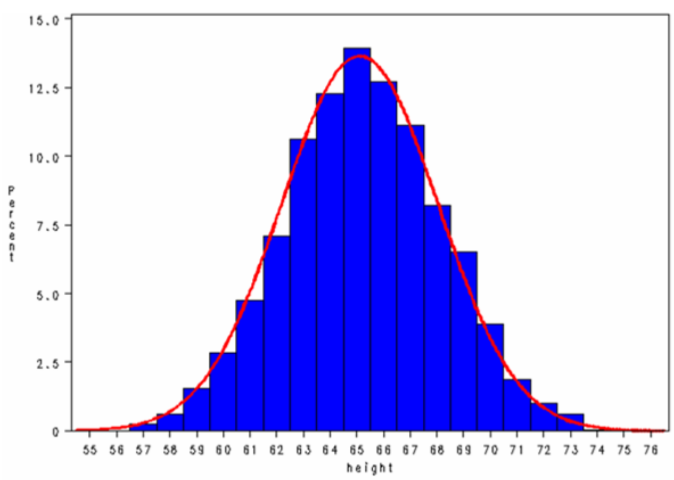
Making Sense of NCEs and Standard Errors

What are Normal Curve Equivalents (NCEs)?

Normal Curve Equivalents, or NCEs, are standardized scores used in education and other social sciences. Student scores are often converted to NCEs to ensure that all assessment scores are on a common scale across years, grades, and subjects. NCEs are similar to percentiles in that they represent where a score falls in a distribution of scores. In PVAAS, the conversion of students' scores to NCEs is necessary only in the growth standard methodology used to measure growth in Math and ELA in grades 4 through 8.

To further understand what NCEs are, let's first discuss distributions. The graph below depicts the distribution of heights in a group of students. Notice that the majority of the students' heights are clustered around the middle, near 65 inches, with fewer students being very short or very tall.

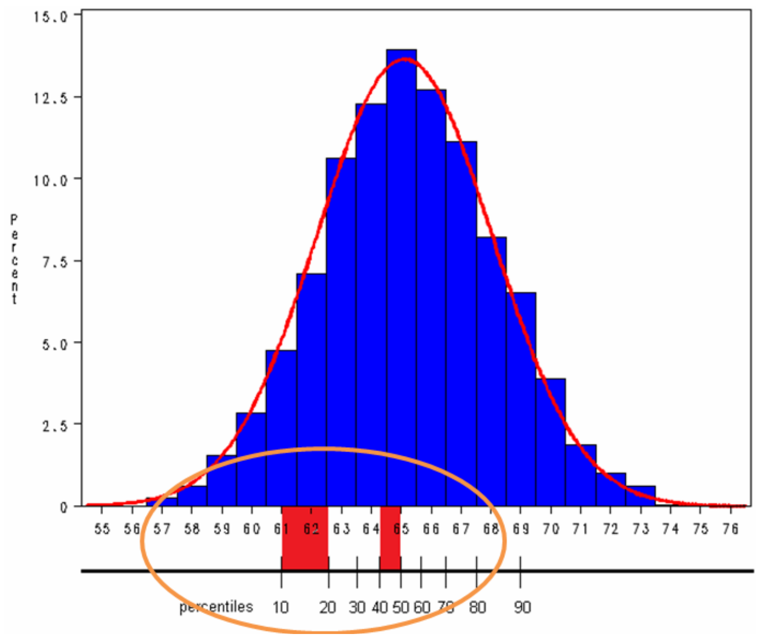


Simulated data

When looking at the achievement of a population of students, the distribution is similar. A large number of students are close to the center of the distribution, and there are fewer students who are very close to the bottom or top of the range. It's important to note that this naturally occurring distribution of student achievement does not result in a predetermined distribution of PVAAS Growth Measures. In other words, there is no predetermined number or percentage of districts, schools, or teachers at any level or growth color indicator in PVAAS.

When graphed, a normal distribution will appear to be a bell-shaped curve, like the red curve in the graph above. A student's position in a distribution can be described in many ways, the most common of which is by percentile. A student whose height is at the 10th percentile is taller than 9% of other students.

