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Student Achievement Growth in Early Elementary Grades and the Persistence of the Achievement Gap

At a Glance

This study found that as early as the beginning of kindergarten and before any formal schooling began for most students, the achievement gap already existed. It was mostly related to students' poverty, ELL status, and SWD status, as well as to schools' having larger proportions of economically disadvantaged students. Students from poor families (as measured by the FRL eligibility), English language learners, and students with disabilities were academically substantially behind their demographically similar peers in both reading and mathematics. Students enrolling in schools with a higher concentration of FRL students were also behind their demographically similar students attending schools with smaller poverty rates; that was true for both academic subjects. Minority students were behind their demographically similar peers in mathematics, but not in reading.

During the first four academic years reading and mathematics learning occurred at equitable rates across all Elementary and K-8 schools. On the other hand, learning rates were related to student characteristics. ELL and Formerly ELL students showed substantially greater learning rates in both reading and mathematics than their demographically similar peers leading to a reduction in an achievement gap between ELL and non-ELL students. On the other hand, economically disadvantaged students and students with disabilities demonstrated substantially smaller annual learning rates in both academic disciplines than their peers leading to an increase in achievement gaps. Minority students demonstrated smaller annual rates of academic growth: Black/African American students – in both reading and mathematics, while Hispanic students – in reading but not in mathematics. Again, these smaller rates of academic growth only exacerbated achievement gaps.

This Research Brief has two goals: (1) describe the pattern of academic growth made by students as they progress from grade K to grade 3 during 2015-2016 through 2018-2019 period and examine what student and school characteristics are related to these growth patterns, and (2) describe the initial achievement gaps between various student groups and changes to these gaps during the same period.

Student Achievement and Demographic Data Used

We used reading and mathematics results on the i-Ready Diagnostic assessments from the beginning and the end of each academic year as a cohort of students progressed from grade K to grade 3 during 2015-2016 through 2018-2019 period. I-Ready Diagnostic assessment was developed by Curriculum Associates, LLC. The student scores are expressed on a vertical scale ranging from 100 to 800 scale score points allowing

the longitudinal exploration of the test results. Student test results on the i-Ready Diagnostic have been shown to be highly correlated with those from the Florida State Assessment in both English language arts and mathematics.

We collected the following demographic characteristics of the students:

- Student poverty indicator as measured by whether a student was eligible for the federal free or reduced-price lunch (FRL) program as of October 2017 (in the middle of the study period),
- English language learner (ELL) status was determined in the following way. At the end of each school year from 2015-2016 to 2018-2019 (four academic years) the student's English for Speakers of Other Languages (ESOL) level was recorded. The student was coded as ELL if he/she was in the ESOL program for three or more academic years during the four-year study period or if the student was in ESOL for only the first two of the four years. If a student was in ESOL initially but exited the program after grade K, the student was coded as formerly ELL,
- Student with Disability (SWD) indicator was coded for students who had any primary exceptionality except gifted at any time during the study period,
- Student gender,
- Student race/ethnicity (Black/African American, Hispanic, or Other).

In addition, we collected school-level percentages of FRL, ELL, SWD, Black, and Hispanic students. Because we aimed to explore what school-level characteristics were related to student achievement growth patterns, we included in the student sample only those students who did not change schools during the study period. That condition reduced the number of students in the sample by about 18%.

When the achievement gaps are reported, it is done generally for subgroups focusing on one dimension at a time. For example, achievement gaps are reported separately for ethnic/racial groups, students' ELL status, SWD status, or FRL classification. Because these student characteristics are often intertwined (for example, most of the minority students are also FRL students), such reporting can obscure the real differences. The inclusion of these demographic variables as separate predictors in a regression model serves the purpose of disambiguating the effects of these grouping characteristics.

Altogether, we used more than 24,000 student records (24,658 with reading results and 24,607 with mathematics results) from 217 traditional elementary schools and K-8 centers. The total number of test results on 8 possible testing occasions (two times during each of the four study years) was 123,102 in reading and 120,661 in mathematics.

