PVAAS PENNSYLVANIA

PVAAS Methodologies

Measuring Growth & Projecting Achievement

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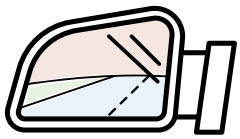
What Does PVAAS Provide to Educators?

PVAAS provides a wealth of information to educators through a variety of reports within a web-based system. This information can be divided into two main categories – measuring growth and projecting achievement. PVAAS also provides data to "look back" at the expected achievement and the longitudinal achievement history of individual students on a range of national, state, and local assessments.



Looking back

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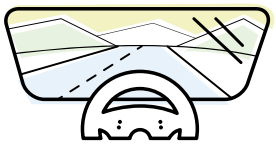
Value-Added Growth Data

- *State Assessments*
- *Local Assessments*

Tracking Student Progress:

Testing History (Achievement)

- *State Assessments*
- *Local Assessments*
- *College Readiness Exams*



Looking forward

Planning for Students' Needs:

Student Projections to Achievement

- *State Assessments*
- *College Readiness Exams*

Looking Back

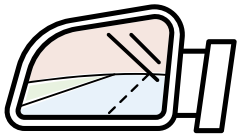
PVAAS provides information on the academic growth students have made in the most recently tested school year. This is what we call "looking back" information as it helps LEAs/districts, schools, and teachers assess how their educational programs and instructional strategies are impacting the academic growth, or progress, of groups of students. This "looking back" information is about the growth of groups of students, and is available at the LEA/district, school, and teacher levels. In PVAAS, there are two ways of measuring growth. Both ways of measuring growth are discussed in detail in later sections. PVAAS looks back and provides a detailed longitudinal view of an individual student's achievement history across grades, subjects, and years.

Looking Forward

PVAAS provides information on students' possible academic performance, or achievement, on future assessments (PSSA, Keystones, Advanced Placement, ACT, ACCESS for ELLs, PSAT, and SAT) – called PVAAS Student Projections. This is what we call "looking forward" information as it helps LEAs/districts, schools, and teachers plan appropriately for the needs of its students – including decisions regarding intervention placement, enrichment opportunities, course selection, and differentiated instruction. This "looking forward" information is available for educators at an individual student level, or for grade-level groups and demographic student groups. Details for projecting student achievement will be discussed in a later section.

Testing History: Achievement

PVAAS provides a range of longitudinal, student level data for LEAs/districts and schools. This is the base for all PVAAS reporting - longitudinal, student level data. This includes the following assessments: PSSA, Keystone Exams, Local Assessments, CDT by PDE, ACCESS for ELLs, Advanced Placement, PSAT, SAT, ACT, and PASA. Student level data in PVAAS follows each student across schools, LEAs/district and across school years.



Looking back

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Value-Added Growth Data

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Tracking Student Progress:

Testing History (Achievement)

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- *Local Assessments*
- *College Readiness Exams*

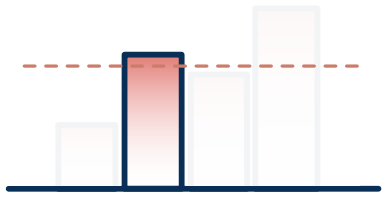
- ✓ PSSA
- ✓ Keystone Exams
- ✓ Local Assessments
  such as Acadience®, aimsWeb®, DIBELS, Exact Path, FastBridge, i-Ready®, iXL, LAS Links, MAP®, STAR, Study Island
- ✓ CDT by PDE
- ✓ ACCESS for ELLs
- ✓ Advanced Placement
- ✓ PSAT
- ✓ SAT
- ✓ ACT
- ✓ PASA

Assessments may be reported on different scales. All student level assessment history in PVAAS is represented in NCEs, Normal Curve Equivalents. This allows for the comparison of student performance on different tests, as well as changes in student level performance over time. PVAAS provides a longitudinal, a visual representation of a student's assessment history. Educators and leaders can view the performance of a student over time and across a range of student learning assessments.

The Concept of **Growth:**

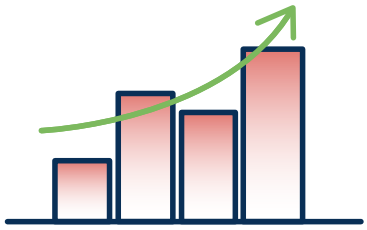
What is meant by academic growth?

When talking about the academic growth for groups of students, it is important to first understand what is meant conceptually about growth versus achievement before getting into the more specific details of how growth is measured in PVAAS.



achievement

Level of performance at a single moment in time, against a set standard



growth

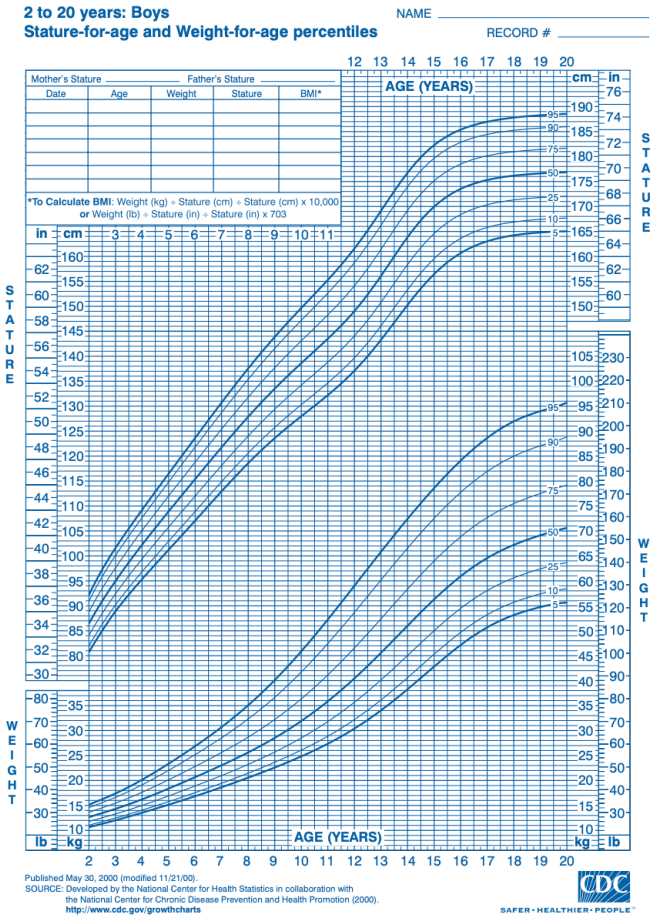
Performance over time, revealing the direction of progress

A Growth Analogy

To help illustrate the difference between achievement and growth, consider an analogy of measuring a child's height.

