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Principles for Measuring Growth Towards College and Career Readiness

Issue Brief

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Executive Summary

This paper develops five principles educators and policymakers should consider when designing assessment and accountability systems that use growth models for the purpose of improving the college and career readiness of high school graduates. These growth model principles are adaptable to different types of testing programs. Potential uses include the design of a state growth model for the Elementary and Secondary Education Act (ESEA) flexibility waiver or for school districts interested in tracking the progress of its own students.

Principle 1: The *minimum goal* for every student should be to become college and career ready by high school graduation.

Principle 2: College and career readiness should be monitored as early as possible and communicated to students, parents, and educators so that they know whether students are on track and can tailor instructional strategies as needed.

Principle 3: The assessment of school performance should be based on multiple measures, including overall student growth and growth for student subgroups—including special needs, low-income, underrepresented racial/ethnic minority, and limited English proficient students.

Principle 4: Growth modeling results should be used to better understand strengths and weaknesses in a school's curriculum and practices.

Principle 5: The assessment of teacher performance should employ multiple measures, including student growth toward college and career readiness.

Growth modeling based on assessments of college and career readiness has strong potential to help stakeholders measure progress—both for individual students and school systems. Growth model results can serve a variety of purposes. Educators and policymakers can use growth modeling results as part of accountability systems, such as the ESEA waiver; to measure improvement; and to more accurately diagnose areas of strength and weakness. For the information to be beneficial, users must familiarize themselves with the limitations of growth models and become well-versed on how to properly interpret growth modeling results.

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Introduction

Today more than ever, educators and policymakers acknowledge that college and career readiness is an essential outcome for students graduating high school. The college and career readiness goal was evident in the development of the Common Core State Standards (Common Core). The Common Core "provide[s] a consistent, clear understanding of what students are expected to learn" in grades K–12 and focuses on ensuring that students graduate from high school ready for both college and career.[i] The Common Core definition of college and career ready is the ability "to succeed in entry-level, credit-bearing college courses or workforce training programs."[ii] The Common Core's focus on college and career readiness was embraced by states, and as of June 2012, the Common Core has been adopted in 46 states and the District of Columbia.[iii]

States have not been alone in recognizing the importance of college and career readiness. The U.S. Department of Education has also emphasized career and college readiness through two of its major education initiatives: Race to the Top and the Elementary and Secondary Education Act (ESEA) Flexibility requests. A main purpose of Race to the Top was to "increase the rates at which students graduate from high school prepared for college and careers."[iv] Likewise, a requirement to receive a waiver from certain provisions of the ESEA is the adoption of college and career ready standards in at least reading/language arts and mathematics.[v]

The adoption of college and career ready content standards like the Common Core is just the first step in ensuring that students graduate from high school ready for college and career. Once standards are adopted, they must be implemented, which involves aligning curriculum and instruction as well as the assessment and accountability system to the standards. Teacher professional development is an essential component at all stages of implementation.

As states and districts update and reform their accountability systems, new metrics are needed to gauge individual and school progress towards college and career readiness. Early monitoring of academic growth towards the college and career readiness goal can help identify problems, so that interventions can be made to get the individual or school system back on track. Further, the design and implementation of a growth system is a requirement for states interested in receiving a waiver as part of the U.S. Department of Education's ESEA Flexibility program.[vi]

This paper focuses on how state and district policymakers may use measures of student-level academic growth to ensure students are meeting college and career expectations. We describe methods for modeling student growth and recommend principles for implementing growth modeling as part of redesigned assessment and accountability systems.

The examples used in the paper are based on the Educational Planning and Assessment System (EPAS®) and ACT's College Readiness Benchmarks. EPAS consists of a sequence of three assessments: EXPLORE® (for students in grade 8 or 9), PLAN® (for students in grade 10), and the ACT® test (for students in grade 11 or 12). Scores range from 1–25 on EXPLORE, 1–32 on PLAN, and 1–36 for the ACT. The College Readiness Benchmarks are the minimum ACT test scores required for students to have a 50% chance of earning a B or higher, or about a 75% chance of obtaining a C or higher in corresponding credit-bearing, first-year college courses by the time they graduate high school. The ACT College Readiness Benchmarks are presented in Table 1, along with EXPLORE and PLAN Benchmarks that indicate if students are on track for college readiness.

