
Some Preliminary Results From North Carolina

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and
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<http://www.uoregon.edu/~stevensj/stevens2012.pdf>

And on NCAASE web site soon: <http://www.ncaase.com/>

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Presentation Purpose

- Share preliminary results of analyses on first cohort of data from North Carolina

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Evolution of Analytic Sample

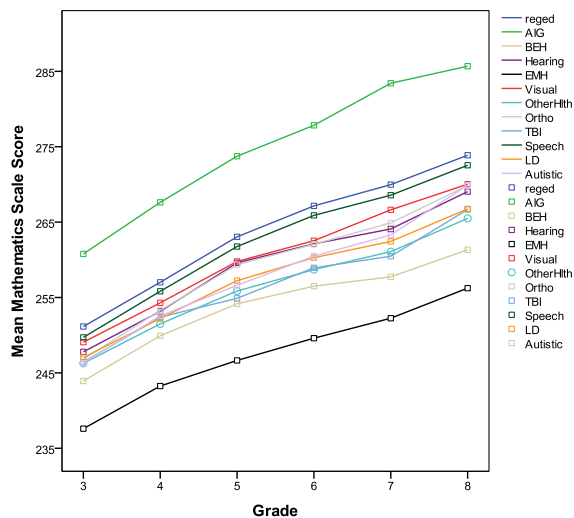
- Original cohort sample grades 3-8, 2001-2006, N=103,123
 - Exclusions:
 - Off sequence cases N=94,808 (91.9%)
 - Missing ethnicity (N=14) or sex codes (N=3); dropped “other” ethnicity (N=30)
 - Missing exceptionality codes (N=255) or exceptionality group less than 10 (Blind, Multihandicapped, Trainable MH, Sever MH; N=245)
 - Restricted to grades 3-6 math (same edition)
 - Missing any math score (N=1,207)
 - Final analytic sample, N=92,028 (89%)
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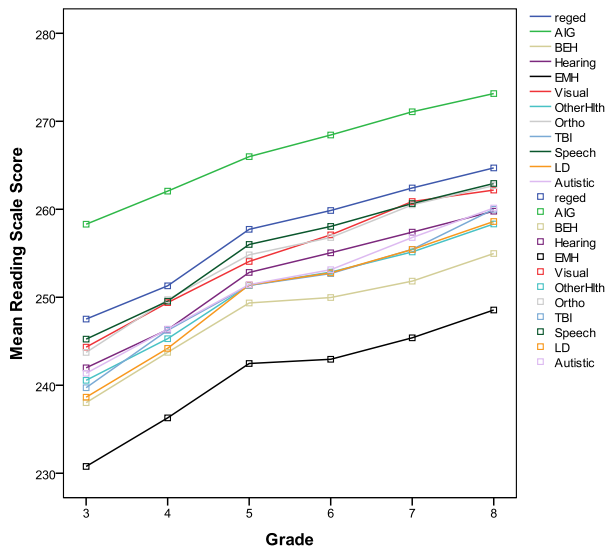
Measurement Occasions

- Grades 3-6, “forward matched”
- All cases with one or more math scores retained
- Distribution of scores over occasions:

Only one score:	6.2%
Two scores:	4.8%
Three scores:	5.2%
All four scores:	83.8%

Observed Means Over Time





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HLM Models

- Grades 3-6 Math within edition
- Two level models with measurement occasions at level 1 nested within students at level 2
- Unconditional model followed by conditional models

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Unconditional Model Output

τ (as correlations)

INTRCPT1, β_0	1.000	0.649	-0.401
TIME1, β_1	0.649	1.000	-0.698
TIME2, β_2	-0.401	-0.698	1.000

Random level-1 coefficient	Reliability estimate
INTRCPT1, β_0	0.829
TIME1, β_1	0.073
TIME2, β_2	0.066

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Unconditional Model Output

Final estimation of fixed effects (with robust standard errors)

Fixed Effect	Coefficient	Standard error	<i>t</i> -ratio	Approx. <i>df.</i>	<i>p</i> -value
Intercept, γ_{00}	251.154057	0.025109	10002.377	92027	<0.001
Slope, γ_{10}	6.623701	0.017941	369.194	92027	<0.001
Slope ² , γ_{20}	-0.428067	0.005748	-74.470	92027	<0.001

Final estimation of variance components

Random Effect	Standard Deviation	Variance Component	<i>df.</i>	χ^2	<i>p</i> -value
Intercept, u_0	6.93152	48.04592	81856	465341.039	<0.001
Slope, u_1	1.42457	2.02941	81856	88155.3297	<0.001
Slope ² , u_2	0.43077	0.18556	81856	87489.0785	<0.001
level-1, <i>r</i>	3.17695	10.09299			

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Full conditional Model with demographics and exceptionality dummy codes

Level-1 Model

$$MATH_{ij} = \beta_{0j} + \beta_{1j} * (TIME1_{ij}) + \beta_{2j} * (TIME2_{ij}) + r_{ij}$$