Every year, during a child's wellness check, the pediatrician measures the child's height and may plot that data point on a chart similar to what we see in the graphic at right. This height measurement by the pediatrician captures a moment in time, similar to achievement. We can compare that child's single height measurement against a benchmark, or against their peers, to put their current height into context.

However, if we want to measure the child's growth, we have to compare that measurement against the child's own prior history. By looking across years, we can identify patterns of growth for that particular child and understand if the child is growing as expected or predicted. Both measures provide valuable information about a child's holistic physical development.



Another Growth Analogy

Think about the game of baseball. Imagine for a moment that the bases on a baseball diamond represent the possible achievement levels of groups of students:

- **First base** represents a history of lower achievement,
- **Second base** is a history of average or middle achievement, and
- **Third base** is a history of higher achievement.

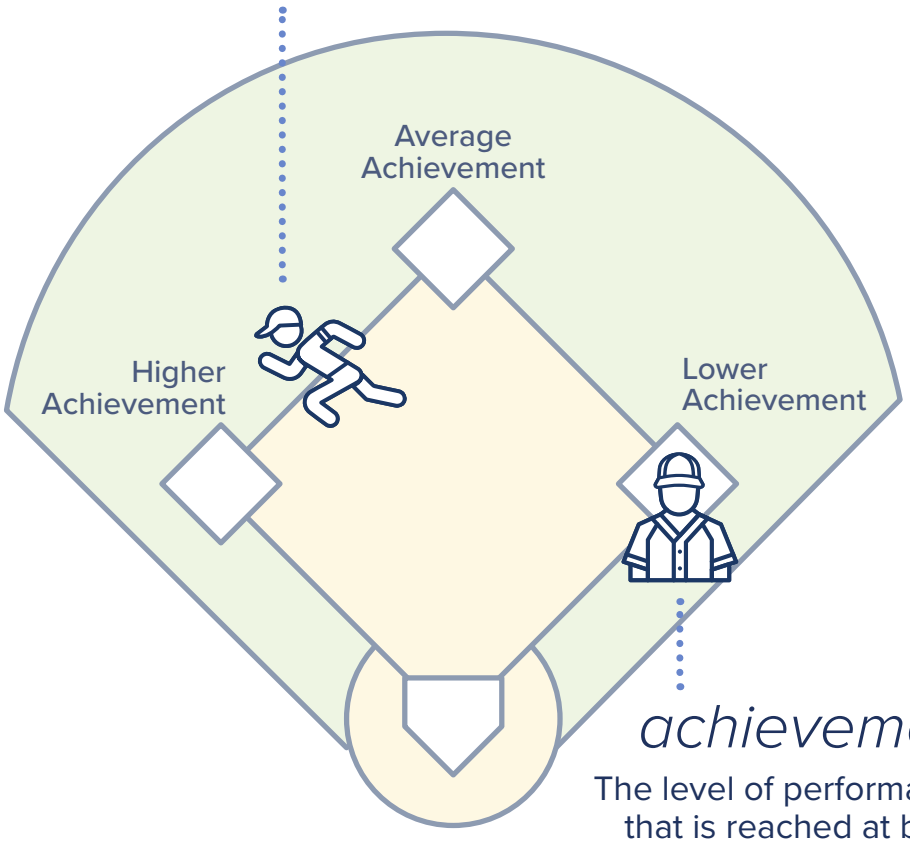
The base that is reached by a batter is their **achievement** while at bat – the location of a student group at the start of a year of learning.

In baseball, once a runner is on base, **something else has to happen** for the runner to move. In education, students experience more instruction and more learning during the school year – and as a result, they may experience **growth**. They may advance to the next base.

This analogy is especially useful when you consider our goals as educators. When a batter hits the ball, you don't just want the runners who are on third base to head for home plate. All runners, on every base, should be advancing! And, you wouldn't want the runners on third base to stand still just because they've already come so far. In the same way, we want all students, whether they have a history of lower, middle, or higher achievement, to gain ground and head toward home, in every inning.

growth

Advancement due to what happens on the field (curriculum, instruction, and assessment during the school year)



achievement

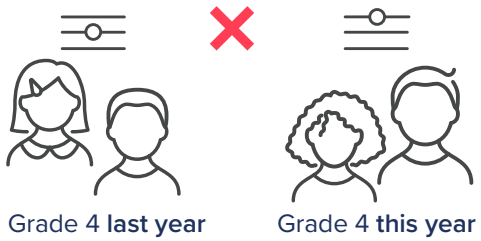
The level of performance that is reached at bat (a school year)

Measuring Growth with PVAAS

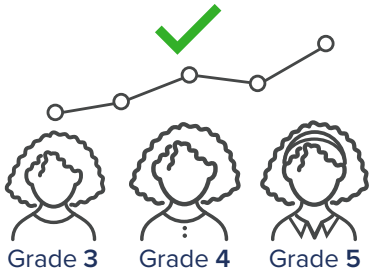
Each year, LEAs/districts and schools receive information regarding the achievement results for their students in the grades and subjects in which they were assessed. This information includes the number and percentage of students who performed in each of the four academic performance ranges - Advanced, Proficient, Basic, and Below Basic. Achievement data from previous years is also included. But, because these data are based on different groups of students each year, it's sometimes challenging for teachers, schools, and LEAs/districts to use the data to make fair comparisons. This is the purpose of PVAAS - to help educators make more fair comparisons.

PVAAS uses the state assessment data to measure the academic growth of groups of students from year to year at the district, school, and teacher levels. As illustrated to the right, PVAAS does NOT compare the achievement of one group of students in a particular subject and grade with the previous year's students in that same subject and grade. For example, the achievement of the most recent group of students in 8th grade Math is NOT compared to the achievement of the previous year's group of 8th grade Math students. Rather, PVAAS measures the growth of each distinct group of students as they progress through grade levels over time.

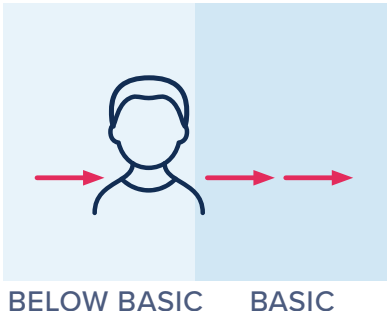
PVAAS measures growth for student groups at ALL achievement levels. To measure growth, it does not compare the percentages of students at various academic performance levels; those performance levels are wide ranges of achievement. Instead, PVAAS looks at scores *within* those ranges and is a more sensitive measure of student progress than comparing percentages of students reaching or exceeding proficiency.



PVAAS does not compare the achievement of one group of students with the previous year's students in that same subject or grade.



PVAAS measures the growth of each distinct group of students as they progress through grade levels over time.



No matter the achievement level at which students enter, they should not lose ground academically.

