IES Institute of Education Sciences

Planning for Diversity in Education Research:
Design, Measurement, and Analysis to Advance Equity and Inclusion

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Annual IES Principal Investigators Meeting
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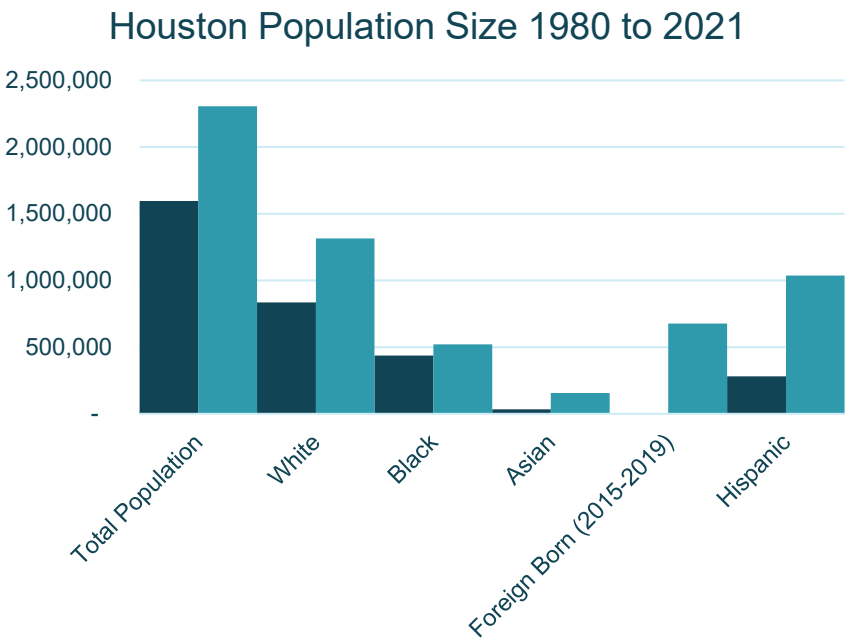
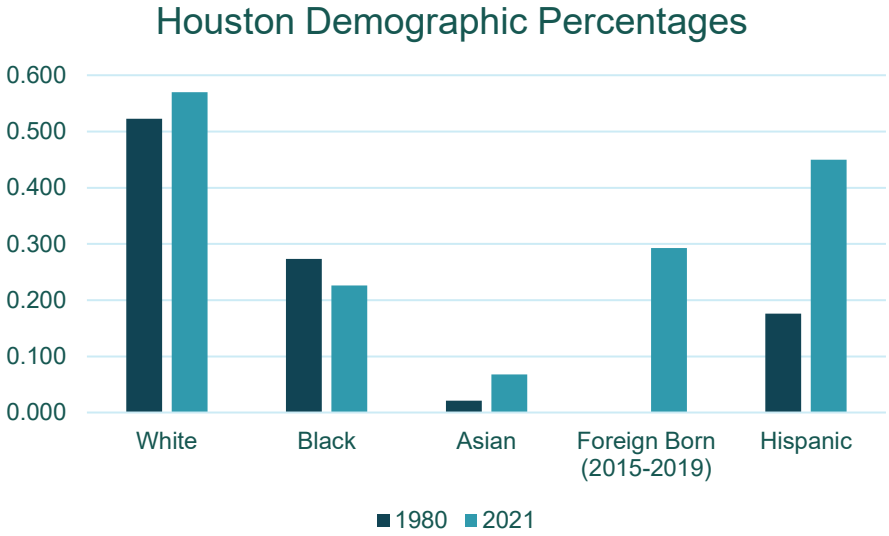
Advancing Equity and Inclusion in the Education Sciences

