

Title: Predicting 11th Grade Colorado ACT Performance Using 9th and 10th Grade CSAP Results

Author(s): Marie Huchton, Colorado Department of Education

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Predicting 11th Grade Colorado ACT Performance Using 9th and 10th Grade CSAP Results

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Research and Evaluation
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March 4, 2011



Executive Summary

Research indicates 9th and 10th grade CSAP can reliably predict a range of Colorado ACT (CO ACT) scores for each student. Using the Colorado Growth Model, predictive linkages can be made from the 9th and 10th grade CSAP to the 11th grade CO ACT in each content area tested. This means that every possible 9th and 10th grade CSAP score has a predicted range of CO ACT scores for students making typical growth. Additionally, 9th grade scores can be used to directly predict 11th grade CO ACT performance without waiting for the 10th grade performance data. Including CO ACT scores in the Colorado Growth Model as an 11th grade state assessment also enhances the consistency of interpretations of growth data into upper high school grades.

It is well known that ACT has a series of pre-ACT assessments known as the EPAS system that includes the tests EXPLORE and PLAN. According to ACT technical manuals, these tests were specifically developed to predict ACT outcomes. Researchers at CDE were interested in how comparable CSAP and EPAS predictions of ACT outcomes might be. Although EXPLORE and PLAN were expressly created to align with the ACT, the correlation between 10th grade CSAP and CO ACT is stronger than that found between PLAN and ACT in Reading, Math and Science. Only in English are PLAN and ACT more highly correlated. Similarly, the correlations between 9th grade CSAP and CO ACT are higher for all the available content areas, English, Reading, and Math, as compared with those of EXPLORE and ACT. Overall, there is nothing in the available data to indicate that the EXPLORE and PLAN are better predictors of student performance on ACT than CSAP. Results from the 9th and 10th grade CSAP gauge performance on the same general knowledge domains and produce roughly equivalent scale score inferences.

Recently, CDE and CDHE published a paper entitled 'Shining a Light on Remediation' (March 2, 2011). Both the current analysis and the remediation paper provide evidence of the utility of CSAP for predicting ACT scores and postsecondary outcomes.

Introduction

As specified under Colorado law 22-7-409 C. R. S., all students enrolled in public schools in grades 3 through 10 must be assessed each year by the Colorado Student Assessment Program (CSAP). Content areas assessed by CSAP include Reading, Writing, and Mathematics for grades 3–10 and Science in grades 5, 8 and 10. Additionally, students in 11th grade are

required to take a standardized, curriculum-based, achievement, college entrance examination selected by the department, administered throughout the United States and relied upon by institutions of higher education that, at a minimum, tests in the areas of reading, writing, mathematics, and science. (C.R.S. 22-7-409 (1.5) (a))

The ACT was chosen to fulfill this post-secondary readiness requirement and has been administered to all 11th graders every April since 2001. According to ACT,

[t]he ACT tests are designed to measure academic skills that are taught in typical college-preparatory curricula in high school and are necessary in the first year of college. High scores on these tests show that a student is proficient in these subject areas and is ready for college-level work. (Allen & Sconing, 2005, p. 1)

Unlike the national ACT, which in general is only taken by college-bound students, the ACT for Colorado (CO ACT) is given to all 11th graders enrolled in Colorado public schools, regardless of their post-graduation aspirations. So rather than being a sample of the more academically inclined (and presumably higher performing) students, CO ACT results reflect the full spectrum of Colorado's 11th grade student academic achievement. For this reason, this document will use ACT when referring to the national exam and its results, and CO ACT when referring to the Colorado-specific administration.

As part of their Educational Planning and Assessment System (EPAS), ACT offers precursor assessments: EXPLORE, to be given in grades 8 or 9, and PLAN in grades 10 or 11. Both the EXPLORE and PLAN are modeled after the ACT, and the EPAS as a whole is designed to be an “interrelated sequence of instruments to measure student educational achievement and assess college readiness from eighth through twelfth grade,” (ACT Technical Manual, 2007, p. 1). Based on a student's composite EXPLORE results, a predicted range of composite PLAN scores is provided; later on when a student's actual PLAN score is available, it can in turn be used to predict a range of likely ACT composite scores. These predicted PLAN scores were constructed using observed data for students taking EXPLORE in 8th/9th grade and PLAN in 10th grade. Predicted ACT scores came from students assessed on the PLAN in 10th grade and the ACT in 12th grade. A note is made in the EXPLORE Technical Report that three years of data were combined to get an adequate sample size for the 9th grade EXPLORE and 10th grade PLAN sequence. The general inference from these analyses is that students achieving a particular score on the EXPLORE have a 75% chance of scoring within the predicted interval on the PLAN. The student's actual PLAN score is then used to predict the 75% probability interval for the ACT. It is important to keep in mind that these predictive analyses are based on ACT's national sample, not specifically on Colorado data.