Additionally, **PVAAS growth measures are fair** for all types of learners – those with histories of both higher and lower achievement, and those with various demographic characteristics – as PVAAS is considering students' entire prior history of achievement.

To understand how PVAAS measures growth during a transition of assessment systems, visit:

Changes in Pennsylvania's State Assessment System: Is there an Impact on PVAAS? (PDF)

https://www.pa.gov/content/dam/copapwp-pagov/en/education/documents/instruction/assessment-and-accountability/pvaas/methodology/pvaas_changesinpaassessments_impactonpvaas.pdf

RED

YELLOW

If educators see that the PVAAS growth measure for a group of students is color-coded red or yellow, it indicates that there is moderate or significant evidence that the group of students did not meet the growth standard (i.e., the group lost ground academically).

This should be cause for concern for educators; they would want to ask some questions about curriculum alignment, effective instructional practices, ongoing formative assessment, placement of students in appropriate courses, and the existence of appropriate academic opportunities for struggling students or students who may need enrichment.

GREEN

If educators see that the growth measure for a group of students is color-coded green, it indicates that the group of students met the growth standard – or, on average, the achievement of the group was maintained.

- In this case, educators would want to determine if green is good enough for that group of students.
- If the achievement of the group is high, then many teachers, schools, and LEAs/districts may say "that green is good." However, even with a green, there are certainly opportunities for students to increase their average achievement and for educators to support students in making academic growth.
- If the group of students is lower achieving, some educators might say that it's good that the group did not slip further behind. However, most educators would agree that green is not sufficient, or good enough, for a lower achieving group of students since this means that the group would simply be maintaining a lower level of achievement. For students with lower achievement, the goal of teachers, schools, and LEAs/districts should be to raise the achievement of the student group.

LIGHT BLUE

DARK BLUE

If educators see that the growth measure for a group of students is color-coded with dark blue or light blue, it indicates that there is moderate or significant evidence that the group of students exceeded the growth standard (i.e., the group gained ground academically).

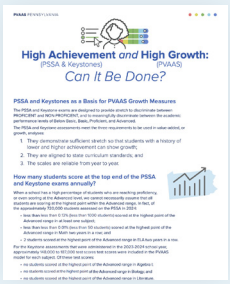
Even higher-achieving groups of students can earn a light blue or dark blue. Remember, the achievement is an average for the group, so not every student in the group is achieving the highest possible score every year. Because of this, teachers, schools, and LEAs/districts in Pennsylvania with high achieving groups of students can also gain ground. Teachers, schools, and LEAs/districts need both achievement data AND growth data to get the complete picture of student learning.

Teachers, schools, and LEAs/districts need **both achievement data AND growth data** to get the complete picture of student learning.

Learn how students at all levels of achievement can demonstrate growth in PVAAS:

[High Achievement *and* High Growth: Can it Be Done? (PDF)]

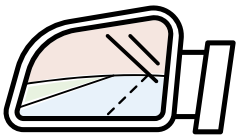
https://www.pa.gov/content/dam/copapwp-pagov/en/education/documents/instruction/assessment-and-accountability/pvaas/methodology/pvaas%20highachievementandhighgrowth.pdf



Predictive Methodology:

Measuring Growth in PSSA Math, ELA, Science, Keystones, and CDT

Remember, as indicated in earlier sections, PVAAS provides information on the academic growth students have made in the last school year. This helps LEAs/districts, schools, and teachers assess how their educational programs and instructional strategies are impacting the academic growth of groups of students.



Looking back

- ✓ PSSA
- ✓ Keystone Exams
- ✓ CDT by PDE

Determining Effectiveness:

Value-Added Growth Data

- *State Assessments*
- *Local Assessments*

Tracking Student Progress:

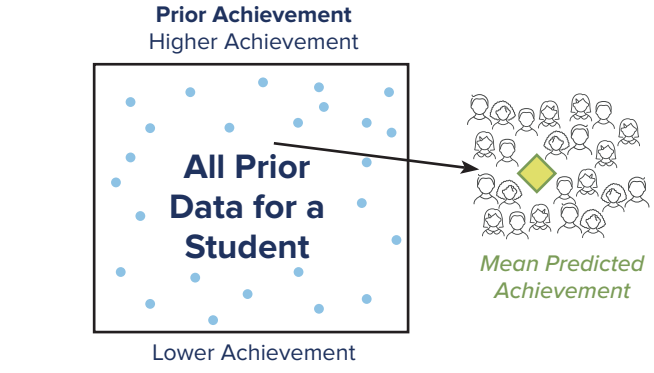
Testing History (Achievement)

- *State Assessments*
- *Local Assessments*
- *College Readiness Exams*

PVAAS utilizes two different methodologies for measuring growth for groups of students. This section details how growth is measured in PSSA Math, ELA, Science, Keystone content areas and PDE's Classroom Diagnostic Tools (CDT).

Conceptual Look at Measuring Growth in PSSA Math, ELA, Science, Keystones, and CDT

In the graphic at right, each dot represents a student in the group where prior state assessment data for that student are used. Those students are going to score along the achievement distribution from low to high achievement. PVAAS uses the student's prior data (as outlined in the table in the subsequent section) to predict the scale score or achievement for a student on their next state assessment in the subject or content area of interest. These predicted scale scores for all students are used to calculate the mean or average predicted achievement for the student group.



◇ *Represents the mean predicted achievement of the group of students*

Next, these students are tested on the state assessment of interest. These students will again score along the achievement distribution from low to high achievement. The average actual achievement is calculated for the group. A comparison of the average actual achievement to the average predicted achievement is then made to estimate the Growth Measure for the student group.

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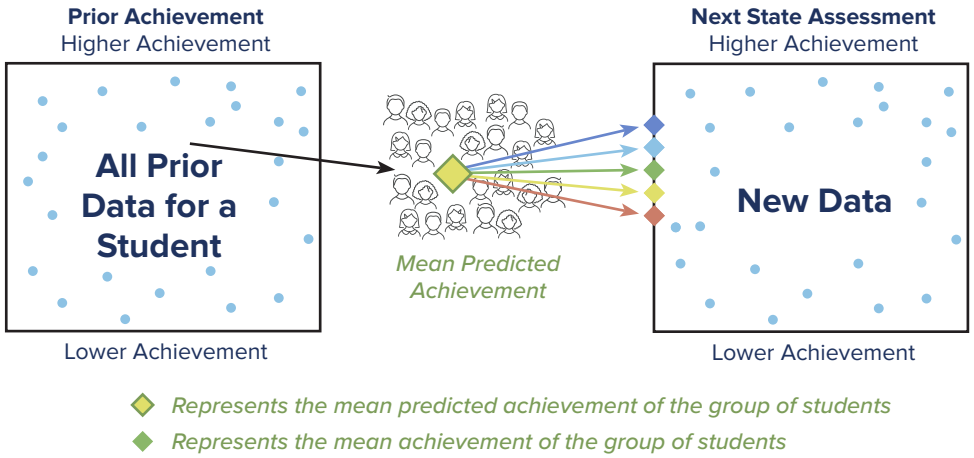


Each Growth Measure is then color-coded as follows, to ease in the interpretation of growth:

GREEN If the evidence indicates the achievement is roughly the same as what was predicted, this indicates that the group of students maintained their achievement, which in PVAAS would be indicated as Green – evidence that the student group met the growth standard.

