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In-Brief: Reliability of the Slope of the easyCBM® Math Measures

Joseph F. T. Nese

Daniel Anderson

P. Shawn Irvin

Julie Alonzo

University of Oregon

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University of Oregon • 175 Education
5262 University of Oregon • Eugene, OR 97403-5262
Phone: 541-346-3535 • Fax: 541-346-5689
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Abstract

This in-brief technical report documents the results from two different analytic approaches for examining the reliability of the slope for easyCBM® math measures in Grades K-8. Results varied by grade, assessment measure, and the analytic approach. Results patterns are discussed.

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Background

The National Center on Intensive Interventions (NCII; https://intensiveintervention.org) evaluates both screening and progress monitoring tools for their technical adequacy, with the goal of helping educators select appropriate tools to meet their needs. Many of the analyses required by NCII are already part of our standard practice in developing assessments and are thus described in detail in the many technical reports we publish as part of our assessment development process. Other analyses, such as the reliability of the slope, reported here, fall outside the scope of our standard technical reports. In this brief, we present the results of our analyses of the reliability of the slope conducted with a population of students in need of intensive intervention.

Methods

Sample

The analytic sample consisted of students who took easyCBM® math progress monitoring measures during the 2014-2015, 2015-2016, and 2016-2017 school years. All students in the sample were identified by their districts as needing intensive intervention in the specific skill area targeted by the assessments for which their data were included in this study. Data from this study are a subset of a much larger extant data set. The larger data set includes scores for all students in all districts with easyCBM® accounts covering fall of 2014 to spring of 2017. From this larger data set, we included only those students identified as needing intensive intervention who had a minimum of 10 assessment scores for a given assessment measure with a minimum of 20 weeks between the first and last administration occasion. Thus, sample sizes varied greatly by grade and assessment measure administered.

Analyses

We analyzed the reliability of the slope using two approaches, *Pearson split-test correlation analysis* and *reliability of the slope*.

Pearson split-test correlation analysis. For each student, assessments were divided into two data subsets comprised of odd and even numbered tests, respectively, depending on the chronological order in which they were taken. An OLS slope of improvement (growth) was estimated for each data subset and for each student.

Reliability of slope. Reliability of the slope is defined here as the ratio of the true score variance to the total variance. The true score variance is the random slope variance in a mixed-effects growth model (lme4 package; Bates, Maechler, Bolker, & Walker, 2015) in the R software environment (R Core Team, 2018). The total variance is the estimation of total variance of each student's individual slope of improvement (R Core Team, 2018).

Results

Results for both analytic approaches (*Pearson split-test correlation* and *reliability of the slope*) are presented for Grades K-8 in Tables 1-9, respectively.

Table 1

Grade K Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	9	PC	-.30	-.81	.45
	9	RS	.28	.00	1.00
Numbers and Operations (NumOp)	31	PC	.62	.33	.80
	31	RS	.51	.22	.97
Geometry (GEO)	1	PC	NA	NA	NA
	1	RS	NA	NA	NA
Measurement (MEAS)	NA	PC	NA	NA	NA
	NA	RS	NA	NA	NA

Note. NA = Not analyzed. [**]Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Table 2

Grade 1 Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	41	PC	-.05	-.35	.26
	41	RS	.10	.00	.44
Numbers and Operations (NumOp)	77	PC	.11	-.12	.33
	77	RS	.18	.00	.45
Geometry (GEO)	22	PC	.42	-.01	.71
	22	RS	.15	.01	.63
Numbers Operations and Algebra (NumOpAlg)	20	PC	.37	-.08	.70
	20	RS	.52	.10	1.00

Note. **Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Table 3

Grade 2 Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	51	PC	.34	.07	.56
	51	RS	.50	.22	.88
Numbers and Operations (NumOp)	45	PC	.39	.11	.62
	45	RS	.57	.28	.97
Measurement (MEAS)	7	PC	.48	-.43	.91
	7	RS	.01	.00	.70
Numbers Operations and Algebra (NumOpAlg)	9	PC	.03	-.65	.68
	9	RS	.06	.00	.93

