Technical Description of HISD Teacher Value-Added Metrics

Introduction

This document describes how SAS implements Houston Independent School District's policy decisions when calculating cumulative gain index values and composites for teachers in the tested subjects and/or grades.

While the following text provides a specific example of a teacher's various value-added measures, the key policy decisions can be summarized as follows:

- A multi-year trend is calculated for an individual subject and grade for up to three years.
- A cumulative gain index is calculated across grades for a subject.
- All teacher value-added measures are centered on the overall district average for that year, subject, and grade.
- A composite is calculated for multiple subjects and grades for up to three years.
- The composite for teachers includes only the subjects for which the teacher has a value-added measure in the current year.
- The composite for teachers weighs each subject/grade/year equally.
- The composite for teachers uses the *most appropriate and robust* statistical approach possible in the calculation of the value-added estimate and associated standard error.

For Teachers with STAAR EOG Testing

If a teacher has taught grades three through eight in math, reading, language, science, and social studies with the STAAR or Stanford test, the following example shows a multiple-year trend, cumulative gain index within a year, and an overall composite across subjects and grades.

Example 1: Available Data for a Sample Teacher across Subjects and Grades

Year	Subject	Grade	Value-Added Gain	HISD District Gain	Standard Error
2010	Science	8	4.20	-0.65	2.00
2010	Reading	7	3.50	1.30	1.50
2011	Reading	8	0.50	-1.20	1.40
2011	Math	8	4.50	2.00	1.60
2012	Math	7	1.50	1.20	1.30
2012	Reading	8	-0.30	0.50	1.20
2012	Math	8	3.80	1.80	1.50

Calculating Gains for the Above Examples

For the teacher in Example 1, a multi-year trend can be calculated using the two years of data for this teacher in a specific subject and grade, eighth-grade math. The multiple-year trends in HISD will use re-estimated value-added gains and standard errors for years prior to the current year. This re-estimation will take into account current year student-level information to provide the most precise and reliable estimate of the prior year using all available information for that teacher in the year being analyzed. Each year used in the HISD multi-year trend is weighted equally, which ensures that teachers are neither advantaged nor disadvantaged due to one particularly different year. Because student groups and scenarios are different every year, this approach will dampen any year-to-year variability. Because the value-added estimates are on the same scale (Normal Curve Equivalents), the composite gain across the years is a simple mean gain using all of the cells with equal weights from above.

The multi-year gain for Example 1 is calculated as follows:

$$Multi_{year}Gain = \frac{1}{2}Math_{8_{2011}} + \frac{1}{2}Math_{8_{2012}} = \frac{1}{2}4.50 + \frac{1}{2}3.80 = 4.15$$

Notice that in the multi-year trend the teacher's score does not take into account the district-level gain when calculating the multi-year NCE gain.

Next, the cumulative gain index can be calculated for math in the current year. This includes a measure that will incorporate the seventh- and eighth-grade math value-added measures for the current year. The cumulative gain index is also centered on the overall HISD district gain for each grade and subject. The cumulative gain index calculation can be split into calculating the gain and then the standard error for that gain. The gain part of the cumulative gain can be calculated as follows:

$$CGI_{Gain} = \frac{1}{2}\left(Math_{8_{2012}} - Dist_{Math8_{2012}}\right) + \frac{1}{2}\left(Math_{7_{2012}} - Dist_{Math7_{2012}}\right)$$
$$= \frac{1}{2}(3.80 - 1.80) + \frac{1}{2}(1.50 - 1.20) = 1.15$$

The standard error of each of the above gains is described in the next section.

Finally, a composite gain that includes more than one subject is calculated. A teacher's composite only includes the subjects for which there is a value-added report in the most recent year. As a result of this policy, the teacher is accountable only for the subject(s) that he or she currently teaches. There are a variety of reasons why a teacher may not teach a particular subject anymore, and this policy mitigates any concerns related to a deliberate decision by the teacher or his/her administrator to focus on other subject(s). As a consequence, this teacher's science report will be excluded from the composite since science had no value-added measure in 2012. However, this teacher's seventh-grade reading report will be included, even though there was no value-added measure for seventh-grade reading in 2012, because there were value-added measures for the subject reading in 2012. The last six rows of the chart above represent the five subject/grade/years that will be used in this sample teacher's composite.