LIGHT BLUE If there is moderate evidence that the average achievement of this group of students was higher than predicted, this would indicate that the group of students increased their average achievement indicated with a Light Blue in PVAAS – moderate evidence that the student group exceeded the growth standard.

DARK BLUE Similarly, if there is significant evidence that the average achievement of this group of students was higher than predicted, this would indicate that the group of students increased their average achievement – indicated with a Dark Blue in PVAAS – significant evidence that the student group exceeded the growth standard.

YELLOW If there was moderate evidence that the average achievement of this group of students was lower than predicted, this would indicate that the average achievement of the group of students slipped indicated with a Yellow – moderate evidence that the student group did NOT meet the growth standard.

RED Similarly, if there was significant evidence that the average achievement of this group of students was lower than predicted, this would indicate that the average achievement of the group of students slipped – indicated with a Red – significant evidence that the student group did NOT meet the growth standard.

A More Detailed Look at Measuring Growth in PSSA Math, ELA, Science, Keystones, and CDT

The methodology used to estimate growth for PSSA Math, ELA, Science, Keystones and CDT is a different methodology than what is used for estimating growth for locally administered assessments.

Students who take the PSSA can have PSSA data in other PSSA state assessed subjects/grades. Additionally, students who take the Keystone exams will have PSSA data from prior years. The Predictive Methodology used for estimating growth in these subjects uses all prior data (across subjects) to calculate predicted scores for the student group. The predicted score for a student is calculated by observing how all students with a similar prior testing history performed on the test of interest, so we have an expectation of how that student should score. Growth is then a function of the difference between the average predicted score of the student group and the average actual score for the student group. Let's take a closer look at this.

Each year, Pennsylvania state assessment data (PSSA and Keystone) are sent directly from the test vendor to the SAS EVAAS team for PVAAS analyses. For the Predictive Methodology discussed in this section, the PVAAS value-added analysis begins at the student level with the collection of individual student data for a minimum of three prior data points. Note that each scale score in each subject is considered a data point. By looking at the relationships between student scores, PVAAS is able to predict future achievement for students. In other words, PVAAS predicts students' future achievement based on students' past performances and the relationships between those subjects.

You may be asking, "Are scores across subjects truly related? Is there a correlation across subjects?" The answer to that is yes, students' prior test scores are in fact related to the current test we are investigating. In other words, the Keystone Algebra I test is highly related to PSSA Math scores in earlier grades. The Keystone Algebra I test is also related (perhaps to a lesser extent) to PSSA ELA and Science scores in earlier grades. Each student's prediction is based on the student's prior test scores, the relationship of those scores to the current year test, and the average schooling experience in the state for the current year. In more technical terms, the multiple correlation coefficient provides the correlation between the predicted score using all prior test scores and the actual score itself. The multiple correlation coefficients between Keystones and PSSA are very strong, meaning that the PSSA provides good data for the student predictions. In recent years, these correlations have typically been in the 0.75 to 0.85 range and have remained stable across years.

Remember that correlations range between -1.0 and +1.0, with values of -1.0 and +1.0 indicating a perfect relationship, which are virtually unheard of in the real world. In general, correlations above or below 0.6-0.7 are considered to indicate a strong relationship. (For more information, reference these resources on Interpreting Correlation Coefficients or What is R Value Correlation?)

When calculating the predicted scores for students, PVAAS specifically utilizes the historical state assessment data, when available, to predict future performances on the PSSAs, Keystones, and CDTs. The table provided below illustrates the data used for each subject.

Predicted Score IN...	Prior Years' Data Used to Calculate Predicted Score
PSSA Science	All prior scores in PSSA Math, ELA, and Science (if available)
Keystone Algebra I	All prior scores in PSSA Math, ELA, and Science (if available)
Keystone Biology	All prior scores in PSSA Math, ELA, and Science; and most recent prior score in Keystone Algebra I (if available)
Keystone Literature	All prior scores in PSSA Math, ELA, and Science; and most recent prior score in Keystone Algebra I and Biology (if available)

While the predicted scores for students are calculated, another analysis is run simultaneously to compute the average of these same students' actual scores. The Growth Measure is then estimated by comparing the average of actual scores to the average of the predicted scores. If students' average actual score is equal to their average predicted score, then the Growth Measure would be 0.0, or in other words, students scored as predicted given their previous testing histories. This would be identified as a green in PVAAS indicating the group of students met the growth standard.

All five colors associated with the PVAAS Value-Added Growth Measure are explained below:

DARK BLUE, or DB, is an indication that the Growth Measure is more than 2 standard errors above 0. There is significant evidence of exceeding the growth standard

LIGHT BLUE, or LB, is an indication that the Growth Measure is at least 1 but less than 2 standard errors above 0. There is moderate evidence of exceeding the growth standard.

GREEN, or G, is an indication that the Growth Measure is less than 1 standard error above 0 and no more than 1 standard error below 0. There is evidence of meeting the growth standard.

YELLOW, or Y, is an indication that the Growth Measure is more than 1 but no more than 2 standard errors below 0. There is moderate evidence of not meeting the growth standard.

RED, or R, is an indication that the Growth Measure is more than 2 standard errors below 0. There is significant evidence of not meeting the growth standard.

For additional information on measuring growth using the SAS EVAAS statistical models on which PVAAS is based, please reference the following resources:

Sanders, W. L., Saxton, A. M., and Horn, S. P. (1997). "The Tennessee Value-Added Assessment System: A Quantitative, Outcomes-Based Approach to Educational Assessment." In Millman, J. (ed.) *Grading Teachers, Grading Schools*, Thousand Oaks, CA: Sage Publications, pp. 137-162.

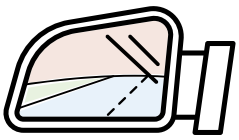
Technical Documentation of PVAAS Analyses. Available at: Statistical Models and Business Rules of PVAAS Analyses.

