Early Reading Skill Development and Characteristics of Reading Skill Profiles:

Analysis of Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) and NAEP 2015 Grade 4 Reading Overlap Sample Data

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Executive Summary

Early reading is an important indicator of future academic success. Unfortunately, many national reports of children's reading skills do not seem to reflect positive changes as results from recent reading assessments show that students do not have sufficient reading skills in the United States. For example, even before the large drops in scores shown in the 2022 National Assessment of Educational Progress (NAEP) reading assessment due to the Covid-19 pandemic, the 2019 NAEP reading assessment results showed that 34 percent of fourth graders performed below the *NAEP Basic* achievement level, and this percentage has increased compared to the three most recent assessments (2013, 2015, and 2017). Additionally, both the 2019 NAEP reading assessment and 2020 NAEP Long-Term Trend age 9 reading assessment results showed a decrease in reading performance for low-performing students and further drops in 2022 due to the Covid-19 pandemic disruptions.

As early reading skill is a strong predictor of reading performance in later grades (Claessens, Duncan, & Engel, 2009; Dogan, Ogut, & Kim, 2015), numerous studies have examined children's reading growth and documented that reading skills develop at varying rates (Boscardin, Muthén, Francis, & Baker, 2008). Also, the research shows that children whose reading growth lags in early grades tend to have lower performance in subsequent grades (Hernandez, 2011). It is important to understand how students' reading skills develop in the early grades and to examine how such development relates to their later reading performance, which can help teachers provide more targeted instructions for all young readers, particularly for those who are struggling or are at-risk for reading difficulties.

Despite the important contributions of these studies, most previous studies used small samples collected in local contexts, which is one of the major limitations of previous research on early reading development. Local studies with relatively small sample sizes make it difficult to generalize the results beyond the specific context in which they were collected, thereby diminishing their utility for national-level policy discussions.

This study presents a replication and expansion of the early reading growth research by utilizing the following nationally representative datasets: Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) and NAEP 2015 grade 4 reading assessment data. The primary objectives for this study are (a) to examine the unique development patterns of early reading skills, (b) to identify the reading skill profiles of students who are struggling or at-risk for reading difficulties in fourth grade, and (c) to examine the relationship between early reading development patterns and grade 4 reading performance.

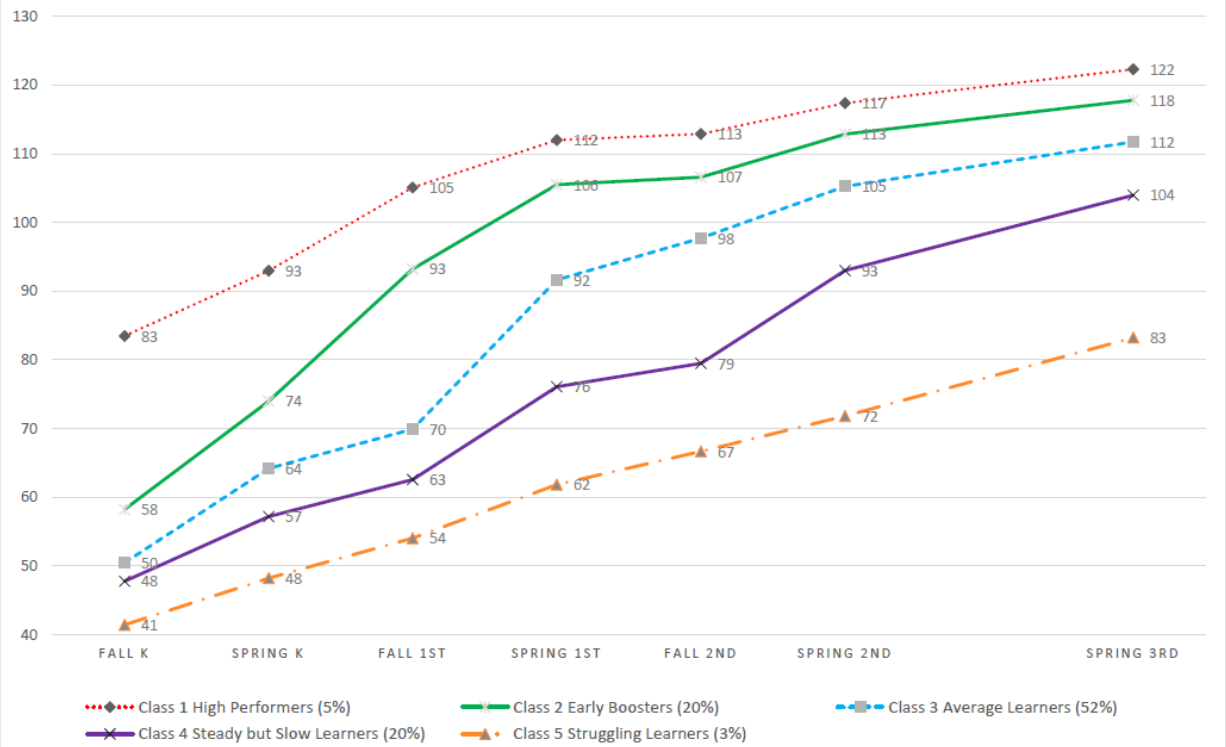
Below is a summary of the results and discussions of the findings:

- Results from the latent growth curve model analysis of overall reading performance show that students demonstrated the most growth in reading from kindergarten through grade 1 (approximately 13-point growth every 6-month period), and the growth

slowed down during second grade (approximately 6-point growth every 6-month period) and slowed down even further during third grade (about 4-point growth every 6-month period).

