

Subgroup Representation and Validity in ACT College Readiness Benchmark Development Samples

JEFF ALLEN, PHD

The ACT College Readiness Benchmarks represent the ACT® test scores associated with a 50% chance of earning a B or higher grade in common credit-bearing first-year college courses (Allen, 2013). The ACT College Readiness Benchmarks were developed using large samples of students, including those identified as English language learners, students with disabilities, racial-ethnic minorities, and low-income students. In this brief, we examine the representation of subgroups in the samples used to develop the ACT College Readiness Benchmarks, the predictive validity of ACT scores by subgroup, and the extent that ACT cut scores associated with a 50% chance of earning a B or higher grade vary by subgroup.

Data and Methods

The information used to identify the student subgroups was provided voluntarily by students via the ACT test registration process. Identification of English language learners was based on whether English was the language most commonly spoken in the student's home. When registering for the ACT, students are asked, "Do you have a disability that requires special provisions from the educational institution?" Positive responses to this question were used to identify students with disabilities. Examinees with documented disabilities may take the ACT with special

accommodations. Options include standard testing time with accommodations, 50% extended testing time, and special testing at schools that can allow more than 50% extended time. Students' ACT scores obtained from extended testing time were not used in the development of the ACT College Readiness Benchmarks. Therefore, some students with disabilities were excluded from the analysis.¹ Racial/ethnic minorities included African American, Native American, Hispanic, Native Hawaiian, students of multiple races, and students of other races (not including White and Asian). Students reporting an annual family income of \$36,000 or lower were classified as low-income.

Table 1 reports the number of students from each subgroup included in the development of the ACT College Readiness Benchmarks. Many students do not provide information on disability status, whether English is the primary language spoken in the home, and family income.² Therefore, the sample sizes presented in Table 1 likely underestimate the actual number of English language learners, students with disabilities, and low-income students included in the development of the ACT College Readiness Benchmarks. Note that the subgroups are not mutually exclusive: A student could be an English language learner, have a disability, be a racial/ethnic minority, and be low-income.

Jeff Allen is a statistician in the Research division at ACT. He specializes in longitudinal research linking test scores to educational outcomes and student growth models.

Acknowledgments

Thanks to Justine Radunzel and Krista Mattern for their helpful suggestions on this paper.

ACT Technical Briefs provide reliability, validity, and other psychometric analyses on ACT education and workforce development assessments, services, and programs and those of our partners. For more on the ACT test, visit www.act.org.

To develop the ACT College Readiness Benchmarks, hierarchical logistic regression models were used to relate ACT scores to the probability of earning a B or higher course grade (see Allen, 2013, for more details). The logistic regression equation is presented below. The equation is characterized by an intercept (α) and a slope (β).

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

A positive slope indicates that the probability of success increases with increasing values of ACT scores, and so can be used to support test validity arguments. From Equation 1, it can be shown that the ACT score associated with a 0.50 probability of success is $X = -\frac{\alpha}{\beta}$. We refer to this score as the 50% success cut score. To derive the ACT College Readiness Benchmarks, two additional steps were taken after fitting the hierarchical logistic regression model. First, each institution's cut score was rounded up to the next integer value. Then, the ACT Benchmarks were defined as the median of the 50% success cut scores, across all postsecondary institutions in the sample. Weights were applied to make the institution samples representative of the national population with respect to enrollment of ACT-tested students by institution selectivity and institution type (four-year more selective, four-year less selective, two-year).

In this study, we examine the slopes (validity coefficients) and 50% success cut scores for each subgroup. The subgroup-specific results are obtained by extending the logistic regression model to include a term for the subgroup indicator (S) and for the interaction of the subgroup indicator and ACT score (SX) (Equation 2).

$$\ln\left(\frac{p}{1-p}\right) = \alpha + \theta S + \beta X + \gamma SX \quad (2)$$

This model can be used to estimate the slope, intercept, and 50% cut score for each subgroup of interest. The subgroup slope is $\beta + \gamma$, the intercept is $\alpha + \theta$, and the 50%

Table 1. Student Subgroup Representation in Development of ACT College Readiness Benchmarks