ACT has also published a series of College Readiness Benchmarks which “are the minimum ACT test scores required for students to have a high probability of success in credit-bearing college courses—English Composition, social sciences courses, College Algebra, or Biology” (ACT, 2010, p. 1). Using course

completion data from a variety of post-secondary institutions, ACT determined the scale score associated with a 50% chance of achieving a B or better in the introductory level courses listed above. It should be noted that “the *benchmark values* represent predictive indicators of success for *typical* students at *typical* colleges” (Allen & Sconing, 2005, p. 3). Although it is not explicit in the technical documentation, the majority of the sample used in this benchmarking process probably took the ACT in 12th grade and entered college the following year; as such, ACT’s results largely reflect those of higher-performing, college-bound students. These College Readiness Benchmarks were also applied to the EXPLORE and PLAN through backwards extrapolation from ACT results for students taking all three assessments.

Linking CSAP and CO ACT

For the purposes of this study, results for Colorado public school students in 11th grade taking the CO ACT in 2010 were matched to their 2009 10th grade CSAP results to create a two year longitudinal data file. Included content areas for CO ACT were English, Reading, Math and Science, and for CSAP were Reading, Math, and Science. Similar, parallel files were created for 2009-2008 and 2008-2007. The score distributions for each assessment and content area were compared across years and found to be reasonably consistent. Year indicators were then removed, effectively combining all 11th grade ACT scores and their associated 10th grade CSAP scores into a single super-cohort. Roughly 138,000 students (about the same sample size as ACT’s national analysis) had valid records for both assessments and were used in the subsequent analyses.

Although there is not perfect correspondence between the content areas tested by CSAP and those of ACT, the predictive relationships of interest are:

- CSAP Reading to CO ACT English,
- CSAP Reading to CO ACT Reading,
- CSAP Math to CO ACT Math, and
- CSAP Science to CO ACT Science

The knowledge domain tested by CSAP Reading overlaps with that of both the English and Reading skill areas on the ACT, and is therefore paired with each for analysis. The correlations between CO ACT and CSAP scores in both grades 10 and 9 are included in Tables 1 and 2 below. Note that all correlations were significant at the $p < .05$ level.

Table 1. Correlation Coefficients among CO ACT and Grade 10 CSAP Scores

Grade 10 CSAP score	Grade 11 CO ACT score			
	English	Reading	Mathematics	Science
Reading	0.77	0.72		
Mathematics			0.83	
Science				0.75

Table 2. Correlation Coefficients among CO ACT and Grade 9 CSAP Scores

Grade 9 CSAP score	Grade 11 ACT score			
	English	Reading	Mathematics	Science
Reading	0.79	0.74		
Mathematics			0.82	
Science				NA

Ranging from 0.72 to 0.83, the grade 10–11 correlations are quite high, indicating close correspondence between the assessments within each content domain. The grade 9–11 correlations are also quite high, ranging from 0.74 to 0.82; in two of the three content areas they are actually higher than the grade 10–11 values. Science is not tested in Grade 9 and is therefore not included in the analysis. Surprisingly, the correlation coefficients between the PLAN and ACT in Table 3 and EXPLORE and ACT in Table 4 are very similar to those between CSAP and ACT.

Table 3. Correlation Coefficients Among ACT Scores and PLAN Scores

PLAN score	ACT score			
	English	Reading	Mathematics	Science
English	0.81			
Reading		0.71		
Mathematics			0.82	
Science				0.67

(ACT Technical Manual, 2007, p. 70)

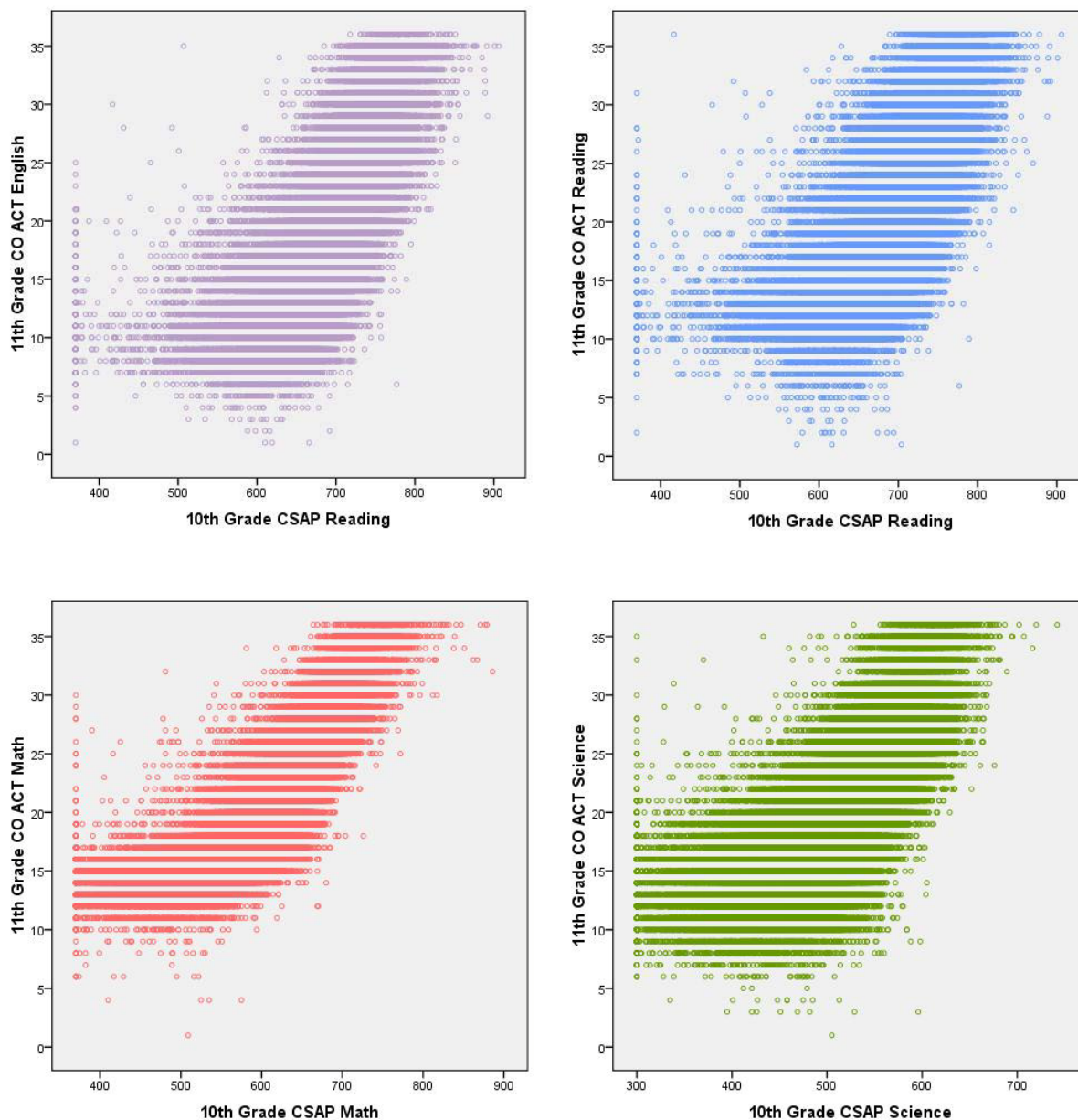
Table 4. Correlation Coefficients Among ACT Scores and PLAN Scores

