The Incremental Value of End-of-Course Assessment Scores for Predicting First-Year Postsecondary Grades

Jeffrey T. Steedle, PhD

Jeffrey T. Steedle is a senior research scientist in Validity and Efficacy Research specializing in educational and labor market outcomes research and validity evidence for ACT's workforce assessment programs.

Students commonly take standardized end-of-course (EOC) assessments to measure achievement of high school course objectives. As an example, the ACT® QualityCore® assessments measure achievement for English language arts (ELA), mathematics, science, and social studies courses. Though EOC assessments help evaluate student progress toward college readiness, the assessment results are not often considered for postsecondary admissions nor course placement. This study examined the value of EOC assessment scores as predictors of postsecondary grades, both alone and in combination with high school grade point average (HSGPA) and the ACT® test. Results revealed that EOC assessments correlated moderately with first-year postsecondary grade point average (FYGPA). The correlations with first-year course grades in a related content area were slightly weaker compared to the FYGPA results but still consistently positive and statistically significant. When added to regression equations already including HSGPA or ACT scores, the EOC assessments provided incremental improvements to the prediction of first-year grades, supporting their use as indicators of college readiness.

Sample

EOC assessment scores were available for 729,160 students from schools across the United States that participated in ACT's QualityCore instructional improvement program. Those records were matched to available ACT test records and postsecondary grade data. 40,601 students with complete data were included in analyses (EOC scores, HSGPA, ACT scores, and first-year postsecondary grades). Nearly all ACT scores came from 11th-grade (54%) or 12th-grade (45%) students who graduated high school between 2009 and 2016. When students had multiple ACT scores; the most recent scores were analyzed. The full sample was 57% female, 11% African American, and 77% White. Ninety-three percent of the sample reported speaking English at home, and the average ACT Composite (average of English, math, reading, and science) score was 22.5—slightly higher than the 2017 national graduating class (21.0).

Each student enrolled in one of 278 postsecondary institutions, 70% of which awarded bachelor's degrees and 30% awarded associate degrees and certificates. Seventy-six percent were public institutions, and most were located in the Midwestern (45%) or Southern (41%) United States. In terms of selectivity, the sample institutions were 4% highly selective, 21% selective, 34% traditional, and 40% liberal or open admissions. The institutions varied in size, with 3% having fewer than 1,000 students, 40% with 1,000–4,999, 18% with 5,000–9,999, 21% with 10,000–19,999, and 18% with more than 20,000 students.

The sample varied across analyses because not all students took every available EOC assessment nor did they have grades from every postsecondary course. Sample demographics were generally similar across analyses, though the samples taking EOC assessments for upper-level courses tended to have higher average ACT Composite scores (e.g., 2.2 points higher for both Pre-Calculus and Physics).

Analyses

The first set of analyses focused on predicting FYGPA. Univariate and bivariate descriptive statistics were calculated for the predictor variables (HSGPA, ACT, and EOC). Next, correlations and multiple correlations between predictors and FYGPA were calculated. The reported results include the estimated correlations before and after correcting for restriction of range.[1] Then, linear regression was applied to examine the predictive value of EOC assessment scores compared to ACT scores in a related content area. Sets of linear regression models were fit to the data to estimate incremental improvements to the prediction of FYGPA:

Model 1: Regress FYGPA on HSGPA
$FYGPA = b_0 + b_1 HSGPA + e$

Model 2: Regress FYGPA on ACT
$FYGPA = b_0 + b_1 ACT + e$

Model 3: Regress FYGPA on EOC
$FYGPA = b_0 + b_1 EOC + e$

Model 4: Regress FYGPA on HSGPA and ACT
$FYGPA = b_0 + b_1 HSGPA + b_2 ACT + e$

Model 5: Regress FYGPA on HSGPA and EOC
$FYGPA = b_0 + b_1 HSGPA + b_2 EOC + e$

Model 6: Regress FYGPA on ACT and EOC
$FYGPA = b_0 + b_1 ACT + b_2 EOC + e$

Model 7: Regress FYGPA on HSGPA, ACT, and EOC
$FYGPA = b_0 + b_1 HSGPA + b_2 ACT + b_3 EOC + e$

Changes in the proportion of FYGPA variance (R^2) were calculated as indicators of incremental predictive value. For example, the R^2 difference between Model 5 and Model 1 indicated the incremental value of an EOC assessment over the predictive accuracy provided by HSGPA alone. Subsequent analyses applied the same methods to examine associations between EOC scores and first-year course grades in related content areas.