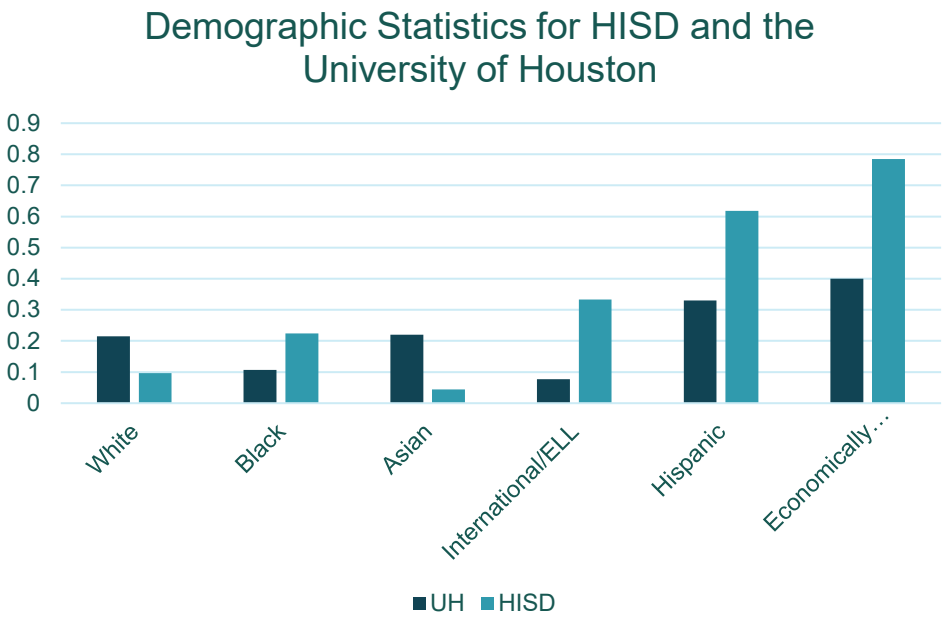
- Mom to 8th Grade Son: “Don’t you want to quit school and help support the family?”
- 8th Grade Son: “No! I want to graduate high school so I can get a better job!”

“I’ve been everywhere, man.” – J. Cash





Houston, then and now



HISD and the University of Houston

- **“All parents are environmentalists until their second child is born!”**

  - M. Zuckerman, 1987

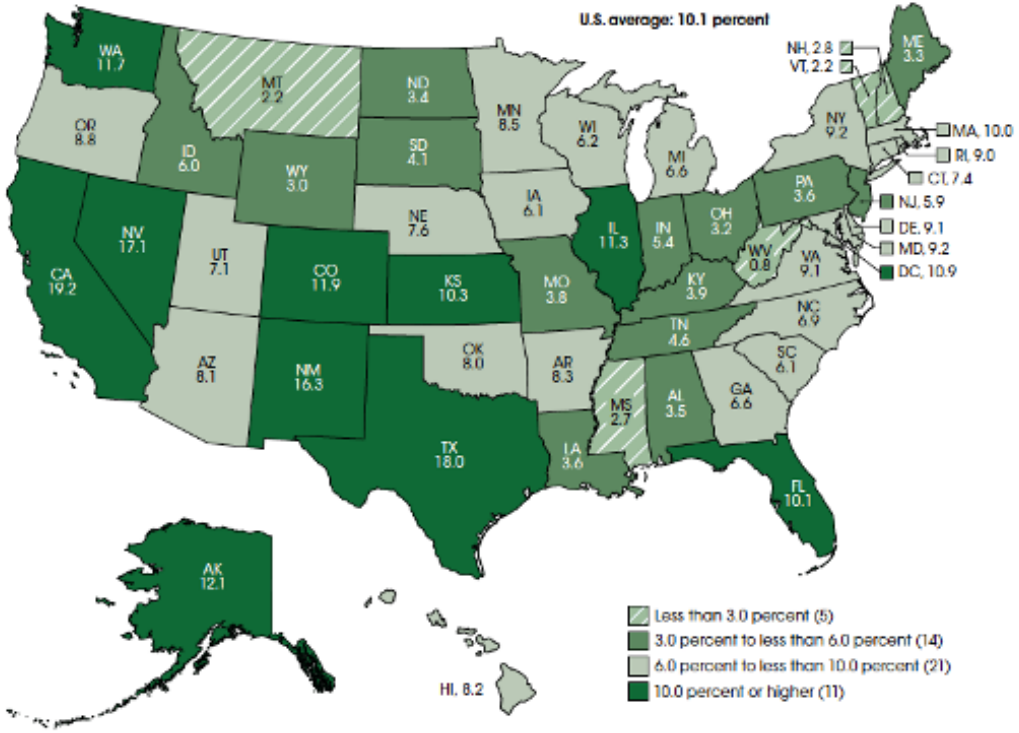
Overview

- What ELs have taught me about diversity
  - Who are English learners
  - The language-achievement connection
    - Students and contexts matter

Who are English Learners?

- **Language Minority Student** (LM)
  - a child who hears and/or speaks a language other than English in the home (see August & Shanahan, 2006 for review of literature)
- **English Language Learner** (ELL)
  - an LM student designated locally (i.e., by the state) as limited English Proficient
- **Limited English Proficient** (LEP)
  - an LM student whose limited command of English prevents independent participation in instruction

Figure 1. Percentage of public school students who were English language learners, by state: Fall 2017



NOTE: Categorizations are based on unrounded percentages.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "Local Education Agency Universe Survey," 2017–18. See *Digest of Education Statistics 2019*, table 204.20.