EXPLORE score	ACT			
	English	Reading	Mathematics	Science
English	0.75			
Reading		0.68		
Mathematics			0.73	
Science				0.65

(EXPLORE Technical Manual, 2007, p. 45)

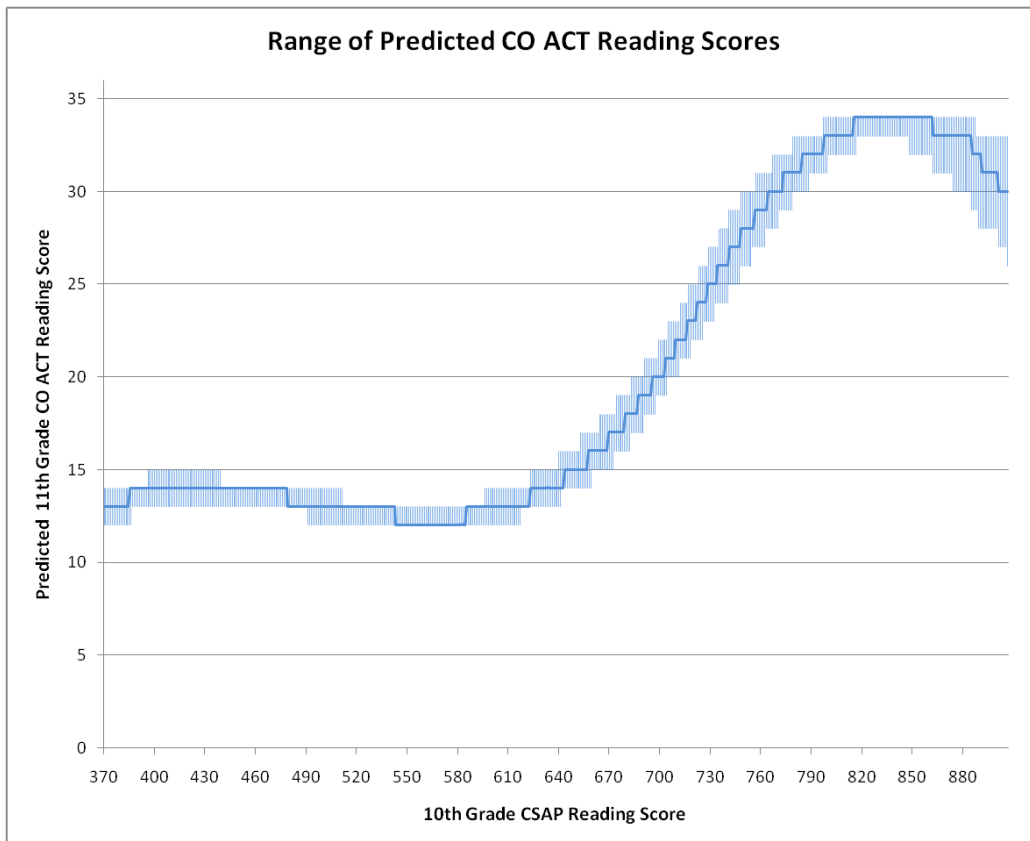
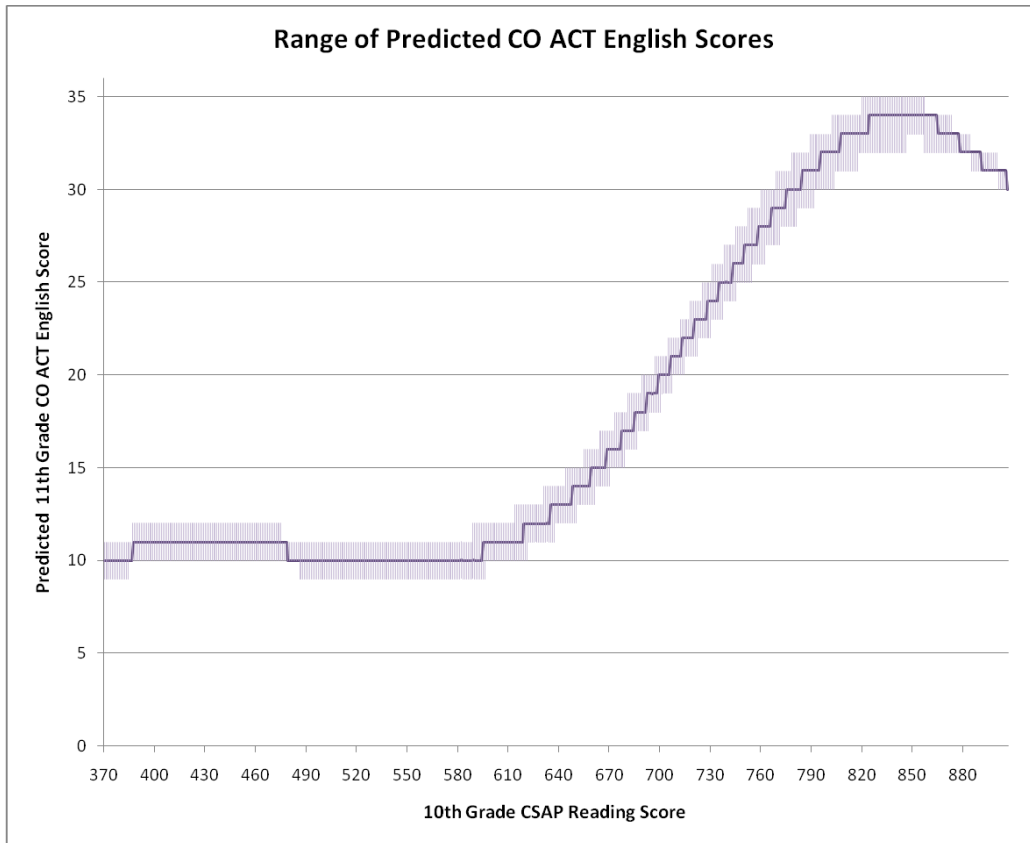
Although EXPLORE and PLAN were expressly created to align with the ACT, scores on these assessments have correlations between 0.65 and 0.82. The correlation between 10th grade CSAP and CO ACT is stronger than that found between PLAN and ACT in Reading, Math and Science. Only in English are PLAN and ACT more highly correlated. Similarly, the correlations between 9th grade CSAP and CO ACT are higher for all the available content areas, English, Reading, and Math, as compared to EXPLORE and ACT. Overall, there is nothing in these data to indicate that the ACT battery of tests is any more aligned between grades than are the CSAP and CO ACT. Results from the 9th and 10th grade CSAP gauge performance on the same general knowledge domains and produce roughly equivalent scale score inferences. Whether the performance level interpretations (i.e., what it means to be proficient) differ across the assessments is outside the purview of this analysis and would entail a review of the CSAP standard setting that took place in 2003.

