The Reliability of CBM Reading Growth Estimates for Different Student Groups

Joseph F. T. Nese

B. Jasmine Park

Aki Kamata

Julie Alonzo

Gerald Tindal

Behavioral Research and Teaching

College of Education

University of Oregon

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easyCBM®

- Online benchmark and progress monitoring tool

- Designed for use within a response to intervention (RTI) framework

- Available in Reading and Math
  - 3 benchmark (screening) measures; fall, winter, spring
  - 17 progress monitoring forms in Reading
  - 10 progress monitoring forms in Math
    - All forms constructed to be of equivalent difficulty using a Rasch model

easyCBM® Adoption

Total number of users

– Over 160,000 registered users nationwide

– Over 1.6 million students

– Over 6.2 million tests taken

New registrations for free site

– 70 in a day (weekdays typically 200+)

– 1,415 in last 7 days

– 6,011 in last 30 days

easyCBM® Reading

Area	Kindergarten	Grade 1	Grade 2	Grades 3	Grades 4-8
Phonological Awareness	Phoneme Segmenting	Phoneme Segmenting	-	-	-
Alphabetic Knowledge	Letter Names	Letter Names	-	-	-
	Letter Sounds	Letter Sounds			
Fluency: Words	Word Reading Fluency	Word Reading Fluency	Word Reading Fluency	Word Reading Fluency	Word Reading Fluency
Fluency: Passages	-	Passage Reading Fluency	Passage Reading Fluency	Passage Reading Fluency	Passage Reading Fluency
Vocabulary	-	-	-	Vocabulary	Vocabulary
Reading Comprehension	-	-	Multiple Choice Reading Comprehension	Multiple Choice Reading Comprehension	Multiple Choice Reading Comprehension

easyCBM® Reading

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Fluency: Words					Word Reading Fluency
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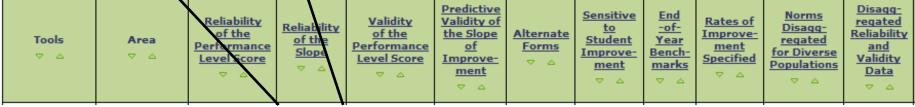| **Area**	**Grades 3-5**
Fluency: Passages	Oral Reading Fluency (ORF)
Reading Comprehension	Multiple Choice Reading Comprehension (MCRC)

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NCRTI

- The National Center on Response to Intervention (NCRTI) has created a clearinghouse for CBM systems by developing a review process of these systems which has centralized and formalized the documentation of CBM technical adequacy.

Tools	Area	Reliability of the Performance Level Score	Reliability of the Slope	Validity of the Performance Level Score	Predictive Validity of the Slope of Improve-ment	Alternate Forms	Sensitive to Student Improve-ment	End -of-Year Bench-marks	Rates of Improve-ment Specified	Norms Disagg-regated for Diverse Populations	Disagg-regated Reliability and Validity Data
▽ △	▽ △	▽ △	▽ △	▽ △	▽ △	▽ △	▽ △	▽ △	▽ △	▽ △	▽ △

NCRTI

- T... al Cen... In... n (NC... c... se for a... ocess centralized and formalized the documentation of CBM technical adequacy.

Reliability of the Slope

"Reliability of the slope is an indicator of how well individual differences in growth trajectories can be detected using a particular measure."

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Purpose

- To determine the reliability of growth rates produced by easyCBM measures for different student groups
    - By grade-level
    - Educational setting (general or special education)
    - English Language Learner (ELL) status
    - Initial performance status

Sample

- Five school districts in the Pacific Northwest
- Data from the 2009-2010 school year.