Table 1: ACT's College Readiness Benchmarks

Subject area test	College Course	EXPLORE score	PLAN score	ACT score
English	English Composition	13	15	18
Reading	College Social Science	15	17	21
Mathematics	College Algebra	17	19	22
Science	College Biology	20	21	24

Although this paper uses EPAS and the College Readiness Benchmarks as examples, the growth model principles presented are the basis of any growth system and are adaptable to different types of testing programs.

Background on Growth Models

Growth models track changes over a period of time (often two or more years) in individual student assessment data and can be calculated in multiple ways. Individual student growth information can then be aggregated to the teacher, student subgroup, or school levels. There are multiple methods of calculating growth. In this paper we will primarily focus on two methods—difference gain scores and value-added models.

Growth models are contrasted with status models, which are the measurement backbone of most accountability systems. Status models—such as simple proficiency rates—measure the achievement level of a group of students at a single point in time. Unlike growth models, status models only require one test score for a student. Status measures, though appropriate for making judgments about the achievement level of students at a point in time, do not measure how much students learned and therefore do not directly measure school effectiveness. When used for school accountability, critics agree that status measures are strongly influenced by the entering achievement level and the socioeconomic status of the students served by the school—which are beyond a school's control. These deficiencies in status measures are among the reasons that growth measures are beginning to become incorporated into accountability systems, such as the ESEA Flexibility waivers.

Growth Model Principles and Features

When transitioning to a system aimed at measuring growth towards college and career readiness, educators and policymakers should consider five basic principles. For each principle, we describe possible features of a growth model tailored to an education system's needs.

Principle 1: *The **minimum goal** for every student should be to become college and career ready by high school graduation.*

The minimum goal for every student should be to meet college and career level expectations, such as the ACT's College Readiness Benchmarks. Some students begin the eighth grade already on track for college and career readiness. These students typically demonstrate above-average growth and become college and career ready. Students not beginning on track must "beat the odds" to become college and career ready. To determine the likelihood that a student can "beat the odds," it's important to define what is meant both by "growth" and "one year's worth of growth."

How to define growth

Growth can be calculated in a number of ways. A basic growth statistic is the simple difference between assessment scores at two points in time (i.e., score 2 minus score 1), sometimes referred to as *difference gain scores*. The advantage of difference gain scores is the ease of calculation and interpretation. A disadvantage of the difference gain score method is that it requires that the tests be on the same scale. States using assessments that lack a common scale would be unable to calculate growth using the difference gain score method. Because measurement error is present in both test scores used to obtain a difference gain score, they typically have higher standard errors of measurement than single test scores.

There are other methods of calculating growth—such as *value-added models* measuring the degree that a school or teacher met or exceeded student growth expectations—that do not require a common scale. Value-added models are also advantageous as they can directly take into account other variables, such as income or ethnicity, which might be related to growth between the two time periods. A disadvantage of value-added models is that they are more complicated to calculate than difference gain scores and require some training to properly interpret.

What is "one year's worth of growth"

Difference Gain Score Methods

As with calculating growth, there are multiple methods for defining what constitutes one year's worth of growth. Two methods include a) the average amount of historical annual growth and b) the amount of annual growth that is needed to remain parallel to the college and career readiness track.[1] When using the difference gains score method for calculating growth, these two methods for defining one year of growth result in very similar one-year growth norms (see Table 2). The one-year growth values range from 1.0 in Science to 1.6 in Reading using the historical average, and from 1.1 in Science to 1.6 in Reading using the college and career readiness track.