Growth Standard Methodology:

Measuring Growth on Local Assessments

As indicated in an earlier section, PVAAS provides information on the academic growth students have made in the last school year on locally administered assessments. This includes locally administered assessments such as Acadience, aimsWeb, DIBELS, Exact Path, FastBridge, i-Ready, iXL, LAS Links, MAP, STAR, and Study Island. Content areas across many of these assessments have included Math, ELA, as well as Spanish versions.. This helps LEAs/districts, schools, and teachers assess how their educational programs and instructional strategies are impacting the academic growth, or progress, of groups of students.

PVAAS utilizes two different methodologies for measuring growth for groups of students. This section details how growth is measured for locally administered assessments. Note: The CDT is not measured using this methodology. The CDT uses the same methodology as the state assessments.



Looking back

✓ Local assessments

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Value-Added Growth Data

- *State Assessments*
- *Local Assessments*

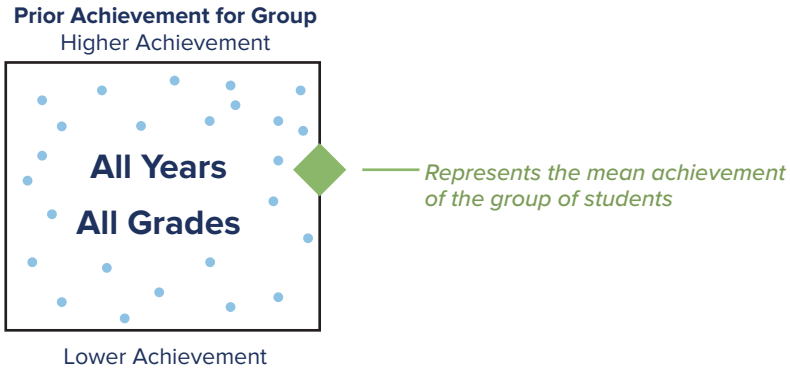
Tracking Student Progress:

Testing History (Achievement)

- *State Assessments*
- *Local Assessments*
- *College Readiness Exams*

Conceptual Look at Measuring Growth on Local Assessments

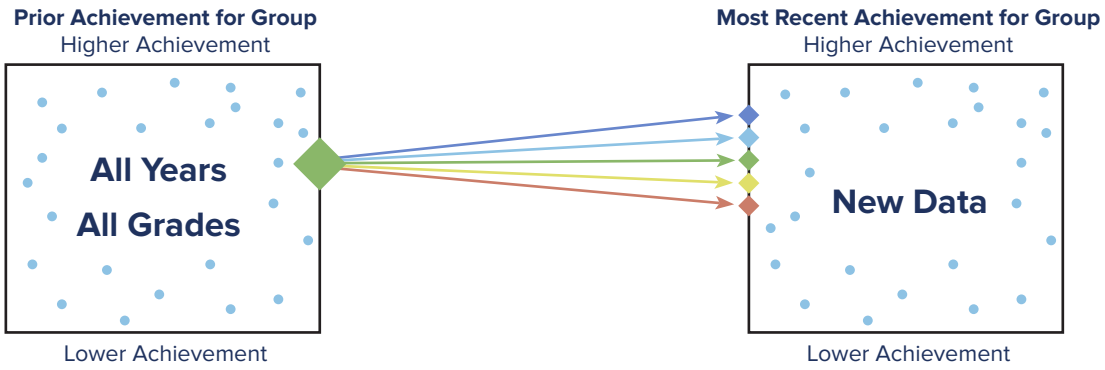
For locally administered assessments, SAS EVAAS uses a Growth Standard Methodology to measure the growth of a group of students. In the graphic below, each dot represents a student in the group being tested with the local assessment. Students in this group are going to score anywhere along the achievement distribution from low to high achievement. To estimate the achievement of this group of students, PVAAS uses the prior locally administered assessment data to estimate the average entering achievement of the group.



After the next round of testing, PVAAS again uses all the prior data for the group of students and adds the data from the most recent round of testing to get a new estimate of the average achievement of the group.

◆ *Represents the mean achievement of the group of students*

Next, PVAAS compares the prior achievement of the student group to the new achievement of the student group. This comparison allows us to estimate the academic growth the student group has made in the past school year. Each Growth Measure is color-coded to ease in the interpretation of growth for each group of students.



◆ *Represents the mean achievement of the group of students*

GREEN If the evidence indicates the exiting (or most recent) achievement is roughly at the same point within the distribution of scores as the entering achievement, this indicates that the group of students maintained their achievement, which in PVAAS would be indicated as Green – evidence that the student group met the growth standard.

LIGHT BLUE If there is moderate evidence that the average achievement of this group of students was at a higher point within the distribution of scores, this would indicate that the group of students increased their average achievement indicated with a Light Blue in PVAAS – moderate evidence that the student group exceeded the growth standard.

DARK BLUE Similarly, if there is significant evidence that the average achievement of this group of students was at a higher point within the distribution of scores, this would indicate that the group of students increased their average achievement – indicated with a Dark Blue in PVAAS – significant evidence that the student group exceeded the growth standard.

YELLOW If there was moderate evidence that the average achievement of this group of students was at a lower point within the distribution of scores, this would indicate that the average achievement of the group of students slipped indicated with a Yellow – moderate evidence that the student group did NOT meet the growth standard.

RED Similarly, if there was significant evidence that the average achievement of this group of students was at a lower point within the distribution of scores, this would indicate that the average achievement of the group of students slipped – indicated with a Red – significant evidence that the student group did NOT meet the growth standard.

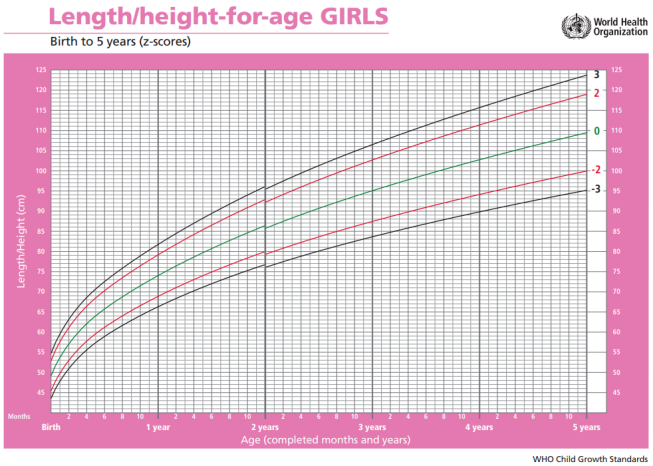
A More Detailed Look at Measuring Growth on Local Assessments

For the PVAAS Growth Standard Methodology:

1. Using all of the available prior locally administered assessment data, PVAAS calculates a robust estimate of achievement for a group of students.
2. The Growth Measure (or gain) from the prior achievement to the current achievement can then be estimated.
3. The Growth Measure is then compared to the growth standard.