	Grade 3		Grade 4		Grade 5	
n	ORF 2175	MCRC 2216	ORF 2232	MCRC 2221	ORF 2380	MCRC 2367
Female	48%		48%		49%	
Ethnic Minority (non-White	29%		31%		31%	
SPED	16%		18%		18%	
ELL	4%		4%		4%	
FRL	48% (9% missing)		46% (13% missing)		44% (14% missing)	

Analysis

- A two-level hierarchical linear growth model represented student reading growth within one academic year,
  - ORF and MCRC, collected in the fall, winter, spring
- Level 1 (*time*)

$$Y_{ti} = \pi_{0i} + \pi_{1i}(Time_{ti}) + e_{ti}$$

- Level 2 (*student*)

$$\pi_{0i} = \beta_{00} + r_{oi}$$
$$\pi_{1i} = \beta_{10} + r_{1i}$$

Reliability

- The proportion of the variance of the true scores to the variance of the observed scores.

$$\lambda_{0j} = \frac{\tau_{00}}{\tau_{00} + \sigma^2/n_j}$$

- Thus, the ratio between the level-2 variance component and the sum of the level-2 and level-1 components, with the latter divided by the number of observations (in this case 3).

(Raudenbush, & Bryk, 2002)

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Results: Grade 3 ORF

Grade 3: Oral Reading Fluency

Group	Fixed effect, Intercept	SE	Level-1 residual variance	Reliability, Intercept	Fixed, effect, slope	SE	Variance, slope	Reliability, Slope	n
All	90.36	0.87	265.52	.94	16.53	0.25	4.12	.04	2216
SPED	67.45	2.17	200.22	.96	14.29	0.55	1.56	.02	357
ELL	72.54	3.33	198.72	.94	16.98	1.07	1.95	.03	91

Results: Grade 3 MCRC

Grade 3: Reading Comprehension

Group	Fixed effect, Intercept	SE	Level-1 residual variance	Reliability, Intercept	Fixed, effect, slope	SE	Variance, slope	Reliability, Slope	n
All	10.06	0.08	6.93	.75	1.58	0.04	0.01	.00	2258
SPED	8.19	0.18	7.21	.71	1.55	0.11	0.67	.21	364
ELL	7.86	0.36	7.67	.71	1.47	0.20	0.02	.01	98

Results: Grade 3 ORF

Grade 3: Oral Reading Fluency

Group	Fixed effect, Intercept	SE	Level-1 residual variance	Reliability, Intercept	Fixed, effect, slope	SE	Variance, slope	Reliability, Slope	n
All	90.36	0.87	265.52	.94	16.53	0.25	4.12	.04	2216
SPED	67.45	2.17	200.22	.96	14.29	0.55	1.56	.02	357
ELL	72.54	3.33	198.72	.94	16.98	1.07	1.95	.03	91
Quartile 1	42.11	0.76	165.87	.76	16.23	0.46	30.92	.36	547
Quartile 2	76.73	0.56	182.50	.26	17.89	0.48	34.40	.36	546
Quartile 3	102.63	0.65	248.86	.15	17.55	0.58	48.40	.36	534
Quartile 4	145.57	1.00	312.12	.72	15.23	0.58	16.78	.14	534

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Results: Grade 3 MCRC

Grade 3: Reading Comprehension

Group	Fixed effect, Intercept	SE	Level-1 residual variance	Reliability, Intercept	Fixed, effect, slope	SE	Variance, slope	Reliability, Slope	n
All	10.06	0.08	6.93	.75	1.58	0.04	0.01	.00	2258
SPED	8.19	0.18	7.21	.71	1.55	0.11	0.67	.21	364
ELL	7.86	0.36	7.67	.71	1.47	0.20	0.02	.01	98
Quartile 1	6.00	0.08	5.02	.00	2.53	0.09	2.50	.59	660
Quartile 2	9.42	0.08	3.62	.00	1.73	0.09	2.38	.66	517
Quartile 3	12.15	0.08	4.72	.00	1.22	0.07	0.81	.34	632
Quartile 4	14.84	0.11	5.63	.00	0.44	0.09	0.14	.07	399