Results

FYGPA Analyses

Table 1 provides descriptive statistics for all predictor variables and FYGPA. EOC scores ranged from 125 to 175. As shown in Table 2, the corrected correlations between EOC scores and HSGPA ranged from .323 to .604 (average of .483). With a range from .377 to .775, the EOC assessments had moderate to strong corrected correlations with the ACT tests. Assessments measuring achievement in similar content areas tended to have higher corrected correlations. For example, ACT English correlated .741 with EOC English tests on average but only .570 with other EOC tests.

Table 1. Predictor Descriptive Statistics

Predictor	N	Mean	SD
HSGPA	40,601	3.35	0.53
ACT English	40,601	22.3	5.9
ACT Math	40,601	21.9	5.0
ACT Reading	40,601	22.9	5.8
ACT Science	40,601	22.3	4.8
ACT Composite	40,601	22.5	4.8
EOC English 9	11,356	158.3	6.0
EOC English 10	22,477	157.0	5.5
EOC English 11	12,406	155.6	6.7
EOC English 12	3,316	153.4	6.3
EOC Algebra 1	9,210	147.6	4.5
EOC Geometry	16,342	146.4	4.6
EOC Algebra 2	19,338	147.4	4.6
EOC Pre-Calculus	8,277	148.3	5.4
EOC Biology	15,990	153.3	5.8
EOC Chemistry	12,097	149.5	6.0
EOC Physics	1,825	146.6	4.7
EOC US History	10,372	148.9	5.1
FYGPA	40,601	2.69	1.07

Table 2. Correlations Between EOC Assessments and Other FYGPA Predictors

EOC	HSGPA	ACT English	ACT Math	ACT Reading	ACT Science	ACT Composite
English 9	.493 (.604)	.676 (.775)	.523 (.634)	.647 (.750)	.546 (.657)	.677 (.776)
English 10	.477 (.562)	.671 (.749)	.522 (.607)	.642 (.723)	.550 (.636)	.674 (.752)
English 11	.468 (.516)	.680 (.726)	.540 (.590)	.658 (.705)	.572 (.622)	.695 (.740)
English 12	.434 (.469)	.676 (.712)	.581 (.619)	.642 (.679)	.580 (.618)	.700 (.734)
Algebra 1	.448 (.481)	.514 (.549)	.661 (.694)	.449 (.482)	.547 (.582)	.606 (.641)
Geometry	.456 (.468)	.567 (.580)	.708 (.719)	.507 (.519)	.608 (.620)	.658 (.670)
Algebra 2	.457 (.479)	.547 (.570)	.684 (.706)	.486 (.509)	.581 (.604)	.642 (.665)
Pre-Calculus	.395 (.405)	.503 (.514)	.670 (.681)	.430 (.440)	.561 (.573)	.613 (.624)
Biology	.491 (.551)	.643 (.702)	.644 (.703)	.611 (.671)	.640 (.699)	.712 (.766)
Chemistry	.496 (.523)	.567 (.595)	.671 (.697)	.509 (.536)	.624 (.651)	.665 (.691)
Physics	.300 (.323)	.384 (.412)	.556 (.588)	.350 (.377)	.503 (.535)	.513 (.545)
US History	.388 (.414)	.605 (.635)	.535 (.565)	.618 (.647)	.564 (.594)	.658 (.686)

Correlations corrected for restriction of range are shown in parentheses. All correlations were statistically significant at the $p < .001$ level.