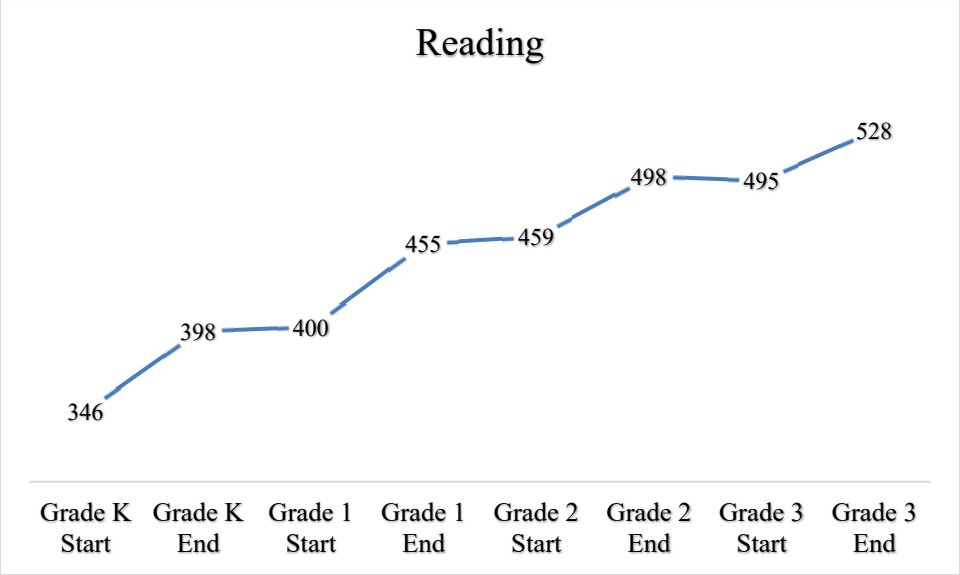
Data Analysis

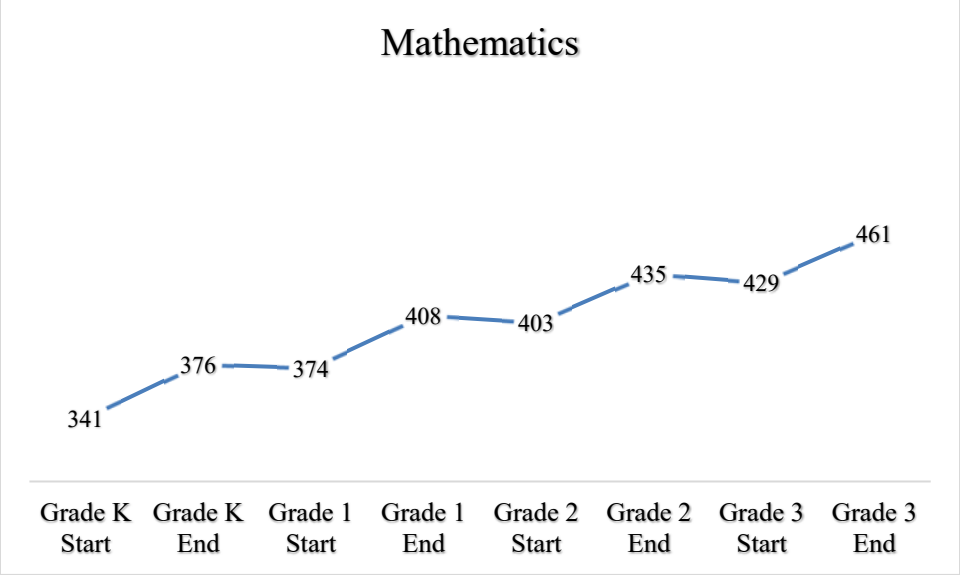
We fit a three-level Hierarchical Linear Model (HLM) to the student achievement data. In this model, the first level was represented by testing results nested within students. (Each student in the sample had between one and eight testing results). Students nested within schools constituted the second level of the model, and schools constituted the third level.