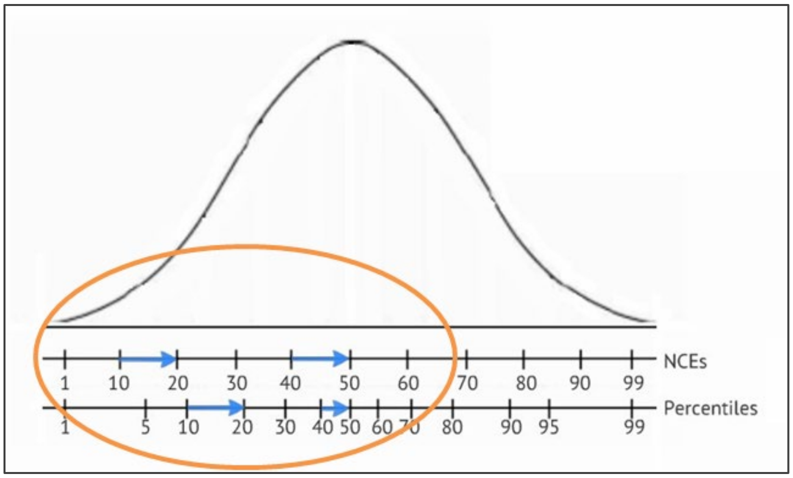
Percentiles present a limitation, however, when describing movement in a distribution. Continuing with our height example, a student at the 10th percentile would have to grow about 1.5 inches to move to the 20th percentile. However, a student at the 40th percentile would only have to grow about 0.75 inches to move to the 50th percentile, as highlighted in the figure below. Although both students would grow the same in percentile points, their growth in inches would be very different.



The same is true with changes in academic achievement. Movement from the 10th to 20th percentile is not comparable to movement from the 40th to 50th percentile. Notice that the percentiles are not at equal intervals along the axis.

The solution to this problem is to use NCEs. NCEs are on an equal-interval scale. NCE stands for Normal Curve Equivalent. NCEs were developed for the United States Department of Education (USDOE), to allow for easier interpretation of movement in a normal distribution.

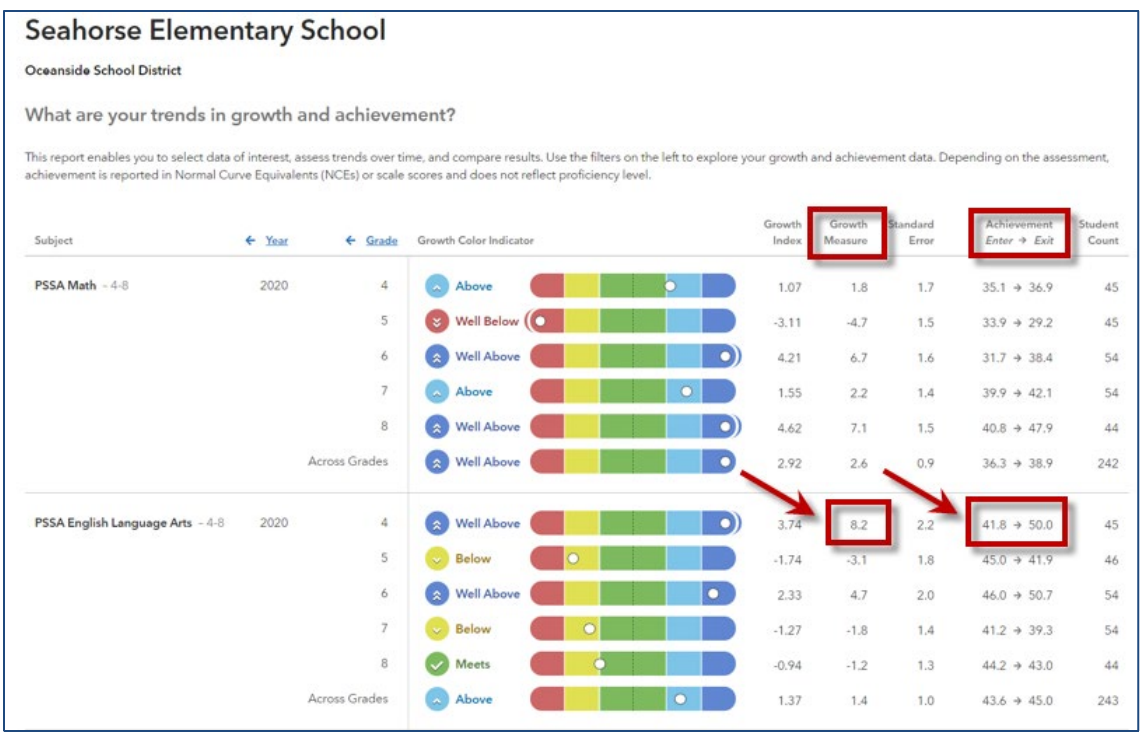
On an equal-interval scale, the difference between 10 and 20 is the same as the difference between 40 and 50, as shown in the graph below. This is different than with a percentile scale where the intervals are different.



