The Impact of ACT Scores on Teaching Effectiveness

Introduction

At the request of the Tennessee Higher Education Commission (THEC), SAS analyzed the TVAAS teacher value-added reporting in conjunction with those teachers' ACT scores to determine whether there is any relationship or predictive properties between the two measures. This research brief summarizes the results of this preliminary research.

Data

Since 1996, TVAAS teacher-level value-added estimates have been available in the State of Tennessee based on statewide standardized tests, such as Tennessee Comprehensive Assessment Program (TCAP) Mathematics, Reading, Science and Social Studies in grades three through eight and End-of-Course (EOC) Algebra I, Algebra II, Biology I, English I, English II, English III and U.S. History. For a particular subject, grade, and year taught by a teacher, TVAAS provides a value-added estimate and standard error. The TVAAS value-added estimate utilizes shrinkage estimation, such that each teacher is assumed to be average (in the state for end-of-course subjects and in the system for TCAP subjects) until the weight of the evidence pulls that estimate above or below the growth expectation. An "effectiveness index" is calculated by dividing each estimate by its standard error, and this index provides interpretation as to the level of certainty that a teacher's estimate is decidedly above or below the expectation of academic progress.

These data were used in conjunction with ACT scores, which were sent to SAS by THEC for teachers who had recently completed their pre-service training in Tennessee. The ACT scores included Math, English, Reading, Science, and the Composite. These scores were then matched to teachers who had received teacher value-added estimates in the school years of 2009 – 2010, 2010 – 2011 and 2011 – 2012. If a teacher taught multiple subjects and grades, a composite was created for the single-year 2011 – 2012 estimate as well as the three-year average.

Tables 1 – 4 summarize some of the basic properties of this data regarding distributions and means. More specifically, Table 1 summarizes the distribution of the ACT scores by subject for the sample of teachers who have ACT scores and at least one TVAAS teacher estimate. The ACT Math scores for these teachers were lower than for the other subjects. However, it is noteworthy that the variation among teacher reading scores was the largest with a standard deviation of 5.23.

Table 2 summarizes the distribution of ACT scores by subject for the grade taught in 2012 for grades four through eight. In all subjects, the mean ACT scores for fourth grade teachers were lower than the other grades. However, the variation in sixth grade teachers' ACT scores was noticeably larger than for some of the other grades taught.

Table 3 summarizes the distribution of ACT scores by subject for the end-of-course subject taught in 2012 for Algebra I, Algebra II, Biology, I English I, and English II. Math teachers tended to have higher ACT Math scores than for the other subjects, and the converse was found to be true for English teachers. This suggests that teachers may self-select into the areas of teaching for which they prefer and/or perhaps have a greater aptitude.

Table 4 summarizes the distribution of TVAAS teacher effectiveness indices by test, subject and year. The number of teachers with merged records across grades four through eight varies considerably. There were fewer Math and Science teachers with TVAAS estimates than there were for Reading and Social Studies. For the

teachers in these samples, the variability among teachers' indices was the largest for Math and Social Studies: respectively, they are 3.81 and 3.52 for the 2012 estimate and 5.24 and 4.53 for three-year estimates. For high school 2012 EOC subjects, the variation was largest for Algebra I (3.09), followed by US history (2.42). This was also true for the three-year estimates.

Analysis

The relationship between teachers' ACT scores and their subsequent single-year 2012 TVAAS effectiveness indices was analyzed in several different ways. Using teacher effectiveness indices as the dependent variable, various statistical models were fitted to the data. Various combinations of ACT scores were used as predictor variables with some models also including discrete variables, such as 'District taught in' and 'university attended.' None of these models yielded significant relationships between ACT scores of teachers and their subsequent estimates of teacher effectiveness. A subset of these findings is presented in Tables 5 – 6, which show Spearman rank correlations.

Initial Conclusions of Preliminary Research

The results from all analyses indicate that there is virtually no relationship between teachers' ACT scores and their subsequent single-year 2012 TVAAS effectiveness estimates. As illustrated in Tables 5 – 6, the observed relationships hover near zero in nearly all cases. For elementary teachers, these overall findings were true whether the data were analyzed across all grades (four through eight) or in grade groups (four through five and six through eight).

A similar study conducted fifteen years ago using three-year TVAAS teacher estimates and ACT scores did show a very positive relationship between ACT Math scores and the TVAAS teacher estimate for math in grades six and beyond. It is surprising that the results of this study did not confirm the earlier research. There are, however, some differences in the datasets that could have caused this discrepancy.