There are several important issues to consider when discussing how PVAAS calculates a measure of growth using the Growth Standard Methodology. First, when measuring the gain students make academically from beginning to end of the year, or from one year to the next, we are measuring their growth by the difference in their academic achievement from one point in time to the next. This simple idea becomes more complicated when we consider that the achievement scores from one point in time to the next must be comparable, or in other words, on the same scale. To ensure scores are comparable, SAS EVAAS converts all scores to NCEs. The NCE distribution is similar to that for percentiles, with the important distinction that the NCE distribution is an equal-interval scale such that moving from 50 to 60 represents the same distance as moving from 70 to 80.

Second, how do we know that the estimated gain or academic growth is what we should expect to see for a group of students? In Pennsylvania, academic growth is compared to the growth standard, which is based on the philosophy that despite the entering achievement of a group of students, they should not lose ground academically. The growth standard represents a group of students maintaining their average achievement. When thinking about this standard, consider the physical growth chart for children (sample at right). A child is considered to meet the minimal expectation for physical growth if they maintain or improve their position in the distribution of length/height as they grow from year to year. Academically, this same concept applies. A group of students meets the growth standard if the group maintains its position in the distribution of achievement scores.



World Health Organization (n.d.). Child Growth Standards: Length/height-for-age, Girls: birth to 5 years (z-scores). Source: https://www.who.int/tools/child-growth-standards/standards/length-height-for-age

Once all achievement estimates are calculated, the gain (or Value-Added Growth Measure) from the beginning of the year to the end of the year can be calculated and compared to the growth standard. If the current achievement of the student group is equal to the prior achievement of the student group, then the difference between the two

estimates of achievement would be 0.0; in other words, students' achievement was maintained from one point in time to the next. This would be identified as a green in PVAAS indicating the group of students met the growth standard.

All Growth Measures reported on the PVAAS reports are estimates. There is natural error involved with any estimate, and this error, or variation, is expressed as the Standard Error. The Standard Error allows you to determine the amount of evidence around the Growth Measure to determine if significant growth, or a lack of growth, is in fact evident for the group of students in question. One of the major functions of the Standard Error is that it allows us to evaluate the significance or level of evidence that the estimate provides that the indicated phenomenon is occurring. When we interpret a Growth Measure, we use the Standard Error to determine if the level of evidence supports that the group of students in question has exceeded or fallen short of the growth standard.

All five colors associated with the PVAAS Value-Added Growth Measure are explained below:

- **DARK BLUE**, or DB, is an indication that the Growth Measure is more than 2 standard errors above 0. There is significant evidence of exceeding the growth standard.
- **LIGHT BLUE**, or LB, is an indication that the Growth Measure is at least 1 but less than 2 standard errors above 0. There is moderate evidence of exceeding the growth standard.
- **GREEN**, or G, is an indication that the Growth Measure is less than 1 standard error above 0 and no more than 1 standard error below 0. There is evidence of meeting the growth standard.
- **YELLOW**, or Y, is an indication that the Growth Measure is more than 1 but no more than 2 standard errors below 0. There is moderate evidence of not meeting the growth standard.
- **RED**, or R, is an indication that the Growth Measure is more than 2 standard errors below 0. There is significant evidence of not meeting the growth standard.

For additional information on measuring growth using the SAS EVAAS statistical models on which PVAAS is based, please reference the following resources:

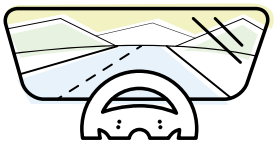
Sanders, W. L., Saxton, A. M., and Horn, S. P. (1997). "The Tennessee Value-Added Assessment System: A Quantitative, Outcomes-Based Approach to Educational Assessment." In Millman, J. (ed.) *Grading Teachers, Grading Schools*, Thousand Oaks, CA: Sage Publications, pp. 137-162.

Technical Documentation of PVAAS Analyses (2020). Available at: Statistical Models and Business Rules of PVAAS Analyses.

Projection Methodology:

Estimating Projections to Students' Achievement on Future Assessments

In addition to providing measures of academic growth, PVAAS provides projected scores for individual students on future assessments the students have NOT yet taken, as well as for students not yet Proficient on a Keystone exam. Projections are available to PSSA, Keystone, PSAT, SAT, ACT, and Advanced Placement (AP) exams, as well as the ACCESS for ELLs assessment given to English Learners. These projections can be used to predict a student's current academic trajectory and may be used to guide counseling and intervention to increase students' likelihood of future success.



Looking forward

Planning for Students' Needs:

Student Projections to Achievement

- *State Assessments*
- *College Readiness Exams*

- ✓ PSSA
- ✓ Keystone Exams
- ✓ ACCESS for ELLs
- ✓ AP Exams
- ✓ PSAT
- ✓ SAT
- ✓ ACT

It can be useful to think about the PVAAS projections as being very similar to expectations we set in our everyday lives. Each day, whether we realize it or not, we generate expectations – about our work, our personal lives, and the world in general. These expectations are based on two things: information and experience. The individual student projections that are provided in PVAAS also rely on information and experience. In this case, the information is a student's testing history, across grades and subjects. The experience is determined by students with similar prior achievement who have already taken the test of interest for the projection, so that students' prior test scores across grades and subjects serve as predictors to their projection to a future assessment. Using this data, the projection model quantifies the projection in a precise and reliable way. In PVAAS, this means that projections indicate what is most likely to happen for a student academically, or in other words, how a student will most likely score on a future assessment if they continue on the same academic path.

Most important to consider is that the projection methodology uses historical assessment data from the most recent five years, when available, to project future PSSA performances in Math, ELA, Science, future Keystone performances in Algebra I, Biology, and Literature, as well as ACCESS for ELLs. Projections to future college readiness exams are also available for PSAT, AP, ACT, and SAT. The table below illustrates the specific data used for each subject and exam.

Projection TO...	Prior Years' Data Used to Calculate Predicted Score
PSSA Math	All prior scores in PSSA Math and ELA (if available)
PSSA ELA	All prior scores in PSSA Math and ELA (if available)
PSSA Science	All prior scores in PSSA Math, ELA, and Science (if available)
Keystone Algebra I	All prior scores in PSSA Math, ELA, and Science (if available)
Keystone Biology	All prior scores in PSSA Math, ELA, and Science; and most recent prior score in Keystone Algebra I (if available)
Keystone Literature	All prior scores in PSSA Math, ELA, and Science; and most recent prior score in Keystone Algebra I and Biology (if available)
PSAT, SAT, ACT, and AP	All prior scores in PSSA Math, ELA, and Science; and most recent prior score in Keystone Algebra I, Biology, and Literature (if available); PSAT NMSQTs as predictors for ACT and SAT projections
ACCESS for ELLs	All prior ACCESS for ELLs domain scores in Listening, Speaking, Reading, and Writing

The reason the predictors listed above can be used in calculating projections is that students' prior test scores are in fact related to the current test we are investigating. For example, the Keystone Algebra I test is highly related to PSSA Math scores in earlier grades. The Keystone Algebra I test is also related (perhaps to a lesser extent) to PSSA ELA and Science scores in earlier grades. Each student's projection is based on the student's prior test scores, the relationship of those scores to the current year test, and the average schooling experience in the state for the current year. In more technical terms, the multiple correlation coefficient provides the correlation between the predicted score using all prior test scores and the actual score itself. The multiple correlation coefficients between Keystones and PSSA are very strong, meaning that the PSSA provides good data for the student predictions. In recent years, these correlations have typically been in the 0.75 to 0.85 range and have remained stable across years.

