A Guide to the Georgia Student Growth Model

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Introduction

The Georgia Department of Education (GaDOE) is implementing the Georgia Student Growth Model (GSGM) in order to provide an additional perspective of student learning, improve teaching and learning, and inform accountability and educator effectiveness. Historically, Georgia's assessment system has only enabled educators and other stakeholders to ask questions such as, "What percentage of students are proficient?" Or, "Are more students proficient this year compared to last year?" The GSGM allows Georgia to move beyond questions about status to ask critical growth-related questions such as:

- Did this student grow more or less than academically-similar students?
- Are students growing as much in math as in English language arts?
- Are students on track to reach or exceed proficiency?

The GSGM provides a wealth of rich information on student, school, district, and state performance on the Georgia Milestones Assessment System. In addition to providing student-level diagnostic information and improving teaching and learning, the GSGM will work in conjunction with other factors as part of the state's accountability system, the College and Career Ready Performance Index (CCRPI), and serve as one of multiple indicators of educator effectiveness with the Teacher Keys Effectiveness System (TKES) and the Leader Keys Effectiveness System (LKES).

Growth vs. Value-Added

A growth model describes the change in student achievement across time. A growth model becomes value-added when the growth is attributed to an entity (a teacher, a school, etc.). In many models, the value-added is the difference between predicted student performance and actual student performance. These models use information about a student (prior achievement, demographic information, etc.) to predict how that student will perform. The student's actual performance is then compared to his or her predicted performance. The difference is considered value-added. The GSGM does not predict performance; rather, it describes observed student growth.

Student Growth Percentiles

Georgia is implementing the student growth percentile (SGP) methodology. SGPs describe the amount of growth a student has demonstrated relative to academically-similar students from across the state. Growth percentiles range from 1 to 99, with lower percentiles indicating lower academic growth and higher percentiles indicating higher academic growth. With SGPs, all students – regardless of their prior achievement level – have the opportunity to demonstrate all levels of growth.

SGPs do not require a vertical assessment scale in order to describe student growth. A vertical or developmental scale is a continuous scale spanning multiple grade levels in the same content area. The GSGM is not specifying how many scale score points a student improved from year to year. Rather, the GSGM describes growth in terms of how a student performed this year relative to other students who have a similar academic history.

Calculating Student Growth Percentiles

SGPs are statistical, regression-based quantities used to characterize the growth of students on state-mandated assessments. SGP calculations utilize quantile regression with b-spline smoothing to create growth norms that model the relationship between students' current and prior achievement scores. Specifically, for each cohort of students taking the assessment in the same content area and grade, quantile regression is used to create 100 conditional percentiles for each student based upon their own scale scores. B-spline smoothing is used in conjunction with the quantile regression analyses to model any non-linearity in the distribution of student scale scores, particularly at the high and low end of the assessment scale. The coefficient matrices derived from the analyses relate prior and current achievement across for students across the entire achievement spectrum. These matrices can be calculated each year so that growth norms are annually updated or can be fixed to a baseline period and used with annual data to allow for growth comparisons across years fixed to the same growth norms.

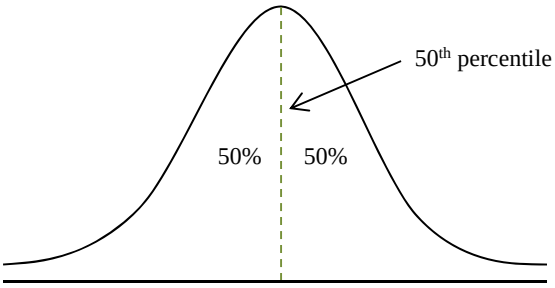
Please refer to *Betebenner, D.W. (2011). A Technical Overview of the Student Growth Percentile Methodology: Student Growth Percentiles and Percentile Growth Projections/Trajectories. Dover, New Hampshire: The National Center for the Improvement of Educational Assessment.*, available at http://www.gadoe.org/Curriculum-Instruction-and-Assessment/Assessment/Documents/SGP_Technical_Overview.pdf, for more detailed information on the technical calculation of student growth percentiles.

Understanding Percentiles

One of the most common applications of percentiles is pediatric height and weight charts. When children go to the pediatrician for their well visits, the pediatrician measures their height and weight and describes the measurements in terms of percentiles. For example, a child may be at the 75th percentile for height. That means that compared to other children his or her age, he or she is taller than 75% of them. The same concept is used in the GSGM to refer to academic growth. A student at the 75th percentile grew more than 75% of his or her academic peers.