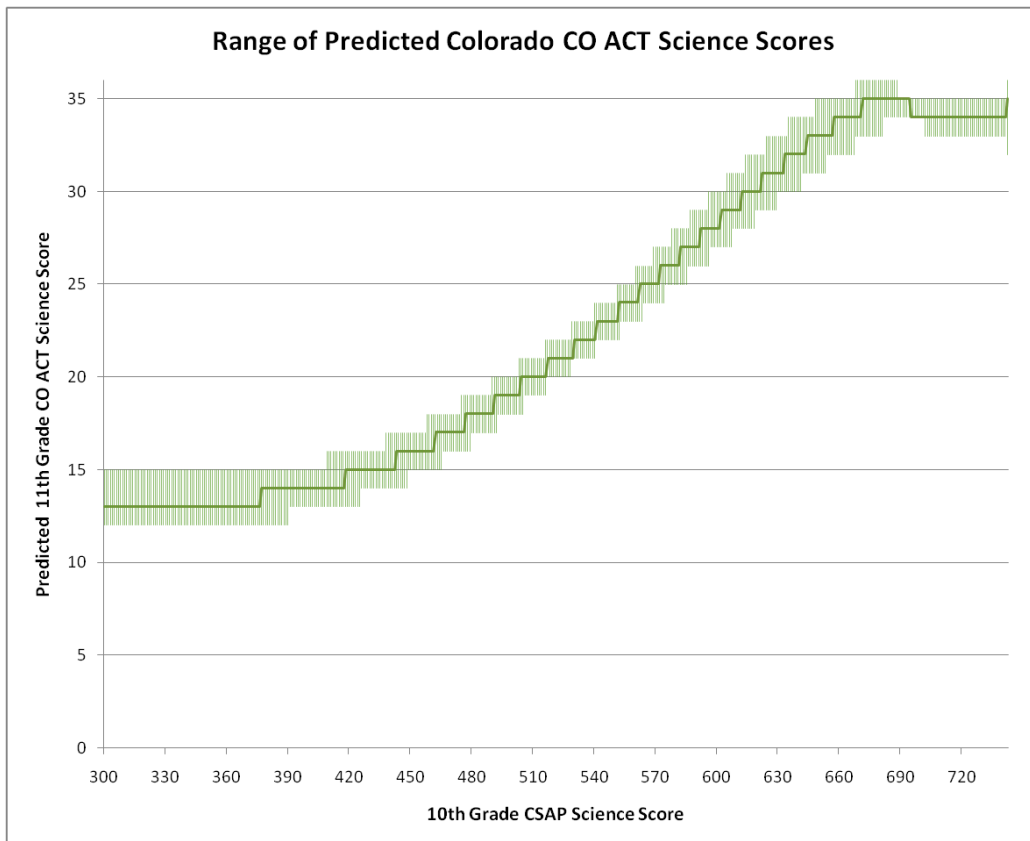
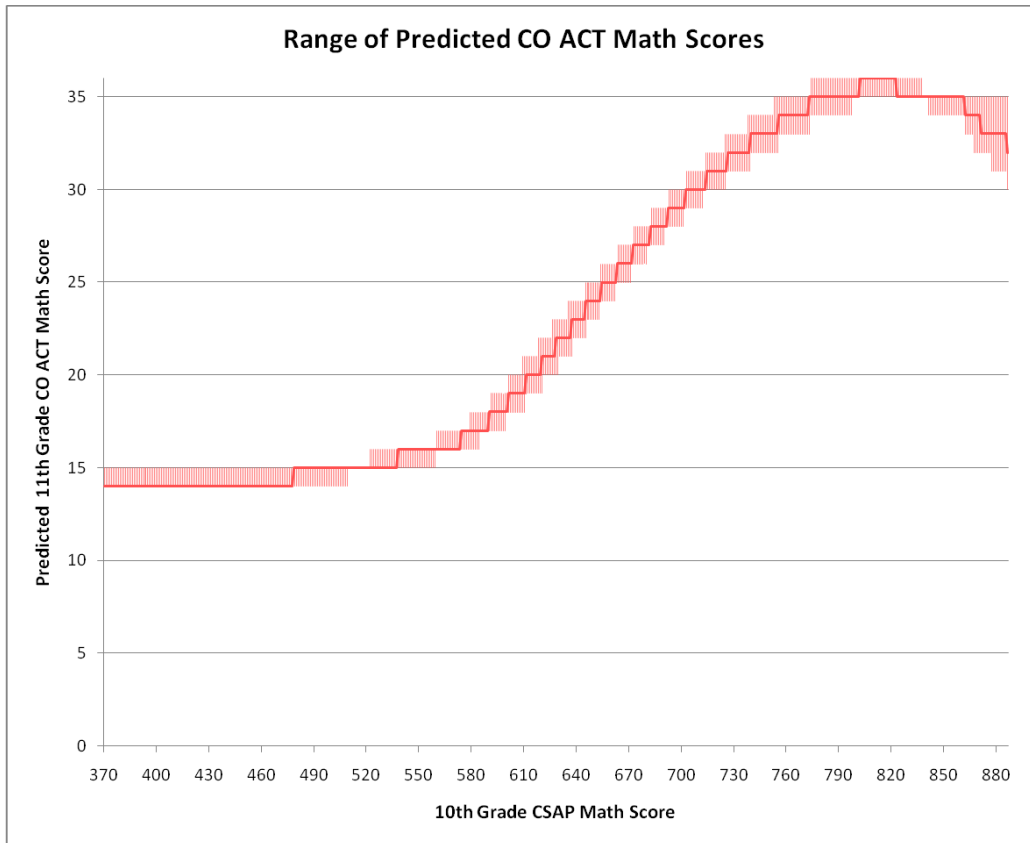
To estimate the predictive linkages between PLAN and ACT, ACT used a bivariate frequency distribution to calculate the score interval capturing 75% of observed student records. According to ACT technical documentation, ACT looked only at the composite scores of students taking the PLAN in 10th grade and the ACT in 12th grade. The composite ACT score is an average of the four content area scores and does not have an equivalent in the CSAP system. Instead, each content area of CSAP was used to predict the corresponding CO ACT content area score by looking at observed student data for the past several years. The scatterplots below provide visual representations of the correlations between 10th grade CSAP and 11th grade CO ACT results as presented in Table 1 above. In particular, note the increased dispersion of CO ACT scores at the bottom and top of the CSAP scale. This increased dispersion is expected and common to all standardized assessments with fixed scales, including EXPLORE, PLAN, and ACT.