The first two columns of Table 3 show the bivariate correlations between individual predictors and FYGPA. With a corrected correlation of .527, HSGPA was the single best predictor of FYGPA. The next best predictors were EOC English 9 (.446), ACT Composite (.427), EOC English 12 (.427), ACT English (.426), and EOC English 10 (.417). On average, individual ACT tests had a corrected correlation of .381 with FYGPA, and EOC assessments had a corrected correlation of .355 with FYGPA.

The last two columns of Table 3 show multiple correlations based on the prediction of FYGPA from multiple predictors: HSGPA and a standardized assessment. The corrected multiple correlation for HSGPA plus an ACT test was an average of .160 greater than the corrected bivariate correlation for the test alone. The average difference was .208 for EOC assessments. Overall, these results indicate that HSGPA accounted for unique variance in FYGPA beyond that captured by ACT or EOC scores.

HSGPA and ACT scores are often used in combination to predict FYGPA. With a corrected multiple correlation of .546, HSGPA plus ACT Composite score accounted for 29.8% of the variance in FYGPA ($R^2 = .298$). Figure 1 illustrates how HSGPA and ACT Composite scores each contributed to the prediction of FYGPA. That is, when controlling for one of the predictors, the other predictor still provided information about which students tended to earn higher FYGPAs. As shown in Table 3, HSGPA plus certain EOC assessments achieved similar or greater predictive validity. Namely, the corrected multiple correlation was .546 or greater for HSGPA plus English 9, English 10, English 11, Algebra 2, Pre-Calculus, Biology, Chemistry, Physics, or US History.

Table 3. Correlation Between Predictors and FYGPA

Predictor	Correlation	Predictors	Multiple Correlation
HSGPA	.483 (.527)		
ACT English	.421 (.426)	HSGPA+ACT Eng.	.519 (.551)
ACT Math	.391 (.358)	HSGPA+ACT Math	.506 (.526)
ACT Reading	.352 (.385)	HSGPA+ACT Read.	.503 (.550)
ACT Science	.360 (.355)	HSGPA+ACT Sci.	.503 (.536)
ACT Comp.	.425 (.427)	HSGPA+ACT Comp.	.521 (.546)
EOC English 9	.350 (.446)	HSGPA+ EOC English 9	.515 (.607)
EOC English 10	.345 (.417)	HSGPA+ EOC English 10	.514 (.585)
EOC English 11	.334 (.374)	HSGPA+ EOC English 11	.495 (.547)
EOC English 12	.393 (.427)	HSGPA+ EOC English 12	.477 (.518)
EOC Algebra 1	.290 (.315)	HSGPA+ EOC Algebra 1	.489 (.545)
EOC Geometry	.313 (.322)	HSGPA+ EOC Geometry	.485 (.529)
EOC Algebra 2	.328 (.345)	HSGPA+ EOC Algebra 2	.503 (.546)
EOC Pre-Calculus	.310 (.319)	HSGPA+ EOC Pre-Calculus	.474 (.600)
EOC Biology	.340 (.391)	HSGPA+ EOC Biology	.516 (.572)
EOC Chemistry	.341 (.363)	HSGPA+ EOC Chemistry	.490 (.564)
EOC Physics	.197 (.213)	HSGPA+ EOC Physics	.447 (.585)
EOC US History	.307 (.329)	HSGPA+ EOC US History	.518 (.553)

Correlations corrected for restriction of range are shown in parentheses. All correlations were statistically significant at the $p < .001$ level.