On the first level, we modeled average student achievement growth during each academic year as well as the achievement growth/decline during the summer periods separately. On the second level, we examined

which student characteristics were related to the initial achievement results (those at the start of Grade K), to the rates of annual achievement growth and the rates of summer achievement growth/decline. At the third level, we studied school factors related to the initial achievement and rates of academic growth/decline.

The charts below show the observed patterns of mean achievement scores for each of the eight testing occasions.





Note: the reading and mathematics scale scores are not directly comparable to each other. The patterns of academic achievement shown in the charts above are based on the observed mean scores, not on a statistical model.

It can be seen that the rates of annual achievement growth (the slopes of the graphs within each academic year) and the rates of summer growth/decline are similar to each other for each academic discipline separately. For example, the rates of annual academic growth in mathematics were 35, 34, 32, and 32 scale

scores per year for grades K, 1, 2, and 3 respectively. Because these rates are approximately the same, fitting a linear model of growth to the data appeared appropriate, and that is what we did.

The initial unconditional statistical model (the model with no predictors at the second and third levels) estimated the average rate of annual academic growth across four academic years, the average rate of academic growth/decline across the three summer periods, and the average initial achievement results in reading and mathematics.

Results of the Initial Model and their Use for Model-Building

Table 1 below shows the results of fitting the unconditional model and compares the annual rates of growth with the 2016-2017 median annual growth of i-Ready students in the USA reported by the Curriculum Associates for 30 weeks of instruction (https://4.files.edl.io/cf97/08/09/18/180052-8928a370-85d0-491d-b0c5-5284c8108535.pdf).

Table 1
Results of the Unconditional HLM Analysis and Median Annual Growth Rates for i-Ready students in the USA

	Reading	**Mathematics**
Initial (Start of Grade K) Mean Scale Score (Standard Deviation)	340.26 (15.499)	338.69 (8.054)
Average Annual Rate of Academic Growth (Standard Deviation)	**45.17** (4.644)	**33.26** (3.674)
Average Rate of Summer Growth/Decline (Standard Deviation)	3.65 (5.115)	-4.47 (4.424)
Median Annual Growth Rate: i-Ready Students in the USA		
Grade K	46	29
Grade 1	47	28
Grade 2	35	26
Grade 3	25	26
Simple Average Across Four Years	**38.25**	**27.25**

The model-based i-Ready mean scale scores at the beginning of grade K were approximately 340 in reading and 339 in mathematics. The average annual rates of academic growth were 45 scale score points per year in reading and 33 scale score points per year in mathematics. These average annual rates of student academic growth of M-DCPS students were higher than the national averages for i-Ready students reported by the Curriculum Associates.

During the summer months, the reading and mathematics results changed by smaller amounts: they grew on average by about 4 scale score points in reading and declined by 4 scale score points in mathematics per summer period. The summer loss in mathematics represents about 13% of the annual growth, which is equivalent to about one month of instruction.

Model-Building Strategy

A common strategy when building a multi-level model is to rely on univariate or multivariate tests of statistical significance of regression coefficients. However, with very large sample size, we faced a likelihood of including certain predictors in the model for which the magnitude of the regression coefficients, although statistically significant, would be too small to be of practical importance. To that end, we used the results of the unconditional model reported above to estimate the minimal magnitude of regression coefficients that would warranty the inclusion of a particular predictor in the model[1]. We considered all student- and school-level variables that we collected for inclusion into the conditional model. However, we decided to include in the model only those student and school characteristics for which the regression coefficients were statistically significant at the .01 level and their magnitudes exceeded the threshold values established as described in the footnote on this page.

Results of the Full Conditional Model

Table 2 below shows the results of fitting a full three-level hierarchical linear model to the data.