In order to accommodate the non-normal distributions of these data, quantile regressions were estimated for each content area using the Colorado Growth Model software. This quantile regression model is in essence a more sophisticated and more flexible version of the bivariate distribution analysis performed by ACT. Both models condition the current year scale score value on the observed distribution of prior year scores. Colorado's growth model can accommodate a scale with more score values, allows more than one prior year of scores to serve as a predictor and results in more fine-grained results, including student growth percentiles (SGPs) and a precise and consistent definition of typical growth. Using this statistical model, multiple years of CSAP data can be used to predict ACT performance; these calculations have already been done, although the results are not included in this report. And in contrast to most other methods for calculating growth, the Colorado growth model does not require assessments to be vertically linked (Betebenner, 2009). That the CSAP has scale scores between 300 and 999 while the ACT runs from 1–36 is no problem for estimating SGPs. The model can also estimate relationships between non-continuous grades, meaning that 9th grade CSAP can be linked directly to 11th grade ACT performance without needing the 10th grade linkage (unlike EXPLORE, which does not directly predict ACT).

Colorado has defined *typical growth* as a student growth percentile greater than or equal to 35 but less than or equal to 65. Low growth is any SGP below 35 and high growth is an SGP above 65. Although the growth percentiles are calculated retrospectively, indicating the observed growth a student has made from the prior to the current year, the model can use this information to estimate the scale score a student would have needed to achieve in the current year to reach a particular SGP value. For this analysis, the scale scores necessary to achieve 35th, 50th and 65th percentile growth were calculated, meaning that every possible 10th grade CSAP score has a predicted range of CO ACT scores for students making typical growth. The graphs below show the predicted CO ACT score for 50th percentile growth as the darker line and the typical growth range between 35th and 65th percentile growth as the lighter band around this line.