Level-2 Model

$$\begin{aligned} \beta_{0j} &= Y_{00} + Y_{01} * (LEP) + Y_{02} * (PARED) + Y_{03} * (SEX) + Y_{04} * (FRL) + Y_{05} * (ACCOMM) + Y_{06} * (TITLE1SC) + Y_{07} * (TITLE1MI) + Y_{08} * (AIG) \\ &+ Y_{09} * (BEH) + Y_{010} * (HEARING) + Y_{011} * (EMH) + Y_{012} * (VISUAL) + Y_{013} * (OTHER) + Y_{014} * (ORTHO) + Y_{015} * (TBI) \\ &+ Y_{016} * (SPEECH) + Y_{017} * (SLD) + Y_{018} * (AUTISTIC) + u_{0j} \\ \beta_{1j} &= Y_{10} + Y_{11} * (LEP) + Y_{12} * (PARED) + Y_{13} * (SEX) + Y_{14} * (FRL) + Y_{15} * (ACCOMM) + Y_{16} * (TITLE1SC) + Y_{17} * (TITLE1MI) + Y_{18} * (AIG) \\ &+ Y_{19} * (BEH) + Y_{110} * (HEARING) + Y_{111} * (EMH) + Y_{112} * (VISUAL) + Y_{113} * (OTHER) + Y_{114} * (ORTHO) + Y_{115} * (TBI) \\ &+ Y_{116} * (SPEECH) + Y_{117} * (SLD) + Y_{118} * (AUTISTIC) + u_{1j} \\ \beta_{2j} &= Y_{20} + Y_{21} * (LEP) + Y_{22} * (PARED) + Y_{23} * (SEX) + Y_{24} * (FRL) + Y_{25} * (ACCOMM) + Y_{26} * (TITLE1SC) + Y_{27} * (TITLE1MI) + Y_{28} * (AIG) \\ &+ Y_{29} * (BEH) + Y_{210} * (HEARING) + Y_{211} * (EMH) + Y_{212} * (VISUAL) + Y_{213} * (OTHER) + Y_{214} * (ORTHO) + Y_{215} * (TBI) \\ &+ Y_{216} * (SPEECH) + Y_{217} * (SLD) + Y_{218} * (AUTISTIC) + u_{2j} \end{aligned}$$

Mixed Model

$$\begin{aligned} MATH_{ij} &= Y_{00} + Y_{01} * LEP + Y_{02} * PARED + Y_{03} * SEX + Y_{04} * FRL + Y_{05} * ACCOMM + Y_{06} * TITLE1SC + Y_{07} * TITLE1MI \\ &+ Y_{08} * AIG + Y_{09} * BEH + Y_{010} * HEARING + Y_{011} * EMH + Y_{012} * VISUAL + Y_{013} * OTHER + Y_{014} * ORTHO + Y_{015} * TBI \\ &+ Y_{016} * SPEECH + Y_{017} * SLD + Y_{018} * AUTISTIC + Y_{10} * TIME1_{ij} + Y_{11} * LEP * TIME1_{ij} + Y_{12} * PARED * TIME1_{ij} + Y_{13} * SEX * TIME1_{ij} \\ &+ Y_{14} * FRL * TIME1_{ij} + Y_{15} * ACCOMM * TIME1_{ij} + Y_{16} * TITLE1SC * TIME1_{ij} + Y_{17} * TITLE1MI * TIME1_{ij} + Y_{18} * AIG * TIME1_{ij} \\ &+ Y_{19} * BEH * TIME1_{ij} + Y_{110} * HEARING * TIME1_{ij} + Y_{111} * EMH * TIME1_{ij} + Y_{112} * VISUAL * TIME1_{ij} + Y_{113} * OTHER * TIME1_{ij} \\ &+ Y_{114} * ORTHO * TIME1_{ij} + Y_{115} * TBI * TIME1_{ij} + Y_{116} * SPEECH * TIME1_{ij} + Y_{117} * SLD * TIME1_{ij} + Y_{118} * AUTISTIC * TIME1_{ij} \\ &+ Y_{20} * TIME2_{ij} + Y_{21} * LEP * TIME2_{ij} + Y_{22} * PARED * TIME2_{ij} + Y_{23} * SEX * TIME2_{ij} + Y_{24} * FRL * TIME2_{ij} + Y_{25} * ACCOMM * TIME2_{ij} \\ &+ Y_{26} * TITLE1SC * TIME2_{ij} + Y_{27} * TITLE1MI * TIME2_{ij} + Y_{28} * AIG * TIME2_{ij} + Y_{29} * BEH * TIME2_{ij} + Y_{210} * HEARING * TIME2_{ij} \\ &+ Y_{211} * EMH * TIME2_{ij} + Y_{212} * VISUAL * TIME2_{ij} + Y_{213} * OTHER * TIME2_{ij} + Y_{214} * ORTHO * TIME2_{ij} + Y_{215} * TBI * TIME2_{ij} \\ &+ Y_{216} * SPEECH * TIME2_{ij} + Y_{217} * SLD * TIME2_{ij} + Y_{218} * AUTISTIC * TIME2_{ij} + u_{0j} + u_{1j} * TIME1_{ij} + u_{2j} * TIME2_{ij} + r_{ij} \end{aligned}$$