Results: Grade 4

Grade 4: Oral Reading Fluency

Group	Fixed effect, Intercept	SE	Level-1 residual variance	Reliability, Intercept	Fixed, effect, slope	SE	Variance, slope	Reliability, Slope	n
All	111.84	0.75	192.89	.95	15.81	0.22	9.96	.13	2213
SPED	88.14	1.86	138.63	.97	13.39	0.48	21.25	.31	395
ELL	91.77	2.51	119.44	.92	13.44	1.16	46.91	.54	80
Quartile 1	70.64	0.83	131.49	.87	13.85	0.39	21.62	.33	572
Quartile 2	100.82	0.42	115.15	.00	15.73	0.52	82.33	.68	521
Quartile 3	121.08	0.43	104.93	.21	18.79	0.48	69.22	.66	526
Quartile 4	159.19	0.97	196.14	.84	15.47	0.49	30.68	.32	541

Grade 4: Reading Comprehension

Group	Fixed effect, Intercept	SE	Level-1 residual variance	Reliability, Intercept	Fixed, effect, slope	SE	Variance, slope	Reliability, Slope	n
All	12.39	0.08	5.91	.85	0.84	0.04	0.29	.12	2229
SPED	10.11	0.19	6.27	.82	0.98	0.10	0.94	.31	397
ELL	8.10	0.33	6.34	.67	1.34	0.23	1.10	.33	85
Quartile 1	7.60	0.10	6.84	.16	1.97	0.09	1.12	.33	630
Quartile 2	11.26	0.08	3.73	.00	1.29	0.09	2.10	.63	456
Quartile 3	14.65	0.06	2.83	.00	0.37	0.07	1.50	.61	686
Quartile 4	17.68	0.06	1.97	.00	-0.52	0.06	0.49	.43	409

Results: Grade 5

Grade 5: Oral Reading Fluency

Group	Fixed effect, Intercept	SE	Level-1 residual variance	Reliability, Intercept	Fixed, effect, slope	SE	Variance, slope	Reliability, Slope	n
All	145.58	0.86	182.84	.96	10.61	0.21	6.98	.10	2382
SPED	116.87	1.97	162.81	.97	11.47	0.45	5.96	.10	432
ELL	116.02	3.12	219.15	.91	15.30	1.11	0.34	.00	89
Quartile 1	93.65	0.96	141.48	.90	13.95	0.38	11.06	.19	584
Quartile 2	133.37	0.42	113.36	.30	12.02	0.42	49.78	.56	608
Quartile 3	158.93	0.45	110.66	.39	11.16	0.41	38.17	.50	560
Quartile 4	200.98	0.91	218.12	.80	5.08	0.45	5.08	.06	586

Grade 5: Reading Comprehension

Group	Fixed effect, Intercept	SE	Level-1 residual variance	Reliability, Intercept	Fixed, effect, slope	SE	Variance, slope	Reliability, Slope	n
All	14.28	0.07	5.28	.79	0.33	0.03	0.03	.02	2344
SPED	12.39	0.19	6.50	.81	0.48	0.09	0.05	.02	418
ELL	11.55	0.36	6.97	.73	0.57	0.21	0.03	.01	82
Quartile 1	10.21	0.11	7.22	.44	1.39	0.08	0.36	.13	660
Quartile 2	14.23	0.08	3.50	.00	0.61	0.07	0.82	.41	513
Quartile 3	-	-	-	-	-	-	-	-	684[+]
Quartile 4	17.93	0.06	1.67	.00	-0.83	0.05	0.36	.39	445

Reliability

- As the random effect variance estimate of the intercept increases, reliability will approach 1.0.

