COLORADO DEPARTMENT OF EDUCATION

Colorado Growth Model

Accountability & Data Analysis Unit

COLORADO Department of Education

Background

The purpose of this fact sheet is to provide a brief technical orientation to the Colorado Growth Model (CGM). This includes background information related to model development, an overview of its analytic methodology, and the current CDE applications of the model.

The CGM was developed jointly by the Colorado Department of Education (CDE), the Technical Advisory Panel for Longitudinal Growth (TAP), and the National Center for the Improvement of Educational Assessment (NCIEA). Its development was required by state statute (SB09-163) and assigned to the Technical Advisory Panel. The model was developed to serve as a primary component of the state educational accountability system. It was first utilized within the state performance frameworks in 2009 and continues to be used to this day. Currently, the methodology in the Colorado Growth Model is being used in some fashion by at least half the states in the country.

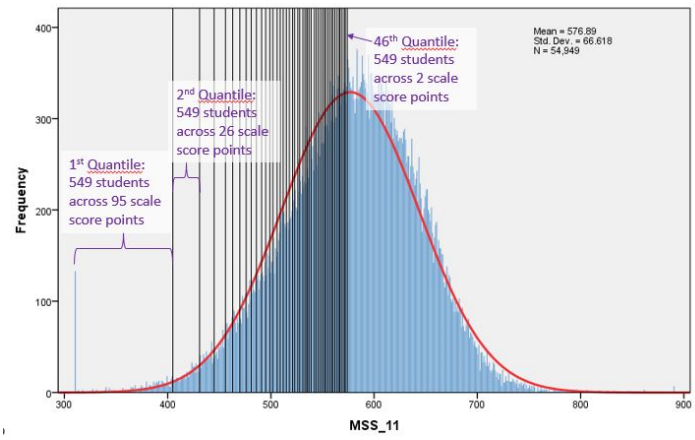
The growth data obtained from the Colorado Growth Model shows how much progress individual students have made between last year and this year as measured by the CMAS and PSAT/SAT assessments (i.e. for English Language Arts and math) along with the between-year change in WIDA-ACCESS overall performance. At the most fundamental level, the obtained student growth percentiles (SGP) are determined by how much students have progressed compared to their 'academic peers'. In Colorado, growth scores are generated for any student that has two or more consecutive assessment scores with typical testing progressions. In addition, median growth percentiles are calculated to describe the growth of groups of students (e.g. by school, grade, sex, ethnicity, etc.).

Methodology

A number of different growth methodologies have been developed nationally to support the needs of education stakeholders including state departments of education[1]. These models include gain-based models, conditional status models, and multivariate models. The Colorado Growth Model, also known as a student growth percentile model or a conditional status model, uses quantile regression to model a student's performance gains across time and assign a growth percentile based upon the student's standing in comparison to their academic peers.

The CGM itself is a conditional status model and relies on large sample sizes to generate reliable estimates. In Colorado, the minimum number of cases typically required to run the model is 2,000, though larger samples on occasion do not show enough score variability for the model to provide results. Given that the calculations are based on a state-wide data set, the minimum n-size requirement has only impacted our calculations during assessment transitions, for the multiple CMAS math pathways from 2015 to 2018 or when smaller groups of students have experienced atypical student assessment progressions.

Figure 1. Example Quantile Distribution for 8th Grade Math



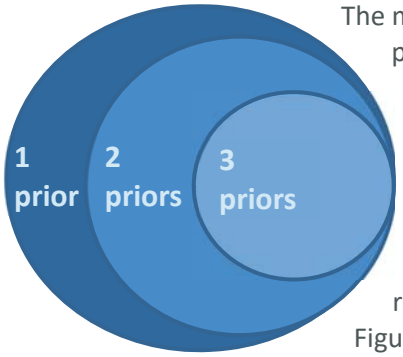
Unlike conditional-mean modeling (i.e. traditional linear regression) which assumes a normal distribution and a generally small, homoscedastic distribution of errors, quantile regression uses conditional-median modeling and allows a more precise characterization of the population distribution, particularly non-normal distributions.[2,3]

The initial step in generating student growth percentiles is using the observed distribution of scale scores by content

area to create 100 percentile buckets. Each bucket contains the same number of students but may represent varying ranges of scale scores (see Figure 1 for an illustration of 'bucketing'). This process reflects the mathematical quantification of the relationship between consecutive years of assessment data and their student score distributions.[2,3] The conditional distribution provides the context to understand a current score normatively.[3]

Conditional distributions are built by linking each prior year scale score to the quantile distribution of current year scale scores; all of these relationships are captured within the coefficient matrices generated in R-software. Note that not every quantile for every prior year scale score will necessarily have observed data. The coefficient matrices reflect simplifications based on statistical analysis such as interpolation to smooth irregular and/or adjust for missing data. It is important to remember that the idea of the "academic peer group" is a heuristic to represent a complex statistical model. It's not as simple as identifying the students to which a student of interest is being compared.

Figure 2. Use of Prior Year Data



The model also uses as much prior year data as is available for each student. This additional data provides more nuanced academic peer groups. The calculations follow the same logic, adding an iteration for each additional prior year of data available. We condition the current year's achievement on the distribution of students with identical previous year scores, but further subset this historical distribution to include only the students that have the same scale score for 2 years prior… then 3 years prior… etc. A student with 3 prior years of data is included in the calculations to build each set of coefficient matrices for 1 prior year of data, 2 prior years of data and 3 prior years of data separately.[3] The student's reported growth percentile is based on the most number of priors available (i.e. 3 years). Figure 2 illustrates how the data is incorporated into the CGM model. All CGM analysis procedures are open-source and available for use in the R-computing software.[4]

Colorado Growth Model Applications

The Colorado Growth Model was developed primarily to support educational accountability determinations. In Colorado, growth is the most heavily weighted indicator in regards to district accreditation and school plan type ratings. At the elementary and middle school level, 60% of the plan type rating is based on growth. For high schools and districts, 40% of the rating is based on growth. Lastly, for Alternative Education Campus performance reports growth is weighted at 35% and is the largest contributor to their results. In effect, growth shows how well schools are doing in helping students progress. The obtained data also informs improvement planning efforts within schools and districts.

Related Technical Resources & References

[1]Costellano, K.E. & Ho, A. (2013). A practitioner's guide to growth models. A paper commissioned by the technical issues in large-scale assessment (TILSA) and accountability systems & reporting (ASR) state collaborative on assessment and student standards. Council for Chief State School Officers.

[2]From Betebenner, D. (2009). Norm- & criterion-referenced student growth. Educational Measurement: Issues and Practice Vol. 28, No. 4, pp. 44-45.

[3]Huchton, M. (2013). CGM 501: A deep dive into the inner workings of the Colorado Growth Model. PowerPoint presentation shared with Colorado Department of Education staff on March 13, 2013.

[4] All R-package open-source files for data preparation are located in the GitHub repository associated with Colorado SGP analyses: https://github.com/CenterForAssessment/Colorado.

Where can I learn more?

- For additional information concerning the Colorado Growth Model visit: http://www.cde.state.co.us/accountability/coloradogrowthmodel
- For questions about this fact sheet, contact Dan Jorgensen, PhD at: Jorgensen_d@cde.state.co.us.
- For a parent friendly fact sheet concerning growth visit: http://www.cde.state.co.us/accountability/growth-fact-sheet-for-parents-2018