Student Subgroup	Subject Area (College Course)			
	English (English Composition)	Mathematics (College Algebra)	Reading (Social Science)	Science (Biology)
English Language Learners	2,103 (2.2%)	1,311 (1.9%)	3,986 (3.0%)	975 (2.3%)
Students with Disabilities	4,714 (4.9%)	3,052 (4.3%)	6,825 (5.2%)	1,799 (4.3%)
Hearing Impairment	340	256	523	160
Motor Impairment	170	113	241	80
Visual Impairment (not correctable)	506	317	748	200
Learning or Cognitive Disability	2,726	1,699	3,855	922
Other Disability	811	563	1,219	352
Multiple Disabilities	161	104	239	85
Racial/Ethnic Minority ³	22,843 (23.7%)	13,976 (19.8%)	32,116 (22.0%)	8,633 (20.7%)
African American	11,908	6,976	15,333	4,444
Native American	4,653	3,117	6,898	1,745
Hispanic	4,002	2,539	6,937	1,633
Native Hawaiian	1	1	0	0
Two or More Races/Other	2,279	1,343	2,948	811
Low-Income	26,072 (27.0%)	16,911 (24.0%)	36,057 (27.5%)	10,161 (24.4%)
Total Number of Students	96,583 (100.0%)	70,461 (100.0%)	130,954 (100.0%)	41,651 (100.0%)

cut score is $X = -\frac{\alpha + \theta}{\beta + \gamma}$. The results for each subgroup can be compared to the results for the total group and results for other subgroups.

Results

In Table 2, validity coefficients are provided for all students included in the ACT Benchmark development samples and by student subgroup. The results show some

variation in validity coefficients across student subgroups. For all subgroups and subject areas, there is a positive relationship between ACT score and probability of success in the college course.

The slopes for students with disabilities are consistently smaller than those for most other subgroups and the total group. The largest relative difference occurs for English (ACT English score predicting success in English

Composition I), where the slope for students with disabilities is 0.093 and the slope for the total group is 0.132, a difference of 30%. This finding is consistent with prior research that found smaller correlations between SAT scores and first-year GPA for students with learning disabilities, relative to students without disabilities (Cahalan, Mandinach, & Camara, 2002). Slopes for English language learners are also smaller than those for the total group in all subject areas. Slopes for racial/ethnic minority and low-income students are more similar to those obtained for the total group.

In addition to variation in slopes across student subgroups, intercepts may vary across subgroups. Variation in intercepts and/or slopes can then lead to variation in the 50% success cut scores. Figure 1 shows how the probability of success curves for College Algebra vary by student subgroup.⁴ From Table 1, the mathematics slope was largest for the total group and smallest for students with disabilities. Therefore, in Figure 1, we see that the gradient is steepest for the total group (solid black line) and flattest for students with disabilities (green dashed line).

Figure 1 shows that there is variation in 50% success cut scores across subgroups. The curve for English language learners reaches the 0.50 probability at an ACT mathematics score of 20.9, while the curve for students with disabilities reaches the 0.50 probability at an ACT mathematics score of 25.6. Table 3 provides estimates of the 50% success cut scores for each subgroup and subject area. For the total group, the cut scores are 17.4, 22.2, 22.1, and 23.1 for English, mathematics, reading, and science, respectively. Note that these scores represent the typical cut score across institutions, but do not incorporate the additional steps used to derive the ACT College Readiness Benchmarks.⁵

Table 2. Logistic Regression Slope Coefficients (Standard Error) for Subgroups Used to Develop the ACT College Readiness Benchmarks

Student Subgroup	Subject Area (College Course)			
	English (English Composition)	Mathematics (College Algebra)	Reading (Social Science)	Science (Biology)
English Language Learners	0.117 (0.009)	0.175 (0.015)	0.106 (0.006)	0.178 (0.016)
Students with Disabilities	0.093 (0.007)	0.150 (0.011)	0.109 (0.005)	0.174 (0.013)
Racial/Ethnic Minority	0.118 (0.005)	0.187 (0.008)	0.126 (0.003)	0.187 (0.008)
Low-Income	0.121 (0.005)	0.190 (0.008)	0.121 (0.003)	0.191 (0.008)
All Students	0.132 (0.004)	0.204 (0.007)	0.135 (0.003)	0.201 (0.007)