Figure 1. Mean FYGPA by HSGPA Range and ACT Composite Score Range

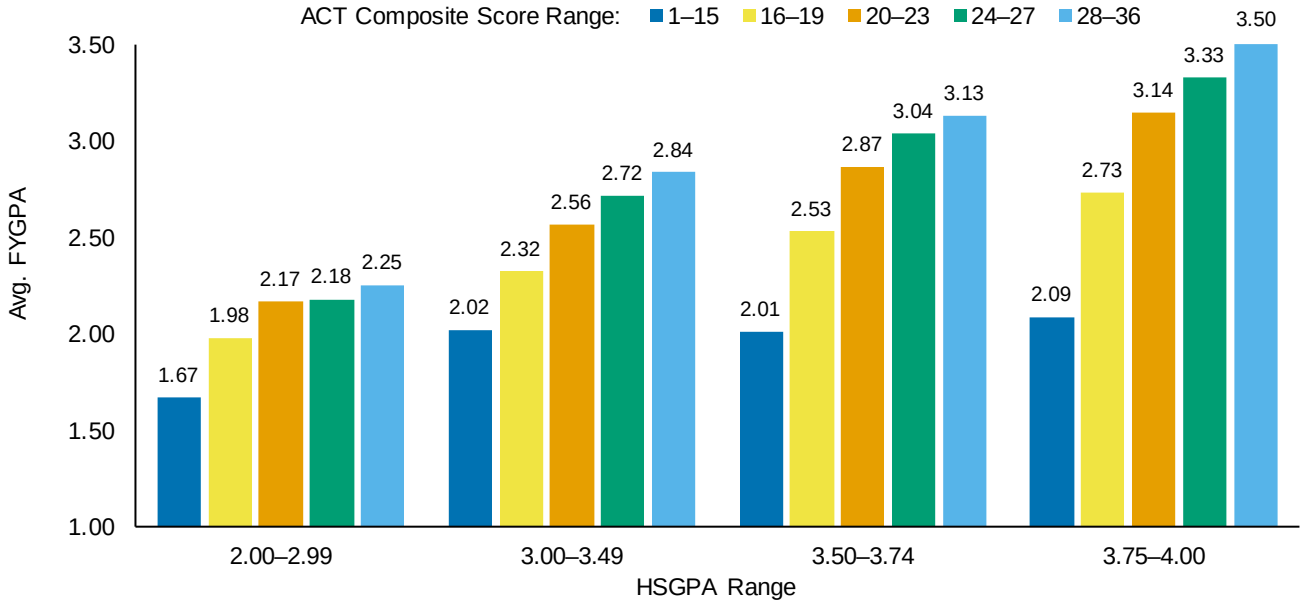

Table 4 compares ACT and EOC scores in terms of their incremental contributions to the proportion of FYGPA variance accounted for by linear regression models. HSGPA alone accounted for 23.3% of the variance in FYGPA. The third and fourth columns of Table 4 reveal that, when ACT scores or EOC scores

were added to the regression model including HSGPA, ACT scores typically provided greater incremental improvements in FYGPA prediction.

The fifth and sixth columns of Table 4 indicate that ACT scores tended to provide greater incremental R^2 improvement over EOC scores than EOC scores provided over ACT scores. A similar study examined the incremental improvements to the prediction of FYGPA provided by the SAT and SAT Subject Tests (Kobrin & Patterson, 2012). Results were highly consistent between the studies, with the course-specific tests (EOC or SAT Subject Tests) adding an average of .014 to R^2. In the current study, the incremental value of the ACT was often greater than the incremental value of the EOC assessments. However, the incremental value of EOC tended to increase for tests taken later in high school. This was especially true for the EOC English 12, Pre-Calculus, Biology, and Chemistry assessments. This finding may reflect temporal proximity between the EOC assessment and the measurement of FYGPA. It may also be explained by greater content overlap between college courses and EOC assessments for courses taken later in higher school compared to courses taken earlier in high school.

The rightmost columns of Table 4 reflect results from predictive models including HSGPA, ACT, and EOC. HSGPA plus EOC scores accounted for 20.0% to 26.6% of FYGPA variance, and adding ACT to those regression models increased that percentage by 0.0% to 1.5%. Likewise, HSGPA plus ACT scores accounted for 25.3% to 26.9% of FYGPA variance. That percentage increased by 0.0% to 1.9% by adding an EOC assessment. In short, adding a second standardized test (either ACT or EOC) to the FYGPA prediction model provided a small, significant improvement to the model's predictive validity.