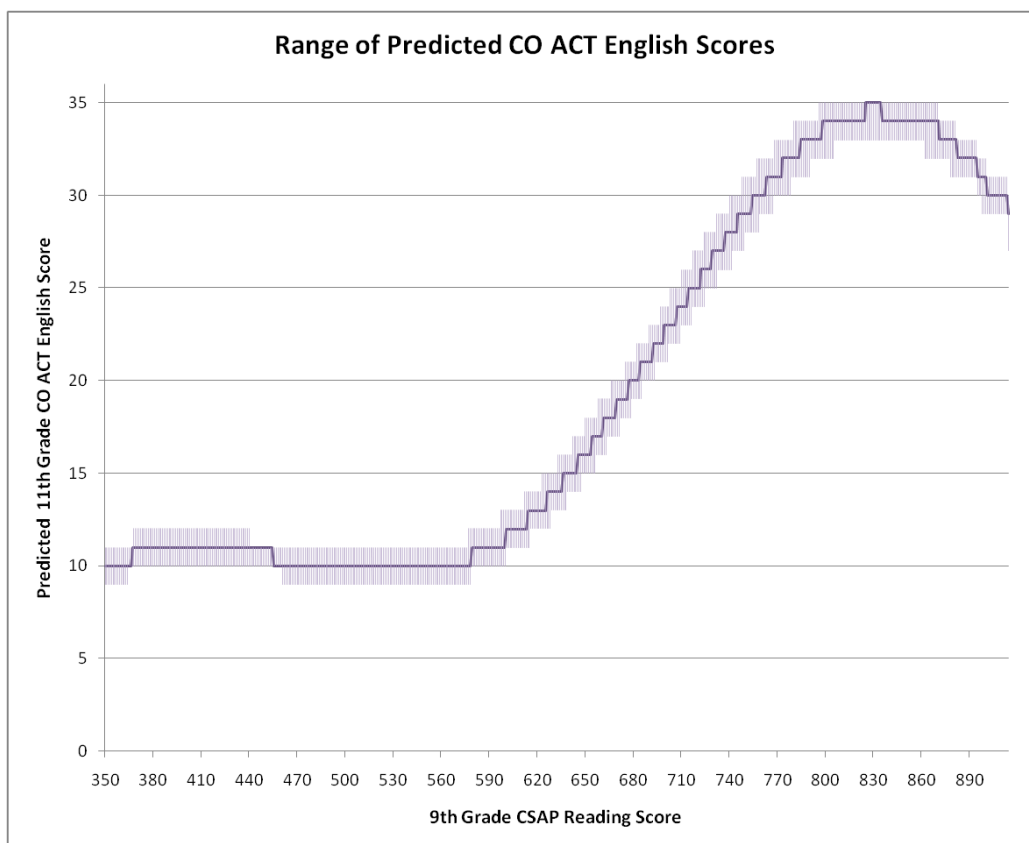


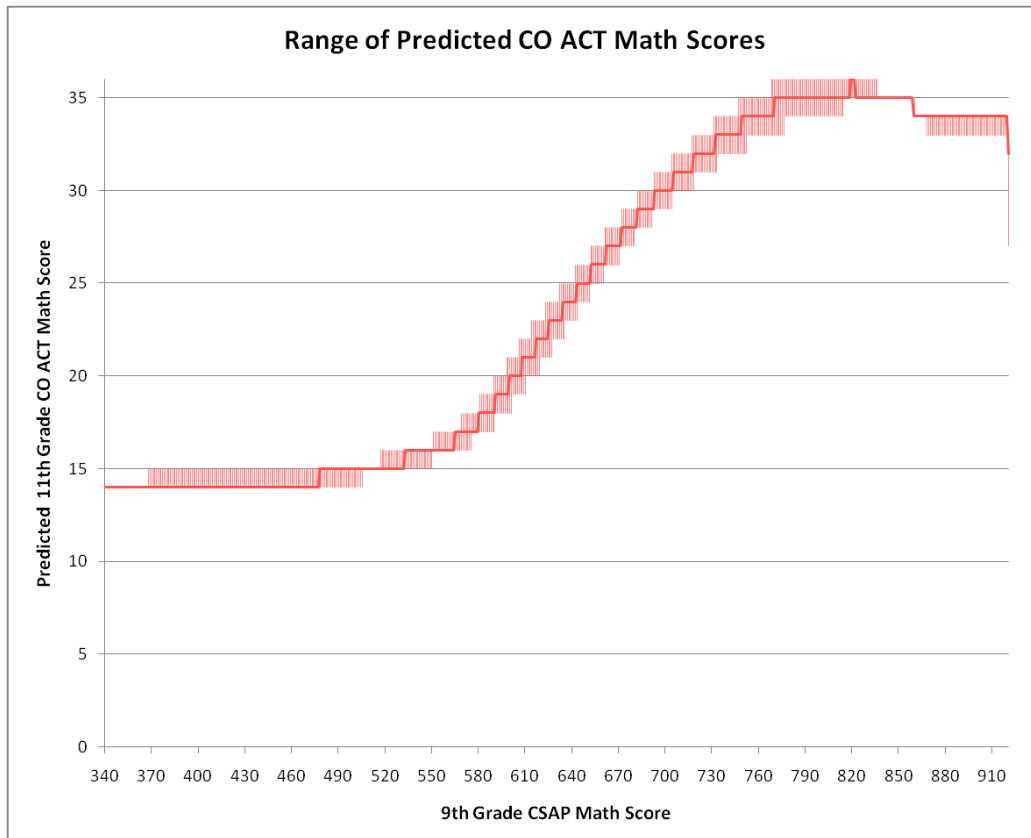
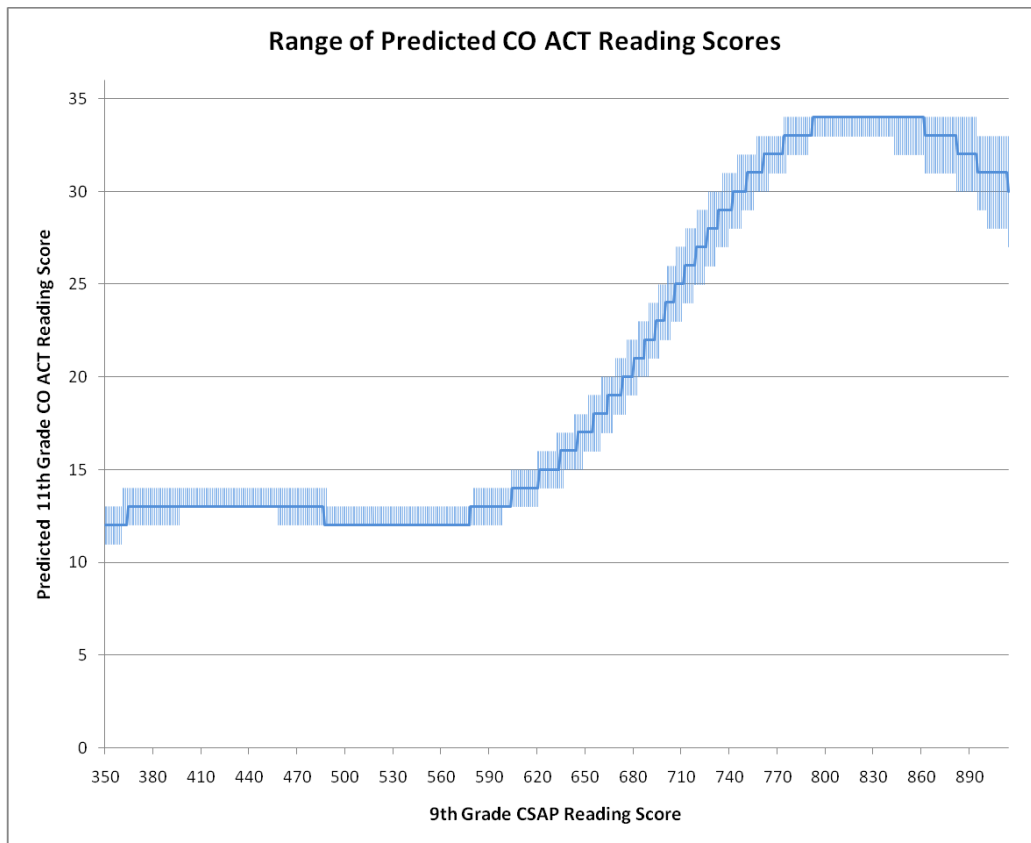


The range of predicted scores varies between 1 and 5 points across content areas and CSAP scores, but generally tends to be about 3 points; this means a student making typical growth will generally achieve a particular CO ACT score plus or minus one. The intervals are larger at the upper and lower ends of the CSAP scale because scores are less precise at the extremes and there are also fewer observed cases, in turn the conditional distributions are also less precise. Because Math scores for CO ACT and CSAP have a higher correlation than Reading scores, the predicted range of scores on this graph is noticeably smaller, 2 points in most areas but occasionally dropping to a single point.