Table 2: Average Annual Score Growth from EXPLORE to the ACT

	Historical Annual Growth		Parallel to Track Growth	
Subject	Average Historical	Per School Year*	EXP-ACT Benchmark Difference	Per School Year*
English	5.3	1.4	5	1.3
Reading	5.9	1.6	6	1.6
Mathematics	4.7	1.2	5	1.3
Science	3.9	1.0	4	1.1

*Average number of months between EXPLORE and the ACT: 45.2

The drawback of average annual growth definitions is that they only give information about how students have been progressing historically, whereas most educational systems would like to raise the standards for growth instead of maintaining status quo.

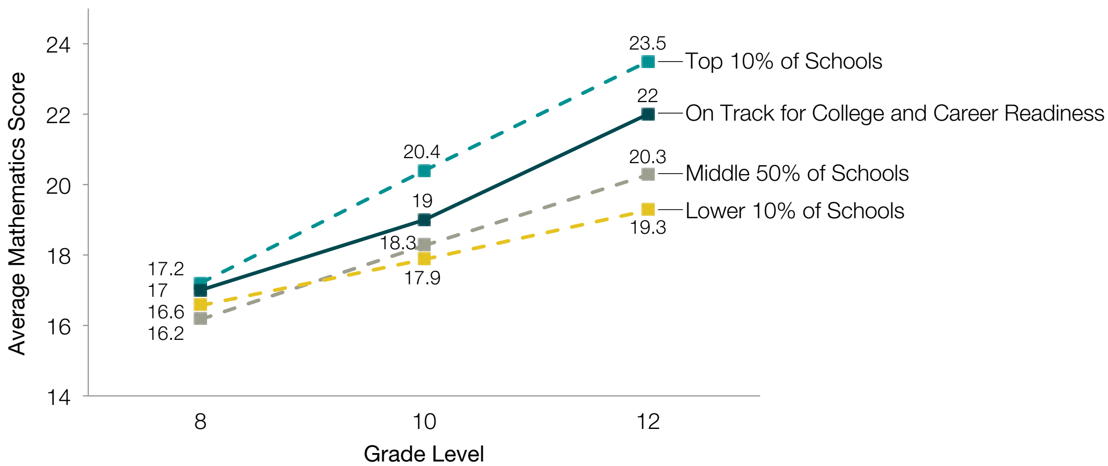
[1] Remaining parallel means that a student's performance remains in the same relative position to a performance standard over time. For example, a student 3 points below the college and career readiness track in eighth grade will achieve one year's worth of growth if she remains 3 points below the college and career readiness track in ninth grade.

Value-Added Methods

An alternative method for defining one year's worth of growth is based on what growth looks like for higher-performing high schools—those schools ranking in the top 10% in effectiveness.[2]

Figure 2 uses data from thousands of school systems who use EPAS to illustrate how growth can vary across schools. One can see that there is substantial variation in Mathematics growth, for example, across high schools. Only the group of higher-performing schools is able to exceed the growth needed to keep students on track for college and career readiness. Unlike the average historical growth, understanding growth at higher-performing schools allows us to see what is possible and lets us set goals beyond the historical average growth.

