

The Relation of Kindergarten Entry Skills to Early Literacy and Mathematics Achievement

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Acknowledgements

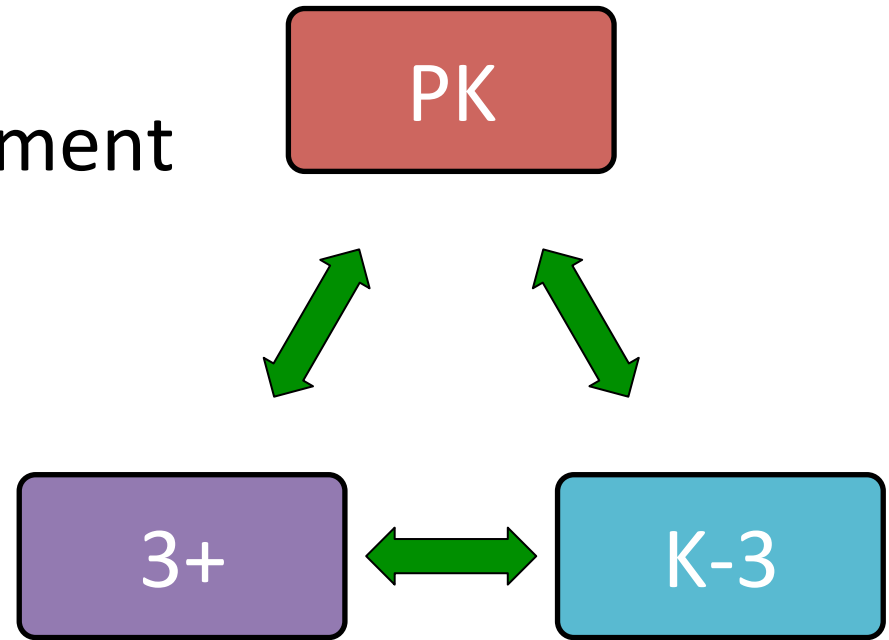
- BRT, COE, UO, IES and the U.S. Dept. of Education:
 - Reliability and Validity Evidence for Progress Measures in Reading (R324A100014 funded from June 2010 - June 2014)
 - Developing Middle School Mathematics Progress Monitoring Measures (R324A100026 funded from June 2010 - June 2014)
- ODE and Dr. Steve Slater for providing the 13-14 OKA data
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- Colleagues, friends, family - Beth, Indy and Jasper

Presentation Outline

- Background and Context
- Theoretical Framework – Sfard’s Metaphors
- RQs
- Methods
 - Data Preparation & Sample
 - Measures
- Analyses and Associated Results
 - EFA
 - CFA
 - SEM
- Discussion
- Limitations & Future Research
- Contributions & Conclusions

Background

- Growing focus on early learning and K-12 alignment
- Kindergarten entry assessments
 - Federal/State support
e.g., RttT, ELC, EAGs
 - 2010 (7 states); 2011 (25);
2012-present (43+) (Connors-Tadros, 2014)

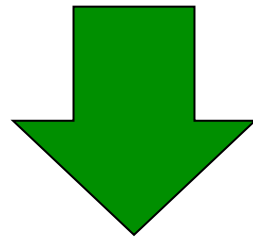


Background cont.

- Oregon Kindergarten Assessment (OKA)
 - Baseline entry skills screening
 - Inform decision-making (instructional)
 - Identify achievement gaps (demographic)
 - Single assessment (Oregon Department of Education, 2013)
- Early Literacy (LNF & LSF); Early Numeracy; Learning-related Behaviors
- Piloted 12-13; *State-wide Field Tested 13-14; State-mandated 14-15

Important Inquiry Around OKA

- OKA a research-based snapshot of interrelated entry skills (Tindal, Irvin, & Nese, Manuscript submitted for publication) though, state practices, and potential floor effects and hypersensitivity may impact utility (Catts, Petscher, Schatschneider, Bridges, & Mendoza, 2009; Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996; Paris, 2005)



Construct Validity (characterize, interrelation)

Predictive-concordant Validity (end-of-year K achievement)

Theoretical Framework

(Sfard, 1998)

Acquisition Metaphor (AM)

