This paper should be cited as Tutwiler, M. S., McCoach, D. B., Hamilton, R., & Siegle, D. (April, 2017). *Trends in reading growth between gifted and nongifted students: An individual growth model analysis.* Paper presented at the annual meeting of the American Educational Research Association, San Antonio, TX.

Trends in Reading Growth between Gifted and Non-Gifted Students: an Individual Growth Model Analysis

Abstract

In this study, we use large-scale, longitudinal data to model the growth in student reading across 3rd, 4th, and 5th grade in three states using multi-level models for change (Singer & Willett, 2003) to fit individual growth models for students nested in schools and districts. Students who were identified as gifted had 3rd grade reading scores that were nearly a full standard deviation higher than their non-gifted peers. However, students identified as gifted showed reading growth that was either similar to, or slightly lower than, their non-gifted peers.

Introduction

Growth curve models have become increasingly prevalent in the educational research literature. Growth curve models allow for the exploration of both intra-individual change and individual differences in the nature of that change. Conceptually, such models fit individual growth trajectories to each students' data. In addition, multilevel growth models allow for the estimation of school and district mean growth trajectories, providing for more dynamic and equitable models of school effectiveness.

Growth models may provide researchers with a more equitable way to evaluate student progress and school accountability. Schools vary widely in terms of their clientele and their students' initial achievement levels, and school achievement and socioeconomic status (SES) are strongly related. Schools that serve less advantaged students tend to have lower average achievement. However, these achievement differences may not be "school effects" or indicators of differential school effectiveness. In contrast, school growth tends to be less related to school SES. Schools that exhibit the highest growth vary in terms of their overall achievement level

Note: This study was conducted by the National Center for Research on Gifted Education (NCRGE - http://ncrge.uconn.edu), which is funded by the Institute of Education Sciences, U.S. Department of Education PR/Award # R305C140018

(and schools that exhibit the highest initial achievement vary in terms of their growth rates), indicating that status and growth measure distinct aspects of school effectiveness—the overall academic performance of the school and the ability of the school to improve student achievement (Goldschmidt, Roschewski, Choi, Auty, Hebbler, Blank, & Williams, 2005).

Very little empirical research has examined the growth of gifted students and compared their growth to that of non-gifted students. One notable exception is the study by Rambo and McCoach (2014), who found that initially high achieving students grew more slowly than average students during school but maintained that same slower growth rate in the summer (Rambo & McCoach, 2014). In contrast, average students grew steeply during the school year but exhibited little to no achievement growth over the summer. Rambo and McCoach speculated that inappropriate curricular opportunities may be at least partially responsible for these differential growth rates. Gifted students' achievement growth results from complex, advanced, and meaningful content provided by a knowledgeable teacher through high-quality curriculum and instruction at an appropriate pace with scaffolding and feedback (Little, 2012; Tomlinson, 2001, 2003, 2012; VanTassel-Baska, 2012). The current research study examines the growth of identified gifted students and compares that growth to the growth of non-identified students in three different states that mandate identification and programming for gifted students. The preliminary analyses that we present in this paper are descriptive in nature; however, they provide empirical research evidence documenting the differences in gifted and non-gifted students' reading growth slopes across third, fourth, and fifth grades.

RQ1: What is the relationship between a student being identified as gifted by the 4th grade and students' growth in reading scale scores, controlling for important demographic factors? We

hypothesized that gifted students would have higher initial reading scores and slower reading growth than non-gifted students.

RQ2: Are there between school differences and between district differences in students' reading growth? We hypothesized that the average growth rates would vary across schools and districts within each of the states.

Methods

Site and Sample

Data were collected from state departments of education in three different states (henceforth States 1-3) with mandatory gifted identification laws, and represent trends in public schools and districts. The data files contain the data for the entire cohort of students who were third graders in 2011-2012 for each of the three states.

Measures:

The databases contain summative state achievement scores (described below) in reading and mathematics for the 2011-2012, 2012-2013, and 2013-2014 academic years for grades 3-5 from three states with mandated services for gifted education. The database also contain data on the following variables for each student: gifted status, free/reduced price lunch status, English Language learner (ELL) status and race/ethnicity (coded according to Federal guidelines).

State 1. *End-of-Grade (EOG)* Tests of Mathematics, English Language Arts/ Reading (grades 3-8) are based on college and career readiness standards, the Common Core State Standards. The tests are vertically scaled, allowing for the measurement of individual student growth. The reported reliability estimates exceed .88 for all grades in mathematics and exceed .87 for all grades in Reading.

State 2. *The state test* was administered annually to grades 3-10 in reading and 3-8 in mathematics. The tests reflect current state standards. The state test is vertically scaled and IRT score reliability estimates are at least .89 across all grades.

State 3. The state test is given annually to students in grades 3-10 in reading, writing, and mathematics and is vertically scaled. The reported reliabilities for the reading and mathematics assessments exceed .90.

Data

Three waves of data represent when students were in the 3rd (2011-2012), 4th (2012-2013), and 5th (2013-2014) grades. The data from State 1 were comprised of 63,323 students clustered in 1,034 schools and 180 districts. The data from State 2 were comprised of 168,444 students in 2,194 schools and 73 districts. The data from State 3 were comprised of 98,764 students clustered within 1,318 schools and 114 districts.