Figure 1 is a visual representation of a normal distribution, commonly referred to as a bell curve. Most naturally-occurring variables (such as height or weight) have this distribution, where more observations are clustered around a mean with fewer observations far from the mean. This visualization is useful for describing percentiles.

Figure 1: Normal Distribution



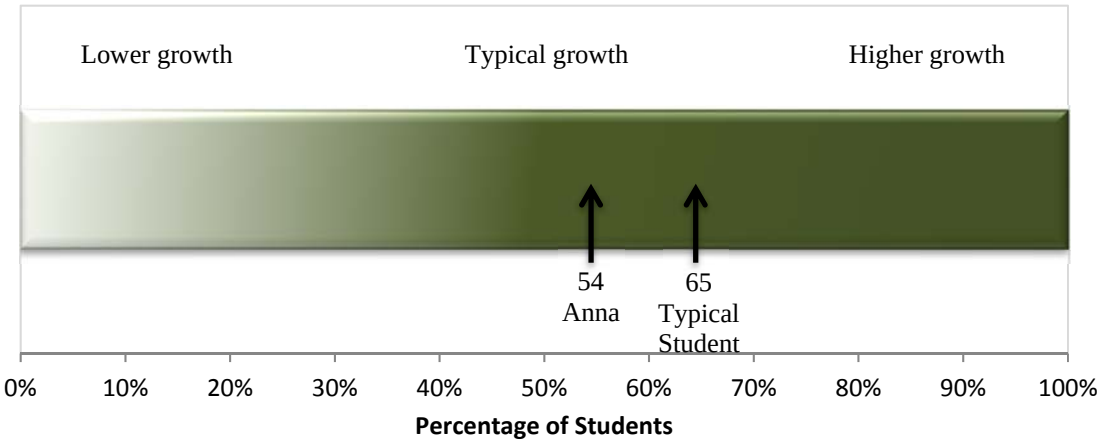
A distribution, for example, of height, weight, or academic achievement.

For any given percentile, a proportion of the distribution falls below it and the remaining proportion of the distribution is above it. Using the 50th percentile as an example, 50% of the distribution falls below the 50th percentile and 50% of the distribution is above the 50th percentile. Expressing student growth in terms of percentiles is very informative – it provides perspective on what is typical growth.

Interpreting Student Growth Percentiles

A fictional student named Anna will be used as an example for interpreting student growth percentiles. Anna has a 6th-grade ELA growth percentile of 54. This means that Anna grew at a rate greater than 54% of academically-similar 6th-grade students in ELA (Figure 2). The median 6th-grade ELA growth percentile for Anna's school is 65. This means that the typical 6th-grade student in Anna's school grew at a rate greater than 65% of academically-similar students in ELA. Additionally, Anna grew at a lower rate in ELA compared to other 6th-grade students in her school on "average."