- Individual development
- Inward-focused
- Self-identification and possession

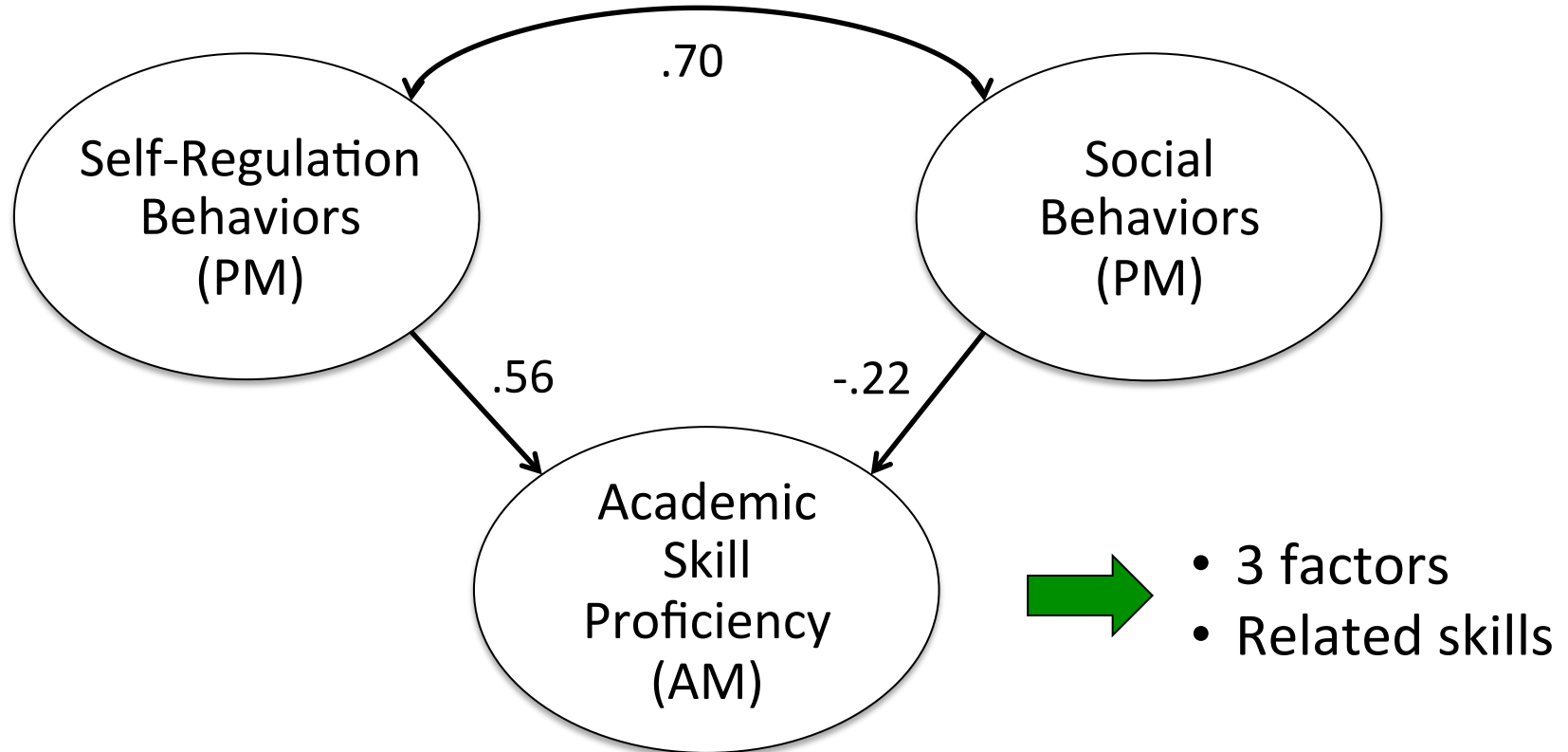
Participation Metaphor (PM)