10.1% or 5 Million in Fall 2017;

8.1% in Fall 2000

Percentage of ELs in US Public Schools 2017

US Instructional Models for ELs

- English Only Programs
  - Structured English Immersion
  - English as a second language
- Bilingual/L1 Programs
  - Dual Language
  - Maintenance or Developmental Programs
  - Transitional Bilingual Education

Academic Performance Indicators for ELs

- Compared to native English-speaking peers on Grade 4 NAEP, ELs were
  - 1/4th as likely to score proficient or above in Reading
  - 1/3rd as likely in Math
- ELs also perform more poorly on State Accountability tests

ELs as a Subgroup of Students

- Unlike all other groupings, membership in the EL category is dynamic and developmental
  - As students become proficient in English, they no longer count as members of the group
- The defining characteristic is causally linked to the outcomes of interest

Distinguishing between Language Proficiency and Language Ability

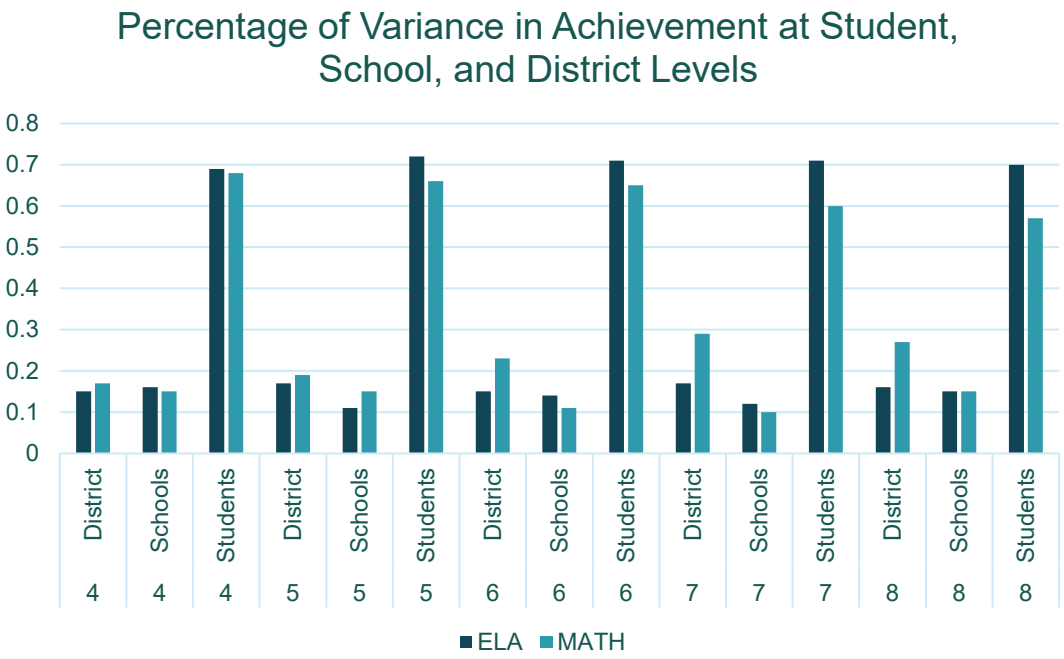
- Language ability is a determinant of academic achievement
- Language allows us
  - to learn from the experiences of others,
  - to communicate our experiences to others,
  - to transfer knowledge from one person to another both directly and indirectly

Language Ability

- Indexes what one knows about the world
- Facilitates acquisition of new knowledge
- In academic domains, it is difficult to differentiate between what one knows about an area and one's vocabulary
  - World knowledge = Word Knowledge

Reading for Understanding: Correlations Across Skills

- Background Knowledge (BK) and Vocabulary (VOC) across grades 7 – 12, respectively
  - 0.81, 0.97, 0.98, 0.94, 0.96, 0.99
- Vocabulary and Reading Comprehension across grades 7 - 12, respectively
  - 0.98, 0.96, 0.99, 0.96, 0.99, 0.94
- BK and VOC determine students' ability to make inferences from text.

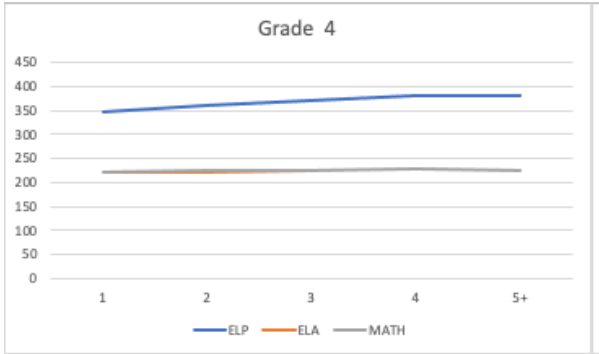


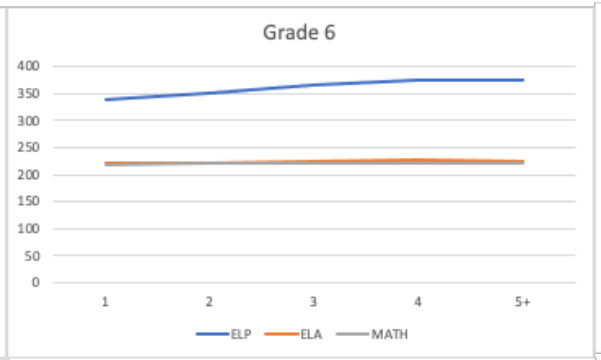
Variance in Achievement at the Student, School, and District Levels