Figure 2: Interpreting Student Growth Percentiles

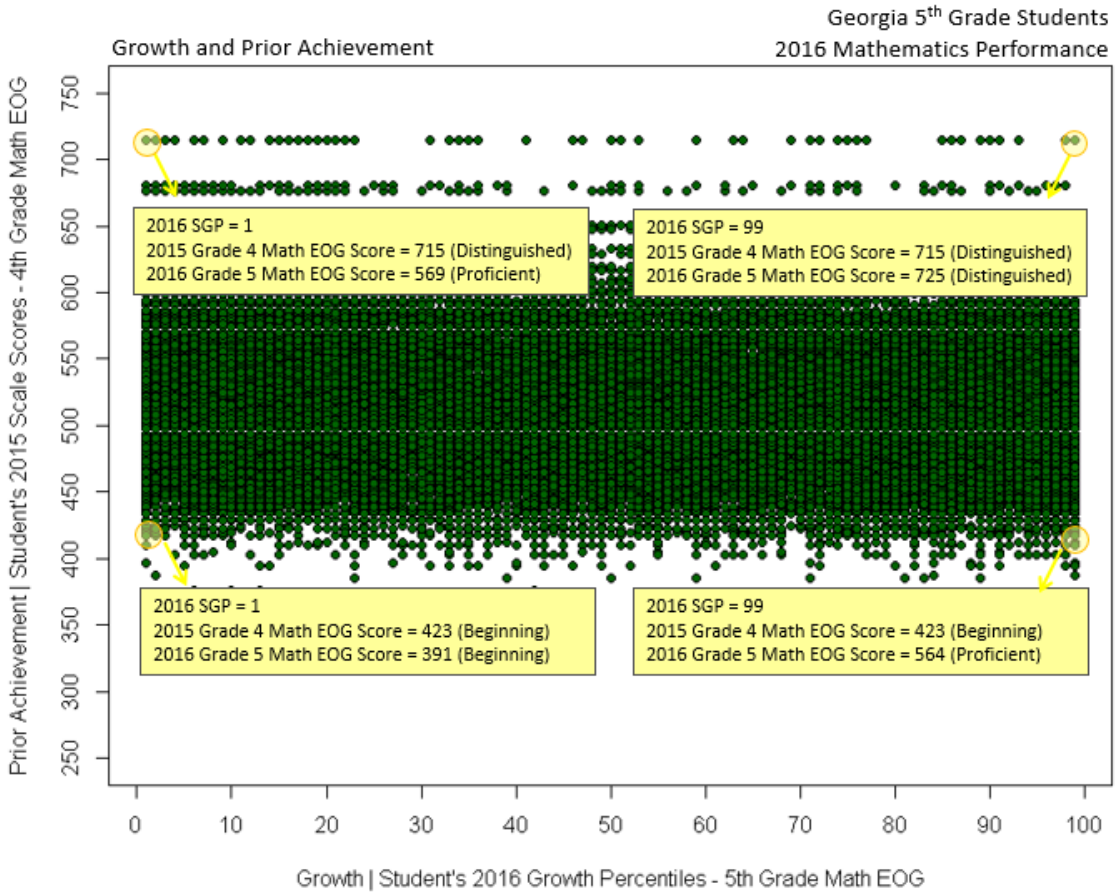


All Students Can Demonstrate Growth

The nature of student growth percentiles ensures that all students – regardless of their prior achievement level – have the opportunity to demonstrate all levels of growth. By measuring growth relative to academically-similar students, SGPs provide an apples-to-apples comparison. A student's growth is relative to that of his or her academic peers – other students from across Georgia with the same prior scores. This means that high-achieving students are being compared to other high-achieving students and low-achieving students are being compared to other low-achieving students.

Figure 3 below displays student-level data for 2016 5th grade mathematics statewide. Student growth is plotted on the x-axis and students' prior achievement (2015 4th grade mathematics scores) is plotted on the y-axis. This figure shows that all students, for all levels of prior achievement, are demonstrating the full range of 1st through 99th percentile growth.

Figure 3: Growth and Prior Achievement



The student in the upper left-hand corner earned the highest possible scale score (715) in grade 4. In grade 5, this student scored a 569, which represented 1st percentile growth. The student is still a Proficient Learner. However, compared to his or her academic peers (the other students across Georgia who scored a 715 in grade 4), this student demonstrated low growth.

The student in the upper right-hand corner also earned the highest possible scale score in grade 4. In grade 5, this student once again scored the highest possible scale score (725), which represented 99th percentile growth. While there was not an opportunity for this student to show a higher level of *achievement* in either the 4th or 5th grades, it was possible for the student to show a high level of *growth* from the 4th grade to the 5th grade, as the student had to learn new content and grow in order to continue to earn the highest scale score.

The student in the lower left-hand corner is a Beginning Learner in grade 4 and scored a 423 in math. In grade 5, this student earned a 391 and remained as a Beginning Learner. This represented 1st percentile growth.

The student in the lower right-hand corner also earned a 423 in grade 4. In grade 5, the student earned a 564 and became a Proficient Learner, which represented 99th percentile growth.