Analytic Plan

We used multi-level models for change (Singer & Willett, 2003) to fit individual growth models for students nested in schools and districts. Details of the measures and models used can be found in *Appendix A*. We conducted all analyses using the StataMP 14 statistical software package (Statacorp, 2015). Preliminary analyses of the relationship between the covariates and student reading growth can be found in *Appendix B*. In fitting the models for each state, we checked for all possible same level interaction effects between covariates within each level. We also checked for all possible interactions of demographic variables and time. Only statistically significant interactions are retained in the final parsimonious models in Table 1. We present our results by state. Additional fitted models, representing our systematic model building approach, are available upon request.

Results

<<INSERT TABLE 2>>

State 1

We note in the bolded rows of Table 1, column 2, that gifted students in State 1 have 3rd grade reading scale scores that are nearly 61 points higher than their non-gifted peers, on average in the population. This represents a relatively large effect size of slightly over 0.80 standard deviation units. Though scores did go up over time for both gifted and non-gifted students, we also note that the growth of gifted students is about 4 points less per year than their non-gifted peers. These trends are visible in Figure 1, where one notes an initial gap at year 3 and general growth for both gifted and non-gifted students across the subsequent 2 years, though the slope of the line for gifted students is slightly less steep.

<<INSERT FIGURE 1>>

State 2

Much like their State 1 peers, we note in the bolded rows of Table 1, column 3, that gifted students in State 2 have 3rd grade reading scale scores that are nearly 20 points higher than their non-gifted peers, on average in the population. This represents a relatively large effect size of nearly 1 standard deviation unit. Gifted and non-gifted students alike showed growth of about 9 points per year in their reading scores over the subsequent two years, with no detectable difference in the magnitude of growth between the two groups. This trend is made salient in Figure 2, which shows the large initial difference and parallel growth in reading scores over time between gifted and non-gifted students.

<<INSERT FIGURE 2>>

State 3

In line with our findings in States 1 and 2, we note in the bolded rows of Table 1, column 4, that gifted students in State 3 had 3rd grade reading scores that were, on average, nearly 9 points higher than their non-gifted peers. Consistent with our results from the other states, this represents a large effect size of nearly a full standard deviation unit. Similar to our findings in State 1, we also note that, while scores do trend upward over time on average, gifted students' reading scores grew by about 0.20 points per year less than their non-gifted peers, on average in the population and controlling for all other factors in the model. We observe this large initial difference and subsequent growth for both gifted and non-gifted students in Figure 3.

<<INSERT FIGURE 3>>

Disadvantaged students

Another important contrast to consider is the relationship between gifted status and achievement for students who are historically disadvantaged (under-represented and eligible for free/reduced-priced lunch). In our sample, 27% of the students in State 1, 43% of the students in State 2, and 32% of the students in State 3 fall under this designation. They are under-represented in gifted classrooms, however, with only 15% (n=800) of gifted students in State 1, 23% (n=3,561) of gifted students in State 2, and 10% (n=1,599) of gifted students in State 3 designated as disadvantaged. An interesting post-hoc contrast, then, would be to compare reading growth between disadvantaged gifted and non-gifted students, as well as non-disadvantaged gifted students and their disadvantaged peers.

Using State 1 as an example, we see in Figure 4 that there is a small difference (ranging between 0.11 and 0.17 standard deviation units) between gifted students who are or are not disadvantaged, on average and controlling for all other factors in the model. The difference

between gifted and non-gifted disadvantaged students is much more striking, ranging between 1.15 and 1.29 standard deviation units. In essence, the persistent gap between gifted and non-gifted disadvantaged students is ten times the magnitude of the gap between disadvantaged gifted students and their non-disadvantaged gifted peers. The gaps in States 2 and 3 (not shown) are similar in direction, though they differ somewhat in magnitude.

Across all three states, after controlling for the other variables in the model, students who receive free lunch start substantially lower and grow more slowly than their reference peers. English learners, on the other hand, start lower, but grow more quickly than their reference peers. The independent effect of underserved status on reading growth is less clear: in two of the three states, underserved students who are neither EL nor FRL start lower and grow slightly more slowly than their reference peers, whereas in one state, underserved students start lower, but grow more quickly than their reference peers.

<<INSERT FIGURE 4>>

Discussion

These analyses demonstrate that gifted students' rate of reading growth in third-fifth grades is similar to or slower than that of their non-gifted peers. Although gifted students who are disadvantaged do tend to score slightly lower than gifted reference students, this difference is quite small in magnitude when compared to the difference between disadvantaged gifted students and their non-disadvantaged gifted peers or when compared to the difference between non-disadvantaged gifted students and their non-disadvantaged, non-gifted peers.

Given that gifted students scored nearly one standard deviation above their reference peers across the three states, gifted students' lower reading growth rates could be the result of regression to the mean effects. However, these lower reading slopes may also indicate a lack of

instructional match between the gifted students and their educational programs. We are in the process of conducting additional analyses, using school and district predictors to determine whether schools' self-reported gifted programming options relate to the growth of gifted students across the schools in our 3 samples. At AERA, we plan to present additional analyses that consider the effects of school and district gifted programs on the growth of gifted students in general, and gifted underserved students more specifically.

