	Mathematics	Mean	-4.518 (0.164)	0.204 (0.007)	-2.475 (0.166)	0.157 (0.007)
		Variance	2.312 (0.419)	0.004 (0.0007)	2.401 (0.432)	0.004 (0.0008)
Social Science	Reading	Mean	-2.984 (0.070)	0.135 (0.003)	-1.330 (0.068)	0.109 (0.003)
		Variance	1.228 (0.132)	0.001 (0.0002)	1.104 (0.125)	0.002 (0.0002)
Biology	Science	Mean	-4.648 (0.168)	0.201 (0.007)	-2.729 (0.191)	0.172 (0.008)
		Variance	1.710 (0.371)	0.002 (0.001)	2.422 (0.528)	0.004 (0.001)

Note: SE = standard error

Table A6

Parameter Estimates from Logistic Regression Models for Explore and Plan Benchmarks

Grade Level (Assessment)	Subject	Intercept (SE)	Slope (SE)	50% score	Benchmark
8 (Explore)	English	-7.287 (0.036)	0.573 (0.003)	12.72	13
	Mathematics	-12.310 (0.059)	0.735 (0.004)	16.75	17
	Reading	-7.784 (0.035)	0.499 (0.002)	15.60	16
	Science	-11.302 (0.053)	0.620 (0.003)	18.23	18
9 (Explore)	English	-8.197 (0.062)	0.602 (0.004)	13.62	14
	Mathematics	-12.181 (0.093)	0.687 (0.006)	17.73	18
	Reading	-7.773 (0.056)	0.460 (0.004)	16.90	17
	Science	-11.951 (0.087)	0.638 (0.005)	18.73	19
10 (Plan)	English	-9.287 (0.023)	0.619 (0.001)	15.13	15
	Mathematics	-11.877 (0.026)	0.632 (0.001)	18.79	19
	Reading	-7.7482 (0.017)	0.424 (0.001)	18.28	18
	Science	-10.716 (0.024)	0.534 (0.001)	20.07	20

Note: SE = standard error

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