- Results from the growth mixture model (GMM) analysis suggest five distinct groups of students (see figure ES-1) characterized as *High Performers* (5 percent of students representing high reading skills at the beginning of kindergarten and maintaining high reading skills), *Early Boosters* (20 percent of students representing rapid growth between kindergarten and grade 1), *Average Learners* (52 percent of students representing average initial reading skills and average reading growth), *Steady but Slow Learners* (20 percent of students representing average initial reading skills but slow reading growth between kindergarten and grade 1), and *Struggling Learners* (3 percent of students representing low initial reading skills and inadequate reading growth during the first 4 years of school). These distinctive reading growth patterns highlight the importance of strong reading foundations and growth in kindergarten and grade 1, which are critical for developing high reading skills by grade 4 (defined as performing at *NAEP Proficient* or above on the NAEP grade 4 reading assessment).

Figure ES-1. Model-Estimated Means for Each Latent Class: Results from Growth Mixture Modeling



NOTE: Students who repeated kindergarten through third grade regardless of whether they were first-time kindergartners and students who advanced ahead and were above the expected grade-level were excluded from the analytic sample.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

- Results from the analysis of reading subskill performance across four time points (fall and spring of kindergarten, and spring of first and second grade) show the importance of foundational reading skills, which are necessary for young readers' adequate reading growth and for their later reading outcomes. While most students master basic decoding skills by grade 1, students who are struggling or at-risk for reading difficulties (predicted to perform below *NAEP Basic*) appear to have trouble developing phonological awareness and sight word skills by the end of the grade 1. Additionally, a high percentage of students without mastery of alphabetic principle at the start of kindergarten (57 percent) and students without phonological awareness by the end of grade 1 (85 percent) was predicted to perform below the NAEP *Basic* level in grade 4. In contrast, students starting kindergarten without mastery of alphabetic principle and without mastery of phonological awareness by the end of grade 1 had a very low chance of performing at or above NAEP *Proficient*.

Findings from the study show that starting kindergarten with sufficient alphabetic principle knowledge is highly related to their reading development, which suggests providing high quality early literacy instructions prior to kindergarten can help students master basic reading skills. Additionally, assessing and monitoring development of all foundational reading skills is critical, especially phonological awareness in kindergarten and grade 1, which seem to serve as a prerequisite for adequate reading growth in early years of schooling. Lastly, providing focused evidence-based instructional support to improve those foundational skills with inadequate growth can prevent students from falling behind and help them to develop appropriate reading skills by grade 4.

Contents

List of Tables

List of Figures

Introduction

The importance of developing reading skills in the early grades to students' academic success in the later grades has been well documented in the literature (Claessens et al., 2009; Dogan et al., 2015). Even though it is widely known that children tend to develop reading skills at varying rates (Boscardin et al., 2008), early reading skills are a strong predictor of reading performance in the later grades, and children whose growth lags in the early grades tend to have lower performance later on.

Despite a well-documented body of literature related to students' reading development, only a relatively small number of studies have examined young children's reading development patterns, especially using nationally representative data. While understanding students' reading development within local contexts can provide useful information to teachers and school administrators, examining patterns and factors related to reading growth at the national level can better inform policymakers and stakeholders and enhance policy discussion for more effective reading education policies and practices for the nation as a whole. Recent results from the 2019 National Assessment of Educational Progress (NAEP) reading assessment, in which 35 percent of U.S. public school fourth-graders performed below *NAEP Basic* (National Center for Education Statistics, 2019), demonstrate a need for robust empirical data on children's early reading development at the national level. The findings also suggest the importance of discussions on policy and practice for early reading education at the national level.

Using the sample from the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), this study identifies reading development patterns of students in kindergarten through grade 3, along with reading skill profiles of students in kindergarten through grade 2, based on data collected from the ECLS-K:2011 reading assessments. These growth trajectories and reading skill profiles are then related to NAEP reading performance in grade 4 using a special 2015 overlap sample of ECLS-K:2011 and the NAEP reading assessment, when the participating students were in fourth grade. In addition, the study explores contextual factors collected from students, schools, teachers, and parents to better understand the facilitators of young children's reading skill development. The study's main contributions are (1) uncovering reading development patterns and reading skill profiles of students in first a few years of school; and (2) testing how these patterns and profiles relate to students' later reading performance in grade 4.

Specifically, the study addresses the following research questions:

- Are there reading development patterns from kindergarten through grade 3 that are common to all students?
- What student, family, and school contextual information is related to students' reading development?

- Are there distinctive reading skill profiles that can be based on the analysis of reading subskills measured from kindergarten through grade 2? If so, how are they related to students' reading development?

- How are early reading growth trajectory patterns related to students' performance on the NAEP grade 4 reading assessment?

- What are the characteristics of the reading skill profiles of students who perform below *NAEP* Basic on the NAEP grade 4 reading assessment?

Literature Review

Importance of Early Reading

Early reading skills as a predictor of overall academic success in the later grades have been studied for decades (Cunningham & Stanovich, 1997; Juel, 1988; Slavin, 1994). Early reading skills are important not only for students' later reading skills (Dogan et al., 2015), but also for their overall academic success in the later grades (Slavin, 1994; Stevenson & Newman, 1986). For example, Juel conducted a longitudinal study of 54 children and reported that the probability of a poor reader by the end of first grade remaining a poor reader at the end of fourth grade was shockingly high (0.88). Many of these poor readers did not master basic decoding skills by the end of fourth grade, while most competent readers mastered these skills by the beginning of second grade. Ellis and Large (1988) followed 40 children, ages 5 to 7, measuring a battery of skills including reading, spelling, vocabulary, phonological awareness, and intelligence to examine the development of early reading skills as well as how well early reading skills predict later reading performance. Interestingly, while reading is one general measure of ability for 5-year-old children, it becomes more multifaceted as children grow older, with phonological awareness becoming a strong predictor of reading skill development for 6-year-old children. By the time children are 7 years old, reading is a blend of multiple skills, including learning new symbol-sound associations and sound blending skills. Ellis and Large also emphasized the importance of phonological awareness, both as a consequence of early foundational reading development (learning to read) and as a contributor to reading skill development as young children learn to read.