References

Goldschmidt, P., Roschewski, P., Choi, K., Auty, W., Hebbler, S., Blank, R. & Williams, A. (2005). *Policymakers guide to growth models for school accountability: How do accountability models differ?* (Tech. Rep.). Washington, DC: Council of Chief State School Officers.

Little, C. A. (2012). Curriculum as motivation for gifted students. *Psychology in the Schools, 49,* 695-705. doi:10.1002/pits.21621

Rambo, K. & McCoach, D. B. (2014). Using summer growth patterns to assess the impact of schools on high achieving and gifted students' reading skills. *Journal of Educational Research.* DOI: 10.1080/00220671.2013.850398

StataCorp. (2015). Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.

Singer, J.D., & Willett, J.B., (2003). Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence. New York, NY: Oxford University Press.

Tomlinson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A. (2003). *Fulfilling the promise of the differentiated classroom: Strategies and tools for responsive teaching.* Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A. (2012). Administrative decision-making for changing times. In R. F. Subotnik, A. Robinson, C. M. Callahan, & E. J. Gubbins (Eds.), *Malleable minds: Translating insights from psychology and neuroscience to gifted education* (pp. 245-256). Storrs: University of Connecticut, The National Research Center on the Gifted and Talented.

VanTassel-Baska, J. (2012). Teacher behavior as a tool to understanding the motivation of gifted learners. In R. F. Subotnik, A. Robinson, C. M. Callahan, & E. J. Gubbins (Eds.), *Malleable minds: Translating insights from psychology and neuroscience to gifted education* (pp. 257-266). Storrs: University of Connecticut, The National Research Center on the Gifted and Talented.

Tables & Figures

Table 1: Fitted individual-growth models of 3rd, 4th, and 5th grade student reading scale scores in State 1 ($n_{student}$=63,323; n_{school}=1,034; $n_{district}$=180), State 2 ($n_{student}$=168,444; n_{school}=2,194; $n_{district}$=73), and State 3 ($n_{student}$=98,764; n_{school}=1,318; $n_{district}$=114).

	State		
	1	2	3
Intercept	573.91***	208.76***	441.77***
	(1.12)	(0.29)	(0.16)
TIME	**24.99*** **	**9.30*** **	**5.18*** **
	(0.14)	**(0.03)**	**(0.02)**
UNDER	-11.42***	-3.53***	-2.39***
	(0.65)	(0.10)	(0.07)
ELL4	-23.11***	-18.07***	-3.97***
	(1.14)	(0.43)	(0.19)
FRL4	-23.24***	-7.18***	-2.98***
	(0.66)	(0.11)	(0.06)
GIFT4	**60.63*** **	**19.52*** **	**8.93*** **
	(1.05)	**(0.18)**	**(0.08)**

UNDER*ELL4			1.36***
			(0.21)
UNDER*GIFT4	8.02***		1.07***
	(2.19)		(0.17)
ELL4*FRL4	6.64***	5.07***	
	(1.58)	(0.45)	
FRL4*GIFT4	16.90***	4.42***	2.39***
	(2.11)	(0.27)	(0.15)
UNDER*TIME	-0.73**	0.14***	-0.05*
	(0.25)	(0.04)	(0.02)
ELL4*TIME	6.32***	1.73***	1.04***
	(0.65)	(0.06)	(0.08)
FRL4*TIME	-1.07***	-0.59***	-0.28***
	(0.24)	(0.04)	(0.02)
GIFT4*TIME	**-4.37*** **		**-0.21*** **
	(0.34)		**(0.03)**
UNDER*ELL4*TIME	-3.49***		-0.68***
	(0.67)		(0.09)
ELL4*FRL4*TIME	2.37***		
	(0.68)		
School-level[a]			
UNDER4_S	-0.08	-0.17	0.014***
	(0.07)	(0.62)	(0.004)
ELL4_S	-0.03	12.33***	
	(0.06)	(1.02)	
FRL4_S	-0.33***	-13.88***	-0.06***
	(0.05)	(0.54)	(0.01)
UNDER4_S*ELL4_S	0.0035***		
	(0.001)		
UNDER4_S*FRL4_S		-9.27***	
		(1.54)	
District-level[b]			
UNDER4_D			-0.01
			(0.01)
ELL4_D	-0.39***		
	(0.10)		
FRL4_D		-10.64***	-0.06***
		(2.14)	(0.01)
GIFT4_D			-0.04
			(0.02)
UNDER4_D*FRL4_D			-0.001*
			(0.0004)

FRL4_D*GIFT4_D			-0.005**
			(0.001)
Variance			
DISTRICT(IDENT)			
Intercept	69.40*	3.81*	0.82*
	(16.55)	(0.99)	(0.14)
SCHOOL(IDENT)			
Intercept	99.37*	8.72*	1.25*
	(7.40)	(0.41)	(0.08)
STUDENT(UNS)			
Intercept	2955.73*	205.70*	36.14*
	(20.59)	(0.96)	(0.24)
Time	204.94*	5.50*	0.16*
	(3.78)	(0.20)	(0.06)
Fit			
-2LL	1906624.76	4030996.6	1856709.94

