easyCBM Iterative Measurement Development: CCSS Math

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Outline

- Original item development
  - Item writing
  - Scaling & test form creation
- Reliability
  - Initial screen
  - Revisions Made
  - Current Reliability
- Criterion Validity Evidence
- Future Directions

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Item Development

Test Blueprint

- Written to specifically align with CCSS Math Standards
- Three response options
- "Oversampling" of Items (~50%)
- Universal Design
  - Minimal, simple, and direct language
  - Line art
  - White Space

Item Writers

- Master/mentor model
  - 5 teacher leads: intensive in-house training
  - 18 item writers: trained and monitored by teacher leads
- All item writers were middle school mathematics teachers (GenEd & SpEd)
- Master trainers were district math specialists, or had extensive teaching experience

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Item Screening

- Minimum of 200 students from across the country responded to each pilot item.
- Items calibrated with item response theory
  - Common scale (all item difficulties directly comparable across grades)
- Items removed from consideration if:
  - Pilot data suggested poor functioning
  - Alignment data suggested the item did not measure the intended standard

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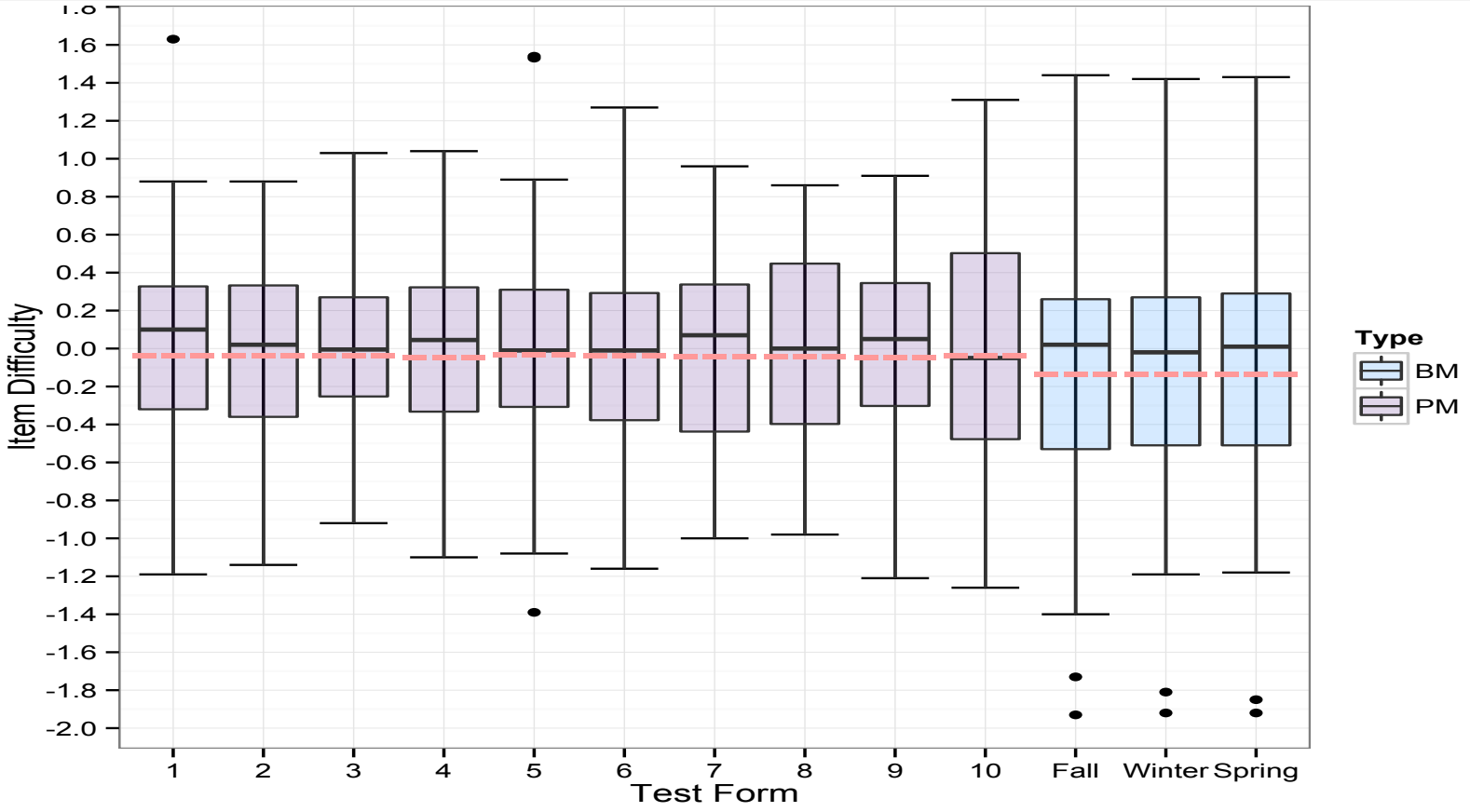
Form Creation