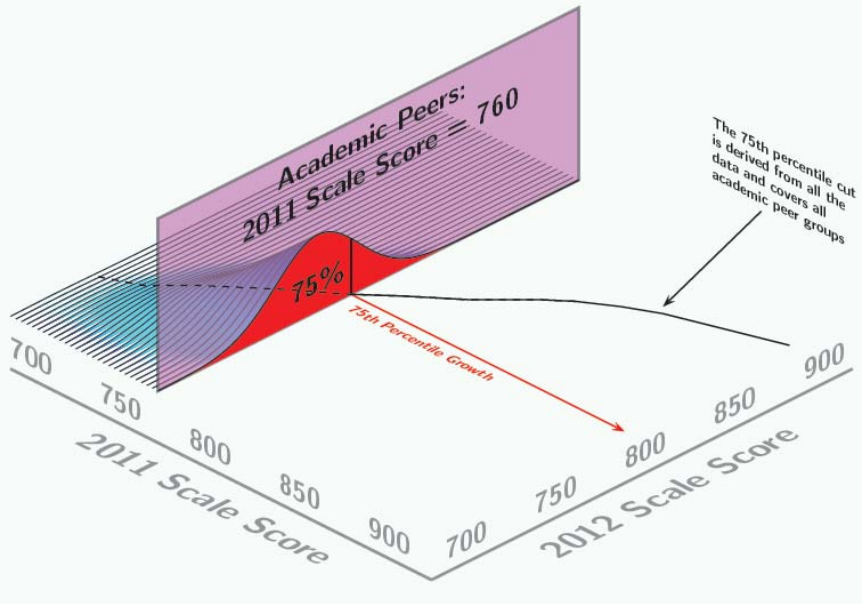
This figure illustrates the importance of the concepts of "academic peers" and a student's "starting point" when measuring growth. The student in the upper left-hand corner and the student in the lower right-hand corner demonstrated very similar achievement in grade 5, scoring a 569 and a 564, respectively. But their SGPs help illustrate a more complete picture of their performance. The student in the upper left-hand corner's 569 represented a low level of growth given his or her prior achievement and the current achievement of his or her academic peers. The student in the lower right-hand corner's 564 represented a high level of growth given his or her prior achievement and the current achievement of his or her academic peers.

Academic Peers

Key to understanding the GSGM and SGPs is understanding the term *academic peers*. Academic peers are students enrolled in the same grade and content area or course statewide with similar prior academic achievement (academic history). In other words, they are students that had the same scores on prior state assessments.

Figure 4 is a visual representation of academic peers. While this figure is simplified to demonstrate only one prior score, it is useful to describe the concept of academic peers. One axis (left) plots 2011 scale scores (prior score) while the other axis (right) plots 2012 scale scores (current scores). Academic peers are all of the students with a similar prior score (in this case, all of the students who scored 760 on last year's assessment). A student's growth percentile describes how he performed on the current assessment relative to his academic peers. In this example, the student's 2012 scale score of 800 places him or her at the 75th percentile. In other words, the student grew more than 75% of his or her academic peers (those students who had the same scale score in 2011). It is important to note that the 75th percentile is actually derived from all academic peer groups. While the example student's current score of 800 placed him or her at the 75th percentile, a student with a prior score of 850 would have needed a current score of approximately 860 to demonstrate 75th percentile growth.

Figure 4: Relationship Between Prior and Current Achievement



There are potentially thousands of academic peer groups – as many as there are combinations of scores. A commonly asked question is, "Can I see a list of students in a particular peer group?" A list of peers, however, is not what is used to calculate a student's growth percentile. The model uses quantile regression to describe the curvy-linear relationship between prior scores and current scores (see Calculating Student Growth Percentiles). That analysis results in a look-up table that relates prior achievement to current achievement. Using this look-up table, any combination of prior scores can be plugged in to obtain an achievement distribution that is dependent on those prior scores. Using that distribution and the current score, a student's growth percentile can be identified.

Priors

Priors are the historical assessment scores being used to model growth. The GSGM uses two years of prior test data; however, one year is used when two years are not available. For example, growth percentiles for an 8th-grade student who just took the 8th-grade state assessment would have his or her 7th- and 6th-grade state assessment scores as priors.

An immediate consecutive prior (prior from the previous year) is required to produce a growth percentile. For example, 4th-grade scores are required to produce 5th-grade growth percentiles. Because one prior is required to produce growth percentiles, students who do not have a prior, including students new to Georgia, will not receive a growth percentile. Similarly, even though there is a 3rd-grade state assessment, 3rd-grade students will not receive growth percentiles as they do not have a prior.

In addition to prior achievement, growth percentile calculations for EOCs also depend on test sequence and timing (i.e., year taken). SGPs will be produced for all sequences for which there are a sufficient number of students to model growth reliably. This includes students who repeat

EOC courses or take them on a block schedule. For uncommon sequences with few students, those students will not receive growth percentiles.