Table 3. Scores Associated with 0.50 Probability of Success (95% Confidence Interval) for Student Subgroups Used to Develop the ACT College Readiness Benchmarks

Student Subgroup	Subject Area (College Course)			
	English (English Composition)	Mathematics (College Algebra)	Reading (Social Science)	Science (Biology)
English Language Learners	15.6 (14.6, 16.5)	20.9 (20.1, 21.6)	21.4 (20.6, 22.2)	22.9 (21.9, 24.0)
Students with Disabilities	20.7 (19.7, 21.8)	25.6 (24.5, 26.7)	25.2 (24.4, 26.0)	26.3 (25.1, 27.5)
Racial/Ethnic Minority	19.4 (18.8, 20.1)	23.3 (22.8, 23.9)	24.6 (24.1, 25.0)	24.9 (24.2, 25.6)
Low-Income	18.4 (17.8, 19.0)	23.0 (22.5, 23.5)	24.1 (23.7, 24.6)	24.2 (23.5, 24.8)
All Students	17.4 (16.8, 18.0)	22.2 (21.8, 22.7)	22.1 (21.7, 22.5)	23.1 (22.6, 23.6)
ACT College Readiness Benchmark	18	22	22	23

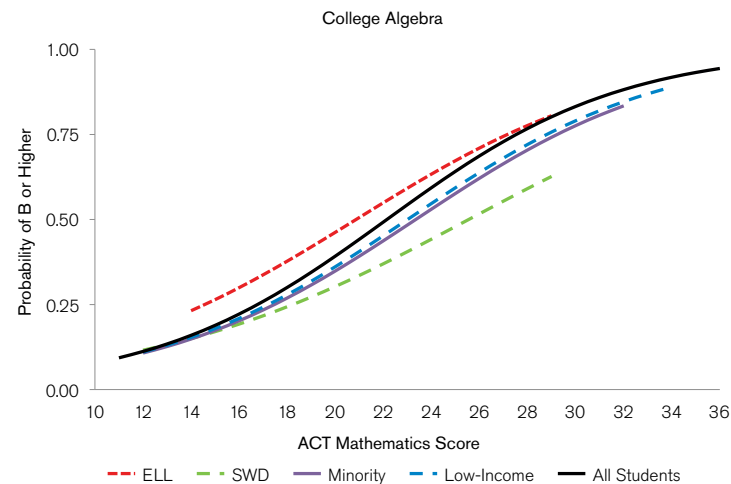


Figure 1. College Algebra probability of success curves, by student subgroup

Across subject areas, 50% success cut scores are consistently lowest for English language learners and highest for students with disabilities. Relative to the total group, the ACT scores required to have a 50% chance of success are lower for English language learners and higher for students with disabilities, racial/ethnic minorities, and low-income students. When the 50% success cut score for a subgroup is higher than the 50% cut score for the total group, *over-prediction* occurs for the subgroup: At the 50% cut score for the total group, the chance of success is lower than 50% for the subgroup. Similarly, when the 50% success cut score for a subgroup is lower than the 50% cut score for the total group, *under-prediction* occurs for the subgroup. More generally, over-prediction (under-prediction) occurs when the probability of success, conditional on ACT scores, is lower (higher) for a subgroup relative to the total group.

The cut score results for English language learners are mostly consistent with prior research that found under-prediction of first-year GPA for English language learners based on SAT Critical Reading, Writing, and total scores (Mattern, Patterson, Shaw, Kobrin, & Barbuti, 2008; Patterson & Mattern, 2012). The cut score results for racial/ethnic minority and low-income students are consistent with prior research, which has found lower probabilities of course success

for these groups conditional on ACT scores (over-prediction, Lorah & Ndum, 2013). Other studies examining first-year GPA (Patterson & Mattern, 2012; Sanchez, 2013) and degree completion (Radunzel & Noble, 2013) also found over-prediction for low-income and racial-ethnic minority students.

The cut score results for students with disabilities are consistent with prior research finding over-prediction of first-year college GPA for special needs students (Ziomek & Andrews, 1996; Huh & Huang, in progress). The prior studies examined students with disabilities who tested with extended time, while the current study only examined students with disabilities who tested under regular time.