Figure 2: Variation in Mathematics Growth by School Performance Level

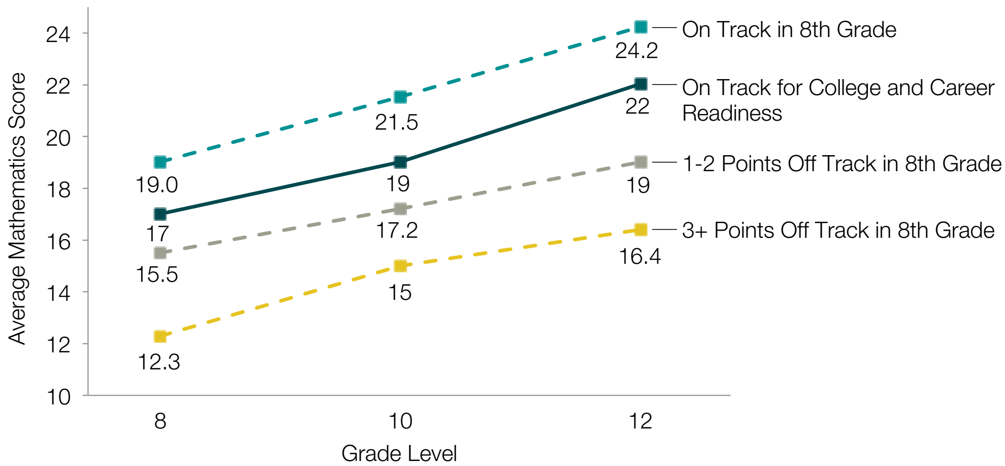


Principle 2: ***College and career readiness should be monitored as early as possible and communicated to students, parents, and educators so that they know whether students are on track and can tailor instructional strategies as needed.***

By the eighth grade, it is very difficult to get students who are not on track back on track. These students have little chance of reaching the ACT College Readiness Benchmarks by the time they complete high school, absent radically intensive interventions that are not typically found in schools (ACT, 2008).[vii] To illustrate, Figure 3 shows the average growth in Mathematics based on how students performed in the eighth grade. Students who were not on track for college and career readiness as eighth graders tend to experience less growth during the high school years. For students who were nearly on track (i.e., 1 to 2 points off track) in Mathematics as eighth graders, 23% went on to meet the ACT College Readiness Benchmark. For students who were off track as eighth graders (i.e., 3 or more points off track), only 5% went on to meet the ACT College Readiness Benchmark.

[2] Where effectiveness is based on value-added models for measuring the effect schools have on raising college and career readiness.

Figure 3: Average Mathematics Growth by Eighth Grade Status

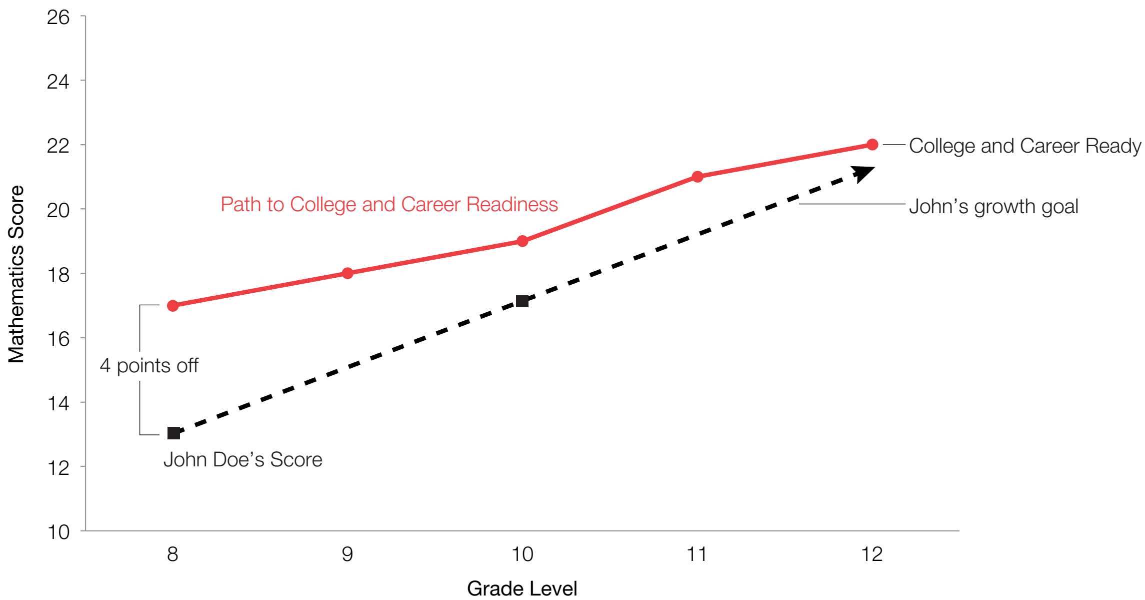


To avoid the problem of receiving information about a student's position on the college and career ready track so late that it is difficult to remedy, monitoring growth should begin prior to the eighth grade—ideally using an assessment system aligned to career and college readiness standards. Targets could then be established earlier to indicate whether students are on track, nearly on track, or off track for college and career readiness. The benefit of including earlier grades is that instructional strategies and interventions could be applied before students fall too far off track.