Table 2
Results of the Conditional HLM Analysis

Regression Coefficient	**Reading**	**Mathematics**
Initial (Start of Grade K) Mean Scale Score	359.72	354.19
FRL	-4.61	-3.10
ELL	-40.33	-19.34
Formerly ELL	14.09	6.90
SWD	-13.44	-12.22
Female	5.71	
Black		-6.04
Hispanic		-3.57
School Percentage of FRL Students	-0.33	-0.14
School is K-8 Center	-6.28	-2.41
Average Annual Rate of Academic Growth	49.72	35.03
FRL	-2.36	-1.42
ELL	0.98	1.01
Formerly ELL	4.23	2.34
SWD	-8.89	-4.55
Black	-4.29	-1.30
Hispanic	-1.14	
Average Rate of Summer Academic Growth/Decline	2.28	-6.20
FRL	1.64	1.24
ELL		1.38
SWD		2.16

Note: The school-level predictors used in the model are shown in italics.

[1]We used the standard errors of the coefficients in the unconditional model along with the sample sizes to find the minimum magnitudes of the regression coefficients for potential predictors in the second and third levels of the model corresponding to the Cohen's *d* of 0.2.

Comparison Group Identification

To interpret the results represented in Table 2, it is necessary to identify the comparison group for each of the three components of the analysis: (1) identifying the average initial achievement and factors related to it (the upper group in the table above), (2) the average annual rate of academic growth and related factors (the middle group), and (3) average rate of academic growth/decline in the summer period (the bottom group).

A comparison group includes those students for whom the values of the predictor variables included in the model are zeros. All but one of the predictors are indicator variables coded as 1 of a student or school has an indicated characteristic and as 0 otherwise. For example, FRL is coded as 1 if a student was eligible to receive free/reduced-price lunch and 0 if he/she was not; a K-8 school is coded as 1 while an elementary school as 0 on an indicator variable K-8 school.

The only predictor variable in the model that was coded differently is the school percentage of FRL students. It was grand-mean centered, meaning that the difference between a particular school FRL percentage and the average of such percentages for all schools (75%) was used as a predictor. For example, for a school with an 85% FRL rate, the value of this predictor would be 10, whereas a school with 65% FRL percentage would have negative 10 as a value of this predictor.

Overall Results on Rates of Growth

One interesting result from the full conditional model is that the average annual rates of student academic growth and the average rates of student academic growth/decline during the summer periods in both reading and mathematics were not related to measured school characteristics. Instead, these rates were related solely to student characteristics. That is, the average rates of student academic growth and summer growth/decline in different schools were similar for demographically similar students.

Some of the other results of the analysis are presented below for each academic subject and initial scores vs. annual rates of growth separately.

Reading Results

Initial Achievement

The comparison group consisted of students in elementary schools with the average level of poverty (percentage of FRL students) who were boys, not students with a disability, have never participated in the ESOL program, and who were not eligible for the FRL program. For such students, the average initial scale score in reading was approximately 360 scale score points.

The values of the regression coefficients in Table 2 above can be interpreted as the average effects of particular predictors. For example, male students in K-8 centers with 85% FRL rate (10 percentage points higher than the average) have their average initial achievement score estimated by the model equal to 359.72 – 6.28 – 10*0.33 = 349.69, approximately 10 scale score points lower than the average initial scale score

for students in the comparison group. That corresponds to approximately 0.6 of the standard deviation (SD) in initial scores in reading, a medium-to-large effect size.[2]

The values of regression coefficients in Table 2 can be interpreted as "net effects" of a particular grouping variable. Here are some examples:

- The initial child poverty gap was about negative 5 scale score points. That is, an FRL student had an expected initial scale score that was 5 scale points lower than a non-FRL child with the same student characteristics attending the same or similar schools.
- The initial school poverty gap was negative 0.3 scale score points. That is for each 10 percentage points increase in the FRL rate at the school, the initial scale score for similar students was expected to decrease by 3 scale score points.
- ELL students were predicted to have the initial score of 40 scale score points lower than their demographically similar non-ELL counterparts in the same or similar schools.
- On the other hand, formerly ELL students (those who exited the ESOL program after grade K) had their expected initial scale score that was 14 scale score points higher than their non-ELL demographically similar counterparts in the same or similar schools.