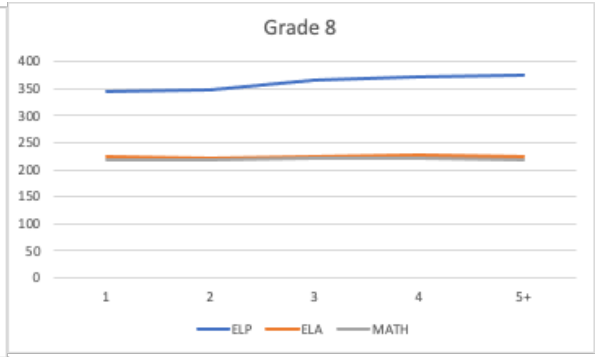
Language Proficiency and Achievement

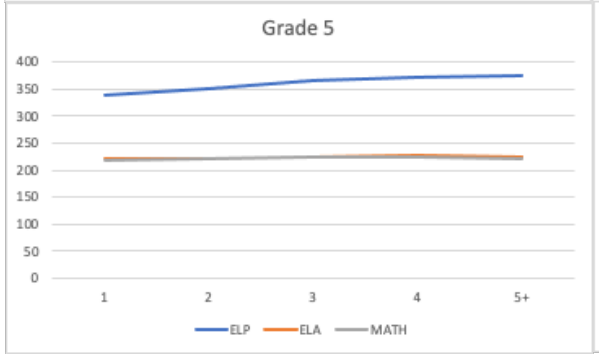
- Differences in language proficiency account for differences in achievement.

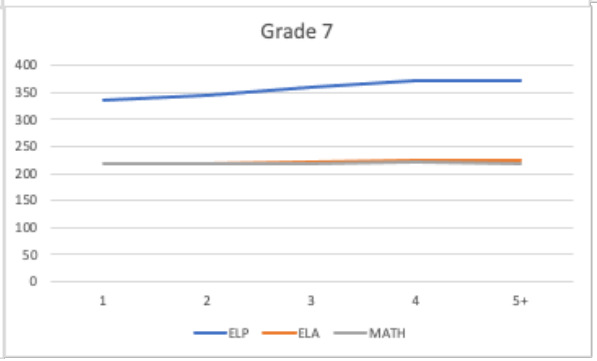
Source	English Language Arts					Math				
	Grade					Grade				
	4	5	6	7	8	4	5	6	7	8
District	0.37	0.54	0.56	0.57	0.58	0.21	0.16	0.26	0.20	0.18
Schools	0.39	0.41	0.38	0.74	0.69	0.34	0.33	0.16	0.28	0.26
Students	0.27	0.35	0.34	0.44	0.36	0.20	0.21	0.18	0.19	0.16