Previous studies used the prior ECLS cohort, the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), to examine the relationship between students' early reading skills and later reading skills. In a study conducted by Claessens et al. (2009), the authors reported that the bivariate correlation between the reading score at the beginning of kindergarten and at the end of fifth grade was 0.50 and that this relationship was observed for all subgroups defined by race/ethnicity and socioeconomic status (SES). Using the subsample of students who participated in ECLS-K and the NAEP 2007 grade 8 reading assessment, Dogan et al. (2015) examined the relationship between early reading skills and eighth-grade reading performance on NAEP. Results from their study show that to have about a 50 percent chance of performing at the *NAEP Proficient* level on the NAEP grade 8 reading assessment, students

(a) needed to be able to comprehend words in context by the end of first grade and identify clues used to make inferences by the end of third grade, and (b) needed the capability to use background knowledge combined with cues in a sentence to understand the use of homonyms by the end of third grade.

Hernandez (2011) conducted a study of a nationally representative sample of 4,000 students using data collected from the National Longitudinal Survey of Youth 1979, which presents even more compelling evidence of the importance of early reading skills. Among students not reading proficiently by the end of third grade, about 16 percent did not graduate from high school. They were four times more likely not to finish high school compared to readers who were proficient by the end of third grade. While poverty impacts non-proficient readers in a negative way, Hernandez suggested that high-quality early interventions can make a positive difference for at-risk readers.

Early reading skills not only predict students' later reading skills and high school completion, but also their literacy experiences later in life. Cunningham and Stanovich (1997) followed a group of first-graders until the 11th grade and found that students' first-grade reading ability was a strong predictor of all of the outcomes measured in their study in the 11th grade, including reading comprehension and written vocabulary. Furthermore, first-grade reading ability predicted the level of exposure to students' reading of print material in the 11th grade. Findings from this study suggest that early reading ability is not just a predictor of students' academic skills in the later grades but is also related to the development of lifetime reading habits. As one might expect, students with more competent reading skills in the first grade tend to engage in more reading activity later, which in turn helps their overall reading skill growth.

Analysis of Early Reading Skill Development

While there have been decades worth of work examining the relationship between early reading skills and students' later academic performance, these studies relied on relatively simple analytic methods, such as correlation or regression analyses of students' reading performance at two time points (e.g., kindergarten entry and the end of fifth grade). In contrast, growth curve modeling views reading development as continuous progress and examines patterns of reading development, thereby providing much richer information about how students develop reading skills over time.

Because of its analytical flexibility, growth curve modeling has become an important way to identify a sample's average reading growth trajectory (Caravolas et al., 2013; Francis et al., 1991; Kamata et al., 2013; Speece et al., 2004). Examining the growth trajectories of early reading skills is important as they can provide useful information to teachers and educators to identify children who do not exhibit expected normal growth in early reading skills. Identifying these students as early as possible and providing adequate support as early as possible are also important since they are predictors of students' later academic and reading skills. Growth curve models can also be used to explore factors that influence individual variation in the developmental patterns of reading skills (Muthén et al., 1998).

One of the commonly reported findings from the early reading growth studies is that students' early reading skill developmental patterns are not linear. For example, McCoach et al. (2006) analyzed the first four data points from the ECLS-K study to examine the growth of students' reading skill development from kindergarten through first grade. Their findings suggest that students made greater reading gains in the first grade than in kindergarten; however, they noted the potential importance of preschool and summer instruction, especially for students from economically disadvantaged families. In a study of 40 children followed from kindergarten through third grade, Speece et al. (2004) found that a fixed quadratic equation best fit the data, which also indicated a nonlinear growth in reading skills. That is, students' early reading skill development slowed over time. Speece et al. also noted the importance and robustness of phonological awareness as a predictor of third-grade word-level knowledge even when other early reading skills are taken into account.

While a conventional growth curve analysis provides more nuanced information about students' reading development patterns than an analysis of reading growth using two time points, one critical assumption of conventional growth curve analysis is that all individuals in the analysis come from a single population and share a single growth trajectory. This does not mean that that the growth trajectory cannot be compared across various student groups—such as those defined by SES (Hecht et al., 2000), language-minority status (Lesaux et al., 2007; Kieffer, 2008; Kieffer, 2011), and/or special education status (Christ et al., 2010)—as these groups can be used as covariates for the growth curve analysis. However, within such a modeling framework, there is the potential for unidentified (unobserved) groups that share similar patterns of reading development (Boscardin et al., 2008; Speece, 2004) but that differ from each other in other ways. Such patterns could be indicative of "…different times of skill onset, different durations of acquisition, and different asymptotic levels of performance" (Paris, 2005, p. 184).

Growth mixture modeling (GMM), a more recently developed analytic method, does not assume that all individuals in the analysis come from a single population. GMM examines the growth trajectories of individuals and identifies unobserved subpopulations within the larger population that share similar growth trajectories (Jung & Wickrama, 2008). These subpopulations, also called latent classes, are identified purely by data and do not represent any observed characteristics in the dataset, such as race/ethnicity. For example, Boscardin et al. (2008) used GMM with reading assessment data collected from 411 children in kindergarten through second grade and identified 10 groups of students that have distinctive reading development patterns. The authors provided empirical evidence that there are multiple distinctive development patterns of early reading skills. Their findings also suggest that the use of GMM can identify students who may face reading difficulties much earlier than when they become an obvious issue (e.g., typically starting in third grade, when the reading demand increases substantially as students read to learn). Additionally, these students can be supported more effectively through targeted interventions that reflect each group's strengths and weaknesses in various domains of early reading skills.