Grade 3: Oral Reading Fluency

Group	Fixed effect, Intercept	SE	Level-1 Variance, σ^2	Reliability, Intercept	Fixed, effect, slope	SE	Variance, **Intercept** τ_{00}	Reliability, **Intercept**	n
All	90.36	0.87	265.52	.94	16.53	0.25	1536.09	.94	2216
SPED	67.45	2.17	200.22	.96	14.29	0.55	1599.52	.96	357
ELL	72.54	3.33	198.72	.94	16.98	1.07	966.68	.94	91
Quartile 1	42.11	0.76	165.87	.76	16.23	0.46	179.30	.76	547
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Quartile 3	102.63	0.65	248.86	.15	17.55	0.58	15.19	.15	534
Quartile 4	145.57	1.00	312.12	.72	15.23	0.58	276.33	.72	534

Reliability

$$\lambda_{0j} = \frac{\tau_{00}}{\tau_{00} + \sigma^2/n_j}$$

Grade 3: Oral Reading Fluency

Group	Fixed effect, Intercept	*SE*	Level-1 Variance, σ^2	Reliability, Intercept	Fixed, effect, slope	*SE*	Variance, **Intercept** τ_{00}	Reliability, **Intercept**	*n*
All	90.36	0.87	265.52	.94	16.53	0.25	1536.09	.94	2216
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- Similarly, as the random effect variance estimate of the slope increases, reliability will approach 1.0.

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Reliability

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Conclusions

- In the discussion of reliability of the growth estimates, groupings matter.
  - Not the groupings that we tend to think about (e.g., SPED and ELL).
  - Rather groupings based on initial status, or proficiency.
- Equivalent to multiple group growth modeling.
  - Next step: latent class growth modeling.

Reliability

- Reliability increases as the number of level-1 units nested within a level-2 unit increases, so as observations increase, so reliability will approach 1.0 (Raudenbush, & Bryk, 2002)

Grade 3: Oral Reading Fluency

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Reliability

$$\lambda_{0j} = \frac{\tau_{00}}{\tau_{00} + \sigma^2/n_j}$$

$$n_j = 3$$

Grade 3: Oral Reading Fluency

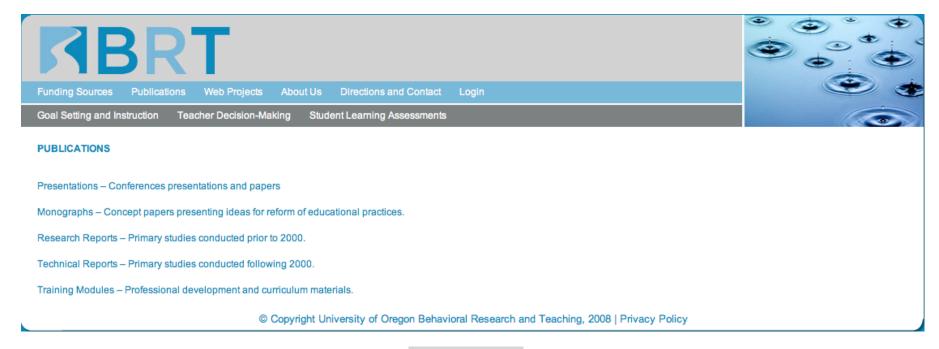| Group	Fixed effect, Intercept	SE	σ^2	Reliability, Intercept	Fixed, effect, slope	SE	τ_{00}	Reliability, Slope	n
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Limitations/Questions

- How do we best measure sensitivity to growth?

- Reliability growth estimates depend on the equivalence of forms.

- Within-year growth is not linear (Christ, et al., 2010; Nese et al., in press)

- More research is needed on the technical properties of the slope estimates produced by CBM reading measures (Wayman et al., 2007)

For More Information

http://www.brtprojects.org

http://easyCBM.com

Measures of Growth Reliability

- Compared change in scores on CBM measures (ORF, word ID) to changes in scores for other reading measures (standardized achievement tests) (Marston & Deno, 1982; Marston, Deno, &Tindal, 1983)

- Mean increase in number of words read per week (Skiba, Deno, Marston, & Wesson, 1986)

- The ratio of the slope value to the standard error of estimate (Fuchs & Fuchs, 1992)

- Evaluation, and reduction, of the standard error of the slope (SEb) (Hintze & Christ, 2004; Christ, 2006)

- Split-half reliability

(From Wayman et al., 2007)

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