Annual Rate of Academic Growth

The comparison group consisted of students who were not students with a disability, have never participated in the ESOL program, who are not eligible for the FRL program, and who are neither Black/African American nor Hispanics. For such students, the average annual rate of academic growth was approximately 50 scale score points per year.

- The child poverty gap on the rate of growth was negative 2 scale score points per year. That is, FRL students grew academically at the 2 scale score points per year slower than their demographically similar non-FRL counterparts across all schools.
- Students with disabilities experienced the rate of academic growth that was 9 scale score points per year lower than their demographically similar non-SWD counterparts.
- The average annual rate of growth of ELL students was a little higher (by about 1 point) than that of non-ELL students, while the annual rate of growth for Formerly ELL students was 4 scale score points per year higher than that of their demographically similar non-ELL counterparts.
- The average annual rates of academic growth were lower for both Black students (by 4 points) and Hispanic students (by 1 point) than that for their demographically similar counterparts.

Average Rate of Summer Academic Growth/Decline

The comparison group consisted of students who were not eligible for the FRL program. For such students, the average rate of summer academic growth was 2 scale score points per summer. Students who were eligible for the FRL program gained and additional 2 scale score points per summer.

[2] The values of 0.2, 0.5, and 0.5 of the Cohen's *d* are generally considered as indicating small, medium, and large effect size respectively.

Mathematics Results

Initial Achievement

The comparison group consisted of students in elementary schools with the average level of poverty who are not students with a disability, have never participated in the ESOL program, and who are not eligible for the FRL program, and who are neither Black/African American nor Hispanics. For such students, the average initial scale score in mathematics was about 354 scale score points.

- The initial child poverty gap was negative 3 scale score points. That is, an FRL student had an expected initial scale score that was 3 scale points lower than a non-FRL child with the same student characteristics attending the same or similar schools.
- The initial school poverty gap was negative 0.1 scale score points. That is for each 10 percentage points increase in the FRL rate at the school, the initial scale score for similar students was expected to decrease by 1 scale score point.
- ELL students were predicted to have the initial score of 19 scale score points lower than their demographically similar non-ELL counterparts in the same or similar schools.
- African American students were predicted to have an initial score that was 6 scale score points lower than their demographically similar non-minority[3] students in the same or similar schools.

Annual Rate of Academic Growth

The comparison group consisted of students who are not students with disabilities, have never participated in the ESOL program, who are not eligible for the FRL program, and who are not Hispanics. For such students, the average annual rate of academic growth was 35 scale score points per year.

- The poverty gap on the rate of growth was negative 1 scale score points per year. That is, FRL students grew academically at the 1 scale score points per year slower than their demographically similar non-FRL counterparts across all schools.
- SWD experienced the rate of academic growth that was 5 scale score points per year lower than their demographically similar non-SWD counterparts.
- The average annual rate of growth of ELL students was a little higher (by 1 point) than that of non-ELL students, while the annual rate of growth for Formerly ELL students was 2 scale score points per year higher than that of their demographically similar non-ELL counterparts.
- The average annual rate of growth for Black/African American students was somewhat lower (by 1 point) than that of their demographically similar counterparts

Average Rate of Summer Academic Growth/Decline

The comparison group consisted of students who were not ELL, not SWDs, and not eligible for the FRL program. For such students, the average rate of summer academic decline in mathematics was 6 scale score points per summer.

- Students who were eligible for the FRL program lost 1 scale score points less per summer than their demographically similar non-FRL peers.

[3] Here and in the rest of the report, the term "non-minority students" refers to students who are neither African American nor Hispanics.