Assessment Inclusion

Prior to the 2014-2015 school year, student growth percentiles were produced for CRCTs (grades 4-8 reading, English language arts, math, science, and social studies) and EOCTs (Physical Science, Biology, 9th-Grade Literature/Composition, American Literature/Composition, US History, Economics/Business/Free Enterprise, Mathematics I, Mathematics II, GPS Algebra, GPS Geometry, Coordinate Algebra, and Analytic Geometry).

For the 2014-2015 and 2015-2016 school years, SGPs were produced for Georgia Milestones EOGs in grades 4-8 in English language arts, mathematics, science, and social studies and all Georgia Milestones EOCs.

Beginning with the 2016-2017 school year, SGPs will be produced for Georgia Milestones EOGs and EOCs in grades 4-8 in English language arts and mathematics.

Retests

Beginning with the 2012-2013 school year, retest data is no longer utilized in the growth model. This means that SGPs should be interpreted as representing students' first (main) attempt on a state-mandated assessment for a grade and content area or for an EOC course.

Missing Data

Some growth/value-added models will impute missing data, meaning they generate a plausible estimate of what a missing test score would be based on the test scores of similar students. The Georgia Student Growth Model does not impute or estimate missing data. If a student does not have at least one immediate consecutive prior (prior from the previous year), a growth percentile will not be produced.

Combining Growth Percentiles

While SGPs are produced for individual students, there are multiple ways of combining SGPs to summarize the growth of a group of students (such as for a classroom, school, or system). These methods include the median growth percentile, mean growth percentile, and the percentage of students demonstrating typical or high growth.

Median SGP (MGP) – One method of combining SGPs for a group of students is to utilize a median. A median is the numerical value separating the higher half of the data from the lower half. In other words, it is the middle value in an ordered list. To obtain the median, one would order all students' SGPs in a group from low to high and select the middle value. If there is an

even number of values, the median is the mean of the middle two values. A median is useful because it is straightforward to interpret – half of the students demonstrated growth above the median, and half of the students demonstrated growth below the median. **Median Growth Percentiles are utilized in the Public and SLDS Growth Model Visualization Tools.**

Mean SGP (MeanGP) – A second method of combining SGPs for a group of students is to utilize a mean. A mean is the sum of the values divided by the number of values. It is often referred to as an average. As such, a mean SGP for a group of students describes the "average" growth of that group of students. Even though it can be more difficult to interpret than a median, a mean is useful, especially for high-stakes purposes, because it is more statistically reliable than a median due to it being a more efficient estimator of central tendency (i.e., it is more precise and minimizes error). This is particularly true for smaller sample sizes. Typically, standard errors for the mean are 20% - 40% smaller than those for the median. **Mean Growth Percentiles are being utilized in the Teacher and Leader Effectiveness Systems (TKES and LKES).**

Percent of Students Demonstrating Typical or High Growth (% T/H Growth) – A third method of combining SGPs for a group of students is to utilize the percent of students demonstrating typical or high growth. The GSGM utilizes three student growth levels – low (1-34), typical (35-65), and high (66-99). Data for the GSGM reveal that students demonstrating low growth generally struggle to maintain their academic status; students demonstrating typical growth generally maintain or improve their academic status; and students demonstrating high growth generally make greater academic improvements. Therefore, the percent of students demonstrating typical or high growth describes the proportion of students that are growing at a level to maintain or improve their academic status. **This metric is utilized in the College and Career Ready Performance Index (CCRPI) Progress calculation.**

All three measures – median, mean, and percent of students demonstrating typical or high growth – are valid methods of combining SGPs. While the use of multiple methods may be confusing, the different methods provide different types of information and are best suited for certain applications. A median is well suited for general conversation and improvement planning as it is straightforward to interpret. A mean is well suited for teacher and leader effectiveness as it has more robust statistical properties. Median and mean both quantify the "middle" of a collection of numbers. The percentage of students demonstrating typical or high growth is well suited for CCRPI because it quantifies the percentage of students passing a threshold – much like utilizing the percentage of students meeting or exceeding expectations on state assessments for the Achievement calculation within CCRPI.

Student Growth Levels

Much like achievement levels are used to describe student performance on state assessments, student growth levels provide context for various values of SGPs. These levels were set using information about the relationship between student growth and status-based achievement. The SGP growth levels are low (1-34), typical (35-65), and high (66-99). A student who demonstrates low growth generally will struggle to maintain his or her current level of achievement. A student who demonstrates typical growth generally will maintain or improve

academically. A student who demonstrates high growth generally will make greater improvements academically.