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τ (as correlations)

INTRCPT1, β_0	1.000	0.580	-0.398
TIME1, β_1	0.580	1.000	-0.700
TIME2, β_2	-0.398	-0.700	1.000

Random level-1 coefficient	Reliability estimate
INTRCPT1, β_0	0.746
TIME1, β_1	0.060
TIME2, β_2	0.061

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Two-level HLM Full Model, Grades 3-6

Fixed Effect	Coefficient	Standard error	<i>t</i> -ratio	Approx. <i>d.f.</i>	<i>p</i> -value
Intercept, γ_{00}	248.982953	0.070271	3543.167	92011	<0.001
LEP, γ_{01}	-0.957679	0.148776	-6.437	92011	<0.001
PARED, γ_{02}	1.233078	0.016237	75.943	92011	<0.001
SEX, γ_{03}	-0.438863	0.041461	-10.585	92011	<0.001
FRL, γ_{04}	-1.434738	0.026509	-54.123	92011	<0.001
Accom, γ_{05}	-1.360080	0.115108	-11.816	92011	<0.001
Title I, γ_{06}	-0.730448	0.044924	-16.260	92011	<0.001
Title I m, γ_{07}	1.411249	0.275616	5.120	92011	<0.001
AIG, γ_{08}	7.058834	0.071883	98.199	92011	<0.001
BEH, γ_{09}	-4.736012	0.296517	-15.972	92011	<0.001
Hearing, γ_{010}	-3.262262	0.548478	-5.948	92011	<0.001
EMH, γ_{011}	-10.465192	0.208056	-50.300	92011	<0.001
Other, γ_{012}	-4.204724	0.228028	-18.440	92011	<0.001
Ortho, γ_{013}	-3.209759	0.936368	-3.428	92011	<0.001
Speech, γ_{014}	-1.404430	0.139572	-10.062	92011	<0.001
SLD, γ_{015}	-2.763083	0.137515	-20.093	92011	<0.001
Autistic, γ_{016}	-6.984025	0.666504	-10.479	92011	<0.001

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Two-level HLM Full Model, Grades 3-6

Fixed Effect	Coefficient	Standard error	<i>t</i> -ratio	Approx. <i>d.f.</i>	<i>p</i> -value
Slope, γ_{10}	6.495522	0.059670	108.857	92011	<0.001
LEP, γ_{11}	0.864604	0.132616	6.520	92011	<0.001
PARED, γ_{12}	0.156684	0.013719	11.421	92011	<0.001
SEX, γ_{13}	-0.147154	0.035925	-4.096	92011	<0.001
FRL, γ_{14}	-0.045221	0.022923	-1.973	92011	0.049
Accom, γ_{15}	-0.414013	0.101777	-4.068	92011	<0.001
Title I, γ_{16}	-0.589088	0.038951	-15.124	92011	<0.001
Title I m, γ_{17}	-0.208741	0.253259	-0.824	92011	0.410
AIG, γ_{18}	0.836801	0.071044	11.779	92011	<0.001
BEH, γ_{19}	0.295478	0.306713	0.963	92011	0.335
Hearing, γ_{110}	0.542390	0.513819	1.056	92011	0.291
EMH, γ_{111}	-0.860869	0.242226	-3.554	92011	<0.001
Other, γ_{112}	-0.799350	0.208813	-3.828	92011	<0.001
Ortho, γ_{113}	0.809906	0.746067	1.086	92011	0.278
Speech, γ_{114}	0.063756	0.113767	0.560	92011	0.575
SLD, γ_{115}	-0.514660	0.121365	-4.241	92011	<0.001
Autistic, γ_{116}	-0.908718	0.608403	-1.494	92011	0.135

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Two-level HLM Full Model, Grades 3-6

Fixed Effect	Coefficient	Standard error	t-ratio	Approx. d.f.	p-value
Slope², γ_{20}	-0.443151	0.019172	-23.115	92011	<0.001
LEP, γ_{21}	-0.073149	0.041165	-1.777	92011	0.076
PARED, γ_{22}	-0.017875	0.004409	-4.055	92011	<0.001
SEX, γ_{23}	0.096271	0.011572	8.320	92011	<0.001
FRL, γ_{24}	-0.020011	0.007391	-2.708	92011	0.007
Accom, γ_{25}	0.049811	0.032436	1.536	92011	0.125
Title I, γ_{26}	0.127364	0.012536	10.160	92011	<0.001
Title I m, γ_{27}	0.137241	0.079016	1.737	92011	0.082
AIG, γ_{28}	-0.232651	0.022785	-10.211	92011	<0.001
BEH, γ_{29}	-0.281532	0.098666	-2.853	92011	0.004
Hearing, γ_{210}	-0.244707	0.172522	-1.418	92011	0.156
EMH, γ_{211}	0.004250	0.078983	0.054	92011	0.957
Other, γ_{212}	-0.017691	0.067083	-0.264	92011	0.792
Ortho, γ_{213}	-0.348676	0.237980	-1.465	92011	0.143
Speech, γ_{214}	0.011045	0.036864	0.300	92011	0.764
SLD, γ_{215}	0.000290	0.038998	0.007	92011	0.994
Autistic, γ_{216}	0.233229	0.194576	1.199	92011	0.231