- Group bonds/community
- Outward-focused
- Group-identification and sharing

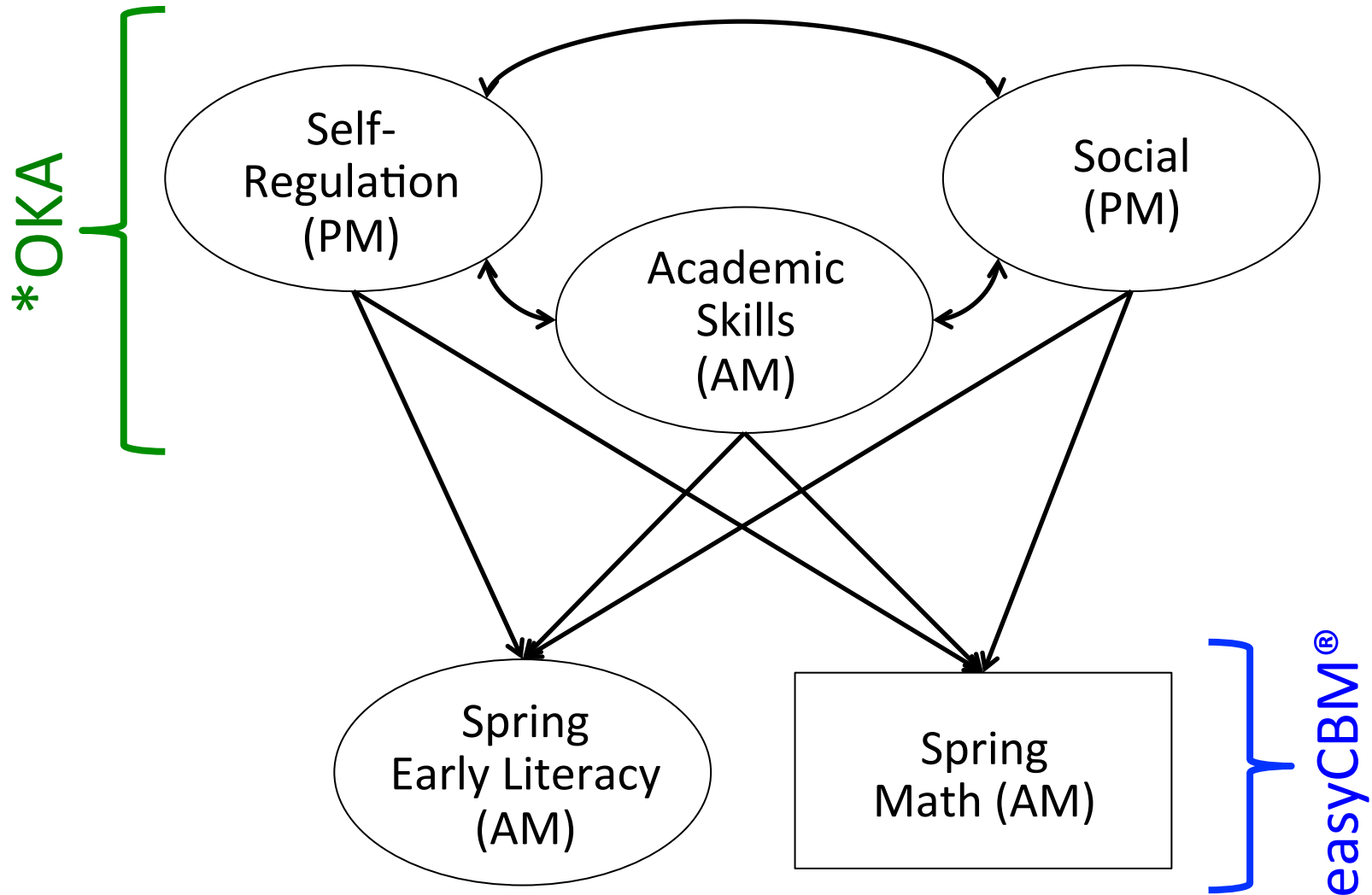
“the individual/social dichotomy does not imply a controversy as to the definition of learning, but rather rests on differing visions of the mechanism of learning” (p. 7)

Preliminary Evidence of Sfard's Framework in the OKA

*Tindal et. al (Manuscript submitted for publication)



Sfard's Framework – This Study



Empirical Basis for the AM

Technically adequate measures:

1. Screen for risk, gauge status, monitor change
(McConnell, McEvoy, & Priest, 2002)
2. Establish valid/parsimonious factor structures
(Justice, Invernizzi, Geller, Sullivan, & Welsch, 2005)

Early Literacy

Early Math

Early Literacy and Math Skills

- *Alphabetic* (e.g., naming and sounding letters)
- *Numeracy* (e.g., early number sense and operations)
- *Interrelated and predict proximal and distal skills*
(e.g., phonemic, vocabulary, word/passage reading, comprehension; higher-order operations, geometric/spatial reasoning, statistics)

(Literacy: see Cummings, Kaminski, Good, and O'Neal, 2011; Linklater, O'Connor, and Palardy, 2009; Ritchey, 2008; Ritchey and Speece, 2006; Speece, Ritchey, Cooper, Roth, & Schatschneider, 2004; Wagner, Torgesen, & Rashotte, 1994)

(Math: see Clements, Sarama, and Lieu, 2008; Foegen, Jiban, & Deno, 2007; Gersten et al., 2012; Gersten, Jordan, and Flojo, 2005; Lembke and Foegen, 2009; Seethaler and Fuchs, 2011; VanDerHeyden et al., 2004; VanDerHeyden, Broussard, and Cooley, 2006)

Empirical Basis for the PM

Technically adequate measures:

1. Characterize early learning-related behaviors
(Bandura, 1991; Zimmerman, 1998)
2. Gauge status and monitor change
3. Document relation to acquisition (Ladd, Birch, & Buhs, 1999)

Self-regulation
Social-interpersonal

Early Learning-Related Behavioral Skills

- **Self-regulation** (e.g., listening, following directions, task focus and completion)
- **Social-interpersonal** (e.g., sharing, working/playing cooperatively, relating to adults/peers)
- ***Interrelated and predict proximal/distal achievement***

(see Cooper and Farran, 1988; Finn, 1993; Ladd, Birch, & Buhs, 1999; McClelland, Acock, & Morrison, 2006; McClelland, Morrison, and Holmes, 2000; McClelland and Morrison, 2003)

Theoretical-Empirical Takeaways

- Skills representing the AM (early literacy/emergent reading and numeracy) and PM (self-regulation/social-interpersonal) are identifiable early, and are measurable
- AM/PM skills are complexly intertwined and positively related in early learning and K-12 contexts (beyond demographic, prior achievement, IQ, and other influences)
- AM and PM appear to underlie the OKA

Research Questions

1. What are the underlying dimensions (latent factors) and interrelations of the learning-related behavioral and academic skill components of the OKA?
2. What is the relation of kindergarten students' entering learning-related behaviors and academic skill to the level of early/emergent literacy and mathematics achievement measured in the spring of the same kindergarten school year when controlling for student demographic characteristics?

Data Structure and Preparation

1. Restrict sample to valid OKA and ≥ 1 spring BM score
2. Zeroes retained when flagged for being included in state reporting and as attempted
3. Merge extant datasets using unique identifier linking OKA to easyCBM district users in OR
4. OKA demographics took precedence

Sample

2013-14 OKA

- 41,000 kindergarten students
- 63% White, 24% Hispanic, 6% Multi-Ethnic, 3% Asian, 2% African American, 1% American Indian/Alaskan Native, 1% Pacific Islander
- 51% Male, 49% Female
- 10% Disability
- 53% Econ. Disadv.
- 18% LEP

2013-14 Spring easyCBM

- 7,200 (EL); 4,200 (Math)
- Roughly same demographic makeup (6% fewer Hispanic/LEP and 6% greater White)

Measures

OKA:

Early literacy (easyCBM LNF and LSF – individual fluency)

Early math (easyCBM Numbers and Operations – group MC)

Approaches to Learning (CBRS; 15-item Mastery Behaviors Scale – teacher ratings of learning-related behavior frequencies; 1 to 5 scale)

easyCBM spring BMs:

Early/Emergent literacy (LSF, PSF, WRF – individual fluency)

Early math (Measurement, Geometry, Numbers & Operations – group MC)

Analyses

1. EFA to determine OKA factor structure (RQ1)
2. CFA to verify the # of factors, the pattern of loadings, and the latent factor correlation; document easyCBM (RQ1)
3. SEM to examine OKA entry skill interrelations and their relation to spring (EL and Math) achievement (RQ2)

Mplus version 7.3 with MLR estimation

(Muthén & Muthén, 1998-2012)

EFA Analysis

- 50% random subsample of OKA
- Geomin (oblique) rotation
- Chronbach's Alpha (CBRS) = .96
- Kaiser-Meyer-Oklin = .96
- Bartlett's Test of Sphericity significant
- Items/measures appropriately correlated
- Two solns compared (reasonableness and AIC/BIC):
2 factors (single behavioral) vs. 3 factors (SR & SI)

EFA Results

Communalities, Pattern and Structure Matrices for EFA Random Subsample for OKA Battery (n = 20,585).

Item	Communalities	Pattern Matrix			Structure Matrix		
		Self-regulation	Social-interpersonal	Academic Skills	Self-regulation	Social-interpersonal	Academic Skills
follows	0.73	0.94 (0.01)	0.00	-0.37	0.78	0.64	0.02
completes	0.87	1.00 (0.01)	-0.11	0.01	0.93	0.59	0.42
successfully	0.85	1.01 (0.01)	-0.16	0.04	0.91	0.55	0.45
attempts	0.69	0.87 (0.01)	-0.07	0.03	0.83	0.53	0.39
concentrates	0.80	0.92 (0.01)	0.03	-0.11	0.89	0.66	0.28
responds	0.86	0.93 (0.01)	0.05	-0.11	0.92	0.69	0.28
time	0.80	0.91 (0.01)	0.02	-0.07	0.89	0.65	0.31
finds	0.81	0.94 (0.01)	-0.01	-0.08	0.90	0.64	0.32
errors	0.63	0.87 (0.01)	-0.15	0.05	0.79	0.46	0.40
returns	0.80	0.90 (0.01)	0.02	-0.06	0.89	0.65	0.32
share	0.93	0.00	0.95 (0.00)	0.09	0.70	0.96	0.13
cooperative	0.95	-0.01	0.97 (0.00)	0.10	0.71	0.97	0.14
turns	0.95	0.02	0.96 (0.00)	0.10	0.72	0.97	0.15
complies	0.80	0.30	0.66 (0.01)	-0.01	0.76	0.87	0.14
fuss	0.73	0.25	0.66 (0.01)	-0.01	0.71	0.84	0.13
LNF	0.76	0.03	0.03	0.85 (0.01)	0.41	0.10	0.87
LSF	0.68	-0.01	0.05	0.83 (0.01)	0.37	0.08	0.83
Math	0.42	0.13	-0.03	0.59 (0.01)	0.36	0.09	0.64