Limitation of Previous Literature

While recent studies have used GMM to address the limitations of conventional growth curve modeling for identifying reading development patterns (Boscardin et al., 2008; Muthén & Muthén, 2000), these studies relied on an assumption that reading development patterns were linear in nature, an untenable assumption given the research that shows that reading growth is nonlinear (Lesaux et al., 2007; Kamata et al., 2013; Kieffer, 2008; Kieffer, 2011).

Another major limitation of previous research on early reading development is that most studies used small samples collected in local contexts. For example, a study conducted by Ellis and Large (1988) followed 40 children, and the Cunningham and Stanovich (1997) study included 56 students. One of the most widely cited studies for reading development, conducted by Juel (1988), followed 54 students. Even though more recent studies, such as one by Boscardin et al. (2008), included larger samples (411 children), most collected data from local or regional settings, which makes it difficult to generalize findings to the national level. Despite the important contributions of these studies, having a relatively small sample size does create a potential issue of generalizability, thereby diminishing their utility for national-level policy discussions.

The current study both replicates and expands upon the concepts developed in previous studies in multiple important ways. First, this study utilizes a nationally representative longitudinal dataset (i.e., ECLS-K:2011) to replicate findings from the previous studies using both small samples and the previous ECLS-K cohort (i.e., ECLS-K:1998). Second, we developed a piecewise model for this study to represent early reading development patterns; the model provides both theoretical and statistical improvements in fit compared to a linear model (Lesaux et al., 2007; Kieffer, 2008; Kieffer, 2011). Third, we conducted the GMM analysis to examine whether there are multiple distinctive early reading skill development patterns. Fourth, we expanded the growth model by including the concept of summer reading loss, in which students show a drop in reading achievement following their return from summer break (Cooper et al., 1996). Lastly, we examined students' reading growth patterns using both their overall reading scores as well as their performance on individual reading assessment items measuring various subskills of early literacy (e.g., alphabetic knowledge, phonological awareness, and vocabulary).

Methods

Data Source

Two national datasets were used for this study. First, data collected from the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011)[1] were used to examine the early reading development patterns of young children. Second, data from the National Assessment of Educational Progress (NAEP) 2015 grade 4 reading assessment were used

[1] The ECLS-K:2011 Kindergarten–Third Grade data file (released in 2016) was used for this study as it was the most recent file available at the time of analysis.

to examine the relationship between students' reading growth from kindergarten through the third grade and their fourth-grade reading performance.

ECLS-K:2011

The Early Childhood Longitudinal Study Kindergarten class of 2010-11 (ECLS-K:2011) is a nationally representative longitudinal study[2] of approximately 18,200 students who were in kindergarten during the 2010-11 school year. Data were collected in nine rounds: fall and spring of the 2010-11 school year (when students were in kindergarten), fall and spring of the 2011-12 school year (when most students were in first grade), fall and spring of the 2012-13 school year (when most students were in second grade), and the spring of the 2013-14, 2014-15, and 2015-16 school years (when most students were in third, fourth, and fifth grades, respectively). The rounds conducted in the fall of first and second grades were conducted with a subsample of approximately one-third of the full sample and are referred to as the fall subsample rounds. Information on cognitive, social, emotional, and physical development was collected, and direct child assessments were conducted, in every round. For the purposes of this study, we used the data collected from kindergarten through third grade.

As having more data points allows more flexibility in the growth modeling, data collected from the fall subsample (approximately 6,000 students) were included in the examination of students' reading growth from kindergarten through third grade, for a total of seven data points (fall and spring of kindergarten through second grade and spring of third grade). Because we wanted to estimate the most typical reading development patterns of young children, we excluded all off-grade students. That is, students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. In addition, children in the analytic sample (approximately 5,700 students) had to have at least one valid reading assessment score across the measurement occasions used for the analysis as well as valid data on their sex and race.

To produce national-level population estimates and accurate standard errors that minimize bias caused by nonresponse, we followed the guidance provided in the ECLS-K:2011 data file user's manual (Tourangeau et al., 2016) and selected the sampling and replicate weights that maximized the number of data sources (e.g., student, teacher, parent) used in the analyses for which nonresponse adjustments were made and maintaining as large an unweighted sample size as possible. For the growth analysis of reading scores, we used the sampling weight W7CF7P_2T170 and its corresponding replicate weights (W7CF7P_2T171 through W7CF7P_2T1740). These weights are adjusted for nonresponse associated with child assessment and child questionnaire data from the first seven data collection rounds. They also account for parent data from fall kindergarten or spring kindergarten and either teacher-, classroom-, or child-level teacher data from all of the first seven rounds.

[2] It is important to note that ECLS-K:2011 is a nationally representative sample of the kindergarten class of the 2010-11 school year. However, the study sample was not refreshed to be representative of all grades assessed at each round of data collection.

To examine subskills of early literacy (i.e., basic reading skills, vocabulary, and comprehension), we used students' responses on the cognitive items that were collected from four data points (fall and spring of kindergarten and spring of first and second grades) in the full sample. For the analysis of students' subskills of early literacy using item-level data, we used the sampling and replicate weights for each measurement occasion suggested by the ECLS-K:2011 data file user's manual.[3]

To confirm the comparability of the fall subsample and the analytic sample to the full sample, we compared several demographic characteristics across the three samples. As shown in Table 1, the weighted fall subsample was similar to the weighted full sample in terms of sex, race/ethnicity, English as the primary home language, the percentage of students with Individualized Education Programs (IEPs) in the fall of kindergarten, the percentage of students who changed schools at least once across kindergarten through third grade, and the average socioeconomic status index. Similar to the comparison between the fall subsample and the full sample, the analytic sample for the growth analysis of reading scores also showed similar demographic characteristics in terms of sex, race/ethnicity, English as the primary home language, the percentage of students who changed schools at least once across kindergarten through third grade, and the average socioeconomic status index.