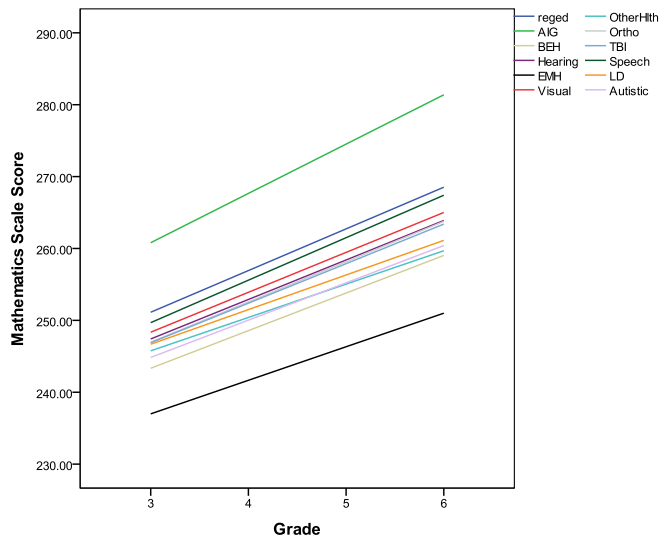
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Two-level HLM Full Model, Grades 3-6

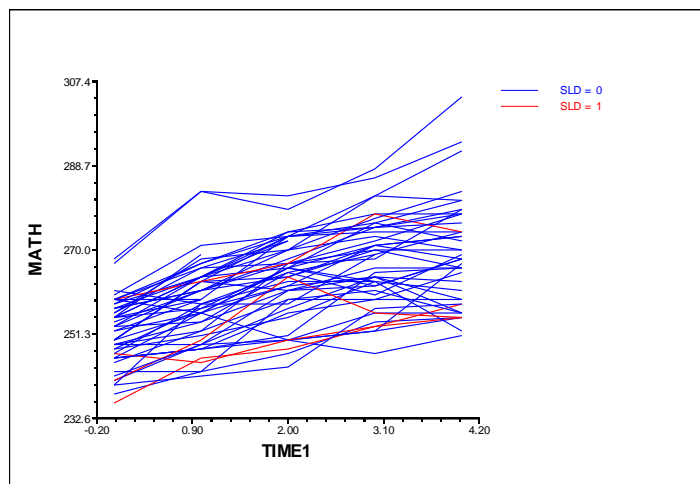
Random Effect	Standard Deviation	Variance Component	d.f.	χ^2	p-value
INTRCPT1, u_0	5.37199	28.85825	81840	321328.73081	<0.001
TIME1 slope, u_1	1.28267	1.64525	81840	87079.28974	<0.001
TIME2 slope, u_2	0.41561	0.17273	81840	87159.43843	<0.001
level-1, r	3.17574	10.08532			

Model comparison test
 χ^2 statistic = 46033.02052
Degrees of freedom = 48
p-value = <0.001