Table 4. Incremental Improvements to R^2 for the Prediction of FYGPA

ACT Predictor	EOC Predictor	Increment of ACT Over HSGPA	Increment of EOC Over HSGPA	Increment of ACT Over EOC	Increment of EOC Over ACT	Increment of ACT Over HSGPA and EOC	Increment of EOC Over HSGPA and ACT
English	English 9	.035	.014	.058	.009	.013	.001
English	English 10	.035	.015	.061	.008	.015	.001
English	English 11	.035	.015	.053	.008	.010	.002
English	English 12	.035	.056	.035	.026	.009	.019
Math	Algebra 1	.023	.007	.047	.006	.008	.000
Math	Geometry	.023	.012	.059	.002	.013	.000
Math	Algebra 2	.023	.014	.040	.010	.005	.003
Math	Pre-Calc.	.023	.021	.013	.024	.000[ns]	.012
Science	Biology	.020	.011	.028	.024	.004	.003
Science	Chemistry	.020	.015	.018	.033	.002	.007
Science	Physics	.020	.004	.021	.009	.001[ns]	.002
Reading	US Hist.	.019	.015	.039	.014	.007	.003

[ns] non-significant; all other R^2 increments were statistically significant at the $p < .05$ level or lower. Some increments less than .0005 appear as .000.

Course Grade Analyses

Additional analyses examined the relationship between HSGPA, ACT scores, and EOC scores and grades in specific first-year content areas—ELA, math, science, and social science[2]—rather than FYGPA. Note that sample sizes in Table 5 are smaller than the preceding analyses since fewer students took a certain EOC assessment and had first-year course grade records in a related content area. The analyses might have been conducted using specific first-year courses (e.g., EOC Physics predicting first-year Physics grades) as opposed to broad content areas, but that would have further restricted the sample size. The relationship between EOC scores and first-year course grades is apparent in Table 5. That is, expected course grades (on a 0.00–4.00 scale) consistently increased as EOC scores increased, and EOC scores had significant positive correlations with first-year course grades. These positive relationships are illustrated in Figures 2 and 3 for English 12 and Algebra 2, respectively.

Next, analyses like those reported in Table 4 for FYGPA were conducted using course grades as the outcome variable (Table 6). Overall, results of these analyses were consistent with the FYGPA analyses. That is, ACT or EOC assessment scores provided small but statistically significant improvements to the prediction of first-year course grades in a related content area. The increments to course grade R^2 in Table 6 were generally smaller than the increments to FYGPA R^2 in Table 4. That result might be explained by the fact that individual course grades are less reliable than FYGPA and are, therefore, more difficult to predict accurately.

Table 5. Association Between EOC Scores and Course Grades

			Mean Course Grade by EOC Score Range					
EOC Predictor	First-Year Course	N	< -1.5 SD	-1.5 to -0.5 SD	M ± 0.5 SD	0.5 to 1.5 SD	> 1.5 SD	*r*
English 9	ELA	6,522	2.02	2.13	2.44	2.59	2.86	.22 (.28)
English 10	ELA	12,599	2.08	2.26	2.50	2.73	2.90	.20 (.25)
English 11	ELA	8,287	1.83	2.13	2.37	2.54	2.74	.21 (.26)
English 12	ELA	2,277	1.92	2.10	2.47	2.67	2.82	.22 (.26)
Algebra 1	Math	4,364	1.64	1.92	2.19	2.49	2.74	.24 (.27)
Geometry	Math	8,567	1.85	2.07	2.27	2.49	2.85	.21 (.22)
Algebra 2	Math	9,575	1.80	1.95	2.23	2.65	2.98	.28 (.30)
Pre-Calc.	Math	1,401	2.33	2.45	2.72	2.87	3.00	.17 (.20)
Biology	Science	6,636	1.86	2.14	2.39	2.61	2.93	.25 (.29)
Chemistry	Science	6,618	1.74	2.21	2.47	2.69	3.13	.28 (.31)
Physics	Science	1,025	2.27	2.37	2.65	2.59	2.96	.15 (.16)
US Hist.	Social Sci.	2,974	1.82	2.10	2.40	2.54	2.75	.24 (.26)

EOC scores on different tests are not directly comparable, so EOC scores are reported in ranges defined by a number of standard deviations relative to the mean.
Corrected correlations are shown in parentheses. All correlations were significant at the $p < .001$ level.