NCEs correspond to percentiles at 1, 50, and 99, as shown above. By definition, a score at the 50th NCE (or percentile) is average. The major advantage of NCEs over percentiles is that NCEs can be averaged. Percentiles cannot be averaged because the distances (or differences) between percentiles are not equal.

What is growth?

In PVAAS value-added reporting, the estimated Growth Measures describe how students moved in the state distribution of scores, in NCE units, from Entering Achievement to Exiting Achievement, as illustrated below. Note that differences may not be exact due to rounding when displayed in the web-based reporting.



Seahorse Elementary School

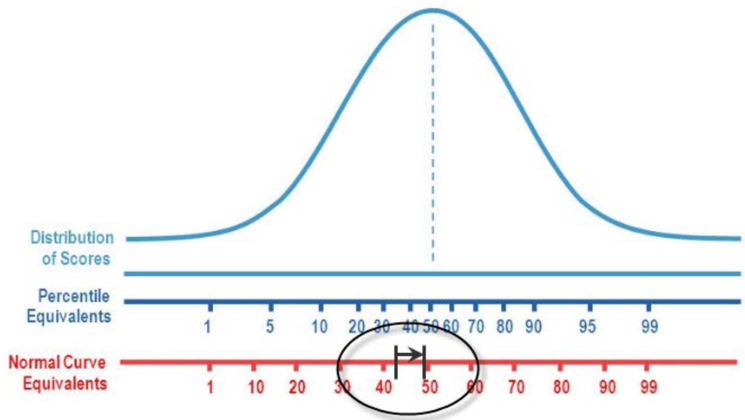
Oceanside School District

What are your trends in growth and achievement?

This report enables you to select data of interest, assess trends over time, and compare results. Use the filters on the left to explore your growth and achievement data. Depending on the assessment, achievement is reported in Normal Curve Equivalents (NCEs) or scale scores and does not reflect proficiency level.

Subject	← Year	← Grade	Growth Color Indicator	Growth Index	Growth Measure	Standard Error	Achievement Enter → Exit	Student Count
PSSA Math - 4-8	2020	4	Above	1.07	1.8	1.7	35.1 → 36.9	45
		5	Well Below	-3.11	-4.7	1.5	33.9 → 29.2	45
		6	Well Above	4.21	6.7	1.6	31.7 → 38.4	54
		7	Above	1.55	2.2	1.4	39.9 → 42.1	54
		8	Well Above	4.62	7.1	1.5	40.8 → 47.9	44
		Across Grades	Well Above	2.92	2.6	0.9	36.3 → 38.9	242
PSSA English Language Arts - 4-8	2020	4	Well Above	3.74	8.2	2.2	41.8 → 50.0	45
		5	Below	-1.74	-3.1	1.8	45.0 → 41.9	46
		6	Well Above	2.33	4.7	2.0	46.0 → 50.7	54
		7	Below	-1.27	-1.8	1.4	41.2 → 39.3	54
		8	Meets	-0.94	-1.2	1.3	44.2 → 43.0	44
		Across Grades	Above	1.37	1.4	1.0	43.6 → 45.0	243

In this example, the group of grade 4 ELA students have an entering achievement of 41.8 in the state distribution, and an exiting achievement of 50.0. These two numbers represent *positions* in the distribution, as marked by the black vertical lines highlighted in the illustration below:



The students *moved up* in the distribution approximately 8.2 NCE units:

$$50.0 - 41.8 \approx 8.2$$

Another way to express this concept is to say that the students experienced approximately 8.2 NCE units of *growth*.