[3] For the analysis of data from the fall and spring of kindergarten, the sampling weight of W1C0 was used. For the analysis of data from the spring of the first and second grades, the sampling weights of W4C4P_20 and W6C6P_20 were used. For all analyses, appropriate corresponding replicate weights were used for variance estimation. This analysis used a different set of weight variables than the growth analysis (W7CF7P_2T170–W7CF7P_2T1740) in order to maximize the number of students analyzed and obtain more reliable and robust parameter estimates.

Table 1. Comparison of Weighted Full Sample, Fall Subsample, and Analytic Sample, by Selected Characteristics: Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011)

	Weighted full sample Unweighted n=18,200 Population size=3,972,600			Weighted fall subsample Unweighted n=6,100 Population size=3,923,800			Weighted analytic sample Unweighted n=5,700 Population size=3,742,100		
	Weighted count	Weighted percent	SE	Weighted count	Weighted percent	SE	Weighted count	Weighted percent	SE
Sex									
Male	2,042,000	51	0.41	2,019,100	51	1.33	1,910,600	51	1.31
Female	1,930,600	489	0.41	1,904,600	49	1.33	1,831,600	49	1.31
Not ascertained	0	†	†	0	†	†	0	†	†
Race/Ethnicity									
White	2,060,800	52	1.68	2,018,500	51	5.20	1,934,600	51	5.28
Black	531,100	13	1.20	529,400	13	2.47	515,300	14	2.45
Hispanic	979,700	25	1.25	982,900	25	4.94	927,100	25	4.97
Asian	191,500	5	0.67	176,500	5	1.10	173,100	5	1.14
Other	209,600	5	0.61	215,300	5	1.42	192,000	5	1.24
Not ascertained	0	†	†	1,200	<1	0.03	0	†	†
Primary language at home (Grade K Fall)									
Non-English	631,000	16	0.81	596,900	15	2.48	562,800	15	2.47
English	3,281,800	83	0.86	3,258,700	83	2.82	3,113,600	83	2.84
Can't choose	53,200	1	0.20	60,700	2	0.52	59,300	2	0.55
Not ascertained	6,600	<1	0.05	7,500	<1	0.06	6,500	<1	0.06

	Weighted full sample Unweighted n=18,200 Population size=3,972,600			Weighted fall subsample Unweighted n=6,100 Population size=3,923,800			Weighted analytic sample Unweighted n=5,700 Population size=3,742,100		
	Weighted count	Weighted percent	SE	Weighted count	Weighted percent	SE	Weighted count	Weighted percent	SE
Missing	0	†	†	0	†	†	0	†	†
Language screener (Grade K Fall)									
Routed through English	3,865,300	97	0.37	3,827,100	98	0.88	3,666,100	98	0.75
Routed through Spanish	95,400	2	0.35	88,600	2	0.89	73,800	2	0.75
Other-language speaker (not routed through English)	7,200	<1	0.06	3,100	<1	0.05	2,200	<1	0.05
Not ascertained	0	†	†	0	†	†	0	†	†
Missing	4,700	<1	0.04	5,000	<1	0.08	0	†	†
Language screener (Grade 1 Spring)									
Routed through English	3,963,600	100	0.05	3,908,600	100	0.11	3,735,600	100	0.08
Routed through Spanish	3,900	<1	0.03	3,300	<1	0.04	1,600	<1	0.03
Not ascertained	0	†	†	0	†	†	0	†	†
Missing	5,200	<1	0.04	11,900	<1	0.10	4,900	<1	0.07
Individualized Education Program (IEP) Status (Grade K Spring)									
Students with IEP	327,600	8	0.44	277,000	7	0.68	231,500	6	0.49
No IEP	3,601,000	91	0.48	3,584,900	91	0.86	3,453,600	92	0.72
Not ascertained	34,000	1	0.22	45,900	1	0.53	44,700	1	0.53

	Weighted full sample Unweighted n=18,200 Population size=3,972,600			Weighted fall subsample Unweighted n=6,100 Population size=3,923,800			Weighted analytic sample Unweighted n=5,700 Population size=3,742,100		
	Weighted count	Weighted count	SE	Weighted count	Weighted count		Weighted count	Weighted count	SE
Missing	10,000	<1	0.11	16,000	<1	0.20	12,400	<1	0.21
IEP Status (Grade 3 Spring)									
Students with IEP	457,500	12	0.43	470,100	12	0.65	387,300	10	0.57
No IEP	3,464,500	87	0.48	3,405,900	87	0.74	3,314,300	89	0.72
Not ascertained	45,000	1	0.20	40,900	1	0.29	34,400	1	0.25
Missing	5,700	<1	0.04	6,800	<1	0.09	6,200	<1	0.09
Number of School Changes (across Grade K to 3)									
Never	2,726,100	69	1.88	2,664,100	68	3.07	2,556,600	68	3.08
Once	1,072,500	27	1.58	1,057,000	27	2.83	991,500	27	2.81
More than once	174,000	4	0.61	202,600	5	0.95	194,100	5	0.97
Missing	0	†	†	0	†	†	0	†	†
		Weighted mean	**SE**		**Weighted mean**	**SE**		**Weighted mean**	**SE**
Socioeconomic status (Grade K Fall and Spring)		-0.07	0.02		-0.07	0.05		-0.06	0.05

† Not applicable.