Figure 2. Mean ELA Course Grade by EOC English 12 Score Range

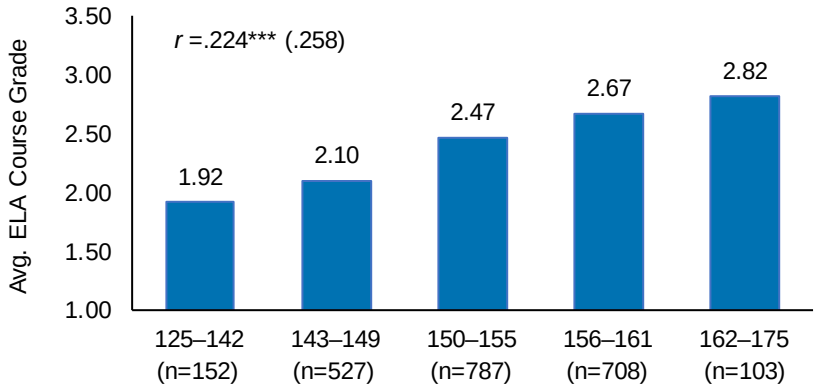

Figure 3. Mean Math Course Grade by EOC Algebra 2 Score Range

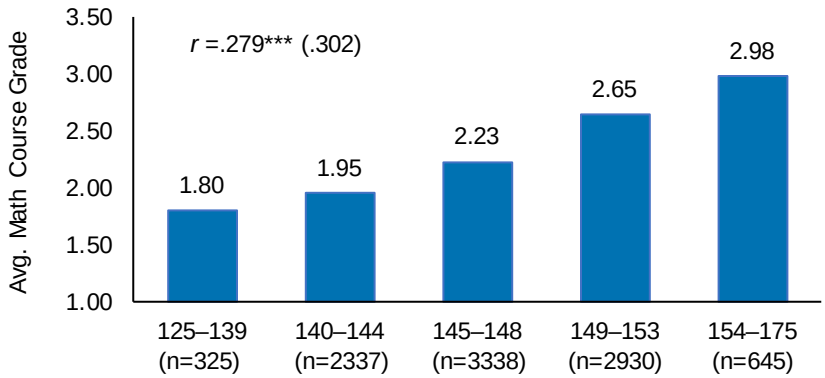

Table 6. Incremental Improvements to R^2 for the Prediction of Course Grades

ACT Predictor	EOC Predictor	First-Year Course	Increment of ACT Over HSGPA	Increment of EOC Over HSGPA	Increment of ACT Over EOC	Increment of EOC Over ACT	Increment of ACT Over HSGPA and EOC	Increment of EOC Over HSGPA and ACT
English	English 9	ELA	.007	.004	.022	.005	.003	.001
	English 10	ELA	.007	.005	.021	.006	.003	.001
	English 11	ELA	.010	.007	.023	.004	.004	.001
	English 12	ELA	.016	.016	.019	.007	.005	.004
Math	Algebra 1	Math	.011	.009	.025	.007	.004	.002
	Geometry	Math	.004	.004	.018	.004	.001	.001
	Algebra 2	Math	.022	.017	.031	.008	.008	.003
	Pre-Calc.	Math	.014	.008	.021	.003	.007	.001[ns]
Science	Biology	Science	.008	.007	.016	.014	.003	.002
	Chemistry	Science	.008	.020	.006	.029	.001	.012
	Physics	Science	.004	.005	.015	.004	.002[ns]	.002[ns]
Reading	US Hist.	Social Sci.	.021	.014	.030	.009	.010	.002

[ns] = non-significant; all other R^2 increments were statistically significant at the $p < .05$ level or lower.