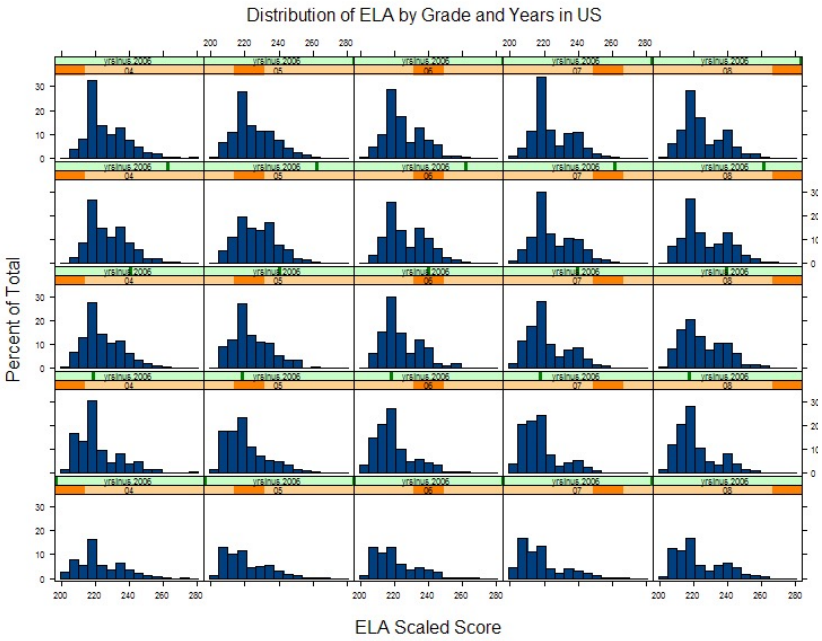


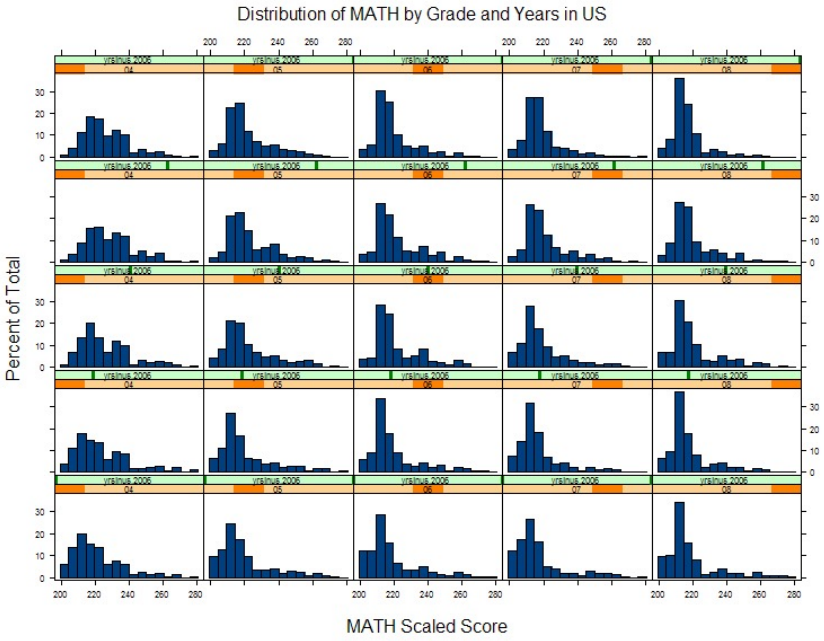




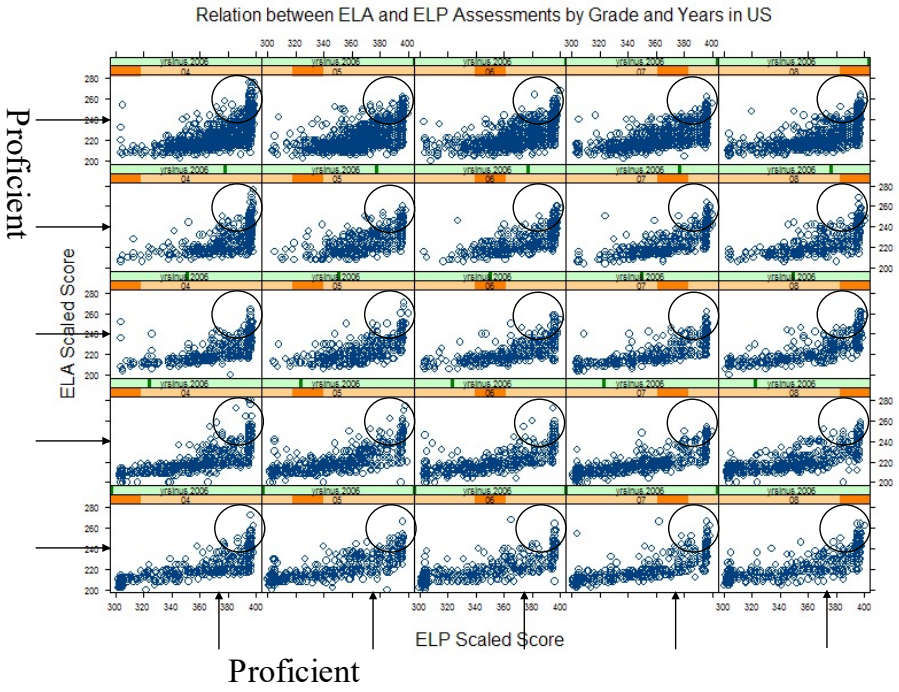


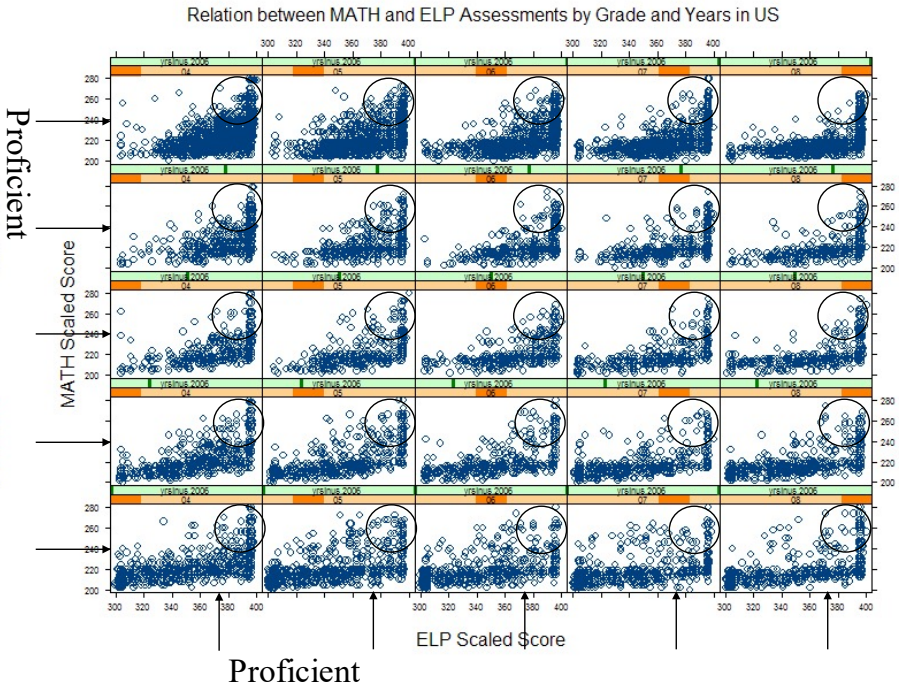
Effects of Years in the US on ELP, ELA, and MATH





Effects of Years in the US on the Distribution of ELA and Math Achievement





The Relationship Between ELP and Achievement in ELA and Math

Validity of ELA and MATH Assessments for ELs

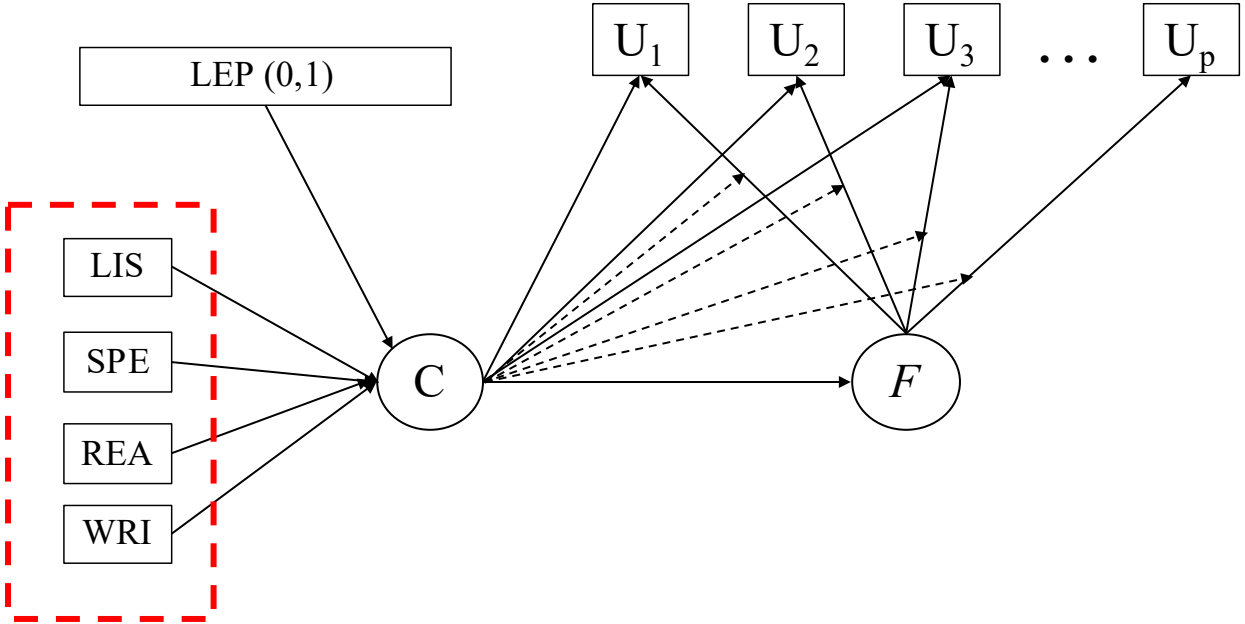
- There are several ways to interrogate the validity of the ELA and MATH assessments for EL students
- One approach combines latent-class and item-response models

Item-Mixture Model

- Propose Three ”Latent” Classes of Student:
  1. Non-EL students (Known Class)
  2. ELs for whom items work the same
  3. ELs for whom items work differently

Questions to be Answered

- Are there two types of EL student?
- Who belongs in each “class/type”
- What level of language determines class membership?