Note: Cells are estimates (standard errors); *p<.05, **p<.01, ***p<.001; [a]-group-mean centered; [b]-grand-mean centered

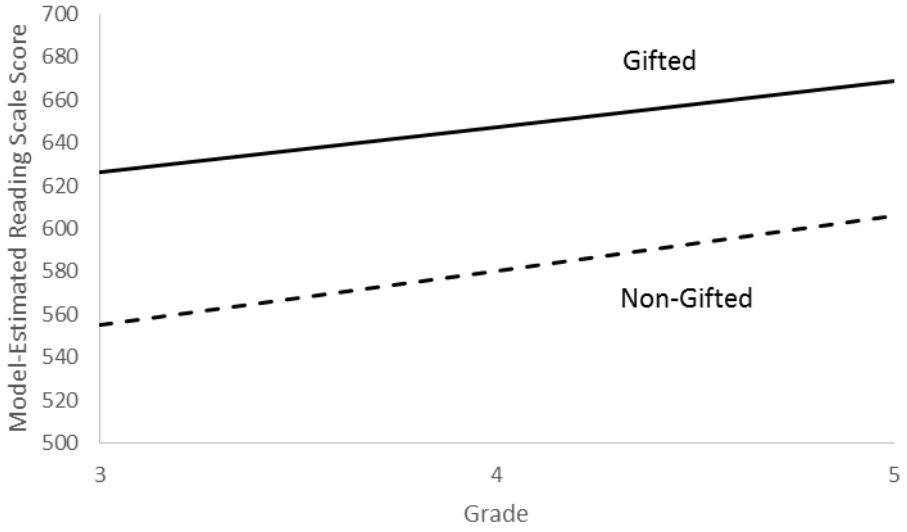

Figure 1. Model-estimated reading scale score growth for prototypical gifted and non-gifted students in State 1.

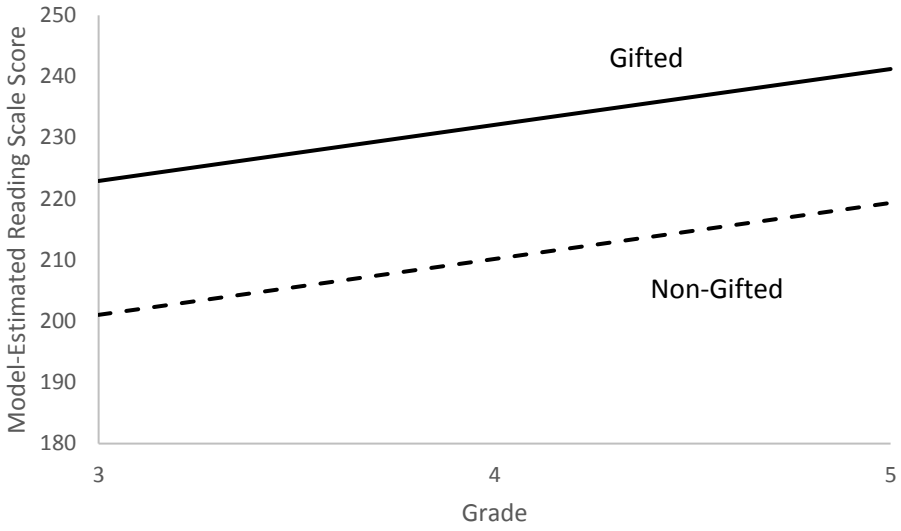

Figure 2. Model-estimated reading scale score growth for prototypical gifted and non-gifted students in State 2.

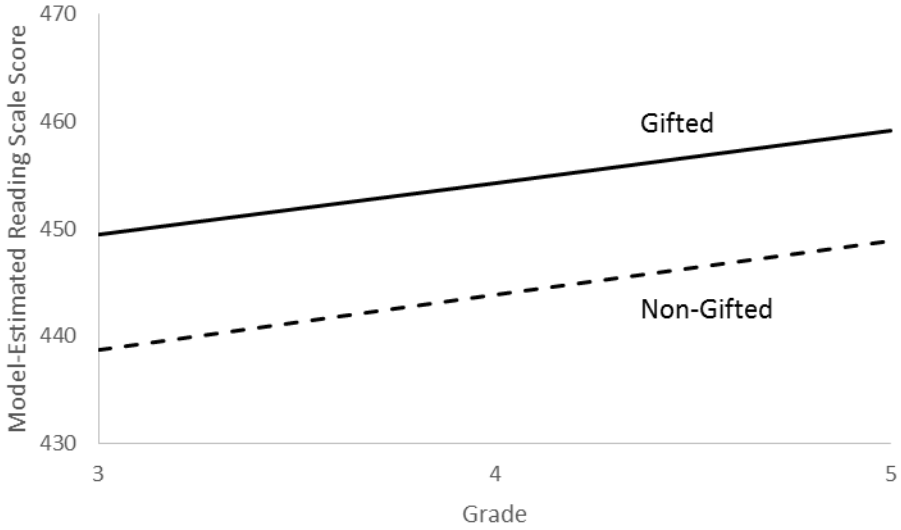

Figure 3. Model-estimated reading scale score growth for prototypical gifted and non-gifted students in State 3.