However, this number is an *estimate* of growth. In the reporting, each estimate is also accompanied by its standard error, discussed in the next section.

What is standard error?

In discussing what standard error is, consider an example of two schools (A and B) with the same Estimated Growth Measure of 3.0 NCE units. In simple terms, this value of 3.0 indicates that both groups of students moved up 3.0 NCE units in the distribution of scores from last year to this year.

Consider also that the two schools have different standard errors. School A is larger than School B, and the testing records from School A are more complete than those from School B, which has some missing scores. Both the quantity (amount) and quality (completeness) of the data affect the strength of the evidence in the estimate. The standard error provides a confidence band around an estimate. Because School A has more data than B and has fewer missing scores, School A will have a smaller standard error than School B.

A smaller standard error indicates that the evidence to support the measure is stronger. In our example, School A has more students, and their testing records are more complete. As a result, there is more evidence that yielded the Growth Measure. Depending on how different their standard errors are from each other, the schools could have different color-coding on their School Value-Added reports.

How is standard error used?

The standard errors are used with the Growth Measures in two main ways within the reporting: (1) in applying the value-added colors and (2) in determining the Average Growth Index, both of which are discussed below.

How are the colors applied?

In PVAAS Value-Added reports, color-coding is applied based on two values: the Estimated Growth Measure and the Standard Error. More specifically, the colors are based on how many standard errors the estimate is from the growth standard.

The growth standard is met when the student group maintains their relative achievement level from one year to the next. In other words, if the estimated Growth Measure is zero, then the student group met the growth standard.

Growth Color Indicators

Well Above	Significant evidence that the school exceeded the growth standard.
Above	Moderate evidence that the school exceeded the growth standard.
Meets	Evidence that the school met the growth standard.
Below	Moderate evidence that the school did not meet the growth standard.
Well Below	Significant evidence that the school did not meet the growth standard.

The legend in the reporting provides a verbal description of the color-coding.

The amount of evidence is quantified by the standard error. The standard errors and colors can be represented in the following way:

- DARK BLUE (Well Above) – Growth Measure is more than 2 standard errors above the growth standard (0).
- LIGHT BLUE (Above) – Growth Measure is more than 1, but less than 2, standard errors above the growth standard (0).
- GREEN (Meets) – Growth Measure is between 1 standard error above and below the growth standard (0).
- YELLOW (Below) – Growth Measure is more than 1, but less than 2, standard errors below the growth standard (0).
- RED (Well Below) – Growth Measure is more than 2 standard errors below the growth standard (0).

Consider the example below, where 6th grade received a dark blue color (Well Above), 7th grade received a yellow color (Below), and 8th grade received a green color (Meets).

Subject	← Year	← Grade	Growth Color Indicator	Growth Index	Growth Measure	Standard Error	Student Count
PSSA English Language Arts - 4-8	2020	4	Well Above	3.74	8.2	2.2	45
		5	Below	-1.74	-3.1	1.8	46
		6	Well Above	2.33	4.7	2.0	54
		7	Below	-1.27	-1.8	1.4	54
		8	Meets	-0.94	-1.2	1.3	44
		Across Grades	Above	1.37	1.4	1.0	243

- For 6th grade, the estimated growth is 4.7 with a standard error of 2.1. The dark blue range begins at two standard errors above 0.0 (in this case, 2 x 2.1 = 4.2). The Growth Measure of 4.7 is more than 2 standard errors (4.2) above 0.0, so it falls into the dark blue range of Well Above.

- For 7th grade, the estimated growth is -1.8 with a standard error of 1.4. The yellow range is between one and two standard errors below 0.0. In this case, that range is between -1.4 and -2.8. The Growth Measure of -1.8 is between one and two standard errors below 0.0 (between -1.4 and -2.8), so it falls into the yellow range of Below.

- For 8th grade, the estimated growth is -1.2 with a standard error of 1.3. The green range is between one standard error below 0.0 and one standard error above 0.0. In this case, that range is between -1.3 and 1.3. The Growth Measure of -1.2 is between one standard error below 0.0 and one standard error above 0.0 (between -1.3 and 1.3), so it falls into the green range of Meets.