

Validity Evidence for the Use of the Calculator Accommodation on the Standards of Learning (SOL) Assessments for the Spring 2009 Administration

The Commonwealth of Virginia permits the use of a calculator accommodation on *SOL* mathematics assessments for limited English proficient (LEP) students and students with disabilities (SWD). The following analysis provides evidence that accommodated mathematics SOL test administration conditions (e.g., calculator accommodation) for limited English proficient (LEP) students and students with disabilities (SWD) allow for valid inferences about students' knowledge and skills which can be combined meaningfully with scores from non-accommodated administration conditions.

Data from the spring 2009 administration were used to investigate the validity evidence of the use of calculator accommodations on both the regular mathematics assessments and the plain English mathematics assessments for LEP students and SWD. The plain English mathematics tests include items in which the language load has been reduced but the construct being measured remains the same. The plain English version of the mathematics tests is available for LEP students at the lowest levels of English proficiency for up to three consecutive years and to SWD based on their Individualized Educational Plans (IEP) or 504 plans.

Summary statistics of the scale scores were computed and factor analyses were conducted for LEP students and SWD who used the calculator accommodation on the regular mathematics tests and the plain English mathematics tests and for those that used any other accommodation. All other accommodations include such things as environmental modifications, visual aids (magnifying glass, masks to maintain place), large test print, assistance with directions, and Braille test form. The mathematics assessments were offered in two modes of administration: traditional paper and pencil or online computer based testing. Data from the paper and online administrations were combined for the analyses.

Tables 1- 4 show the summary statistics of scale scores by grade level for LEP students and SWD for grades 3-8 regular and plain English mathematics¹. Summary statistics provided include mean, standard deviation, minimum and maximum of the mathematic scale scores by grade level across all cores.

Table 1 shows that the average scale scores for LEP students using the calculator accommodation on the regular mathematics tests are generally lower than those for students using other accommodations, excluding calculator use. Similarly, Table 2 shows that the average scale scores for LEP students using the calculator accommodation on the plain English mathematics tests are also generally lower than those for students using other accommodations, excluding calculator use. Results indicating that LEP students

¹ All students are allowed to use a graphing calculator on the EOC level mathematics tests, i.e., Algebra I, Plain English Algebra, Algebra II, and Geometry. Therefore, there were no cases where calculators were used as an accommodation by SWD and LEP students on the EOC level mathematics tests.

who received the calculator accommodation consistently scored lower than students who did not suggests that this accommodation is not improving the performance of the LEP students who received it over those who used other accommodations.

Table 3 shows that the average scale scores for the SWD using the calculator accommodation on the regular mathematics tests are generally the same or lower than those for students using other accommodations, excluding calculator use. Table 4 displays similar results for the SWD using the calculator accommodation on the plain English math test. Again, results indicating that the SWD who received the calculator accommodation consistently scored lower than students who did not suggests that this accommodation is not improving the performance of the SWD who received it over those who were tested with a different accommodation.

Table 1 Summary statistics of scale scores for limited English proficiency students (LEP) with and without calculator accommodation for regular Math

Level/ Subject	Calculator	N	Mean	Std Dev	Min	Max
Grade 3 Math	Yes	20	362	53	271	483
	No	2662	450	67	87	600
Grade 4 Math	Yes	21	397	50	284	488
	No	2275	437	70	81	600
Grade 5 Math	Yes	51	385	88	176	600
	No	2023	461	77	213	600
Grade 6 Math	Yes	68	365	83	186	521
	No	1284	392	80	111	600
Grade 7 Math	Yes	61	360	66	238	510
	No	745	386	77	197	600
Grade 8 Math	Yes	18	364	73	254	541
	No	795	411	102	180	600

Table 2 Summary statistics of scale scores for limited English proficiency students (LEP) with and without calculator accommodation for plain English Math

Level/ Subject	Calculator	N	Mean	Std Dev	Min	Max
Grade 3 PE Math	Yes	121	385	62	250	600
	No	2737	430	74	86	600
Grade 4 PE Math	Yes	168	392	62	218	526
	No	1963	416	78	85	600
Grade 5 PE Math	Yes	167	419	77	231	600
	No	1566	427	92	19	600
Grade 6 PE Math	Yes	114	372	73	208	548
	No	1079	368	93	130	600
Grade 7 PE Math	Yes	55	341	64	224	514
	No	960	356	85	164	600
Grade 8 PE Math	Yes	12	359	81	253	495
	No	934	384	108	152	600

Table 3 Summary statistics of scale scores for students with disabilities (SWD) with and without calculator accommodation for regular Math