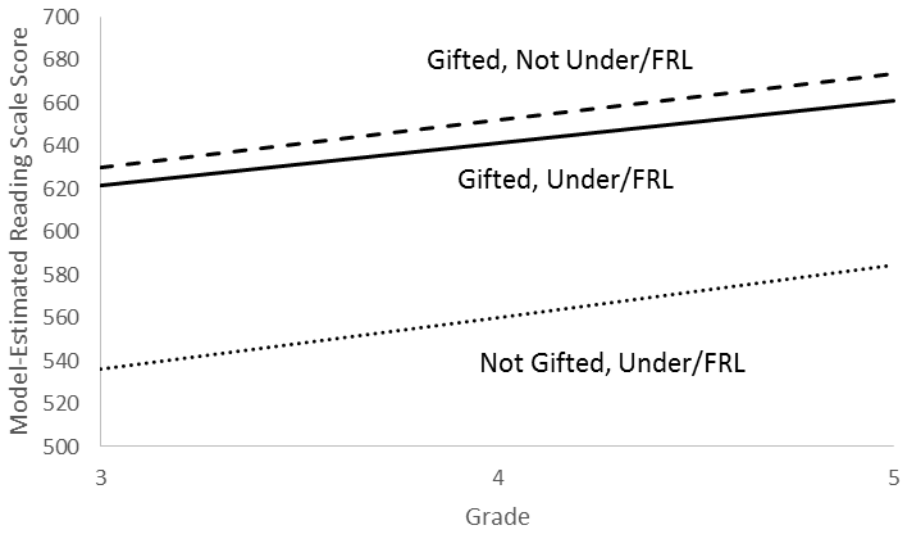

Figure 4. Model-estimated reading scale score growth of prototypical gifted students who are and are not disadvantaged (under-represented & qualify for free/reduced priced lunch), as well as non-gifted disadvantaged students in State 1.

Appendix A

Measures

Outcome

READ – a continuous variable indicating the reading scale score of a student in a given school and district during the 3rd, 4th, and 5th grade

Question Predictors

TIME – a continuous variable indicating the time-period during which the reading score is being estimated (3rd, 4th, or 5th Grade) centered on the 3rd grade (i.e., Grade – 3)

GIFT4 – a dichotomous variable indicating if a student was identified as gifted by the 4th grade in a given school and district (0 if not)

Control Variables

UNDER – a dichotomous variable indicating if a student in a given school and district was identified as under-represented (black/latino) (0 if not)

ELL4 – a dichotomous variable indicating if a student in a given school and district was identified as an English language learner (ELL) in the 4^{th} grade (0 if not)

FRL4 – a dichotomous variable indicating if a student in a given school and district was iden tified as qualifying for free or reduced-priced lunch (FRL) in the 4^{th} grade (0 if not)

UNDER4_S – a variable indicating the proportion of students in a school and given district identified as under-represented in the 4^{th} grade

ELL4_S – a variable indicating the proportion of students in a school and given district identified as ELL in the 4^{th} grade

FRL4_S – a variable indicating the proportion of students in a school and given district identified as qualifying for FRL in the 4^{th} grade

GIFT4_S – a variable indicating the proportions of students in a school and given district identified as gifted in the 4^{th} grade

UNDER4_D– a variable indicating the proportion of students in a district identified as under-represented in the 4^{th} grade

ELL4_D – a variable indicating the proportion of students in a district identified as ELL in the 4^{th} grade

FRL4_D – a variable indicating the proportion of students in a district identified as qualifying for FRL in the 4^{th} grade

GIFT4_D – a variable indicating the proportions of students in a district identified as gifted in the 4^{th} grade

School variables were group-mean centered and district variables were grand-mean centered. In the analytic plan that follows, we describe the proposed control variables as vectors on the student (A_{ijk}), school (B_{ij}) and district (C_i) level. Descriptive statistics are given in Table A1.

Table A1. Descriptive statistics of student, school, and district-level covariates for State 1 ($n_{student}$=63,323; n_{school}=1,034; $n_{district}$=180), State 2 ($n_{student}$=168,444; n_{school}=2,194; $n_{district}$=73), and State 3 ($n_{student}$=98,764; n_{school}=1,318; $n_{district}$=114).

	State 1			State 2			State 3		
	3	4	5	3	4	5	3	4	5
READ	562.25	587.77	612.22	203.58	213.34	221.88	440.14	446.07	449.96
	(74.29)	(62.76)	(70.68)	(20.16)	(20.59)	(20.78)	(9.17)	(9.54)	(9.63)
UNDER		0.39			0.52			0.42	
		(0.49)			(0.50)			(0.49)	
ELL4		0.20			0.09			0.11	
		(0.40)			(0.28)			(0.32)	
FRL4		0.45			0.64			0.56	
		(0.50)			(0.48)			(0.50)	
GIFT4		0.08			0.09			0.15	
		(0.28)			(0.29)			(0.37)	
UNDER4_S[a]		0.00			0.00			0.00	
		(17.57)			(0.20)			(20.00)	
ELL4_S[a]		0.00			0.00			0.00	
		(13.79)			(0.09)			(6.23)	
FRL4_S[a]		0.00			0.00			0.00	
		(20.34)			(0.23)			(19.91)	
GIFT4_S[a]		0.00			0.00			0.00	
		(5.49)			(0.10)			(4.67)	
UNDER4_D[b]		0.00			0.00			0.00	
		(21.38)			(0.21)			(18.10)	
ELL4_D[b]		0.00			0.00			0.00	
		(11.05)			(0.06)			(2.98)	
FRL4_D[b]		0.00			0.00			0.00	
		(20.54)			(0.10)			(11.98)	
GIFT4_D[b]		0.00			0.00			0.00	
		(3.91)			(0.04)			(6.02)	