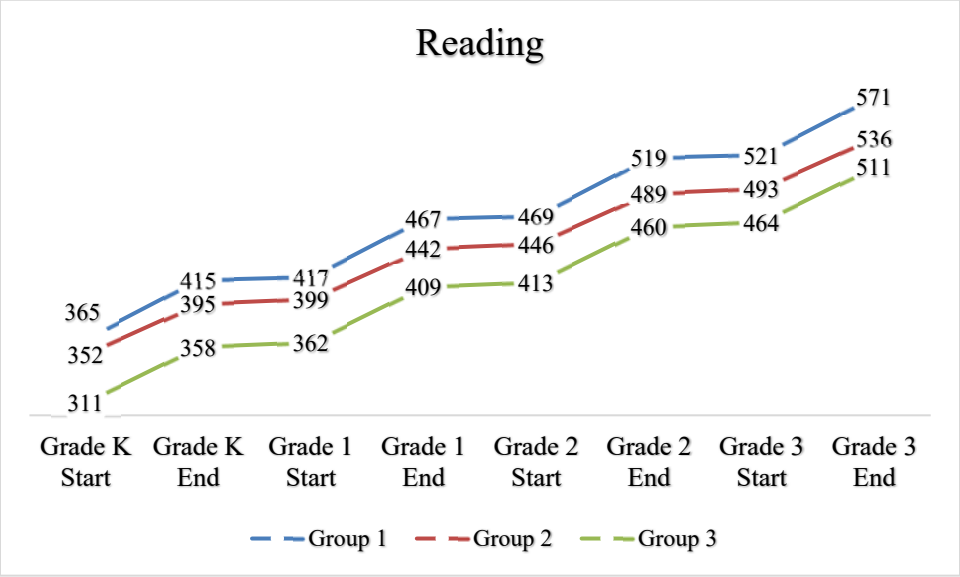
- ELL students lost 1 scale score point less per summer than their demographically similar non-ELL peers.
- Students with disabilities lost 2 scale score points less per summer on average than their demographically similar non-SWD counterparts.

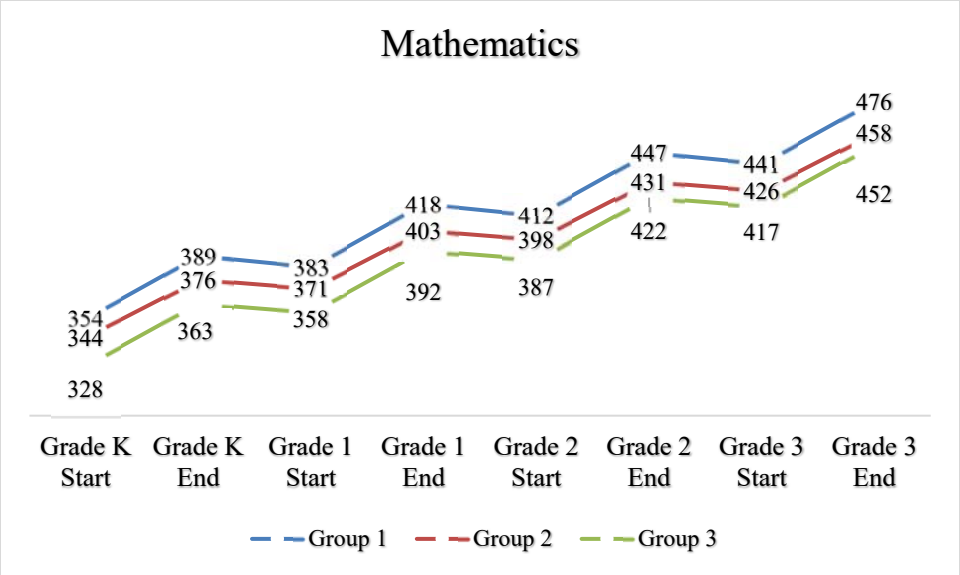
Example Cases

Using the results shown in Table 2, it is possible to construct the average trajectories of academic achievement growth/decline during the study period for several example cases.