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Investigating Test Functioning: Reliability

- **Reliability** is

  "concerned solely with how the scores resulting from a measurement procedure would be expected to vary across replications of that procedure" (Haertel, 2006)

- Separate from validity (but is a prerequisite)

Internal Consistency	Alternate Form
Test-retest	Split-half
Generalizability Theory	Etc.

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Initial Investigations into Reliability

- Sample included ~1,000 students in Oregon, with Five CCSS test forms per grade investigated
- Initial screening of data suggested some items weren't working well
- Items were removed, and reliability was adequate, but still less than ideal

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Brief Dive into Results

Grade 6 Test Form Point-Biserial Correlations

Item	Form				
	6	7	8	9	10
1	.277**	.386**	.473**	.269**	.342**
2	.201**	.382**	.283**	.263**	.461**
3	.534**	.358**	.383**	.404**	0.126
4	.617**	.199**	.343**	.366**	.201**
5	.220**	.415**	.198**	.265**	.343**
6	.508**	.431**	.266**	.231**	.301**
7	.480**	.255**	.467**	.395**	.240**
8	.404**	.156*	.319**	.343**	.237**
9	.313**	-0.003	0.137	.268**	0.124
10	.256**	.188**	0.007	.144*	0.081
11	.241**	.416**	.261**	.266**	.442**
12	.530**	.388**	.396**	.487**	.349**
13	.471**	.373**	.404**	0.063	.377**
14	.409**	.335**	.441**	.410**	.323**
15	.248**	.227**	.512**	.407**	.267**
16	.338**	.405**	.253**	.351**	.282**
17	.402**	.385**	.497**	.463**	.445**
18	.346**	.395**	.315**	.424**	.342**
19	.337**	.219**	.520**	.195**	.386**
20	.478**	.252**	.148*	.284**	.409**
21	.322**	.288**	.290**	.510**	.259**
22	0.042	.472**	.314**	.250**	.420**
23	.400**	.518**	.479**	.174*	.154*
24	.228**	0.138	.156*	.245**	0.048
25	.281**	.258**	.507**	.184*	.154*

Note. Items displayed in red font were removed prior to subsequent analyses.

* $p < .05$

** $p < .01$

Brief Dive into Results

Cronbach's Alpha Reliability Coefficients

		Alpha			
		Day 1		Day 2	
Grade	Form	Full model	Reduced Model	Full model	Reduced Model
6	6	.70	.72	.77	.79
6	7	.66	.69	.67	.72
6	8	.69	.76	.74	.78
6	9	.65	.70	.61	.65
6	10	.57	.63	.59	.69

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Test-Retest Reliability Coefficients

Grade	Form	Test-Retest *r*
6	6	.69
6	7	.69
6	8	.71
6	9	.73
6	10	.61

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Grade 6: Alternate Form Reliability Coefficients

Test form	6	7	8	9	10	n
6	-	.432	.601	.597	.465	.662
7	.376	-	.819	.641	.760	.572
8	.721	.525	-	.813	.744	.591
9	.492	.720	.426	-	.752	.522
10	.197	.784	.553	.728	-	.549
n	.806	.491	.665	.743	.569	-

Note. Coefficients below the diagonal represent correlations from the first testing occasion, while the coefficients above the diagonal represent correlations from the second testing occasion occurring one week later.