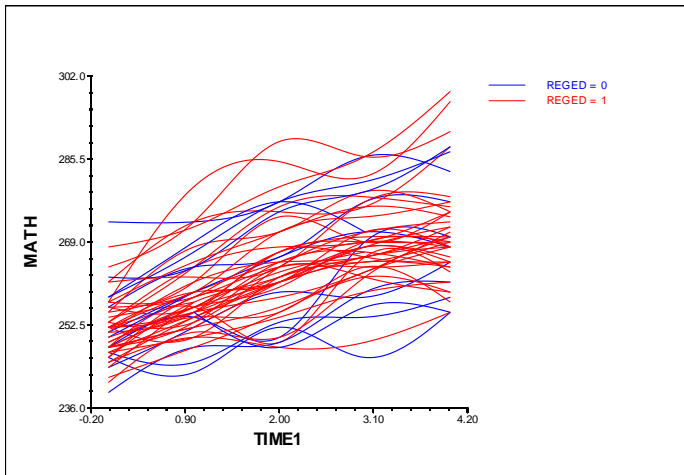
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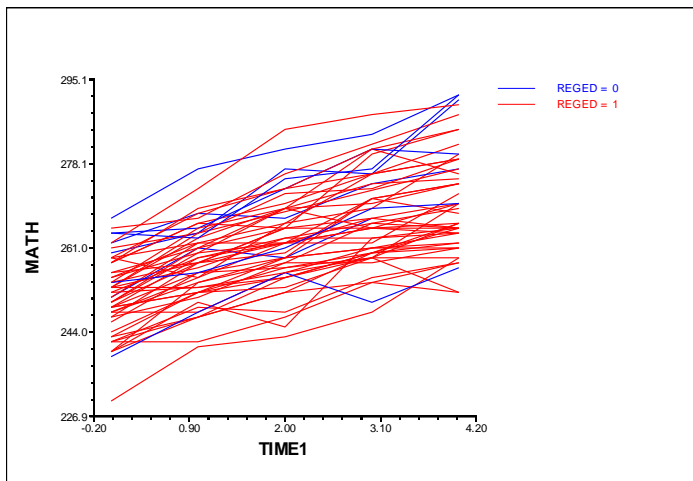
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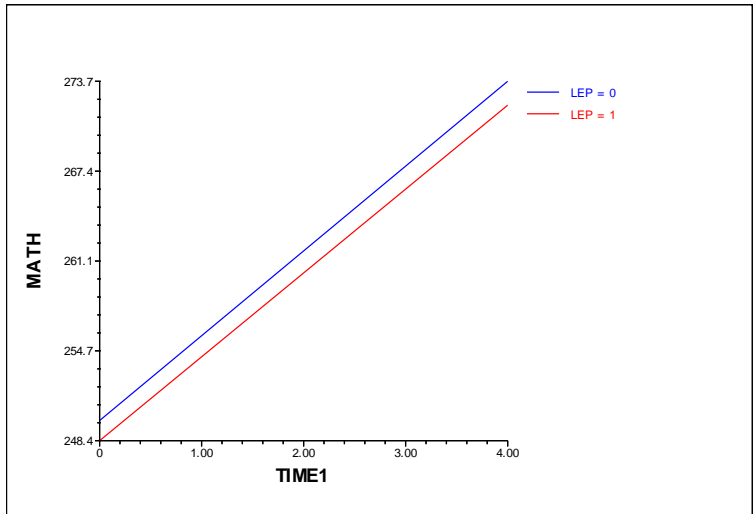
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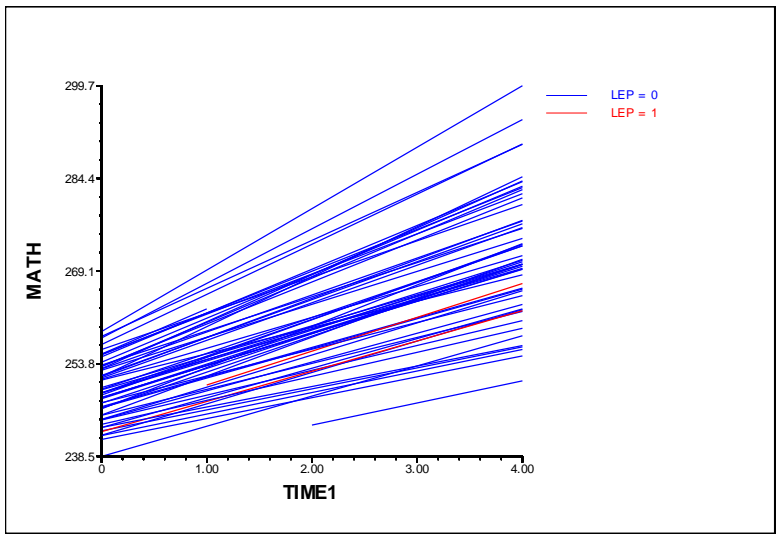
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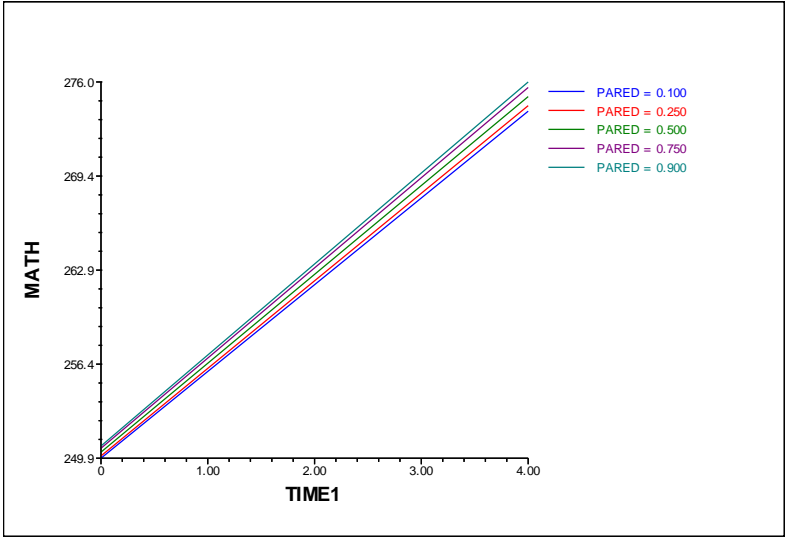
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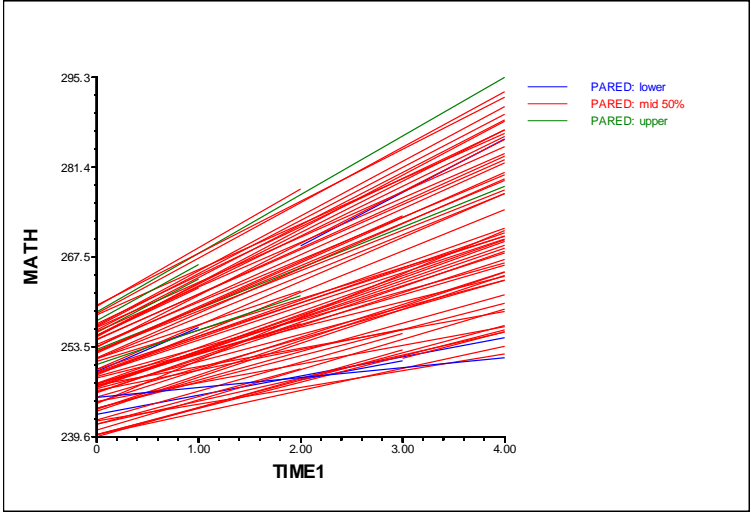
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Latent Variable Regression