Model 3

IRT Mixture Model with Known and Unknown Latent Class Membership and Invariance for One ELL Class

Model Specifications

- Three classes:
    1. NLEP students (Class Known)
    2. ELs with item parameters = NLEP
    3. Els with item parameters ≠ NLEP
- Class 1: $F \sim N(0,1)$
- Class 2: $F \sim N(\alpha,\psi)$
- Class 3: $F \sim N(0,1)$

*Non-invariance of item parameters for Class 3 puts *F* on a different scale from *F* in Class 1 and 2

Model Fit Statistics

Model Loglikelihoods							
Grade	Cohort	ELA			MATH		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
4	2006	-1,016,055	-1,015,516	-1,014,618	-996,717	-995,953	-995,191
	2007	-898,692	-898,138	-897,114	-1,039,630	-1,038,842	-1,038,210
6	2006	-1,060,206	-1,059,538	-1,058,884	-1,028,559	-1,028,054	-1,027,488
	2007	-947,252	-946,739	-946,024	-1,050,005	-1,049,333	-1,048,857
8	2006	-1,028,500	-1,027,889	-1,027,194	-1,179,357	-1,178,527	-1,177,922
	2007	-986,463	-985,507	-985,056	-1,133,520	-1,132,625	-1,132,220

Model 1: 2 classes (Ell, non ELL); loadings and Threshold fixed same across classes; non Ell factor means = 0, variances = 1; Ell class means, variances free

Model 2: 2 classes (ELL, non Ell); loadings and thresholds free across classes; factor means = 0, variances = 1 for both classes

Model 3: 3 classes; Class 1 = non ELL's, factor means = 0, variances = 1; Class 2 = ELL's with loadings and thresholds fixed same as class 1, means and variances free; Class 3 = Ell's with loadings and thresholds free, means = 0, variances = 1

Grade	Cohort	AIC					
		ELA			MATH		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
4	2006	2,032,261	2,031,322	2,029,540	1,993,576	1,992,180	1,990,671
	2007	1,797,533	1,796,566	1,794,533	2,079,402	2,077,959	2,076,708
6	2006	2,120,562	2,119,366	2,118,072	2,057,260	2,056,382	2,055,265
	2007	1,894,653	1,893,769	1,892,352	2,100,152	2,098,940	2,098,002
8	2006	2,057,150	2,056,067	2,054,692	2,358,857	2,357,328	2,356,131
	2007	1,973,075	1,971,304	1,970,417	2,267,181	2,265,523	2,264,728

Grade	Cohort	BIC					
		ELA			MATH		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
4	2006	2,032,941	2,032,637	2,030,917	1,994,220	1,993,422	1,991,977
	2007	1,798,212	1,797,878	1,795,908	2,080,045	2,079,199	2,078,012
6	2006	2,121,243	2,120,682	2,119,452	2,057,904	2,057,626	2,056,572
	2007	1,895,333	1,895,083	1,893,730	2,100,795	2,100,182	2,099,307
8	2006	2,057,833	2,057,388	2,056,077	2,359,503	2,358,576	2,357,443
	2007	1,973,757	1,972,621	1,971,797	2,267,826	2,266,767	2,266,036

Grade	Cohort	Sample size adjusted BIC					
		ELA			MATH		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
4	2006	2,032,702	2,032,176	2,030,434	1,993,994	1,992,987	1,991,519
	2007	1,797,974	1,797,417	1,795,425	2,079,819	2,078,763	2,077,554
6	2006	2,121,004	2,120,221	2,118,969	2,057,679	2,057,191	2,056,114
	2007	1,895,095	1,894,622	1,893,247	2,100,570	2,099,746	2,098,849
8	2006	2,057,595	2,056,927	2,055,594	2,359,278	2,358,140	2,356,985
	2007	1,973,518	1,972,160	1,971,314	2,267,600	2,266,332	2,265,578

AIC, BIC and sBIC

Class 2 Factor Means and Variances

(Class 1 Means = 0, Variances = 1)

Grade	Cohort	ELA Factor		Math Factor	
		Mean	Variance	Mean	Variance
4	2006	-0.558	0.301	-0.151	0.503
	2007	-0.413	0.305	**-0.023**	0.481
6	2006	-0.749	0.293	-0.294	0.487
	2007	-0.955	0.274	-0.293	0.589
8	2006	-0.883	0.272	-0.248	0.578
	2007	-0.712	0.267	-0.136	0.456