The composite ACT intervals predicted by the PLAN (as reported on page 32 of the PLAN Technical Manual) range from 3 to 5 points and show the opposite pattern from the plots above. In other words, very low and very high PLAN scores are associated with more accurate prediction of ACT scores (with interval widths of 3–4), but the mid-range of PLAN scores yields greater imprecision in prediction (with wider ACT intervals of 5 points).

The Colorado Growth Model was similarly used to directly measure growth spanning the two-year period between 9th grade CSAP and 11th grade CO ACT (without using the 10th grade CSAP scores at all). The graphs of the predicted CO ACT scores are presented below.





In general, the same trends found for the grade 10–11 CSAP prediction of ACT hold for the grade 9–11 predictions. There were a few more students at the highest CSAP values in Grade 9, leading to wider intervals at the very top of the scale. ACT has not published equivalent EXPLORE to ACT predictions, therefore comparisons between the assessments are not possible.

CSAP, ACT, and College Readiness

The reported analyses on both the 10th and the 9th grade predictions demonstrate that, by using CSAP scores and the Colorado Growth Model, relatively accurate predictions of later ACT scores are possible. This in turn suggests that simply using Colorado’s state assessments in early high school years can help identify students at risk of not being college-ready. These students can then receive appropriate supports and intervention so as to graduate post-secondary ready. This identification process utilizes ACT’s own research into post-secondary success.

ACT has defined benchmark scores within each content area as thresholds for college readiness. As described above, students scoring at or above each benchmark score demonstrate the level and breadth of skill necessary to succeed in a post-secondary institution. Table 5 shows the needed scale score on the 10th grade CSAP predicted to yield a college ready ACT score in 11th grade, based on the analysis reported above. The table also includes alternative benchmarks proposed by the Colorado Department of Higher Education (DHE) that reflect the expectations of colleges within the state of Colorado for students taking the CO ACT. This reflects the discrepancy between the national sample of high-performing ACT-takers going to post-secondary institutions that require entrance exams, and the full population of Colorado high school students attending a wide assortment of 2- and 4-year institutions with varying admission requirements.

Table 5. ACT and DHE College Readiness Benchmarks with Observed and Predicted Percentages

	ACT college ready				DHE college ready			
	Scale score threshold		% scoring at or above threshold		Scale score threshold		% scoring at or above threshold	
	ACT	CSAP	Observed	Predicted	ACT	CSAP	Observed	Predicted
English	18	685	59.8%	60.5%	18	685	59.8%	60.5%
Reading	21	703	46.9%	44.7%	17	669	68.5%	72.4%
Math	22	628	36.8%	35.1%	19	601	50.9%	51.8%
Science	24	552	25.6%	22.3%	24	552	25.6%	22.3%

As reported in the table above, a student making typical growth would need to achieve a score of 685 on the 10th grade CSAP Reading test to expect to achieve the benchmark of 18 on the CO ACT English in the subsequent year. A CSAP Reading score of 703 yields a predicted CO ACT Reading score of 21, while a CSAP Math score of 628 and a CSAP Science score of 552 would likewise predict college readiness. The benchmarks proposed by DHE are lower in Reading and Math, indicating that a student would need a 669 on the CSAP Reading and a 601 in Math to be college-ready in Colorado.

Table 5 also presents information about the percent of students in the dataset who actually scored at or above the corresponding benchmark on the CO ACT, compared to the percent of students predicted by the Colorado Growth Model to reach the benchmark. In 11th grade, 59.8% of students actually achieved an English CO ACT score of 18, while the growth model predicted that 60.5% of students would meet this cut based on their 10th grade CSAP Reading scores. On the CO ACT Reading test, 46.9% scored 21 or above compared to a predicted 44.7%. On CO ACT Math, 36.8% of students scored 22 or above while CSAP Math scores predicted 35.1%. Finally on CO ACT Science, 25.6% of students scored 24 or above compared to a predicted 22.3%.

The close correspondence between predicted and observed percentages of college-ready benchmark performance suggest that 10th grade CSAP scores are good predictors of 11th grade CO ACT scores and college readiness. The benchmarks proposed by DHE for Reading yielded 68.5% of students college-ready compared to a predicted 72.4%, while in Math 50.9% were observed ready compared to a predicted 51.8%. As with the national ACT benchmarks, the correspondence is not perfect, but still quite good.

The analyses reported herein present a clear picture of the CSAP and CO ACT as highly related assessments. It has been shown that the CSAP is an excellent predictor of ACT achievement and of later college-readiness. Based on these findings, there is no need to replace the 9th and 10th grade CSAP with EXPLORE and PLAN. Instead, CDE should build on the current foundation of assessments to include CO ACT data in the Colorado Growth Model, and retool the assessment system to explicitly culminate in post-secondary readiness.

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