Note: Cells are means (sd); [a]-group-mean centered; [b]-grand-mean centered

Data Analytic Plan

To estimate the relationship between gifted identification and growth in student reading scale scores, we fit the following individual growth model (Singer & Willett, 2003), which estimates average student reading scale scores at a given time, clustered by their 4th grade school and district.

Level 1 – Time:

$READ_{ijkl} = \pi_{0ijk} + \pi_{1ijk}TIME_{ijkl} + \varepsilon_{ijkl}$,

Where $\varepsilon_{ijkl} \sim N(0,\sigma^2_{\varepsilon})$

Level 2 – Student:

$\pi_{0ijk} = \gamma_{00} + \gamma_{01}GIFT4_{ijk} + \omega_{02}A_{ijk} + r_{0ijk}$

$\pi_{1ijk} = \gamma_{10} + \gamma_{11}GIFT4_{ijk} + \omega_{12}A_{ijk} + r_{1ijk}$,

$$Where \begin{bmatrix} r_{0ijk} \\ r_{1ijk} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_0^2 & \sigma_{01} \\ \sigma_{10} & \sigma_1^2 \end{bmatrix}\right)$$

Level 3 – School:

$\gamma_{00} = \gamma_{000} + \delta_{000}B_{ij} + s_{0ij}$,

Where $s_{0ij} \sim N(0,\sigma^2_s)$

Level 4 – District:

$\gamma_{000} = \gamma_{0000} + \Omega_{000}C_i + u_{0i}$,

Where $u_{0i} \sim N(0,\sigma^2_u)$

Composite Model:

$READ_{ijkl} = \gamma_{0000} + \Omega_{0000}C_i + \delta_{000}B_{ij} + \gamma_{01}GIFT4_{ijk} + \omega_{02}A_{ijk} + \gamma_{10}TIME_{ijkl} + \gamma_{11}(GIFT4_{ijk} \times TIME_{ijkl}) + \omega_{12}(A_{ijk} \times TIME_{ijkl}) + [u_{0i} + s_{0ij} + r_{0ijk} + r_{1ijk}TIME_{ijkl} + \varepsilon_{ijkl}]$

In the proposed population model above:

- $READ_{ijkl}$ is the model-estimated reading scale score for a student nested in a given school and district, at a given point in time, given their gifted status in 4th grade as well as other student, school, and district covariates
- γ_{0000} is the population average 3rd grade reading score for non-UNDER, non-ELL, non-FRL, non-GIFTED students from an average school in an average district

- γ_{10} is the population average change in reading scale score for non-gifted students, controlling for all other factors in the model
- Ω_{0000} is the effect of a vector of district-level covariates (C_i) on 3rd grade reading scale scores, controlling for all other factors in the model
- δ_{000} is the effect of a vector of school-level covariates (B_{ij}) on 3rd grade reading scale scores, controlling for all other factors in the model
- ω_{02} is the effect of a vector of student-level covariates (A_{ijk}) on 3rd grade reading scale scores, controlling for all other factors in the model
- ω_{12} is the effect of a vector of student-level covariates (A_{ijk}) on growth in student reading scale scores between 3rd and 5th grade, controlling for all other factors in the model
- γ_{01} is the effect of student gifted status on 3rd grade reading scale scores, controlling for all other factors in the model
- γ_{11} is the effect of student gifted status on change in reading scale scores, controlling for all other factors in the model
- u_{0i}, s_{0ij}, r_{0ijk}, $r_{1ijk}TIME_{ijkl}$, and ε_{ijkl} are the residual terms

To answer our research question, we fit the above model to data from each state, and examined the statistical significance, magnitude, and direction of effects of γ_{01} and γ_{11}.

Appendix B

Bivariate relationships between the student-level covariates and reading scores over time were explored by randomly sampling 192 students from each state and fitting linear trends lines for students who were and were not identified by the demographic characteristics. As can be seen the figures that follow, the same general trends hold across all three states: Under-represented students, students classified as English language learners, students who qualify for free/reduced

price lunch, and students who are not gifted show lower 3rd grade reading scores and, often, less growth in scores over time (the exception being students identified as gifted having less-steep growth slopes than their peers).