Outcome	Predictor	Estimated Coefficient	Standard Error	t-ratio	p-value
TIME1, β_1	INTRCPT2, γ_{10}^*	-27.967293	1.173678	-23.829	0.000
	LEP, γ_{11}^*	0.997161	0.139781	7.134	0.000
	PARED, γ_{12}^*	-0.013992	0.015497	-0.903	0.367
	SEX, γ_{13}^*	-0.086409	0.037585	-2.299	0.022
	FRL, γ_{14}^*	0.153367	0.024899	6.160	0.000
ACCOMM, γ_{15}^*	-0.225758	0.103454	-2.182	0.029	
TITLEISC, γ_{16}^*	-0.487984	0.040795	-11.962	0.000	
TITLEIMI, γ_{17}^*	-0.404078	0.261137	-1.547	0.122	
AIG, γ_{18}^*	-0.140243	0.079817	-1.757	0.078	
BEH, γ_{19}^*	0.951010	0.267025	3.562	0.001	
HEARING, γ_{110}^*	0.993933	0.509511	1.951	0.051	
EMH, γ_{111}^*	0.587664	0.253446	2.319	0.020	
OTHER, γ_{112}^*	-0.217356	0.199675	-1.089	0.277	
ORTHO, γ_{113}^*	1.254183	0.786313	1.595	0.110	
SPEECH, γ_{114}^*	0.258150	0.118871	2.172	0.030	
SLD, γ_{115}^*	-0.132210	0.123384	-1.072	0.284	
AUTISTIC, γ_{116}^*	0.057972	0.557959	0.104	0.918	
$\beta_0 \gamma_{117}^*$	0.138414	0.004707	29.405	0.000	

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Latent Variable Regression

Outcome	Predictor	Estimated Coefficient	Standard Error	t-ratio	p-value
TIME2, β_2	INTRCPT2, γ_{20}^*	7.219642	0.347105	20.800	0.000
	LEP, γ_{21}^*	-0.102623	0.042470	-2.416	0.016
	PARED, γ_{22}^*	0.020075	0.004850	4.139	0.000
	SEX, γ_{23}^*	0.082764	0.011851	6.984	0.000
	FRL, γ_{24}^*	-0.064167	0.007815	-8.210	0.000
ACCOMM, γ_{25}^*	0.007952	0.032050	0.248	0.804	
TITLEISC, γ_{26}^*	0.104884	0.012858	8.157	0.000	
TITLEIMI, γ_{27}^*	0.180675	0.081088	2.228	0.026	
AIG, γ_{28}^*	-0.015406	0.024941	-0.618	0.536	
BEH, γ_{29}^*	-0.427289	0.083719	-5.104	0.000	
HEARING, γ_{210}^*	-0.345108	0.160729	-2.147	0.032	
EMH, γ_{211}^*	-0.317830	0.076273	-4.167	0.000	
OTHER, γ_{212}^*	-0.147097	0.062699	-2.346	0.019	
ORTHO, γ_{213}^*	-0.447461	0.245912	-1.820	0.068	
SPEECH, γ_{214}^*	-0.032178	0.037494	-0.858	0.391	
SLD, γ_{215}^*	-0.084748	0.038400	-2.207	0.027	
AUTISTIC, γ_{216}^*	0.018286	0.175359	0.104	0.917	
$\beta_0 \gamma_{217}^*$	-0.030776	0.001392	-22.112	0.000	