Remember that correlations range between -1.0 and +1.0, with values of -1.0 and +1.0 indicating a perfect relationship, which are virtually unheard of in the real world. In general, correlations above or below 0.6-0.7 are considered to indicate a strong relationship. (For more information, reference these resources on Interpreting Correlation Coefficients or What is R Value Correlation?).

Projections can be made for any students with any set of available predictor scores defined in the projection model. However, to protect against bias due to measurement error in the predictors, projections are made only for students who have at least three available predictor scores (except for projections to grade 4 assessments in which two available predictor scores are used). In addition to the projected score itself, the standard error of the projection is calculated. Given a projected score and its standard error, it is possible to calculate the probability that a student will reach a specified benchmark of interest. In the case of Pennsylvania, probabilities of performing at a Basic level or higher, at a Proficient level or higher, or at an Advanced level on a future PSSA or Keystone exam are calculated. Probabilities of performing at or above specified college benchmarks on the PSAT, SAT, and ACT are also calculated, as well as probabilities of scoring a 3 or higher on an AP exam. These probabilities are calculated as the area above the benchmark cut score using a normal distribution with its mean being equal to the projected score and its standard deviation being equal to the standard error of the projected score.

A More Detailed Look at the Projection Methodology

The PVAAS Projection methodology is in fact quite complex and involves the use of many data points across multiple subjects and multiple years. Let's look at a more detailed perspective of this methodology to provide further insight into this modeling process.

To do this, let's consider an example. Suppose we wish to project the 8th grade Math score for a student named Tyler. This student was new to Pennsylvania at the beginning of his 5th grade year. To date, we have the following state assessment data available for Tyler from grades 5-7:

1. Grade 5 Math and grade 5 ELA
2. Grade 6 Math and grade 6 ELA
3. Grade 7 Math and grade 7 ELA

First, we would create a projection model for 8th grade Math based on all of the students in the state who have already taken 8th grade Math and have the same prior scores as Tyler. The next step is to construct a formula, which can take all of those prior test scores and make the best possible prediction for all the students in the state who have already taken 8th grade Math.

Grade	5th	6th	7th	8th
Math	42	54	47	53
ELA	47	51	53	54

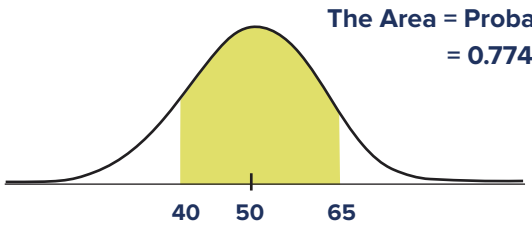
In this example:

> Projected Score (Grade 8 Math) = a (grade 5 Math) + b (grade 5 ELA) + c (grade 6 Math) + d (grade 6 ELA) + e (grade 7 Math) + f (grade 7 ELA) + g,
>
> *where a, b, c, d, e, f, and g are estimated numbers based on correlations across subjects, and grade 5 Math, grade 5 ELA, etc. are test scores.*

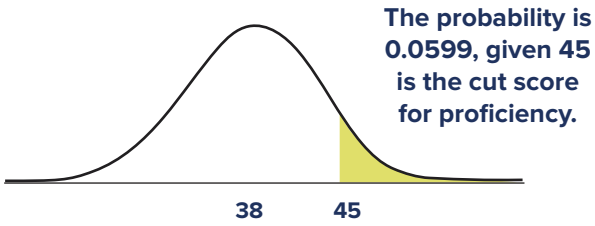
To then calculate the projected 8th grade Math score for Tyler, we need to (1) substitute the values of the test scores for Tyler into the formula, and (2) calculate the estimate of his 8th grade Math score. The estimate from this model would then be the projected score for Tyler. Since the projected score is an estimate, we would also calculate the standard error for that estimate. In our example, once Tyler's scores are inputted into the model, we get a projected score of 38 with a standard error of 4.5.

Now, what does the standard error really tell us? What can we do with the standard error? We can use the estimated projected score and the standard error to calculate the probability that the student will score in a selected performance level or higher. This probability is the PVAAS projection probability. The key to calculating the PVAAS projection probability is to consider the estimated projected score as the average, or mean, of all possible estimates, and the standard error as the standard deviation of all the possible estimates. With this consideration in mind, it is reasonable to think that all possible estimates would form an approximately normal distribution with the estimated projected score as the mean and the standard error of the estimated projected score as the standard deviation. We can then use statistical normal distribution techniques, and the area under the normal curve to determine probabilities.

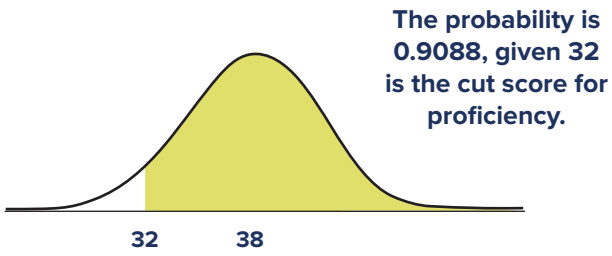
Going back to a "Stats 101" course, recall that the area under a normal curve is always equal to 1, or a probability of 100%. In a general example with a normal distribution with a mean of 50 and a standard deviation of 10, we could calculate the probability that a value would be between 40 and 65. To do that, we would calculate the area of the region under the curve that is between 40 and 65. Using statistical tables or software, we would be able to determine that the area under the curve is 0.7745, and therefore the probability that a value is between 40 and 65 is 77.45%.