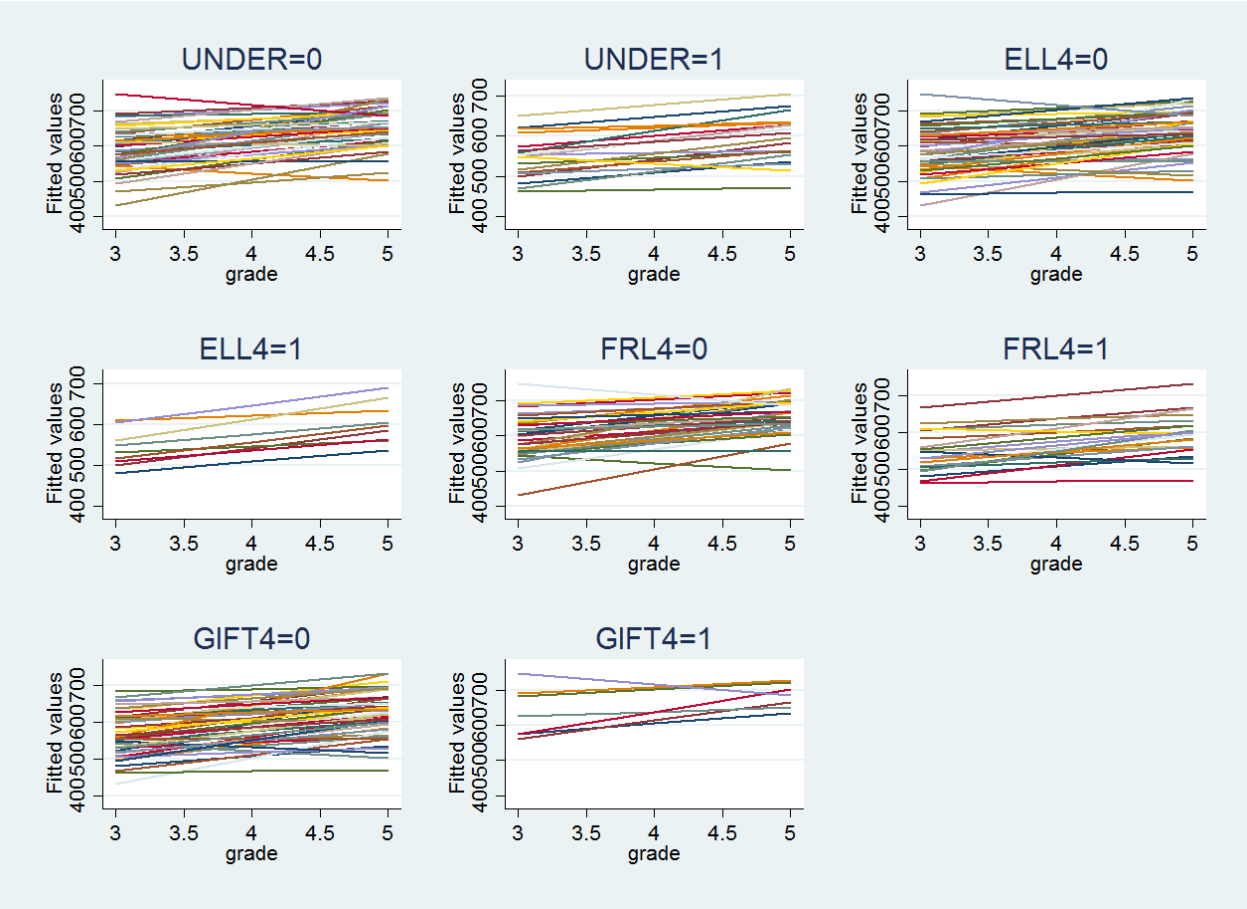

Figure A1. State 1 student reading growth by demographics of interest (n=192).