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Outcome	Predictor	Original Coefficient	Adjusted Coefficient	Difference	Standard Error Difference	
TIME1 β_1	INTRCPT2	6.49552	1.17348	-27.96729	34.462815	
	LEP	0.86460	0.02063	0.99716	-0.132557	
	PARED	0.15668	0.00621	-0.01399	0.170676	
	SEX	-0.14715	0.00610	-0.08641	-0.060745	
	FRL	-0.04522	0.00768	0.15337	-0.198588	
	ACCOMM	-0.41401	0.01649	-0.22576	-0.188255	
	TITLE1SC	-0.58909	0.00709	-0.48798	-0.101104	
	TITLE1MI	-0.20874	0.03899	-0.40408	0.195337	
	AIG	0.83680	0.03507	-0.14024	0.977044	
	BEH	0.29548	0.04412	0.95101	-0.655532	
	HEARING	0.54239	0.07824	0.99393	-0.451544	
	EMH	-0.86087	0.05911	0.58766	-1.448533	
	OTHER	-0.79935	0.03532	-0.21736	-0.581994	
	ORTHO	0.80991	0.11974	1.25418	-0.444277	
	SPEECH	0.06376	0.01938	0.25815	-0.194393	
	SLD	-0.51466	0.02235	-0.13221	-0.382450	
	AUTISTIC	-0.90872	0.08439	0.05797	-0.966689	
	TIME2 β_2	INTRCPT2	-0.44315	0.34655	7.21964	-7.662793
		LEP	-0.07315	0.00467	-0.10262	0.029474
		PARED	-0.01788	0.00178	0.02007	-0.037950
SEX		0.09627	0.00142	0.08276	0.013507	
FRL		-0.02001	0.00216	-0.06417	0.044156	
ACCOMM		0.04981	0.00387	0.00795	0.041858	
TITLE1SC		0.12736	0.00171	0.10488	0.022481	
TITLE1MI		0.13724	0.00877	0.18067	-0.043433	
AIG		-0.23265	0.01014	-0.01541	-0.217245	
BEH		-0.28153	0.01073	-0.42729	0.145757	
HEARING		-0.24471	0.01765	-0.34511	0.100401	
EMH		0.00425	0.01628	-0.31783	0.322081	
OTHER		-0.01769	0.00875	-0.14710	0.129406	
ORTHO		-0.34868	0.02679	-0.44746	0.098785	
SPEECH		0.01105	0.00450	-0.03218	0.043223	
SLD		0.00029	0.00558	-0.08475	0.085038	
AUTISTIC		0.23323	0.01983	0.01829	0.214943	

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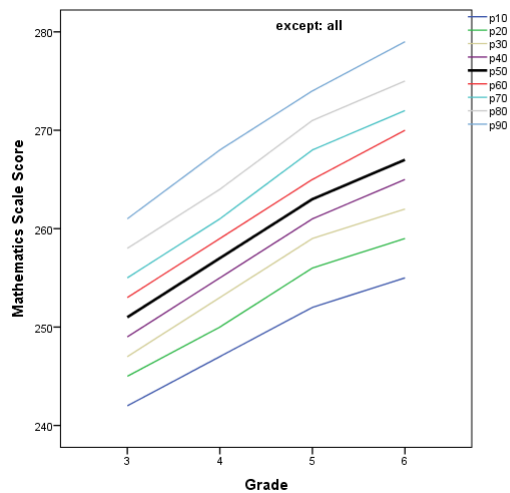
Growth Norms

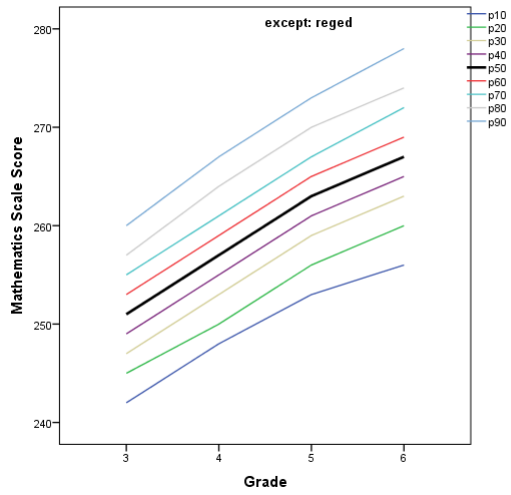
- Betebenner’s growth percentiles attracting a lot of attention
 - Reminder about absolute vs. relative growth
 - Some advantages and disadvantages (flexible application, vertical scaling, precision of the predictor, sample size, ordinal, normative)
- Some other approaches to norms:
 - Absolute growth based on “populations”
 - Absolute growth based on cohort
 - Absolute growth based on models (e.g., EB estimates, nonparametric or semiparametric estimates)
 - Smoothing and curve fitting
- Some examples follow

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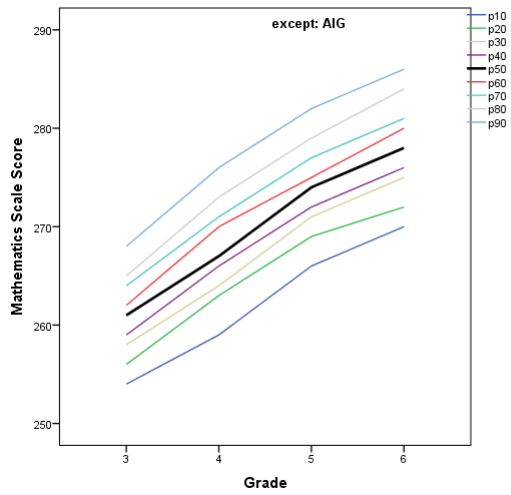
“Population” Growth Norms

- Cross-sectional; uses all students in the sample (before exclusions for HLM analysis, includes those with missing data; requires valid math score in year of interest)
- Typically involves smoothing (not done yet here)
- Advantages and disadvantages
- Sample size by exceptionality category:

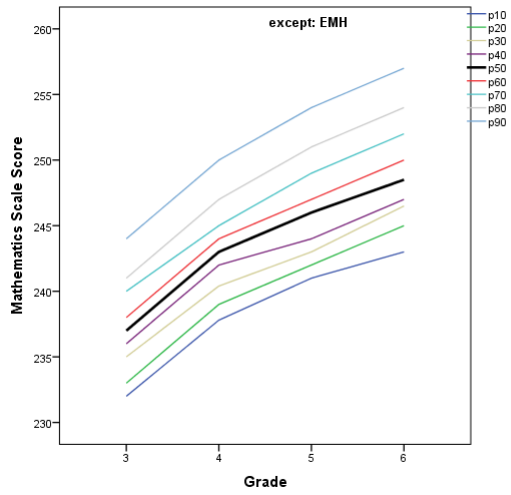




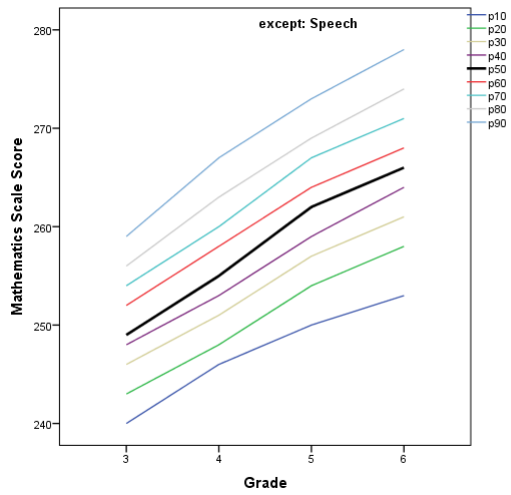
31



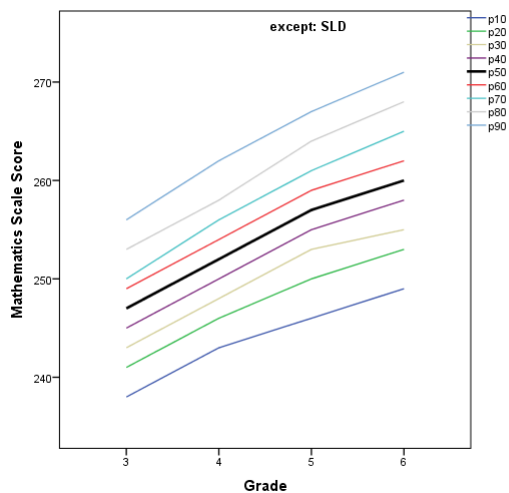
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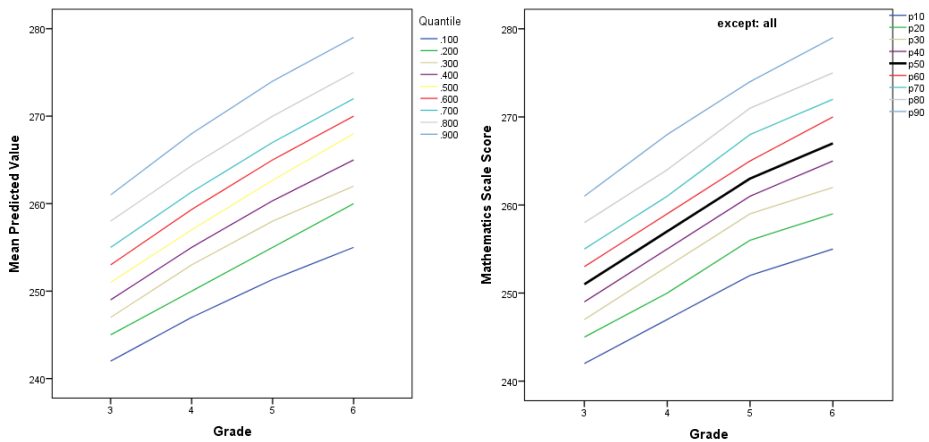
“Longitudinal” Growth Norms

- Stable cohort of students present across all measurement occasions
- Cross-sectional; uses all students in the sample (before exclusions for HLM analysis, includes those with missing data; requires valid math score in year of interest)
- Typically involves smoothing
- Advantages and disadvantages
- For this NC cohort, no differences for entire group between cross-sectional and longitudinal deciles
- Differences emerge as smaller subgroups analyzed

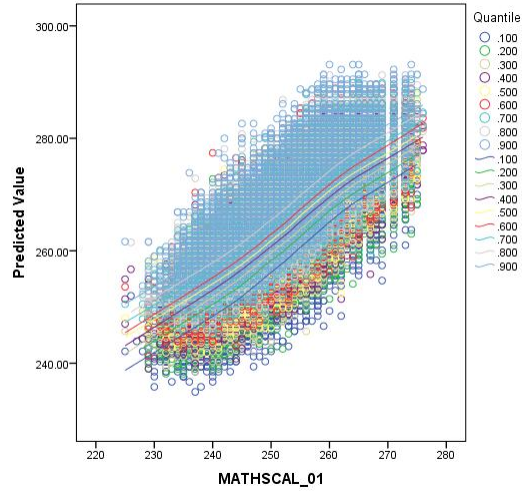
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Quantile Regression

- Conditional on time
- Conditional on prior achievement



Quantile Regression: All Students



Quantile Regression: Speech Exceptionality