Conclusions

This study focused on estimating the unique contribution of EOC assessment scores to the prediction of first-year postsecondary grades. EOC assessment scores correlated moderately to strongly with HSGPA and ACT scores, so it was expected that the three measures would, to some extent, be redundant as predictors of first-year grades. As in previous studies (Westrick, Le, Robbins, Radunzel, & Schmidt, 2015), HSGPA was the single best predictor of FYGPA. For individual assessments, English tests (either EOC or ACT) tended to be better predictors of FYGPA compared to tests in other content areas. This study detected evidence that ACT scores accounted for slightly more unique variance in first-year grades than EOC assessment scores. EOC scores correlated with first-year grades (FYGPA and grades in related content areas), and they significantly improved the prediction of first-year grades beyond that provided by HSGPA or ACT scores. The degree of improvement was small as measured by the change in R^2; this was expected given the high correlation among predictors examined in the current study, which were all measures of academic preparation in core content areas. These findings are consistent with prior research examining the incremental validity of additional measures of academic preparation as predictors of college success (e.g., Allen, Ndum, & Mattern, in press). Moreover, it is important to note that small changes in R^2 are often associated with meaningful differences in expected outcomes, which underscores the value of additional sources of information even when such findings occur (Mattern & Allen, 2016). Thus, overall results support the notion that EOC assessment scores are useful indicators of college readiness.

Notes

1. Bivariate and multiple correlations were corrected for restriction of range using the methods described in Sackett, P. R., & Yang, H. (2000). Correction for range restriction: An expanded typology. *Journal of Applied Psychology, 85*(1), 112–118. doi:10.1037/0021-9010.85.1.112. The population standard deviations of QualityCore scores were estimated using the full database of QualityCore scores. When HSGPA was a predictor, the population standard deviation was assumed to be 0.60; ACT. (2017). *The ACT® technical manual*. Iowa City, IA: ACT. Retrieved from https://www.act.org/content/dam/act/unsecured/documents/ACT_Technical_Manual.pdf
2. ELA included Grammar, Reading, Composition I, Composition II, Literature, Speech/Rhetoric, and Other. Math included Arithmetic Skills, Elementary Algebra, Intermediate Algebra, College Algebra, Trigonometry, Pre-Calculus, Calculus, Computer Science, Statistics/Probability, and Other. Science included Biology, Chemistry, Physics, Botany, Ecology, Engineering, Anatomy, Health Sciences, Astronomy, Geology, and Other. Social Science included American History, Other History, Psychology, Sociology, Geography, Anthropology, Archaeology, Political Science, Economics, Law, Philosophy, Religion, Other, Ethics, Human Development, and Criminal Justice.

References

Allen, J., Ndum, E., & Mattern, K. (in press). An empirically-derived index of high school academic rigor. *Educational Measurement: Issues and Practice.* doi: 10.1111/emip.12236

Kobrin, J. L., & Patterson, B. F. (2012). The SAT and SAT Subject Tests: Discrepant scores and incremental validity (Research Report 2012-2). New York, NY: *The College Board*. Retrieved from https://files.eric.ed.gov/fulltext/ED563078.pdf

Mattern, K. D., & Allen, J. (2016). *More information, more informed decisions: Why test-optional policies do NOT benefit institutions or students*. Iowa City, IA: ACT. Retrieved from https://www.act.org/content/dam/act/unsecured/documents/MS487_More-Information-More-Informed-Decisions_Web.pdf

Westrick, P. A., Le, H., Robbins, S. B., Radunzel, J. M. R., & Schmidt, F. L. (2015). College performance and retention: A meta-analysis of the predictive validities of ACT® scores, high school grades, and SES. *Educational Assessment*, *20*(1), 23–45. doi:10.1080/10627197.2015.997614