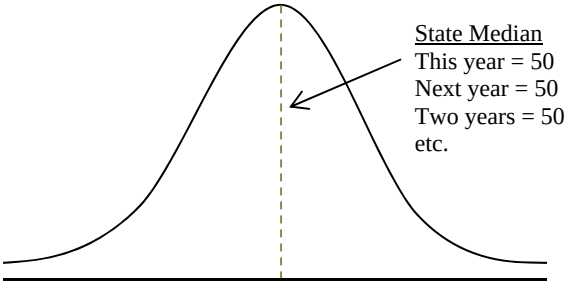
Growth Over Time (Baseline-Referenced Growth Percentiles)

Cohort-referenced student growth percentiles describe a student's growth relative to academically-similar students in the state in a given year. With these SGPs, student and school growth is relative to the state. Cohort-referenced SGPs can continue to be reported during an assessment transition.

SGPs can also be anchored to a baseline, enabling the comparison of statewide growth from year to year. With baseline-referenced SGPs, a student's growth is relative to academically-similar students from the baseline years. All students can demonstrate lower or higher growth than students in the baseline. These SGPs cannot be reported during an assessment transition.

Figure 5 is a visualization of the SGP distribution without a baseline (cohort-referenced). With cohort-referenced SGPs, the median SGP for the state will be 50 every year – half of students would be below 50 and half would be above 50.

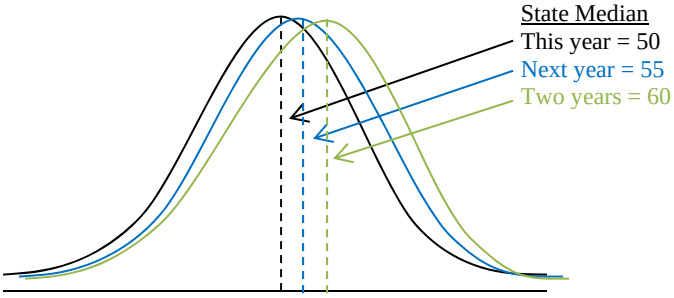
Figure 5: Cohort-Referenced SGP Distribution (No Baseline)



Without setting a baseline, the state median will always be 50 with half of students below 50 and half above 50.

Establishing a baseline allows the state to observe change in overall student growth over time. Figure 6 is a visualization of the SGP distribution with a baseline.

Figure 6: Baseline-Referenced SGP Distribution



With setting a baseline, the state median can change from year to year, representing statewide change in growth over time.

It is useful to consider this concept in the context of pediatric height and weight charts. When a 7-year-old boy's height is measured and his height percentile determined, the doctor does not wait for all 7-year-old boys to be measured that year to determine the percentile. Rather, information about 7-year-old boys from prior years is used to establish that relationship. The same concept is applied in the GSGM. The relationship between prior achievement, current achievement, and growth from prior years is used to establish the relationship.

The baseline is an average of at least four years of data in order to allow for a more stable comparison. All reported SGPs and whether they were cohort- or baseline-referenced are included in Table 1.

Table 1: Cohort- and Baseline-Referenced SGPs

Assessment	Cohort-Referenced	Baseline-Referenced
CRCT Reading		2010-2014
CRCT ELA		2010-2014
CRCT Mathematics		2010-2014
CRCT Science		2010-2014
CRCT Social Studies	2010-2012	2013-2014
EOCT 9th Grade Literature		2010-2014
EOCT American Literature		2010-2014
EOCT GPS Algebra	2012	
EOCT GPS Geometry	2012-2013	
EOCT Mathematics I	2010-2013	
EOCT Mathematics II	2011-2014	
EOCT Coordinate Algebra	2013-2014	
EOCT Analytic Geometry	2014	
EOCT Physical Science		2010-2014
EOCT Biology		2010-2014
EOCT US History	2010-2012	2013-2014
EOCT Economics		2010-2014
Georgia Milestones EOGs	2015-current	
Georgia Milestones EOCs	2015-current	

Note: The year refers to the spring of each schools year (e.g., 2015 refers to the 2014-2015 school year).