Note. OKA where: LNF = Letter Names Fluency, LSF = Letter Sounds Fluency, Math = Numbers and Operations, and item abbreviations for the CBRS behavioral rating segment. Primary factor loadings for the three extracted factors (*Self-regulation*, *Social-interpersonal*, and *Academic Skill Proficiency*) are bolded with standard errors shown in parentheses (Preacher & MacCallum, 2003).

EFA Results cont.

3-factor solution most appropriate, best fit (AIC and BIC), minimal cross-loading for OKA:

1. Self-regulation (items 1-10 CBRS)
2. Social-interpersonal (items 11-15 CBRS)
3. Academic Skills Proficiency (LNF, LSF and Numbers & Operations)

OKA Factor correlations:

- *SR* and *SI* = .70 (strong)
- *SR* and *ASP* = .42 (moderate)
- *SI* and *ASP* = .05 (very low)

CFA Analysis

- 50% random subsample (OKA)
- 3 unidimensional models initially specified (OKA)
- Follow-up concurrent estimation (OKA)

- Two concurrent models (easyCBM matched subsample – 1 spring achievement factor, with/without Math included)

CFA Results

Unstandardized and Standardized Loadings for CFA Random Subsample for the OKA Battery

CBRS Item / Measure	Self-regulation		Social-interpersonal		Academic Skills	
	Unstandardized	Standardized	Unstandardized	Standardized	Unstandardized	Standardized
follows	3.36 (0.04)	0.88				
completes	4.81 (0.07)	0.94				
successfully	4.14 (0.06)	0.92				
attempts	2.88 (0.04)	0.85				
concentrates	4.18 (0.05)	0.92				
responds	5.20 (0.07)	0.94				
time	4.03 (0.05)	0.91				
finds	4.14 (0.05)	0.92				
errors	2.48 (0.03)	0.81				
returns	4.04 (0.05)	0.91				
share			7.18 (0.15)	0.97		
cooperative			8.79 (0.24)	0.98		
turns			9.63 (0.28)	0.98		
complies			3.86 (0.05)	0.91		
fuss			3.36 (0.05)	0.88		
LNF					15.15 (0.10)	0.91
LSF					8.00 (0.08)	0.83
Math					1.93 (0.02)	0.61

Note. $n = 20,585$. CBRS items and academic achievement measures specified to load on a single factor (*Self-regulation*, *Social-interpersonal*, or *Academic Skills*) based on three-factor solution results in EFA. All parameter estimates significant, $p < .001$.

CFA Results cont.

3-factor solution appropriate, with strong loadings and identical pattern for OKA:

1. Self-regulation (.81 to .94)
2. Social-interpersonal (.88 to .98)
3. Academic Skills Proficiency (.61 to .91, LNF and LSF > NOps)

OKA Factor correlations:

- *SR* and *SI* = .79 (strong, .09 higher)
- *SR* and *ASP* = .39 (moderate, .03 lower)
- *SI* and *ASP* = .20 (low, .15 higher)

CFA Results cont.

Unstandardized and Standardized Loadings for easyCBM-matched Subsample for the easyCBM Spring Benchmarks

Spring measure	Unstandardized	Standardized
LSF	14.05 (0.28)	0.93
PSF	9.37 (0.27)	0.60
WRF	9.37 (0.23)	0.65

Single early/emergent literacy factor most appropriate for spring achievement BMs:

- .60 to .95, LSF > PSF and WRF
- *Spring EL and Spring Math (cont) = .51 (moderate)*

SEM Analyses

- Univariate and bivariate distributions and scatterplots (Arbuckle, 1996; Byrne, 2012; Kline, 2010)
- Skew < 2 and kurtosis < 7 for all measures (West, Finch, & Curran, 1995)
- Measurement portion based on EFA/CFA – 3 OKA factors, each predicting spring achievement
- 3 models specified and compared (AIC, BIC, χ^2):
 - Model 1: No Demographics
 - Model 2: Full Demographics
 - Model 3: Sans Nonsignificant Demographics