Level/ Subject	Calculator	N	Mean	Std Dev	Min	Max
Grade 3 Math	Yes	306	392	74	216	600
	No	2242	438	79	149	600
Grade 4 Math	Yes	463	405	69	237	600
	No	2121	436	81	81	600
Grade 5 Math	Yes	576	416	86	176	600
	No	1958	456	93	161	600
Grade 6 Math	Yes	651	354	80	186	600
	No	1870	386	91	130	600
Grade 7 Math	Yes	752	366	74	181	600
	No	1289	378	84	24	600
Grade 8 Math	Yes	213	370	91	106	600
	No	2533	369	102	12	600

Table 4 Summary statistics of scale scores for students with disabilities (SWD) with and without calculator accommodation for plain English Math

Level/ Subject	Calculator	N	Mean	Std Dev	Min	Max
Grade 3 PE Math	Yes	1239	406	73	218	600
	No	3120	431	73	86	600
Grade 4 PE Math	Yes	1538	407	67	203	600
	No	2859	426	71	85	600
Grade 5 PE Math	Yes	1763	417	81	75	600
	No	2655	442	83	109	600
Grade 6 PE Math	Yes	808	371	75	195	566
	No	2149	372	80	191	600
Grade 7 PE Math	Yes	512	354	68	181	546
	No	1514	364	71	164	600
Grade 8 PE Math	Yes	116	367	77	240	600
	No	2309	394	92	106	600

Tables 5 - 8 show the summary of factor analyses results for LEP students and SWD, respectively as well as Divgi's index (Hattie, 1985) values. Factor analyses can provide information on the number and nature of the underlying variables being measured by the items on each mathematics test. "[Factor analysis] tells us, in effect, what tests or measures belong together – which ones measure virtually the same thing, in other words, and how much they do so." (Kerlinger, 1973, p.659). Divgi's index is the ratio of the difference between the first and second eigenvalues to the difference between the second and third eigenvalues. A value that is greater than 3.0 implies that the test in question is characterized by a dominant first dimension.

Tables 5 - 8 present the first three eigenvalues and corresponding Divgi's index values for each analysis for the LEP and SWD subgroups, respectively. The cells with 'NA' indicate that the N-counts were too small for factor analysis.

The factor analyses results for LEP students with and without calculator accommodations for regular math and plain English math are shown in Tables 5 and 6, respectively. In all but a few cases the first eigenvalue is substantially larger than the second, and the second and the third eigenvalues are of similar magnitude. In addition, the results show that all values of Divgi's index exceed 3.0. For assessments with sufficient N-counts to support comparisons to be drawn, these results suggest that the math assessments across all grades and core forms are characterized by a dominant primary dimension for LEP students both with and without a calculator accommodation. This is an indication that the *SOL* math assessments are measuring a dominant trait or main factor for LEP students regardless of whether they received the accommodation or not.

Tables 7 and 8 show the factor analyses results for SWD with and without calculator accommodations for regular math and plain English math. Similarly, in all but a few cases the first eigenvalue is substantially larger than the second, and the second and the third eigenvalues are of similar magnitude. Additionally, all values of Divgi's index exceed 3.0. For assessments with sufficient N-counts to support comparisons to be drawn, these results suggest that the math assessments across all grades and core forms are characterized by a dominant primary dimension for SWD both with and without a calculator accommodation. This is an indication that the *SOL* mathematics assessments are measuring a dominant trait or main factor for the SWD regardless of whether they received the accommodations or not.

Table 5 Summary of factor analyses results for limited English proficient (LEP) students with and without calculator accommodation for regular Math

Level/ Subject	Core	Calculator	N- Count	Eigenvalues			Divgi's Index
				λ_1	λ_2	λ_3	
Grade 3 Math	1	Yes	17	NA	NA	NA	NA
		No	1444	5.85	0.73	0.54	27.62
	2	Yes	3	NA	NA	NA	NA
		No	1218	5.51	0.80	0.60	23.07
Grade 4 Math	1	Yes	21	NA	NA	NA	NA
		No	1180	7.32	0.78	0.55	27.35
	2	Yes	0	NA	NA	NA	NA
		No	1095	6.21	1.00	0.85	34.48
Grade 5 Math	1	Yes	39	NA	NA	NA	NA
		No	945	6.27	0.79	0.66	41.87
	2	Yes	12	NA	NA	NA	NA
		No	1078	5.86	1.10	0.83	17.56
Grade 6 Math	1	Yes	36	NA	NA	NA	NA
		No	566	7.06	0.87	0.74	46.05
	2	Yes	32	NA	NA	NA	NA
		No	718	7.72	1.87	0.71	5.06
Grade 7 Math	1	Yes	1	NA	NA	NA	NA
		No	27	NA	NA	NA	NA
	2	Yes	60	6.92	3.06	2.53	7.33
		No	718	6.92	1.87	0.75	4.48
Grade 8 Math	1	Yes	7	NA	NA	NA	NA
		No	291	11.61	1.24	1.08	63.33
	2	Yes	6	NA	NA	NA	NA
		No	168	11.23	1.68	1.34	27.86
	3	Yes	5	NA	NA	NA	NA
		No	336	10.09	1.63	1.00	13.27