In the charts below, such trajectories are constructed for three example groups:

1. White girls who are not FRL, not ELL, and not SWD in elementary schools with the average percentage of FRL students; this group can be characterized as "privileged" students,
2. African American boys who are FRL, not ELL, not SWD in elementary schools with 85% of FRL students (10 percentage points higher than the average); this is a subgroup of minority students in poverty,
3. Hispanic girls who are FRL, ELL, and not SWD in K-8 centers with 85% of FRL students; this is a subgroup of minority students in poverty who are still learning English.





In these example cases, Students in Group 1 had higher initial scores in both reading and mathematics and maintain that advantage on average throughout the study period. Students in Group 2 start behind their privileged peers and fall even farther behind by the end of the study period. Students in Group 3 start even farther behind than students in Group 2 (related to their ELL status) but are catching up to them during the study period.

The negative effect of being an English learner on the average initial scores observed in this study is rather large. However, it should be noted that the ELL group does not include those students who were ELL in grade K but exited the ESOL program afterward. These students (who acquired sufficient English knowledge and skills in a short period) are considered Formerly ELL. Had these students been included in the ELL group, the initial average ELL disadvantage would have been substantially smaller while the ELL advantage in terms of average annual rates of academic growth would have been larger (see Table 2).

Discussion

This study focused on the three parameters of educational attainment in early elementary grades (K-3): differences in initial (at the start of grade K) achievement, average annual rates of academic growth, and average rates of summer academic growth/decline.

The results of the comparisons of differences in students' initial achievement indicated that as early as the beginning of kindergarten and before any formal schooling began for most students, the achievement gap already existed. These differences were mostly related to students' poverty, ELL status, and SWD status, as well as to schools' having larger proportions of economically disadvantaged students. Specifically, students from poor families (as measured by the FRL eligibility), English language learners, and students with disabilities were academically substantially behind their demographically similar peers in both reading and mathematics. Students enrolling in schools with a higher concentration of FRL students were also behind their demographically similar students attending schools with smaller poverty rates; that was true for both academic subjects. Minority students were behind their demographically similar peers in

mathematics, but not in reading. Girls were ahead of demographically similar boys in the initial reading achievement.

Of these differences, those related to students' minority and economically disadvantaged status are often discussed as achievement gaps. As mentioned above, these achievement gaps exist at the very beginning of the formal schooling in Grade K. To close the achievement gaps, students who are initially behind their peers academically must demonstrate higher rates of growth during any academic year and not fall behind during summer breaks. The analysis of the annual learning rates showed that this did not happen.

The rates of annual academic growth were not related to school characteristics. That is, reading and mathematics learning occurred at equitable rates during the first four academic years across all Elementary and K-8 schools. In contrast, learning rates were related to student characteristics.

- ELL and Formerly ELL students showed substantially greater learning rates in both reading and mathematics than their demographically similar peers leading to a reduction in an achievement gap between ELL and non-ELL students.
- Economically disadvantaged students and students with disabilities demonstrated substantially smaller annual learning rates in both academic disciplines than their peers thus increasing achievement gaps.
- Minority students demonstrated smaller annual rates of academic growth: Black/African American students – in both reading and mathematics, while Hispanic students – in reading but not in mathematics. Again, these smaller rates of academic growth only exacerbated achievement gaps.

As to the summer learning growth/decline, we did not find any average learning loss in reading knowledge and skills as measured by the i-Ready Diagnostic assessments. On the other hand, we found a substantial loss in mathematics knowledge and skills during summer months, equivalent in magnitude to about one month of learning during an academic year. Interestingly, this summer learning loss in mathematics was lower for economically disadvantaged students, English language learners, and students with disabilities. It is possible that summer gain/loss was influenced by student participation in summer programs, but we did not explore that possibility in this Research Brief.