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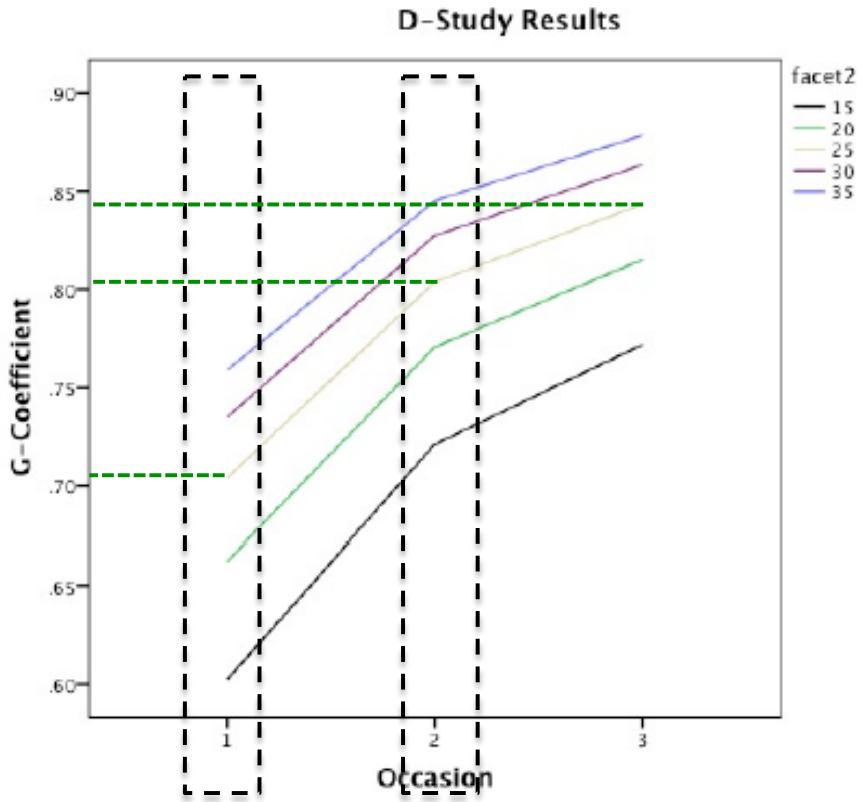
Brief Dive into Results



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Overall Takeaway: Not good enough

- What to do? Revise.
- Items were noticeably more difficult than NCTM
  - Included 5 NCTM items rated as aligning with the CCSS
- **Removed** 5 poorest functioning items from each form
- Conducted additional pilot
- Replaced items with those that pilot data suggest function better.

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What effect did the changes have?

- Cronbach's alpha now > .9 for all measures investigated.
- Split-half reliability > .8
- Overall takeaway – it looks like it worked!

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Now they're reliable, are they valid?

- **Validity** is

  "An overall evaluative judgment of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of interpretations and actions based on test scores" (Messick, 1995)

- Basically – does the test ***actually*** measure what it ***says*** it measures
- Not a property of the test