NOTE: Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The socioeconomic status variable is a continuous measure that combines information on parents' occupational prestige scores, income, and education from the fall of 2011 and the spring of 2012. It ranges in value from -2.33 to 2.60. This composite variable was not created for grades 2 or 3 because some of the data needed were not collected in the spring of 2013 (when parents were not asked for education information) or the spring of 2014 (when parents were not asked for occupation information). Counts reported in this table (for the number of students) are rounded to the nearest hundredth. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

One of the major strengths of the ECLS-K:2011 dataset is its rich set of contextual information collected not only from students but also from parents, teachers, and school administrators. Obtaining contextual information from multiple types of respondents on a variety of topics—including the characteristics of the child and the child's family, the community, nonparental care and education arrangements, and school and classroom environments—can lead to a more accurate picture of the children and their educational experiences.

To provide contextual information on the students analyzed in this study, we examined the responses from the teachers and school administrators in the analytic sample collected in the fall of kindergarten and the spring of first through third grades.[4] A vast majority of teachers (above 90 percent) were female, White (approximately 70 to 75 percent), and recipients of either bachelor's or master's degree (above 90 percent). The average number of years of teaching ranged from 13 to 15. In terms of school characteristics, about 70 percent of students attended schools that had 300 to 750 students. Of these schools, about 90 percent were public and approximately 42 percent were located in suburban areas.

NAEP 2015 Grade 4 Reading Assessment

NAEP is a nationally representative assessment of students in grades 4, 8, and 12 on a broad range of academic subjects. For this study, results from the NAEP 2015 grade 4 reading assessment were used as a distal outcome. The NAEP reading assessment measures students' vocabulary knowledge and comprehension skills in various genres of text, including fiction, poetry, exposition, persuasive, and procedural text (National Assessment Governing Board, 2015). Students' performance on the NAEP reading assessment is classified into the three NAEP achievement levels (*NAEP Basic*, *NAEP Proficient*, and *NAEP Advanced*) determined by the National Assessment Governing Board. *NAEP Basic* indicates partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade. *NAEP Proficient* indicates solid academic performance, demonstrating competency over challenging subject matter. *NAEP Advanced* indicates superior performance. The current study focused on students who performed below *NAEP Basic* on the NAEP reading assessment, exploring possible early indicators of students at risk of below *NAEP Basic* performance on the NAEP reading assessment in grade 4 based on their reading development trajectories and early literacy subskill development patterns from kindergarten through grade 3.

Among the students in the ECLS-K:2011 sample, approximately 600 of them also participated in the NAEP 2015 grade 4 reading assessment. This overlap sample from ECLS-K:2011 and the NAEP 2015 reading assessment provides an opportunity to examine how the development in reading skills in the early grades is related to students' performance on the NAEP grade 4 reading assessment. To analyze the relationship between students' early reading skill development patterns and performance on the NAEP grade 4 reading assessment, NAEP scores were projected for the full ECLS-K:2011 sample using a statistical link based on the ECLS-K:2011

[4] It is important to note that the ECLS-K:2011 sample is designed to be representative of the students in the kindergarten class of the 2010-11 school year but is not representative of teachers and school administrators who responded to the ECLS-K:2011 teacher and school administrator questionnaires.

and NAEP 2015 grade 4 overlap sample, which is described in detail in the "Analytic Methods and Results" section below.

Measures and Variables

In this section, we describe the cognitive assessments and contextual survey items available in the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) and the NAEP 2015 reading assessment. Additionally, we describe the variables from these studies that we use in our analyses.

ECLS-K: 2011

The ECLS-K:2011 includes direct assessments of students' cognitive skills in the reading and executive function domains. These cognitive assessments were administered to students individually, and the scores from some of these assessments were vertically scaled, allowing the longitudinal analysis.

Direct reading assessment. The ECLS-K:2011 reading scores were used to examine students' reading skill development, which is the primary interest of this study. Reading assessment data were collected by individual administration. The ECLS-K:2011 reading assessment is assembled in two stages in which students are given a set of common items at the first stage (also called the routing block) to obtain a preliminary estimate of their reading ability. Based on their performance at this stage, one of three sets (i.e., easy, medium, and difficult) of ability-appropriate items is administered at the second stage, allowing students to demonstrate their reading skills fully. The assessment measures basic reading skills (e.g., print familiarity, the alphabetic principle, letter recognition, beginning and ending sounds, rhyming words, word recognition, and phonemic awareness), sight words, vocabulary, and reading comprehension. For reading comprehension questions, students are asked to (a) identify information stated in the text (e.g., definitions, facts), (b) make complex inferences within and across texts, and (c) judge the appropriateness and quality of the text.

Overall reading scores[5] were calculated using Item Response Theory, which examines students' response patterns (e.g., correct, incorrect, or omitted response) to assessment items and estimates their abilities on the same scale using item parameter information, such as item difficulty and discrimination. In addition, the reading assessment scores were vertically scaled, which allows the longitudinal analysis of students' reading achievement over time (Tourangeau et al., 2015).

For this study, students' vertically scaled reading assessment scores from kindergarten through third grade from seven measurement occasions (the fall and spring of the kindergarten, first-grade, and second-grade years and the spring of third grade) were used to estimate their

[5] Statistical and psychometric analyses were conducted to examine whether the items included in the ECLS-K:2011 reading assessment measure a single underlying construct (i.e., reading); the results suggest evidence of the unidimensional construct of reading acquisition (Najarian et al., 2018a).

reading development trajectories. For the analysis of students' reading subskills, students' item response data from four measurement occasions (the fall and spring of kindergarten and the spring of first and second grades) were used. The ECLS-K:2011 reading items measure various reading subskills, such as print familiarity, letter recognition, vocabulary, and reading comprehension with varied cognitive targets (e.g., identifying explicit information, making complex inferences, and critically evaluating the text).