First, the current study used single-year estimates, rather than three-year estimates, due to data constraints. There simply was not enough data for three-year estimates.

Second, as Table 7 illustrates, the distribution of teacher estimates varies widely within each ACT range and it becomes larger as the ACT scores become higher. In other words, each ACT range contained very ineffective teachers and very effective teachers. However, the percentage of highly effective math teachers tends to increase as ACT scores increased (note the 75th percentile column). A conclusion may be that while ACT Math scores are likely a poor screen to identify teachers likely to be ineffective in the future, it may be useful to indicate teachers likely to be effective in math in the future.

Third, it appears that for the most recent cohorts of Tennessee high school teachers for whom TVAAS estimates exist, the distributions of ACT Math scores were concentrated towards the high end of the ACT scale. This suggests that a considerable percentage of beginning teachers enter teaching with a high degree of content knowledge. See Table 3 for example. The median ACT Math scores for Algebra I and Algebra II teachers was 26 while the ACT Math scores at the 25th percentile were 21 and 25 for Algebra I and Algebra II, respectively. This is positive evidence that Tennessee's newer EOC math teachers are entering teaching with relatively high ACT math scores. This apparent shift in the distribution could at least partly explain why very little overall relationship was apparent in these investigations, yet similar investigation over a decade ago found very positive relationships between ACT Math scores and TVAAS EOC math estimates.

TABLE 1. DISTRIBUTION OF MERGED ACT SCORES

ACT Subject	N	Mean	Std. Dev.	10th P-tile	25th P-tile	50th P-tile	75th P-tile	90th P-tile
ACT Math	1,057	20.90	4.30	16.00	18.00	20.00	24.00	27.00
ACT English	629	23.21	4.57	18.00	20.00	23.00	26.00	29.00
ACT Reading	1,041	23.06	5.23	16.00	20.00	23.00	27.00	30.00
ACT Science	1,044	21.55	3.67	17.00	19.00	22.00	24.00	26.00
ACT Composite	1,177	22.55	3.90	18.00	20.00	22.00	25.00	28.00

TABLE 2. DISTRIBUTION OF ACT SCORES BY 2012 ELEMENTARY GRADE TAUGHT

Grade in 2012	N	Mean	Std. Dev.	10th P-tile	25th P-tile	50th P-tile	75th P-tile	90th P-tile
Four								
ACT Math	209	19.3	3.6	15	17	19	22	25
ACT English	127	22.1	4.4	17	19	23	25	28
ACT Reading	205	21.3	4.7	15	18	21	24	28
ACT Science	205	20.4	3.2	17	18	20	23	25
ACT Composite	220	21.0	3.4	17	19	20	23	26
Five								
ACT Math	189	20.1	3.7	16	17	19	23	26
ACT English	98	22.2	3.9	18	20	22	25	27
ACT Reading	186	22.4	5.1	16	19	22	26	29
ACT Science	186	21.0	3.5	17	19	21	23	25
ACT Composite	205	21.8	3.7	17	19	22	24	27
Six								
ACT Math	201	20.3	4.3	15	17	20	23	26
ACT English	130	22.8	4.6	17	20	23	26	29
ACT Reading	199	22.5	5.1	16	19	22	26	29
ACT Science	199	21.4	3.9	16	19	21	24	26
ACT Composite	219	22.0	3.7	17	20	22	24	27
Seven								
ACT Math	137	21.6	4.0	17	18	21	25	27
ACT English	84	23.4	4.4	18	20	24	26	29
ACT Reading	133	23.8	4.7	19	21	24	27	30
ACT Science	134	22.3	3.3	18	20	22	25	27
ACT Composite	152	22.9	3.4	19	20	22	25	28
Eight								
ACT Math	93	21.2	3.9	16	18	21	25	26
ACT English	58	23.7	4.4	18	21	23	27	29
ACT Reading	92	24.3	4.7	18	21	25	28	30
ACT Science	92	21.5	3.5	17	19	22	24	26
ACT Composite	105	23.1	3.6	18	21	23	26	28