Summary

The ACT College Readiness Benchmarks were developed using large samples of students, including those identified as English language learners, students with disabilities, racial-ethnic minority, and low-income students. The strength of relationship between ACT scores and probability of earning a B or higher in common first-year credit-bearing courses was similar across student subgroups. Validity coefficients for students with disabilities were smaller than those for the unweighted total group by 13% (science) to 30% (English). Validity coefficients for English language learners

were larger than those for students with disabilities in English, mathematics, and science, but smaller than those for the total group. Coefficients for racial/ethnic minorities and low-income students were similar to those for the total group. The ACT scores associated with a 50% chance of course success were consistently lower for English language learners and higher for students with disabilities.

Limitations of this study include the use of student-reported data for subgroup identification, the use of a proxy variable for identifying English language learners, and relatively small sample sizes for some subgroups. Also, the study did not include students who only tested with extended time, so did not examine whether testing with extended time affects validity coefficients or 50% success cut scores. This study employed a single dimension of college readiness—academic achievement measured by ACT scores. Other measures of readiness such as high school grades and coursework were not considered, nor were other factors that affect readiness, such as conscientiousness (Mattern et al., 2014). Additional research is needed to examine the extent that cut scores and validity coefficients based on multiple measures of college readiness vary by student subgroup. ■

Notes

- 1 Among students in the 2015 ACT graduating class who reported having a disability that requires special provisions, about 25% only took the ACT with extended time testing.
- 2 Among students in the 2015 ACT graduating class, 52% responded to the item on disability status, 82% responded to the item on English language use in their home, and 72% responded to the item on family income.
- 3 Beginning in 2010, “Other” was no longer used as a response option for race/ethnicity and Native Hawaiian became a response option. Most students included in the ACT College Readiness Benchmarks sample took the ACT prior to this change.
- 4 To avoid reporting estimates outside of the range supported by the data, probability of success estimates are plotted for each ACT score with a sample of 10 or more students (i.e., $n \geq 10$).
- 5 Here the 50% cut scores are derived from the fixed effect parameter estimates of Equation 1 instead of the weighted median cut score across institutions used to derive the ACT College Readiness Benchmarks.

References

- Allen, J. (2013). *Updating the ACT College Readiness Benchmarks*. (ACT Research Report 2013-6). Iowa City, IA: ACT.
- Cahalan, C., Mandinach, E. B., & Camara, W. J. (2002). *Predictive validity of SAT® I: Reasoning Test for test-takers with learning disabilities and extended time accommodations*. (College Board Research Report 2002-5). New York, NY: The College Board.
- Huh, N., & Huang, C. (2015). *Examining the validity of ACT Composite scores and high school grade point averages in predicting first-year college success for students with disabilities*. Manuscript in progress.
- Lorah, J., & Ndum, E. (2013). *Trends in achievement gaps in first-year college courses for racial/ethnic, income, and gender subgroups: A 12-year study*. (ACT Research Report 2013-8). Iowa City, IA: ACT.
- Mattern, K., Burrus, J., Camara, W., O'Connor, R., Hanson, M. A., Gambrell, J., Casillas, A., & Bobek, B. (2014). *Broadening the definition of college and career readiness: A holistic approach*. (ACT Research Report 2014-5). Iowa City, IA: ACT.
- Mattern, K. D., Patterson, B. F., Shaw, E. J., Kobrin, J. L., & Barbuti, S. M. (2008). *Differential validity and prediction of the SAT®*. (College Board Research Report 2008-4). New York, NY: The College Board.
- Patterson, B. F., & Mattern, K. D. (2012). Validity of the SAT® for predicting first-year grades: 2009 SAT validity sample. (College Board Statistical Report No. 2012-2). New York, NY: The College Board.
- Radunzel, J., & Noble, J. (2013). *Differential effects on student demographic groups of using ACT® Composite score, ACT Benchmarks, and high school grade point average for predicting long-term college success through degree completion*. (ACT Research Report 2013-5). Iowa City, IA: ACT.
- Sanchez, E.I. (2013). *Differential effects of using ACT® College Readiness Assessment scores and high school GPA to predict first-year college GPA among racial/ethnic, gender, and income groups*. (ACT Research Report 2013-4). Iowa City, IA: ACT.