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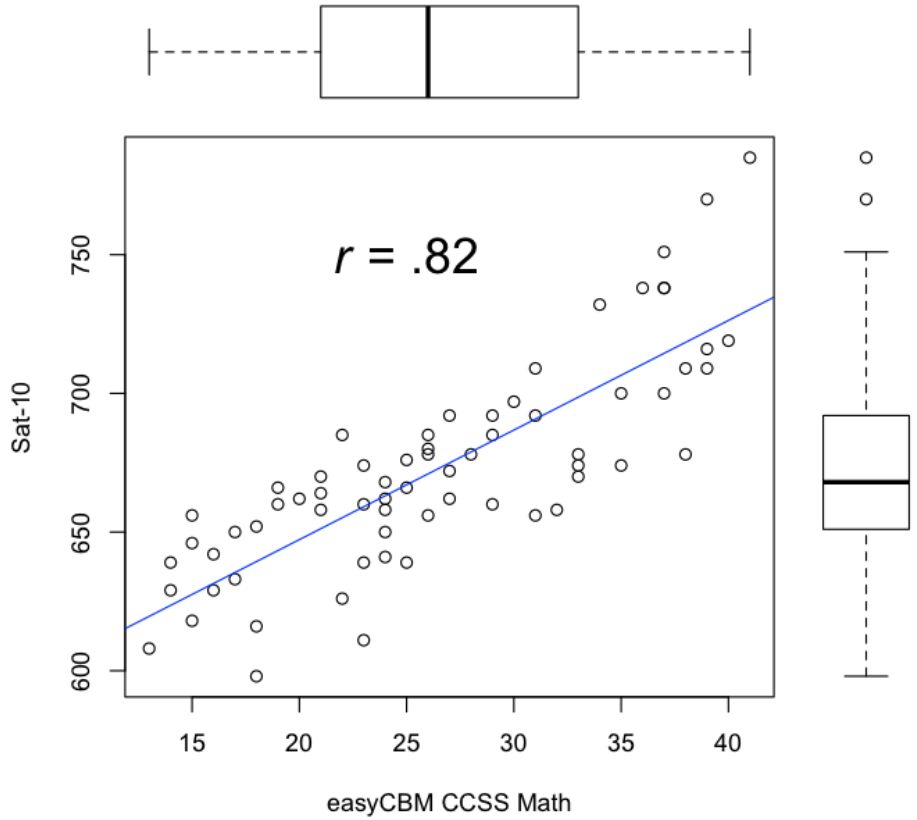
Preliminary Investigations

- Criterion validity
  - How well do students' scores on easyCBM "go along" with scores from a criterion measure
  - Note. Measures are not designed to be exactly the same, but scores should at least correlate.
- Sample
  - 65 students in Oregon in each grade.

Criterion Validity Results: Grade 6



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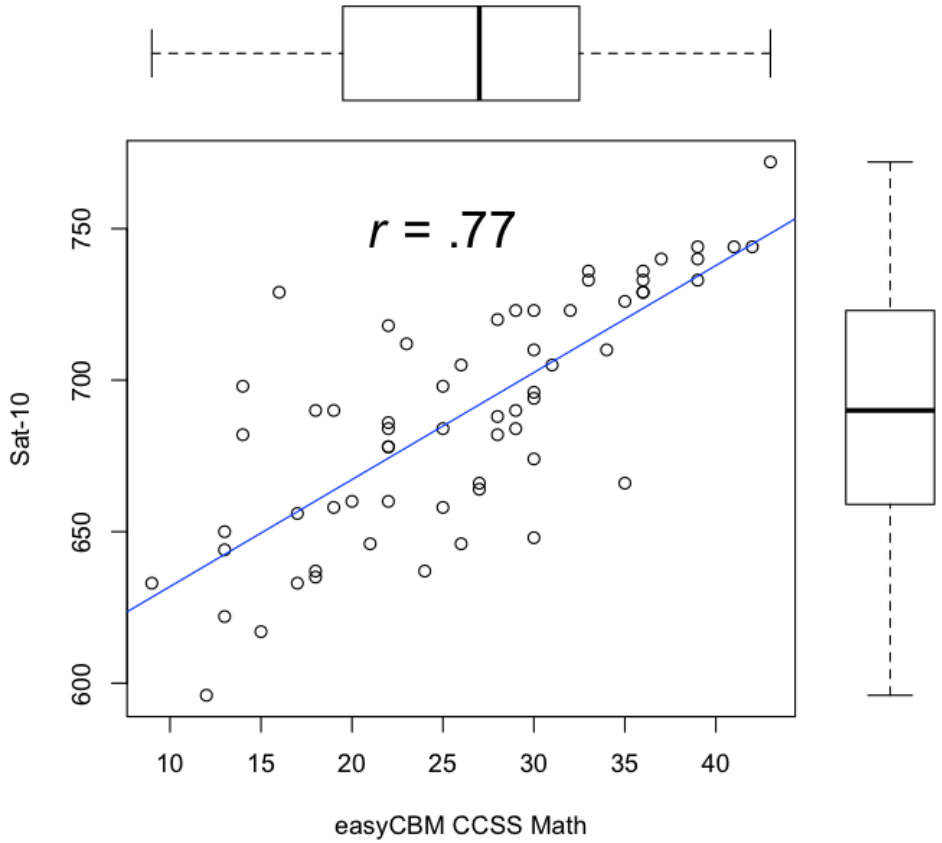
Criterion Validity Results: Grade 7