TABLE 3. ACT DISTRIBUTIONS BY 2012 END-OF-COURSE SUBJECT TAUGHT

End-of-Course Subject	N	Mean	Std. Dev.	10th P-tile	25th P-tile	50th P-tile	75th P-tile	90th P-tile
Algebra I								
ACT Math	63	25.3	4.4	19	21	26	28	31
ACT English	34	24.7	5.1	17	22	26	28	29
ACT Reading	62	23.8	5.7	17	20	23	28	31
ACT Science	63	23.7	3.9	18	21	24	26	28
ACT Composite	80	24.9	4.3	19	22	25	27	30
Algebra II								
ACT Math	29	26.9	3.5	23	25	26	28	34
ACT English	19	24.8	4.4	20	22	24	28	33
ACT Reading	28	24.5	6.2	16	21	24	31	33
ACT Science	29	24.3	3.5	20	22	24	27	30
ACT Composite	41	26.1	4.0	21	23	26	29	31
Biology I								
ACT Math	34	22.6	4.2	18	19	22	26	28
ACT English	24	24.5	4.1	19	21	24	28	30
ACT Reading	33	23.9	5.3	17	21	24	28	30
ACT Science	33	23.4	3.7	19	21	23	25	28
ACT Composite	38	24.0	4.0	20	21	24	28	29
English I								
ACT Math	53	21.3	4.6	16	19	21	24	27
ACT English	28	25.8	4.1	21	22	25	29	31
ACT Reading	54	25.4	5.5	18	22	26	29	33
ACT Science	54	21.9	4.2	16	20	22	24	26
ACT Composite	66	24.0	4.0	19	22	24	27	29
English II								
ACT Math	52	22.2	3.9	17	20	22	25	28
ACT English	30	26.4	4.5	21	23	26	30	32
ACT Reading	52	26.6	5.3	20	24	27	29	35
ACT Science	53	22.5	3.5	18	21	23	24	27
ACT Composite	61	24.7	3.7	20	22	25	27	29

Note: There were insufficient data to report English III and U.S. History.

TABLE 4. DISTRIBUTION OF TVAAS TEACHER EFFECTIVENESS INDICES

Teacher Index by Subject and Year	N	Mean	Std. Dev.	10th P-tile	25th P-tile	50th P-tile	75th P-tile	90th P-tile
2012 Elementary Index								
TCAP Math	436	3.40	3.81	-0.61	0.99	2.86	5.21	8.39
TCAP Reading	477	1.13	1.92	-1.33	-0.06	1.15	2.29	3.32
TCAP Science	403	1.78	3.00	-1.54	-0.10	1.42	3.39	5.58
TCAP Social Studies	429	1.93	3.52	-2.14	-0.31	1.65	3.90	5.95
2012 High School End-of-Course Index								
EOC Algebra I	80	0.87	3.09	-3.32	-0.98	0.92	2.90	4.61
EOC Algebra II	41	0.48	3.17	-2.89	-1.76	0.66	2.57	4.51
EOC Biology I	38	0.69	2.23	-2.81	-0.12	1.07	1.75	3.49
EOC English I	66	-0.03	2.19	-2.83	-1.24	0.29	1.61	2.58
EOC English II	61	-0.01	2.27	-2.05	-0.86	0.17	1.64	2.19
EOC English III	33	-0.35	1.81	-1.97	-1.03	-0.32	0.80	1.28
EOC US History	36	0.95	2.42	-1.93	-1.11	0.93	3.03	4.02
3 Year Elementary Index								
TCAP Math	155	3.69	5.24	-0.90	0.80	2.74	5.46	9.94
TCAP Reading	190	0.45	2.44	-3.00	-0.92	0.65	1.89	3.45
TCAP Science	134	0.83	4.20	-3.39	-1.47	0.60	2.46	5.58
TCAP Social Studies	161	1.61	4.53	-3.08	-1.38	1.49	4.07	7.17
TCAP Composite	901	2.28	4.57	-2.50	-0.36	1.70	4.30	7.54
3 Year High School End-of-Course Index								
EOC Algebra I	39	2.81	4.28	-1.87	-0.31	2.63	5.95	8.28
EOC Biology I	14	1.70	3.95	-2.96	-1.22	2.49	3.78	4.49
EOC English I	29	0.03	3.06	-3.52	-1.28	0.54	1.91	3.58
EOC English II	16	0.95	1.71	-1.22	-0.45	0.90	2.17	3.49
EOC US History	17	0.73	4.01	-4.68	-0.35	0.54	3.52	5.60
EOC Composite	217	0.86	3.45	-3.23	-1.14	0.80	2.98	4.74

Note: 3 Year High School End-of-Course Indices are not available for Algebra II and English III.