Note. **Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Table 4

Grade 3 Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	22	PC	.19	-.26	.56
	22	RS	.23	.00	.95
Numbers and Operations (NumOp)	15	PC	.20	-.35	.65
	15	RS	.09	NA	NA
Geometry (GEO)	5	PC	-.08	-.90	.86
	5	RS	.36	.00	1.00
Numbers Operations and Algebra (NumOpAlg)	15	PC	.13	-.41	.60
	15	RS	.34	.00	1.00

Note. NA = Not analyzed. **Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Table 5

Grade 4 Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	24	PC	.26	-.16	.60
	24	RS	.24	.01	.77
Numbers and Operations (NumOp)	31	PC	-.13	-.46	.24
	31	RS	.04	.00	.33
Measurement (MEAS)	NA	PC	NA	NA	NA
	NA	RS	NA	NA	NA
Numbers Operations and Algebra (NumOpAlg)	16	PC	.22	-.31	.64
	16	RS	.12	.00	.84

Note. NA = Not analyzed. **Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Table 6

Grade 5 Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	19	PC	.31	-.17	.67
	19	RS	.42	.00	1.00
Numbers and Operations (NumOp)	69	PC	.23	-.01	.44
	69	RS	.29	.07	.58
Geometry Measurement and Algebra (GeoMeasAlg)	6	PC	.44	-.58	.92
	6	RS	.84	.23	1.00
Numbers Operations and Algebra (NumOpAlg)	6	PC	.28	-.69	.89
	6	RS	.46	.00	1.00

Note. **Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Table 7

Grade 6 Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	5	PC	.65	-.55	.97
	5	RS	.76	.01	1.00
Numbers and Operations (NumOp)	8	PC	.41	-.42	.87
	8	RS	.18	.00	1.00
Algebra (ALG)	NA	PC	NA	NA	NA
	NA	RS	NA	NA	NA
Numbers Operations and Ratios (NumOpRat)	4	PC	.50	-.89	.99
	4	RS	.04	.00	1.00

Note. NA = Not analyzed. **Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Table 8

Grade 7 Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	3	PC	.88	NA	NA
	3	RS	.62	NA	NA
Numbers Operations Algebra and Geometry (NumOpAlgGeo)	2	PC	NA	NA	NA
	2	RS	NA	NA	NA
Measurement Geometry and Algebra (MeasGeoAlg)	NA	PC	NA	NA	NA
	NA	RS	NA	NA	NA
Numbers Operations and Algebra (NumOpAlg)	12	PC	.58	.01	.87
	12	RS	.29	.03	.90

Note. NA = Not analyzed. **Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Table 9

Grade 8 Pearson Split-test Correlation (PC) and Reliability of Slope (RS) Analyses Results

Measure	*n*	Analytic Approach	Correlation coefficient (*r*)	95% Confidence Interval	
				Lower	Upper
CCSS Math	86	PC	.41	.21	.57
	86	RS	.65**	.43	.92
Algebra (ALG)	24	PC	.27	-.15	.61
	24	RS	.38	.05	.93
Geometry and Measurement (GeoMeas)	NA	PC	NA	NA	NA
	NA	RS	NA	NA	NA
Data Analysis Numbers Operations and Algebra (DANumOpAlg)	32	PC	.45	.13	.69
	32	RS	.44	.12	.88

Note. NA = Not analyzed. **Lower bound of the confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40.

Discussion

Results varied by grade, measure, and analytic approach. We document reasonable reliability of the slope, whereby the lower bound of the 95% confidence interval around the median correlation estimate falls below 0.50 but meets or exceeds 0.40, for the Grade 8 CCSS Math measure using the *reliability of slope* analytic approach. Results for all grades and measures varied greatly and were, on average, relatively less encouraging. Given extant data were used for the analyses reported here, we are currently planning a series of studies to better control for sample population characteristics as well as instructional/assessment approach. For many grades and measures, for example, correlation coefficients were not estimable or reliable given extremely low sample size. We anticipate improved reliability of the slope results for all grades and measures in planned studies.

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