Finally, once the college and career ready track has been established for the appropriate grade levels, the information should be shared with students, parents, and educators through the use of student growth reports. Student growth reports should be designed so that students, parents, and educators understand where the student stands at each grade level and how far she needs to grow to reach college and career readiness.

Figure 4 is a sample student growth report that could be shared with teachers and parents. The report shows the path to college and career readiness with the scores needed at each grade level for a student to be on track to meet the Math Benchmark of 22 in spring of grade 11 or grade 12.

Figure 4: Student Growth Profile: John Doe Mathematics Example



John Doe took EXPLORE in the eighth grade and scored a 13, which is 4 points below the path to college and career readiness. For John to meet the tenth grade College and Career Readiness Benchmark (19) John would need to grow 6 points over the next two years. As the average growth for students like John is only about 2.7 points (see Figure 3), a growth goal of 6 points in 2 years would be very difficult to achieve.

Although it is unlikely that John could meet the tenth grade Benchmark, with this information John, his teachers, and his parents can see that he needs extra help to catch up to the college and career readiness path. The information allows John's teachers and parents to set more realistic goals such as halving the distance to the college and career readiness target for tenth grade and continuing remediation so that John is closer to the College Readiness Benchmark.

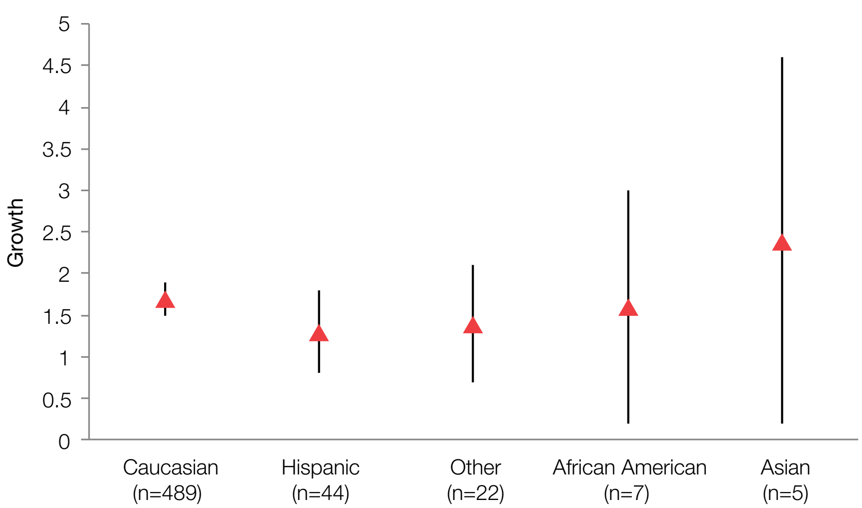
Principle 3: ***The assessment of school performance should be based on multiple measures, including overall student growth and growth for student subgroups—including special needs, low-income, underrepresented racial/ ethnic minority, and limited English proficient students.***

Although we have primarily discussed individual student growth, the growth information can also be used at aggregate levels. Student growth can be aggregated to the school level to provide an estimate of how the school as a whole performs. A school's aggregate growth towards college and career readiness should be used in the assessment of school effectiveness, joining other effectiveness measures such as graduation rate, attendance, academic behaviors, community involvement and citizenship, and enrollment and success in college and careers.

School growth measures can also measure how much growth occurs for student subgroups—including students with special needs, as well as low-income, underrepresented racial/ethnic minority, and limited English proficient students. By aggregating individual student scores for subgroups, the school can monitor whether all subgroups are meeting challenging growth goals.