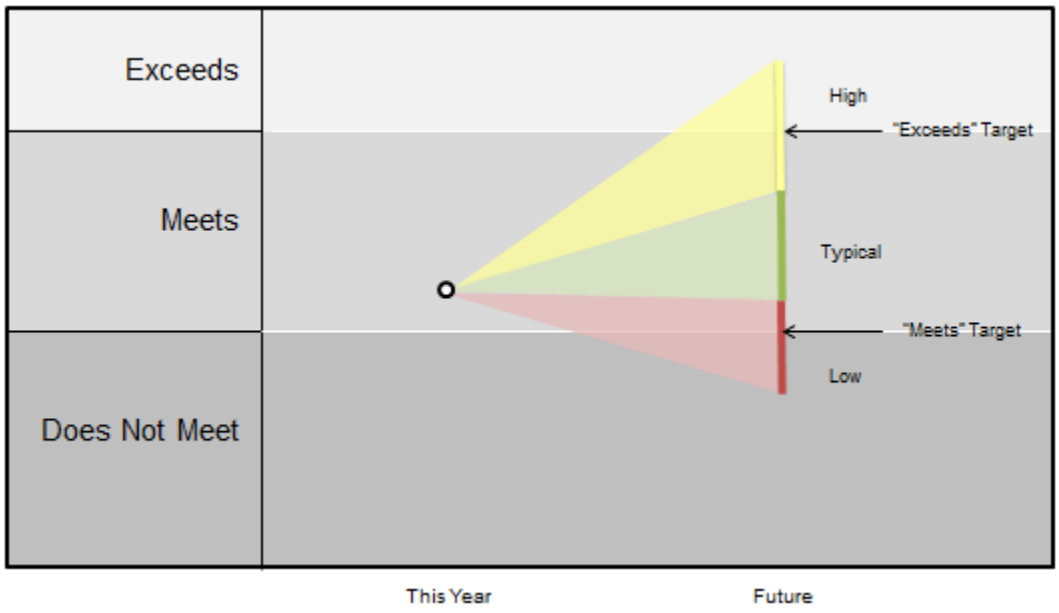
Growth to Proficiency (Growth Projections and Growth Targets)

In addition to describing observed growth, the GSGM can provide information on possible future growth in the form of growth projections and growth targets. SGPs analyze historical student assessment data to model how students performed on earlier assessments, how they performed on later assessments, and what level of growth they demonstrated in between. This information is used to create growth projections and growth targets for each student. The growth targets tells us, based on where students are now, how much they need to grow to perform at each achievement level on the next assessment. The growth projections tell us, for all levels of growth, where a student may score on next year's assessment. Growth projections and targets will not be

provided during the first few years of Georgia Milestones implementation. Several years of implementation will be required to provide projections and targets.

Figure 7 is a graphic demonstration of growth projections and targets (using the state's legacy assessment system). The growth projection concept is illustrated by the multi-colored fan. This year, the example student scored just above Meets. The fan indicates where on the assessment scale the student may score next year, depending on the level of growth he demonstrates. For example, if he demonstrates very low growth, 1st percentile, he will likely score Does Not Meet. If he demonstrates very high growth, 99th percentile, he will likely score Exceeds. The growth targets, expressed as SGP values, tell us specifically what level of growth he must demonstrate to score Meets or Exceeds. In other words, the growth projection tells us "if you grow this much, you will score here" while the growth target tells us "to score here, you must grow this much."

Figure 7: Growth Projections and Growth Targets



Accessing Data

Students and parents receive student growth reports that provide information on students' academic progress and achievement. Students and parents can work with their teachers to better understand student performance and the support or enrichment opportunities that might contribute to them meeting or exceeding academic expectations.

The public can access school- and district-level SGP data through an interactive data tool at http://gastudentgrowth.gadoe.org/.

Educators have access to detailed SGP data for their students through the Statewide Longitudinal Data System (SLDS). They can utilize SGPs, in addition to other information about student performance, to improve student learning, instruction, and educational programs.

Assessment Transitions

One important feature of the methodology used within the Georgia Student Growth Model (GSGM) is that the Student Growth Percentile (SGP) is robust to scale transformations like those associated with changes in assessment systems. SGP calculation was not interrupted during the transition to Georgia Milestones Assessment System.

Additional Information

There are many resources available on the Georgia Student Growth Model website at gsgm.gadoe.org. Resources include an animated introduction to SGP video; documents, such as this guide and FAQs; technical information; a technical evaluation, a tutorial series providing in-depth information on the model; and information on student growth reports, including sample reports and interpretation videos.