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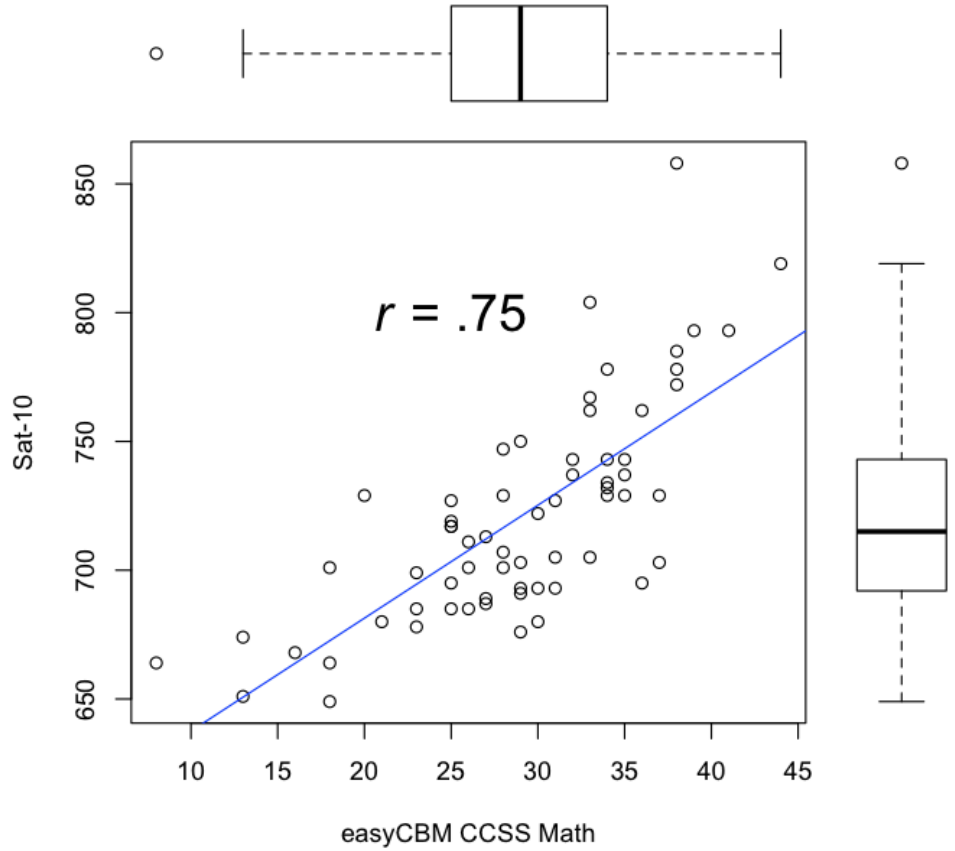
Criterion Validity Results: Grade 8



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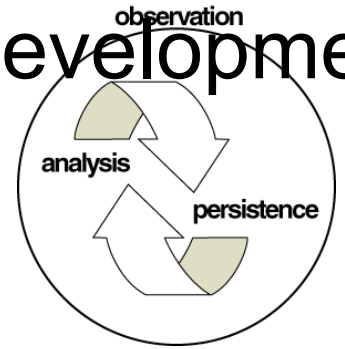
Where to from here?