As previously mentioned, individual student scores contain some uncertainty (i.e., measurement error) which becomes part of the school growth measures. It is best practice to include the standard error when using the scores for decision making or when presenting the information publicly. The inclusion of the standard error helps to ward against the tendency to make improper inferences about a school's effectiveness, particularly when there are only a small number of students. For example, the simple average difference between EXPLORE (grade 8) and PLAN (grade 10) Reading scores are presented in Figure 5 for four racial/ethnic groups from an actual high school. When looking at the mean reading scores, a teacher may be tempted to say that Asians far outperformed Hispanic students (2.4 to 1.3). By including the sample sizes and standard errors, the teacher can see that there are very few Asian students (5) and the larger standard error (2.2) indicates that there is a high degree of uncertainty in the score. In fact, the racial/ethnic subgroup differences here are not statistically significant (i.e., the differences seen here are not meaningful). The additional information provided by standard errors helps to illustrate that simple differences in scores do not necessarily indicate that one group is statistically outperforming another group.

Figure 5: Example Subgroup Analysis Grade 9-10 Growth in Reading



Note: Mean growth differences by student race/ethnicity are not statistically significant.

Principle 4: ***Growth modeling results should be used to better understand strengths and weaknesses in a school's curriculum.***

School leadership teams can better understand strengths and weaknesses across the curriculum by examining aggregated growth for student groups of different achievement levels, as well as for student groups on different curricular tracks. Growth reporting can be done by subject area (English, mathematics, reading, and science)—as well as by content standard categories so that educators can better use the data to pinpoint areas in need of improvement. A common score scale can make it easier for educators to measure and understand growth statistics.

Value-added models can also provide diagnostic information. Examples of diagnostic value-added data are presented in Table 3 where value-added scores are presented for four successive high school graduating cohorts. The value-added scores represent the degree that the school exceeded student growth expectations (from EXPLORE in grade 8 to the ACT in grade 11 or 12) in Mathematics—as well as for more specific mathematics content areas (Elementary Algebra, Algebra and Coordinate Geometry, and Plane Geometry and Trigonometry).

Table 3: Example of Diagnostic Value-Added Data

Year	Overall Math	Elementary Alg.	Alg./ Coordinate Geom.	Plane Geom./ Trig.
2007	0.63	0.65	0.31	0.18
2008	0.89	0.77	0.49	0.54
2009	1.31	1.19	0.38	0.74
2010	0.62	0.83	0.54	0.08

First, the value-added scores are all positive, indicating that the high school is exceeding student growth expectations in mathematics. Second, look at the individual cohorts (i.e., the years) to examine trends. For the 2010 cohort, the school appears to be strongest in Elementary Algebra and perhaps weakest in Plane Geometry and Trigonometry. Further, after seeing improvements from 2007 through 2009, there appears to be a decline in performance in Plane Geometry and Trigonometry for the 2010 cohort.

From looking at the data, it might lead the school leaders to examine further what it is about their courses that leads to strength in Elementary Algebra compared to the other areas. School leaders also might examine what contributed to the decline in performance in Plane Geometry and Trigonometry.

Principle 5: ***The assessment of teacher performance should employ multiple measures, including student growth toward college and career readiness.***

Similar to the assessment of school performance, inferences about teacher effectiveness can be informed by how much growth towards college and career readiness occurs for students under each teacher's care. The assessment of teacher performance is more complex than the assessment of school performance because assessments do not always bound the same time frame as high school courses and assessment standards do not always align one-to-one with course standards. Moreover, teacher effectiveness estimates often have higher degrees of uncertainty (higher standard errors) than school estimates and differences in classroom composition (e.g., prior achievement level, socioeconomic status) may affect the estimates.[3]

A further complication in using growth measures to assess teacher performance is that a student's performance in a particular subject area is not always due to the efforts of only one teacher. Some education systems utilize team teaching where two or more teachers, often a general education and a special education teacher, collaborate to plan and teach lessons together. Likewise, other education systems encourage teaching across the curriculum where teachers of non-tested subjects such as social studies are urged to incorporate tested subject areas into their lesson plans. For instance, the Common Core State Standards include a set of literacy standards in history/social studies, science, and technical subjects geared towards teachers in those subject areas as well as English language arts.[viii] The literacy standards are designed to augment the subject area content standards to "help students meet the particular challenges of reading, writing, speaking, listening, and language in their respective fields."[ix] Thus, a student's growth in reading may not be attributable to a single teacher.