Bolded/Underlined not different from 0

Factor Means for Non-ELs and ELs in the Invariant Class

ELP Subtest	Grade 4		Grade 6		Grade 8	
	2006	2007	2006	2007	2006	2007
			ELA			
Listening	1.14[a]	1.60	1.23[a]	1.41[a]	1.13[a]	1.55[a]
Speaking	1.62	1.11[a]	2.28	1.29[a]	1.84	2.19
Reading	56.99	47.99	47.91	54.05	25.51	18.19
Writing	1.48	1.62	2.54	1.41[a]	1.86	1.81
			MATH			
Listening	1.12[a]	1.29[a]	1.94	1.45[a]	1.22[a]	1.15[a]
Speaking	1.25[a]	0.94[a]	0.84[a]	0.96[a]	0.82[a]	0.84[a]
Reading	14.30	9.48	9.83	12.87	14.52	5.42
Writing	1.88	1.51	2.19	2.36	2.38	5.40

Odds Ratios for Class Membership for EL_I and EL_NI

	Grade 4 2006		Grade 4 2007	
Measure	**ELA *ES***	**MATH *ES***	**ELA *ES***	**MATH *ES***
ELP SS	1.56	1.40	1.41	1.15
Reading SS	1.80	1.68	1.99	1.68
Writing SS	1.02	1.07	0.99	0.90
Listening RS	0.81	0.73	0.79	0.63
Speaking RS	0.87	0.77	0.80	0.64

	Grade 6 2006		Grade 6 2007	
Measure	**ELA *ES***	**MATH *ES***	**ELA *ES***	**MATH *ES***
ELP SS	1.84	1.49	2.09	1.61
Reading SS	1.89	1.70	1.95	1.77
Writing SS	1.26	1.23	1.20	1.22
Listening RS	0.91	0.80	0.83	0.68
Speaking RS	0.94	0.73	0.83	0.66

	Grade 8 2006		Grade 8 2007	
Measure	**ELA *ES***	**MATH *ES***	**ELA *ES***	**MATH *ES***
ELP SS	1.80	1.43	1.63	1.43
Reading SS	1.84	1.84	1.85	1.63
Writing SS	1.40	1.46	1.41	1.65
Listening RS	0.93	0.69	0.93	0.60
Speaking RS	0.93	0.63	0.93	0.58

Effect Sizes Comparing the Latent EL Classes for Grades 4, 6 and 8

Grade	Cohort	Entropy	Average Latent Class Probabilities	
			EL_Invariant	EL_Not Invariant
		ELA		
4	2006	.990	.919	.922
	2007	.991	.921	.932
6	2006	.994	.921	.934
	2007	.995	.941	.922
8	2006	.995	.921	.938
	2007	.996	.907	.953
		MATH		
4	2006	.987	.889	.896
	2007	.988	.877	.912
6	2006	.993	.896	.919
	2007	.993	.899	.918
8	2006	.994	.915	.935
	2007	.995	.902	.943

Entropy and Posterior Probabilities

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	Grade 4 2006				Grade 4 2007			
	ELA		MATH		ELA		MATH	
PL Level	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %
1	0	7	0	6	0	5	0	5
2	0	12	0	11	0	13	0	12
3	4	42	5	39	1	34	4	30
4	96	40	95	43	99	48	96	53

	Grade 6 2006				Grade 6 2007			
	ELA		MATH		ELA		MATH	
PL Level	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %
1	0	10	0	10	0	15	0	11
2	0	17	0	15	1	28	1	21
3	8	49	10	45	21	49	14	45
4	92	24	90	30	77	8	85	22

	Grade 8 2006				Grade 8 2007			
	ELA		MATH		ELA		MATH	
PL Level	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %	Invariant %	Not-Invar. %
1	0	19	0	16	0	13	0	14
2	0	18	1	16	0	19	1	18
3	8	41	7	37	4	43	9	42
4	91	22	92	31	96	25	89	26

Percent of Latent Class Members based on ELP Performance Level

IFEPs, RFEPs, and ELs

- Subgroups of Language Minority Students
  - Initially Fluent English Proficient (IFEP)
  - Reclassified English Proficient (RFEP)
  - English Learners (ELs)
- Explanatory Item Response Models of DIF

Improving the Measurement of Vocabulary for ELs

- Items did not to differ for IFEP vs. never-EL
- Items did not to differ for RFEP vs. never-EL
- For more information see:
  - https://academicvocab.times.uh.edu/

Conclusions

- Heterogeneity across the student body is underappreciated and under-researched
- For ELs, a major source of ignored heterogeneity is English proficiency
- Contexts influence student outcomes, but may conflate student differences with organizational differences
- More careful consideration of student differences will provide more informed understanding of group diversity and context effects

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Disclaimer

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THANKS!

Any questions?

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