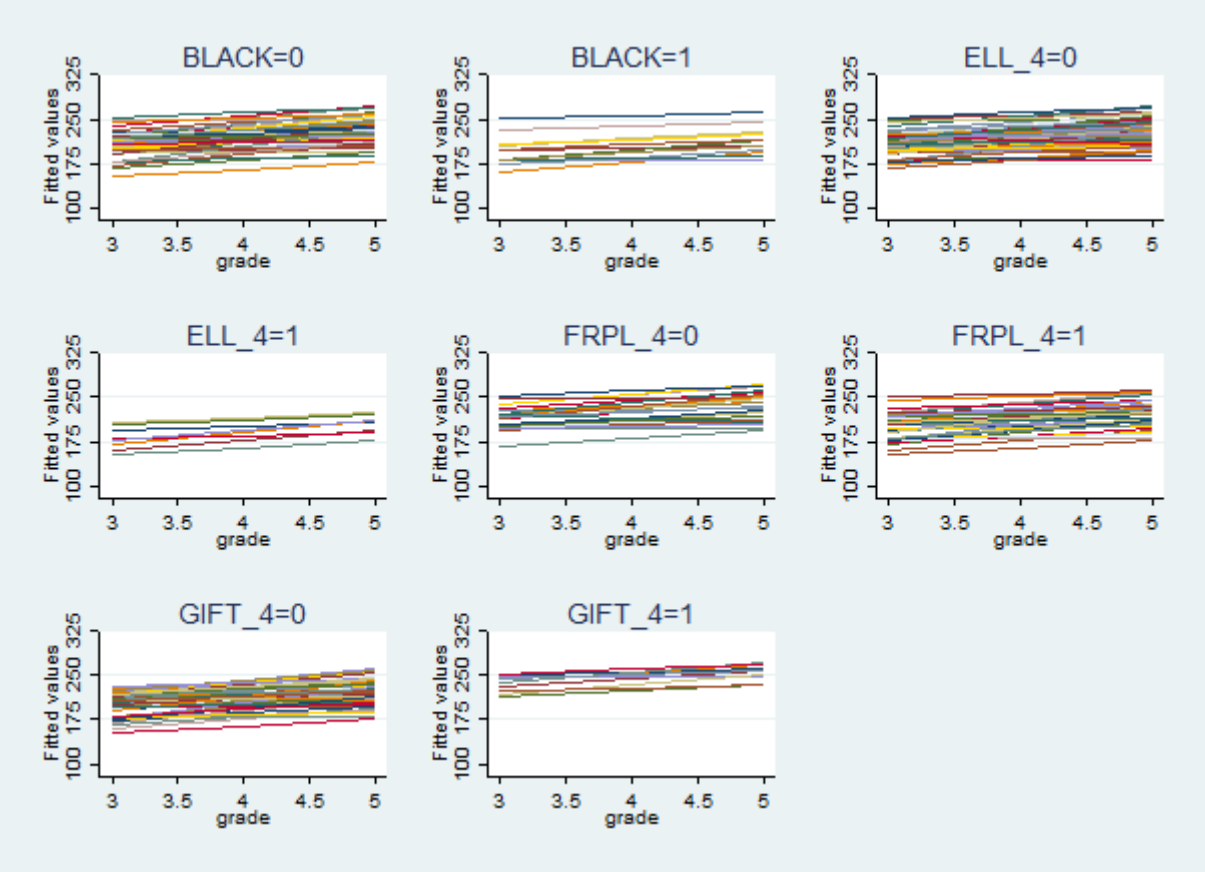

Figure A2. State 2 student reading growth by demographics of interest (n=192).

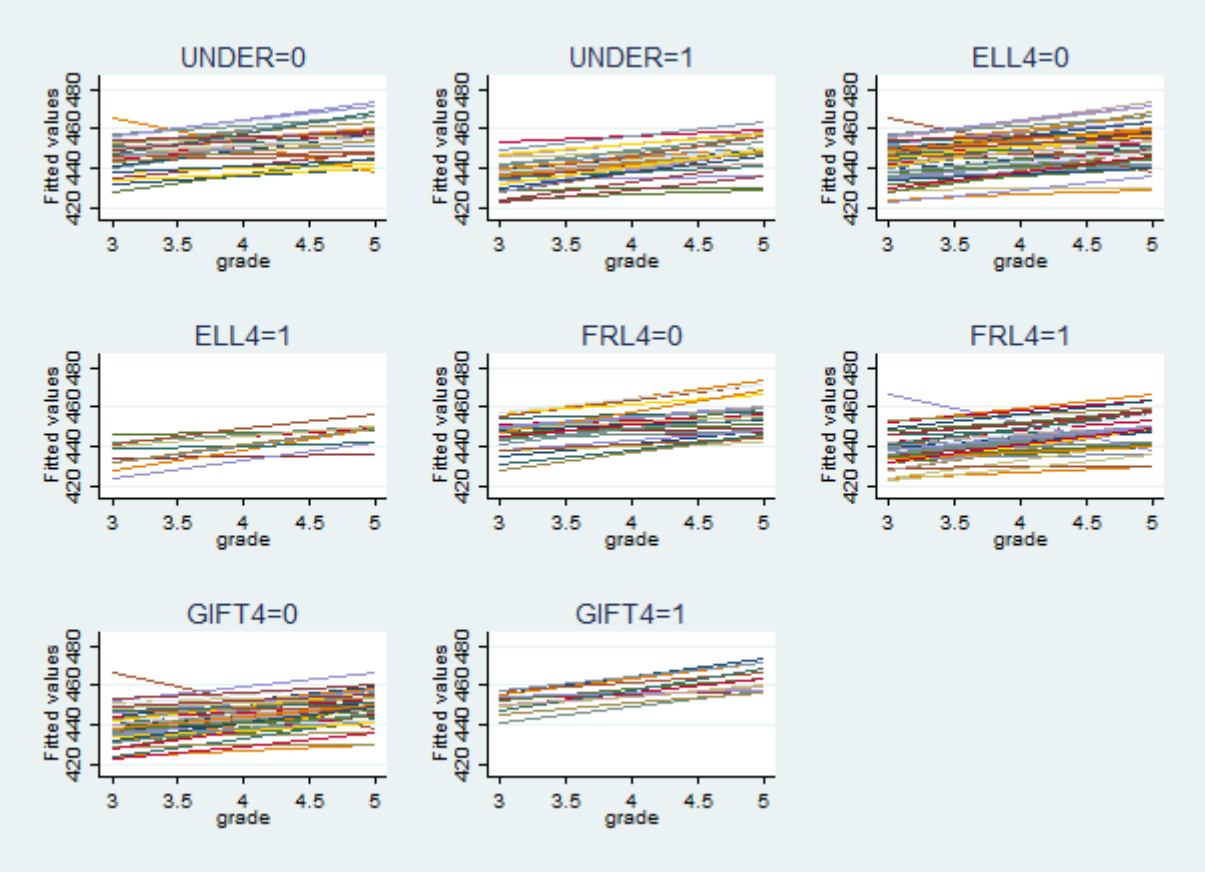

Figure A3. State 3 student reading growth by demographic of interest (n=192).