When using teacher value-added estimates of student performance, the school system should take into consideration when there is explicit cooperation between teachers so that the estimates no longer represent the efforts of an individual teacher. For example, a roster validation process where teachers are asked to confirm whether or not they taught a student assigned to them can be used to document cooperation and team teaching. Statistical models can then be used when two or more teachers were jointly responsible for a classroom of students or when one teacher taught for the first part of the year and another teacher for the second part of the year.[x]

[3] Value-added models can be used to account for the differences in classroom composition to better isolate the teacher effect.

For these reasons, student growth should be one, but not the only, measure of teacher effectiveness. The weight given to student growth in evaluating teachers should depend on the assessment-course time frame overlap, degree of standards alignment, and the level of statistical uncertainty about the teacher effectiveness estimate. Growth models that use end-of-course assessment as the endpoint are likely to be given greater weight because of better assessment-course time frame overlap and higher degrees of standards alignment. Standard errors should be reported with all teacher effect estimates and used to interpret the degree of uncertainty about the estimates. Educator training is also needed to help principals and teachers understand the measures and how they can be used to improve instruction.

Conclusion

With states' adoption of college and career ready standards, such as the Common Core, they must design new accountability systems to monitor whether students are leaving high school prepared for college and careers. Growth modeling provides a mechanism for monitoring this progress as well as serving a variety of other instructional and accountability purposes. Educators and policymakers can use growth modeling results as part of accountability systems, such as the ESEA waiver to measure improvement and to more accurately diagnose areas of strength and weakness. For the information to be beneficial, users must familiarize themselves with the limitations of growth models and become well-versed on how to properly interpret growth modeling results.

[i] "Common Core State Standards." http://www.corestandards.org/.

[ii] Common Core State Standards. "About the Standards." http://www.corestandards.org/about-the-standards.

[iii] Catherine Gewertz. "Common-Standards Watch: Montana Makes 47," *Education Week*, November 4, 2011, http://blogs.edweek.org/edweek/curriculum/2011/11/common-standards_watch_montana.html. Alaska, Nebraska, Texas, and Virginia have not adopted Common Core. Minnesota has adopted the English standard and not the math standard.

[iv] U.S. Department of Education, "U.S. Department of Education Overview Information: Race to the Top Fund; Notice Inviting Applications for New Awards for Fiscal Year (FY) 2010," *Federal Register* 74, no. 221 (November 2009): 59836.

[v] U.S. Department of Education, *ESEA Flexibility Request* (Washington, DC: U.S. Department of Education, Revised February 10, 2012).

[vi] U.S. Department of Education, *ESEA Flexibility Request* (Washington, DC: U.S. Department of Education, Revised February 10, 2012).

[vii] ACT, *The Forgotten Middle: Ensuring that all Students Are on Track for College and Career Readiness Before High School* (Iowa City, IA: ACT, 2008).

[viii] Common Core State Standards. "English Language Arts Standards" http://www.corestandards.org/the-standards/english-language-arts-standards.

[ix] Common Core State Standards. "English Language Arts Standards" http://www.corestandards.org/the-standards/english-language-arts-standards.

[x] Heinrich Hock and Eric Isenberg, "Methods of Accounting for Co-Teaching in Value-Added Models" (paper presented at the association for education finance and policy 36th annual conference papers and posters, March 21, 2011), https://aefpweb.org/sites/default/files/webform/Hock-Isenberg%20Co-Teaching%20in%20VAMs.pdf