Table 6 Summary of factor analyses results for limited English proficient (LEP) students with and without calculator accommodation for plain English Math

Grade	Core	Calculator	N-Count	Eigenvalues			Divgi's Index
				λ_1	λ_2	λ_3	
Grade 3 PE Math	2	Yes	121	7.79	1.71	1.61	61.78
		No	2737	8.11	0.73	0.54	37.22
Grade 4 PE Math	2	Yes	168	7.17	2.04	1.56	10.66
		No	1963	8.62	0.86	0.82	189.90
Grade 5 PE Math	2	Yes	167	7.85	1.71	1.53	33.33
		No	1566	9.46	0.88	0.78	78.86
Grade 6 PE Math	2	Yes	114	8.03	2.05	1.86	32.12
		No	1079	9.67	0.83	0.51	27.24
Grade 7 PE Math	2	Yes	55	6.45	3.40	3.07	9.30
		No	960	8.11	1.18	0.68	13.94
Grade 8 PE Math	3	Yes	12	NA	NA	NA	NA
		No	934	11.61	1.36	0.62	13.97

Table 7 Summary of factor analyses results for students with disabilities (SWD) with and without calculator accommodation for regular Math

Grade	Core	Calculator	N-Count	Eigenvalues			Divgi's Index
				λ_1	λ_2	λ_3	
Grade 3 Math	1	Yes	162	8.29	1.77	1.38	16.63
		No	1220	9.36	1.03	0.65	21.76
	2	Yes	144	9.35	2.02	1.69	21.79
		No	1022	8.53	1.68	0.82	7.90
Grade 4 Math	1	Yes	238	7.18	1.79	1.06	7.48
		No	1211	9.81	1.17	0.53	13.61
	2	Yes	225	7.93	2.34	2.15	30.30
		No	910	8.09	1.71	1.31	15.73
Grade 5 Math	1	Yes	315	8.34	1.29	1.11	38.10
		No	1023	9.72	0.78	0.70	118.27
	2	Yes	261	8.07	1.28	1.17	64.02
		No	935	8.35	1.41	0.93	14.29
Grade 6 Math	1	Yes	322	7.98	1.32	1.17	44.71
		No	897	8.84	0.76	0.69	124.61
	2	Yes	329	7.08	1.92	1.00	5.61
		No	973	8.48	1.57	1.03	12.85
Grade 7 Math	1	Yes	150	6.22	1.58	1.38	23.65
		No	202	8.36	1.44	1.16	24.28
	2	Yes	602	6.62	1.95	0.71	3.77
		No	1087	8.02	1.48	0.61	7.53
Grade 8 Math	1	Yes	34	NA	NA	NA	NA
		No	300	11.13	1.11	1.01	94.57
	2	Yes	49	NA	NA	NA	NA
		No	609	10.79	1.08	0.73	27.76
	3	Yes	130	8.58	1.94	1.77	39.64
		No	1624	9.57	1.13	0.69	19.05

Table 8 Summary of factor analyses results for students with disabilities (SWD) with and without calculator accommodation plain English Math

Grade	Core	Calculator	N-Count	Eigenvalues			Divgi's Index
				λ_1	λ_2	λ_3	
Grade 3 PE Math	2	Yes	1239	8.71	0.96	0.65	24.52
		No	3120	8.25	0.73	0.60	58.42
Grade 4 PE Math	2	Yes	1538	6.95	1.58	1.10	11.07
		No	2859	7.49	1.03	0.99	146.06
Grade 5 PE Math	2	Yes	1763	7.80	0.93	0.76	39.78
		No	2655	7.89	0.85	0.69	45.06
Grade 6 PE Math	2	Yes	808	7.59	1.58	0.63	6.31
		No	2149	7.91	1.18	0.53	10.42
Grade 7 PE Math	2	Yes	512	5.86	1.95	0.74	3.24
		No	1514	6.28	1.55	0.51	4.53
Grade 8 PE Math	3	Yes	116	7.07	2.67	1.76	4.82
		No	2309	9.22	1.78	0.51	5.87

References

Hattie, J. (1985). Methodology review: Assessing unidimensionality of tests and items. *Applied Psychological Measurement, 9*, 139–164.

Kerlinger, F. N. (1973). *Foundations of behavioral research*. New York: Holt, Rinehart, & Winston