TABLE 5. SPEARMAN CORRELATION COEFFICIENTS BETWEEN 2012 GRADE 4-8 TEACHER EFFECTIVENESS INDEX AND ACT SCORES

Note: This table presents Spearman Correlation Coefficients between the 2012 TVAAS Effectiveness Index by Subject and the ACT score by subject. The first row of each section presents the coefficient, and * indicates whether the coefficient is statistically significant or not ($p<0.10$). The second row of each section presents Prob > |r| under H_0: Rho=0. The third row presents the number of observations.

2012 TVAAS Index by Subject	ACT Math	ACT English	ACT Reading	ACT Science	ACT Comp
TCAP Math	0.03372	-0.04449	-0.04372	-0.00110	0.01389
Probability	0.5002	0.4955	0.3843	0.9826	0.7725
Number of Observations	402	237	398	398	436
TCAP Reading	-0.08335*	-0.02149	-0.08804*	-0.08015*	-0.07477
Probability	0.0794	0.7282	0.0666	0.0946	0.1029
Number of Observations	444	264	435	436	477
TCAP Science	-0.02075	0.00022	0.04506	0.06634	0.07595
Probability	0.6884	0.9974	0.3881	0.2030	0.1280
Number of Observations	376	224	369	370	403
TCAP Social Studies	0.12780*	0.13141*	0.11459*	0.07538	0.16634*
Probability	0.0108	0.0475	0.0234	0.1368	0.0005
Number of Observations	397	228	391	391	429

TABLE 6. SPEARMAN CORRELATION COEFFICIENTS BETWEEN 2012 END-OF-COURSE TEACHER EFFECTIVENESS INDEX AND ACT SCORES

Note: This table presents Spearman Correlation Coefficients between the 2012 TVAAS Effectiveness Index by Subject and the ACT score by subject. The first row of each section presents the coefficient, and * indicates whether the coefficient is statistically significant or not ($p<0.10$). The second row of each section presents Prob > |r| under H_0: Rho=0. The third row presents the number of observations.

As another note, the large negative relationship between ACT Science scores and TVAAS biology scores is surprising and is not readily explainable. However, a more detailed examination indicates that this relationship was not due to one or two outliers but the downward pattern had a degree of consistency.

2012 TVAAS Index by Subject	ACT Math	ACT English	ACT Reading	ACT Science	ACT Comp
EOC Algebra I	0.22760*	-0.08288	-0.00611	0.10971	0.01607
Probability	0.0728	0.6412	0.9624	0.3920	0.8875
Number of Observations	63	34	62	63	80
EOC Algebra II	0.32535*	0.12097	0.22155	0.07625	-0.03588
Probability	0.0850	0.6218	0.2572	0.6942	0.8238
Number of Observations	29	19	28	29	41
EOC English I	-0.26896*	-0.19530	-0.12157	-0.11746	-0.13174
Probability	0.0515	0.3193	0.3812	0.3976	0.2917
Number of Observations	53	28	54	54	66
EOC English II	0.09036	-0.10007	0.05012	0.21241	0.13060
Probability	0.5241	0.5988	0.7242	0.1268	0.3158
Number of Observations	52	30	52	53	61
EOC English III	-0.16204	-0.01477	0.01283	-0.17352	-0.04153
Probability	0.4010	0.9551	0.9473	0.3680	0.8185
Number of Observations	29	17	29	29	33
EOC Biology I	-0.12832	0.01266	-0.32353	-0.40662*	-0.21129
Probability	0.4695	0.9532	0.0663	0.0189	0.2029
Number of Observations	34	24	33	33	38
EOC U.S. History	0.13503	0.03316	0.27569	0.05795	0.21253
Probability	0.4612	0.8961	0.1267	0.7527	0.2133
Number of Observations	32	18	32	32	36

TABLE 7. 2012 TVAAS TEACHER EFFECTIVENESS INDEX IN TCAP MATH (GRADES 4 – 8) BY ACT SCORE GROUPS

	2012 TVAAS Teacher Index in TCAP Math							
ACT Math Score	**N**	**Mean**	**Std. Dev.**	**10th P-tile**	**25th P-tile**	**50th P-tile**	**75th P-tile**	**90th P-tile**
16 or below	57	3.56	3.96	-0.10	1.12	2.74	4.94	10.19
17 – 18	84	3.13	3.16	-0.32	0.88	2.75	4.70	6.97
19 – 21	103	3.18	3.45	-0.45	1.03	2.66	5.11	6.55
22 – 24	76	3.02	4.12	-1.56	0.49	2.54	4.97	9.54
25 – 27	63	3.92	4.32	-1.34	1.20	3.24	6.03	10.02
28 or greater	19	4.07	4.74	-0.59	0.07	3.45	7.16	8.39