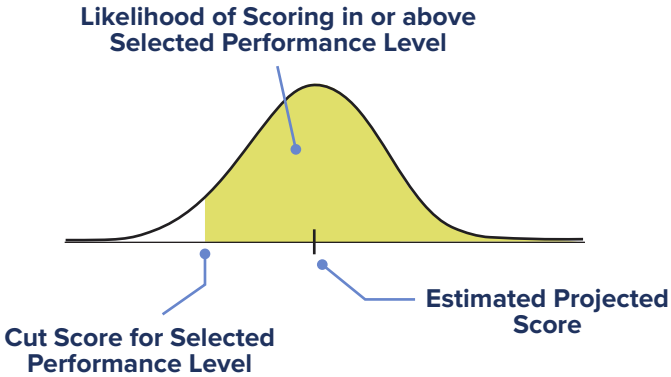
Let's revisit our example of calculating a projected score and projection probability for Tyler for 8th grade Math. Remember that we calculated Tyler's estimated projected score to be 38 with a standard error of 4.5. So, how likely is it that Tyler will score a 45 or more, knowing that the cut score for proficiency on the 8th grade PSSA Math assessment is 45? In this case, we would use the normal curve technique described above to find the area under the curve to find Tyler's projection probability of reaching a Proficient level or higher on the 8th grade Math assessment. With a cut score of 45 for proficiency on the 8th grade Math assessment, we see that Tyler has a low likelihood (only 5.99%, or 6%, probability) of reaching proficiency or higher on the grade 8 Math test given his own testing history and his projected score.



However, what if the cut score for proficiency is 32, not 45? How likely is it then that Tyler will score a 32 or more, knowing that the cut score for proficiency on the 8th grade PSSA Math assessment is 32? Again, we would use the normal curve technique to find the area under the curve to find his projection probability. With a cut point of 32 for proficiency on the 8th grade Math assessment, we see that Tyler has a high likelihood (90.88%, or 91%, probability) of reaching proficiency or higher on the grade 8 Math test given his own testing history and his projected score.



In summary, PVAAS calculates the likelihood of a student scoring in a selected performance level or higher (or selected benchmark or higher) by calculating the probability that the actual score will be above the associated cut score. PVAAS uses the estimated projected score and the standard error from the PVAAS Projection Model to calculate this projection probability.



Statistical Considerations

PVAAS analyses make use of scores from Pennsylvania's state assessments, specifically the PSSA and Keystone exams. The scales from these assessments must meet three criteria to be used in value-added and projection analyses by SAS EVAAS.

1. They demonstrate sufficient stretch so that students with a high achievement history and those with a low achievement history can show growth.
2. They are aligned to state curriculum standards.
3. The scales are reliable from year to year.

Accounting for Student Demographics

Due to the relationship of demographics and achievement, many assume there is the same relationship between growth and demographics. However, a review of the literature indicates that demographic variables (such as socioeconomic status and racial/ethnic background) typically have little to no significant relationship with student growth measures as long as you can sufficiently account for the prior achievement of students.

The SAS EVAAS team has found that the only way to adequately account for prior achievement is to use all available test data for each student to dampen the effects of measurement error. Hence, value-added analyses in PVAAS measure the change in students' academic achievement levels from one point in time to another using ALL prior data to sufficiently account for the prior achievement of students. Factors that remain relatively constant over time have been shown to have little or no impact on students' progress or growth. This approach has been confirmed through a variety of robust statistical analyses. In 2004, a SAS, Inc. and Vanderbilt team published a study that closely examined SES and demographic adjustments and concluded that "SES and demographic [variables] add little information beyond that contained in...test scores."

As a result, additional adjustments for the demographic status of students are not included in the analyses as it accounts for students' prior achievement. Evidence from PVAAS reporting in Pennsylvania has yielded results to show that there are many districts, schools and teachers in Pennsylvania making significant growth with EL students, minority students, economically disadvantaged students, and students with IEPs.

The following are literature reviews on the topic of growth and student demographics:

1. Ballou, D., W. Sanders, and P. Wright. 2004. "Controlling for Student Background in Value-Added Assessment." Journal of Education and Behavioral Statistics, 29(1), pp. 37-65.
2. An economist-based perspective by UCLA researchers Pete Goldschmidt, Kilchan Choi and Kyo Yamashiro provided a similar finding in their study comparing value-added models: "First, adding in an adjustment for student SES (as measured by eligibility for free- or reduced-price lunch) adds very little once a student's initial status is controlled... This indicates that student initial status captures many of the effects that SES is attempting to measure. In other words, by controlling for initial status, the model already captures the preceding effects that SES might have on students." Choi, K., P. Goldschmidt, and K. Yamashiro (2006). Exploring Models of School Performance: From Theory to Practice (CSE Report 673). Los Angeles, CA: National Center for Research on Evaluation, Standards, and Student Testing (CRESST), p. 24.
3. A single measure of student achievement has inherent limitations due to the fact that achievement is correlated to a student's socioeconomic status and past performance (Hershberg, et al.; Olson, 2007; Sanders, 2000).

4. Fallon (2003) reports that the importance of value-added assessment is it being based on the experimental design that removes virtually all influence of genetics and socio-economic factors. The design provides a measure of the direct effect of the effectiveness of schools.

5. [Value-added assessment systems] can remove the effects of factors not under the control of the school, such as prior performance and socioeconomic status, and thereby provides a more accurate indicator of school or teacher influence than is possible when these factors are not controlled (McCaffrey, Lockwood, Koretz & Hamilton, 2003; Ross, Wang, Sanders, Wright & Stringfield, 1999a; Wright, Horn & Sanders, 1997).

Methodology Resources

The SAS EVAAS methodologies and algorithms have been published in open literature since 1997. For those interested in learning more about the business rules and technical aspects of the statistical models used in all applications in Pennsylvania, please see the following two resources.

1. Sanders, W. L., Saxton, A. M., and Horn, S. P. (1997). "The Tennessee Value-Added Assessment System: A Quantitative, Outcomes-Based Approach to Educational Assessment." In Millman, J. (ed.) Grading Teachers, Grading Schools, Thousand Oaks, CA: Sage Publications, pp. 137-162.

   (Chapters 12 through 16 focus on the Education Value-Added Assessment System (EVAAS) upon which PVAAS is based.)

2. Technical Documentation of PVAAS Analyses, available at: Statistical Models and Business Rules of PVAAS Analyses
3. SAS EVAAS: Topics in PVAAS Reporting (PDF)

PVAAS Learning Resources

There are e-Learning resources and online help available on the PVAAS website. The e-Learning resources can be found by clicking on the e-Learning button on the right side of the blue menu bar. Online help can be found for any report by clicking on the Help button on the right side of the blue menu bar when on any web-based report.

Additionally, check out these videos and links to deepen your understanding of PVAAS:

1. What Should You Know About PVAAS? (PDF)
2. Baseball and PVAAS: What's the Connection? (Video) and Video Companion Guide (PDF)
3. e-Learning Module: The Concept of Growth
4. High Achievement and High Growth: Can it Be Done? (PDF)

For additional resources on this topic,
visit the PVAAS webpage on **pa.gov/education** >