Each subject/grade/year used in the composite is weighted equally as was done with the years above. Again, since the value-added estimates are on the same scale (Normal Curve Equivalents), the composite gain across the six subject/grade/years is a simple mean gain using all of the cells with equal weights. The composite gain is calculated using the following formula:

$$Comp\ Gain = \frac{1}{6}Read_{7_{2010}} + \frac{1}{6}Math_{8_{2011}} + \frac{1}{6}Math_{8_{2012}} + \frac{1}{6}Math_{7_{2012}} + \frac{1}{6}Read_{8_{2011}} + \frac{1}{6}Read_{8_{2012}}$$
$$= \frac{1}{6}3.50 + \frac{1}{6}4.50 + \frac{1}{6}3.80 + \frac{1}{6}1.50 + \frac{1}{6}0.50 - \frac{1}{6}0.30 = 2.25$$

Of course this composite gain can also be centered on the overall district gain. Instead of subtracting each individual gain, the average district gain for the subjects and grades above can be subtracted from the gain above. Using a similar formula as above, the overall average district gain is 0.93. So the district-centered overall composite gain is 2.25 - 0.93 = 1.32.

Calculating Standard Errors for the Above Examples

The standard error for the multi-year trend value-added gain cannot use the same simple mean and weighting approach as described above. To calculate the standard error of the average, you must do a slightly different calculation. In the first two scenarios, cumulative gain index and multi-year trend, the students in each of the different value-added measures for the most part are completely different. This allows us to assume that the measures are independent of one another.

A simple standard error calculation, which does assume independence, would be represented as follows:

$$SE\ Multi_{year}Gain = \frac{1}{2}\sqrt{\left(\left(SE\ Math_{8_{2011}}\right)^2 + \left(SE\ Math_{8_{2012}}\right)^2\right)} = \frac{1}{2}\sqrt{((1.60)^2 + (1.50)^2)} = 1.097$$

To calculate the standard error for the cumulative gain, you would do the same thing for all of the subjects and grades that are included in the calculation. There is no need to take into account the error around the overall district level gains.

$$SE\ CGI\_Gain = \frac{1}{2}\sqrt{\left(\left(SE\ Math_{7_{2012}}\right)^2 + \left(SE\ Math_{8_{2012}}\right)^2\right)} = \frac{1}{2}\sqrt{((1.30)^2 + (1.50)^2)} = 0.992$$

Therefore the cumulative gain index would simply be the cumulative gain divided by the standard error of the cumulative gain.

$$CGI = \frac{CGI_{Gain}}{SE\ CGI\_Gain} = \frac{1.15}{0.992} = 1.12$$

The simple formula of standard error does not address the relationships between each subject/grade/year. More specifically, the students taught by this teacher in eighth-grade math in 2012 could also be taught by this teacher in 2012 in eighth-grade reading. Furthermore, the teacher could have taught the same students in seventh-grade reading in 2010 as well as in eighth-grade reading in 2011. Since these student scores are certainly related to one another, the standard error values of value-added measures for each subject/grade/year are not assumed to be independent.

The first step towards calculating the standard error, which does not assume independence, would be the standard formula for the *variance* of a sum of two values:

$$Var\left(\frac{X+Y}{2}\right) = \left(\frac{1}{2}\right)^2 Var(X) + \left(\frac{1}{2}\right)^2 Var(Y) + 2\left(\frac{1}{2}\right)^2 Cov(X,Y)$$

The standard error is the square root of the variance, and the variance is the square of the standard error. Since the composites utilize the standard error, the composite standard error can be represented by the following formula:

$$SE\left(\frac{X+Y}{2}\right) = \frac{1}{2}\sqrt{Var(X) + Var(Y) + 2Cov(X,Y)}$$

Please note the term Cov(X,Y) in the equation. The covariance is a measure of relationship, and it is a function of the correlation of two values. If the values have a positive relationship, then the covariance will be positive. Most of the time, there will be a positive relationship, and this means that the TCAP composite standard error is larger than it would be assuming independence. The term Cov(X,Y) is calculated as follows:

$$Cov(X,Y) = Correlation(X,Y)\sqrt{Var(X)}\sqrt{Var(Y)}$$

The correlation can range from -1 to 1, and it will typically be from 0 to 1, indicating a positive relationship. A correlation of zero would lead to the simple formula used at the beginning of this section. The EVAAS value-added modeling estimates the covariance using all of the information about what students are in what subject/grade/year for each teacher. This will lead to the appropriate standard error that will typically be between these two extremes of correlation.