To determine what reading subskills the items measured, we used the item specification information provided in the ECLS-K:2011 psychometric report for kindergarten through second grade (Najarian et al., 2018a; Najarian et al., 2018b).

Direct executive function assessment. Two important components of executive function abilities related to learning were measured in the ECLS-K:2011 through direct child assessment: working memory and cognitive flexibility. *Working memory* was measured using the Numbers Reversed task (a subtest of the Woodcock-Johnson III Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001), which asked students to repeat long strings of orally presented numbers in reverse order. Among the six scores developed for this measure, the *W*-ability score (a special transformation of the Rasch ability scale) was used in this study, as it is recommended for longitudinal analysis by the ECLS-K:2011 user's manual (Tourangeau, et al. 2015). *Cognitive flexibility* was measured using the Dimensional Change Card Sort (DCCS; Zelazo, 2006), which asked students to sort a series of picture cards according to different rules. Scores were computed using the scoring rules for the DCCS. It is important to note that the administration mode for the DCCS changed from a physical card sort to a computerized test in second grade and that the scoring range changed accordingly (for details, see Tourangeau et al., 2015). Because of this change, the cognitive flexibility scores were not vertically scaled. The assessment scores from the two executive function assessments were used to examine the relationship between reading growth trajectories and executive function skills.

NAEP Grade 4 Reading Assessment

The NAEP reading assessment includes two types of text (i.e., literary and informational), and each text type is represented by two subscales (literary and informational). The final NAEP reading score is a weighted composite of these two subscales, with each subscale contributing 50 percent to the composite score. The composite scale score is used to place students within the NAEP achievement level. As mentioned previously, this study focuses on students performing below *NAEP Basic*.

ECLS-K:2011 Contextual Variables

The contextual questionnaires from students, parents, teachers, and school administrators that were administered as a part of the ECLS-K:2011 provide a wide range of information about students. Some of the variables in the questionnaires were surveyed repeatedly over time (e.g., students' primary home language, special education eligibility status), while others were surveyed just once or at several time points (e.g., student motivation for reading). Although it would be interesting to examine the relationships between all of the contextual variables

available in the data file, it is not realistic to do so in one study, as there are more than 16,000 of them.

To make the study more manageable, we reviewed every questionnaire administered to students, parents, teachers, and school administrators at each time point from the fall of kindergarten through the spring of third grade and selected the variables related to the following:

- reading, such as teachers' ratings of students' literacy skills, instructional practices when teaching reading, and students' motivation level for reading;
- major demographic characteristics that are often controlled for in educational research, such as students' socioeconomic status, race/ethnicity, and primary home language; and
- other variables related to students' achievement in general, such as their ability to focus and approaches to learning (Mulligan et al., 2016; Rathbun & Zhang, 2016).

Basic descriptive statistics and correlations between reading achievement variables and other variables (e.g., executive function scores and contextual variables) were analyzed for the selected variables. The results of these analyses are reported in appendix tables A1–A16 and discussed in the "Analytic Methods and Results" section below.

Analytic Methods and Results

Descriptive Statistics and Variable Correlations

Results from the basic descriptive and correlation analyses are reported in three categories in this section:

- average reading scores from the ECLS-K:2011 assessments collected across 4 years (i.e., from kindergarten through third grade) and correlations among the reading scores;
- average scores from the two executive function assessments (i.e., Numbers Reversed for working memory and DCCS for cognitive flexibility) as well as the correlations between these scores and reading scores; and
- descriptive statistics of various contextual variables collected from teachers and parents and the correlations between these variables and reading scores.

Reading Assessment

The average reading scale scores for the analytic sample ranged from 53 (kindergarten fall) to 111 (third grade spring) on a 0–141 scale,[6] exhibiting a gradual increase over time (see Table A1 and Figure A1). As Table A3 shows, the correlations among the seven reading scores ranged

[6] The average reading and Numbers Reversed task scores reported in this section are from the ECLS-K:2011 Kindergarten–Third Grade Restricted-Use Data File.

from 0.53 (between kindergarten fall and third grade spring) to 0.88 (between first grade spring and second grade fall).

Executive Function Assessments

The average scale scores for the Numbers Reversed task (measuring students' working memory) for the analytic sample ranged from 436 (kindergarten fall) to 491 (third grade spring) on a scale of 393–603, and the correlations among the Numbers Reversed task scores ranged from 0.36 (between kindergarten fall and second grade spring) to 0.57 (between spring of second and third grades). The average DCCS (measuring cognitive flexibility) scores from kindergarten fall to first grade spring ranged from 15 to 16 (maximum score of 18) and from 6 to 7 from second grade fall to third grade spring (maximum score of 10).[7]

The correlations between the reading and Numbers Reversed task scores ranged from 0.29 (kindergarten fall reading and third grade spring Numbers Reversed scores) to 0.51 (kindergarten fall Numbers Reversed and kindergarten spring reading scores). The correlations between reading and DCCS task scores ranged from 0.20 (kindergarten fall reading and third grade spring DCCS scores) to 0.39 (second grade fall DCCS and third grade spring reading scores). Overall, among the two executive function assessments, the Numbers Reversed task displayed higher correlation with the reading scores. For additional details, see Tables A2 and A3.

Contextual Variables

Among the teacher and parent rating variables (e.g. students' Approaches to Learning,[8] social skills and behaviors, Attentional Focusing,[9] and Inhibitory Control[10]), the teacher-reported Approaches to Learning and executive function-related scales (i.e., Attentional Focusing and Inhibitory Control) showed moderate relationships to students' reading scores across kindergarten through third grade, ranging from 0.27 to 0.45 for Approaches to Learning, from 0.28 to 0.41 for Attentional Focusing, and from 0.21 to 0.33 for Inhibitory Control. As reported by parents, these rating variables show weak correlations with students' reading scores. Overall, teacher ratings of students' literacy and language skills were significantly related to students' reading scores. The parent-reported frequency of student reading outside of schools showed small to moderate positive relationship with students' reading skills across time points.