SEM Results

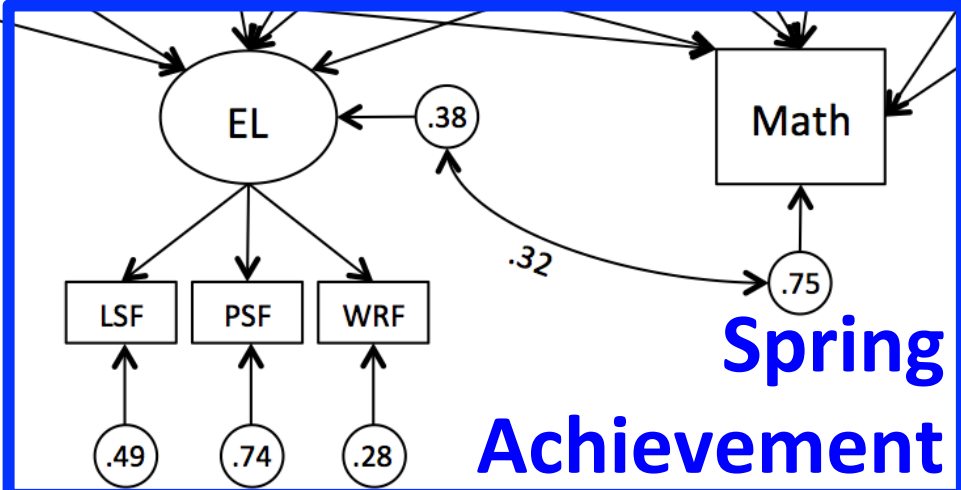
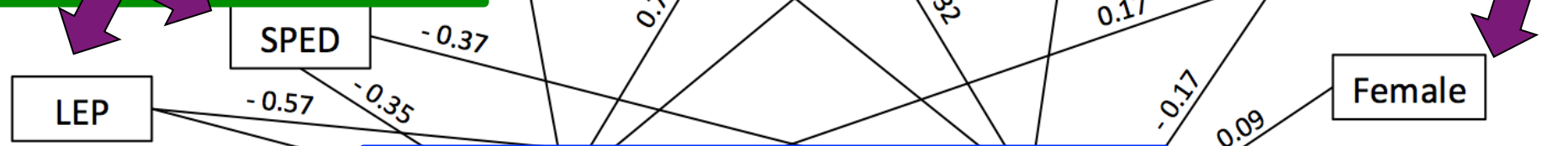
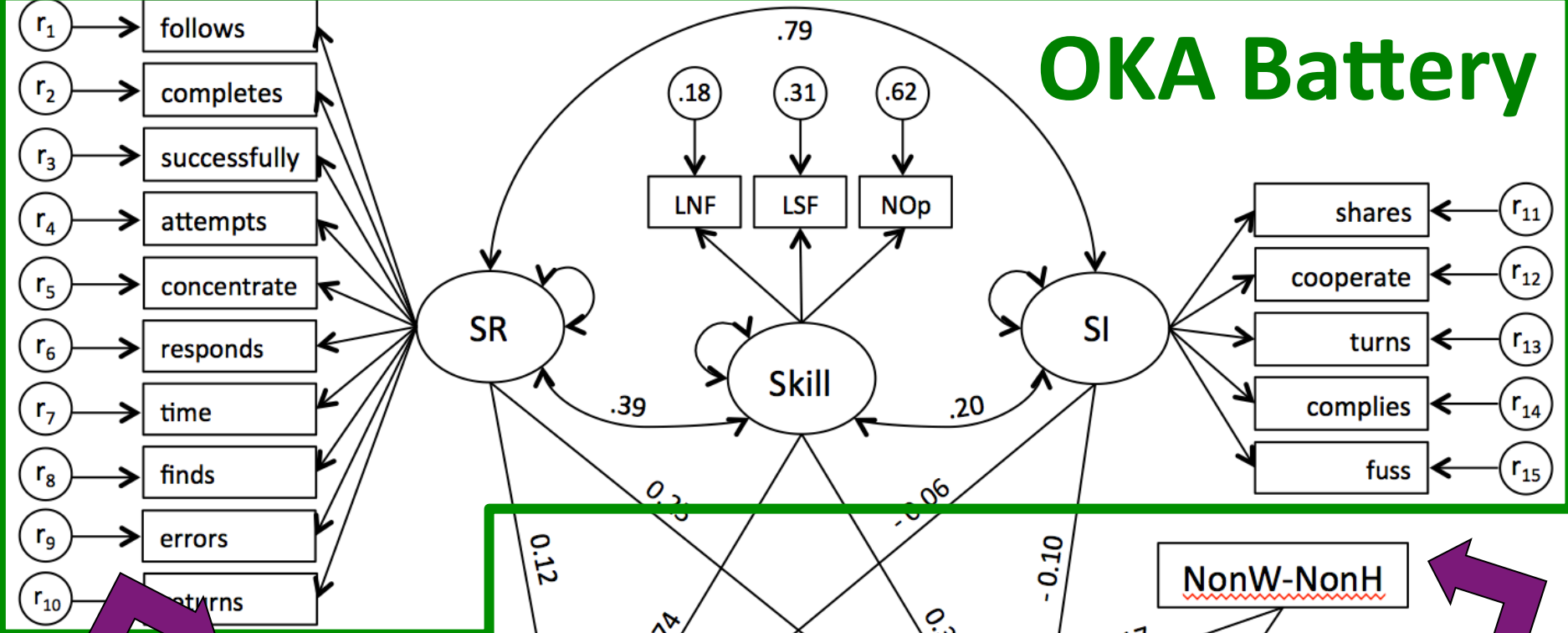
Model Fit Information Criteria for Specified SEM