- Measures appear reliable and to be measuring what we intend them to measure.
- Are we done? **NO!**
- Measurement development is **iterative**



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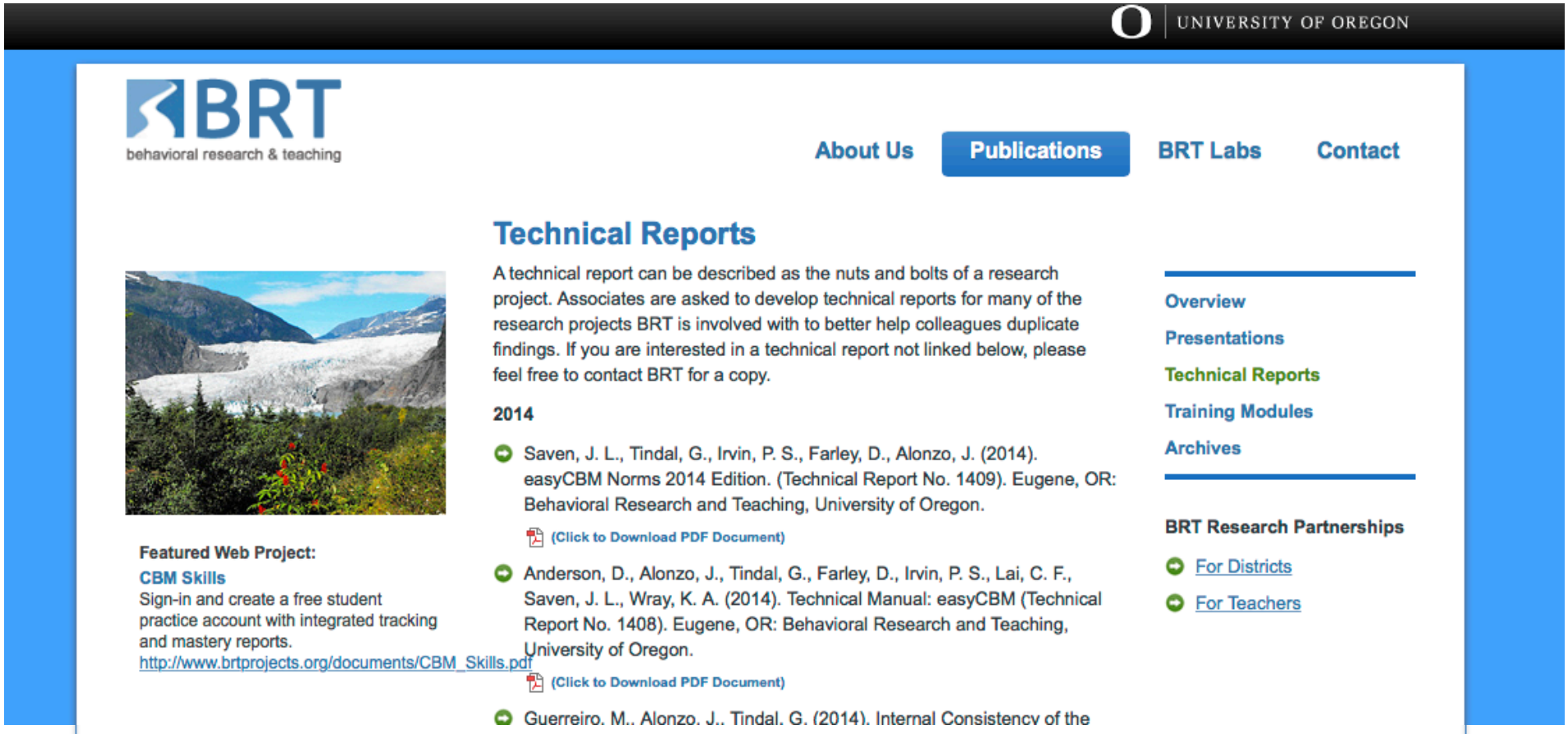
Continued Investigations

Current

- Item functioning (annual evaluation)
- Vertical scale creation
- Dimensionality
  - Does the test only measure one thing? Multiple things?
- Average growth

Planned

- Item fairness
- More investigations into reliability & validity



Thanks!

- Daniel Anderson: Behavioral Research and Teaching
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  - http://www.brtprojects.org/publications/technical-reports

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