Fit Criteria	Model 1	Model 2	Model 3
AIC	1967148.50	1966800.65	1966794.38
BIC	1968054.18	1967438.00	1967404.49
Chi-square	--	319.85*	3.47*

Note. Chi-square difference test statistics compare the adjacent/nested model, and are based on loglikelihood values and scaling correction factors available with MLR estimation in Mplus 7.3, in which significant values indicate a better fitting model (Muthén & Muthén, 2015a), * $p < .05$.

- *Economic Disadvantage* and *Nonwhite-Hispanic* removed from *Early/Emergent Literacy* and *Math*
- *Female* removed from *Emergent Literacy*

OKA Battery



Demographic Covariates

Spring Achievement

SEM Results cont.

Reference Group: white, male, no disability, English proficient

Spring EL (.62)

- 1 SD ASP ; .74 SD
- 1 SD SR ; .12 SD
- 1 SD SI ; -.06 SD
- NW-NH ; .17 SD
- Disability ; -.35 SD
- LEP ; .12 SD

Spring Math (.25)

- 1 SD ASP ; .32 SD
- 1 SD SR ; .25 SD
- 1 SD SI ; -.10 SD
- NW-NH ; -.17 SD
- Disability ; -.37 SD
- LEP ; -.57 SD
- Female ; .09 SD

Discussion

1. Validation of the state's entry model (RQ1)
2. Statistically significant and practically meaningful relations b/t entry skills and spring achievement (RQ2)
3. Demographic relations offer evidence of early gaps widening, closing, remaining the same, and perhaps being created over kindergarten (RQ3)

Limitations and Future Research

1. Nonexperimental design
 - “Preparedness” talk likely unwarranted
 - Caution when generalizing to and beyond cohort
2. Lack of specificity at district, school, classroom, and student levels – capacity, appropriateness and consequences of inferences
3. Little explained about math performance

Limitations and Future Research cont.

Sample RQs:

- How should OKA data influence decision-making at the state level and more localized levels like districts, schools, and classrooms?
- Can data from the OKA be used to identify and address achievement gaps that persist over time?
- Should classroom teachers use OKA data to guide instruction, and in what manner should this be done – what is the impact of doing so?
- How do results from the OKA impact the way in which publicly funded PK-12 learning systems are aligned and improved in Oregon?

Contribution and Conclusions

- Examines the underlying structure of a state-mandated entry assessment – inferences around entry skills, including gaps
- Extends beyond entry into the complex interplay of skills over kindergarten – utility of the OKA for decision-making
- The OKA (improved) may offer a link between PK and K-12 schooling



Completing a dissertation is sort of like sparring with an advisor who knows MMA. You might be finished, but not without a lot of bumps and bruises.

Thank you for serving as my
dissertation committee.
Additional discussion and
questions are welcome.

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Sample –Subsample Dems

Demographics for Statewide Full Analytic Sample, Random Subsamples, and easyCBM-matched Subsample

Demographic Characteristic	Full Analytic		EFA50		CFA50		easyCBM	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i> *	%
All Students	41,170	100.00	20,585	100.00	20,585	100.00	9,164	100.00
Sex								
Female	20,074	48.76	9,978	48.47	10,096	49.05	4,524	49.37
Male	21,906	51.24	10,607	51.53	10,489	50.95	4,640	50.63
Race/Ethnicity								
Asian	1,410	3.42	684	3.32	726	3.53	392	4.28
Black	977	2.37	506	2.46	471	2.29	188	2.05
Hispanic	9,790	23.78	4,867	23.64	4,923	23.92	1,564	17.07
American Indian/Alaskan Native	553	1.34	287	1.39	266	1.29	112	1.22
Multi-Ethnic	2,310	5.61	1,149	5.58	1,161	5.64	594	6.48
Pacific Islander	316	0.77	157	0.76	159	0.77	47	0.51
White	25,814	62.70	12,935	62.84	12,879	62.56	6,267	68.39
Disability Status								
Non-disability	37,276	90.54	18,641	90.57	18,635	90.53	8,341	91.02
Disability	3,894	9.46	1,944	9.44	1,950	9.47	823	8.98
Economic Status								
Not Economically Disadvantaged	19,251	46.76	9,644	46.85	9,607	46.67	4,252	46.40
Economically Disadvantaged	21,919	53.24	10,941	53.15	10,978	53.33	4,912	53.60
English Proficiency Status								
Not Limited English Proficient	33,601	81.62	16,854	81.88	16,747	81.36	8,055	87.90
Limited English Proficient	7,569	18.38	3,731	18.12	3,838	18.64	1,109	12.10

Note. Demographic breakdown by full analytic sample, the two 50% random subsamples, and the matched easyCBM subsample using both count and percentages relative to the associated (sub)sample. *casewise deletion.

Extra Slides as Needed

Overall OKA Desc Stats (missingness)

Descriptive Statistics for 2013-14 OKA Total Scores (Full Analytic Sample)

OKA	<i>n</i>	Miss	Min	Max	<i>M</i>	<i>SD</i>	Skew	Kurtosis
LNF	40,676	494	0	100	18.49	16.71	0.74 (0.01)	-0.09 (0.02)
LSF	40,306	864	0	100	6.72	9.71	1.79 (0.01)	3.12 (0.02)
Math*	40,588	582	0	16	8.02	3.17	0.24 (0.01)	-0.38 (0.02)
SR**	40,364	806	10	50	35.35	8.52	-0.38 (0.01)	-0.18 (0.02)
Social**	40,364	806	0	25	19.51	4.37	-0.67 (0.01)	0.12 (0.02)
AL total**	40,364	806	14	75	54.85	12.14	-0.45 (0.01)	-0.09 (0.02)

Subsample OKA Desc Stats

Descriptive Statistics for 2013-2014 OKA for Full Analytic Sample, Random Subsamples, and easyCBM-matched Subsample

OKA Segment	Full Analytic			EFA50			CFA50			easyCBM		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
LNF	40,676	18.49	16.71	20,351	18.47	16.77	20,325	18.52	16.65	9,114	19.74	16.55
LSF	40,306	6.72	9.71	20,153	6.70	9.73	20,153	6.74	9.68	9,102	6.94	9.82
Math	40,588	8.02	3.17	20,301	8.03	3.18	20,287	8.01	3.16	9,072	8.13	8.13
SR*	40,364	35.35	8.52	20,190	35.31	8.55	20,174	35.38	8.48	9,098	35.58	8.47
Social*	40,364	19.51	4.37	20,190	19.49	4.38	20,174	19.52	4.36	9,098	19.50	4.40
AL total*	40,364	54.85	12.14	20,190	54.81	12.19	20,174	54.90	12.09	9,098	55.08	12.16

Descriptive Statistics by Demographics for OKA Total Scores: Achievement Measures

Group	LNF		LSF		Math	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Sex						
Female	19.25	16.49	7.07	9.79	7.99	3.05
Male	17.77	16.88	6.39	9.61	8.05	3.27
Race/Ethnicity						
White	20.94	16.40	7.79	10.00	8.41	3.12
Nonwhite/Hispanic	9.81	13.34	2.92	6.37	6.83	2.85
Nonwhite/Non-Hispanic	22.04	18.16	8.20	11.24	8.28	3.38
Economic Disadvantage						
Not Disadvantaged	24.22	16.97	9.81	11.10	8.87	3.20
Disadvantaged	13.40	14.70	3.95	7.2	7.27	2.93
Disability						
No Disability	19.15	16.80	7.07	9.90	8.14	3.15
Disability	12.11	14.34	3.35	6.67	6.86	3.08
LEP						
Not limited	20.94	16.68	7.79	10.18	8.36	3.15
Limited	7.34	11.51	1.78	4.62	6.46	2.74

OKA Desc
Stats by
Demo-
graphics