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[7] Correlations across the Dimensional Change Card Sort (DCCS) administration were not included because of differences in the scoring rules.

[8] Approaches to Learning items ask teachers and parents to report whether students exhibit a selected set of learning behaviors (such as keeps belongings organized; shows eagerness to learn new things; works independently; easily adapts to changes in routine; persists in completing tasks; pays attention well; and follow classroom rules). The rating scale is the mean rating on these items. See Tourangeau et al. (2015) for details.

[9] The Attentional Focusing scale is the mean of six items. A higher score on this scale indicates that the child exhibits more behaviors that demonstrate the ability to focus attention on the environment relevant to the task. See Tourangeau et al. (2015) for details.

[10] The Inhibitory Control scale is the mean of teachers' ratings of how students react to hypothetical situations. A higher score indicates that students exhibit more behaviors demonstrating the ability to hold back or suppress a behavior, as necessary, for a particular situation. See Tourangeau et al. (2015) for details.

In contrast, teachers' instructional practices, such as frequency of teaching specific reading skills or activities related to reading instruction, and professional development activities did not correlate with students' reading scores. For detailed results, see Tables A4–A16.

Any variables with a moderate bivariate relationship to students' reading scores that were used for further analysis (such as the reading growth pattern analysis) to describe potential differences in students' reading growth trajectories are described in Study Part I below.

Study Part I: Analysis of Reading Development

In this first part of the study, students' reading growth trajectories from kindergarten through third grade were modeled, and further analysis was conducted to investigate whether the reading development patterns were the same for all students. Contextual variables collected from students, parents, teachers, and school administrators were further analyzed to identify contextual factors that are related to students' reading development trajectories.

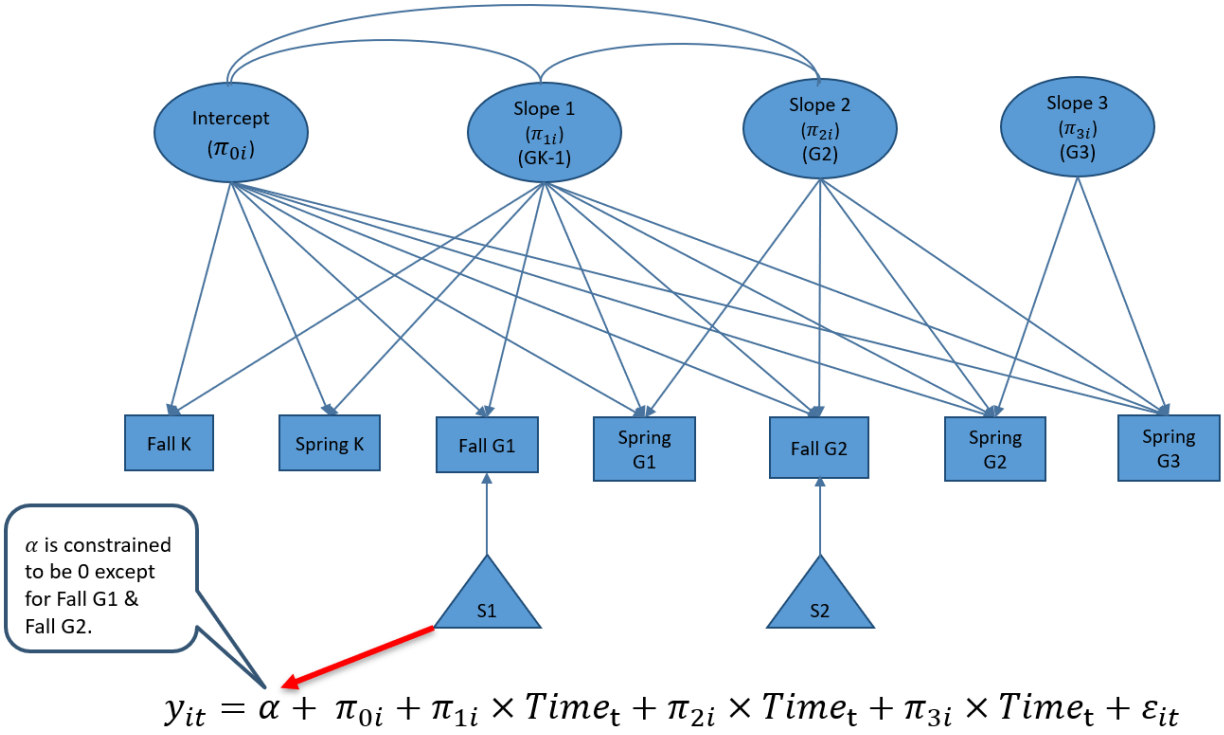
Analytic Method

Three separate steps were taken in the analysis of reading development. In step 1, latent growth curve model analyses were conducted to examine students' reading growth from kindergarten through third grade, accounting for the summer loss of reading achievement. Based on the model fit comparison, the best-fitting model was selected as a baseline model for the growth mixture modeling (GMM). In step 2, the best-fitting model was supplemented with the GMM analysis to identify potential latent classes of students with distinctive growth trajectories. In step 3, the latent class membership derived from the GMM was used for the descriptive analysis to study the association between latent class membership based on students' reading development trajectories in the primary grades and contextual information collected from students, parents, teachers, and school administrators. All analyses were conducted using Mplus 8 (Muthén & Muthén, 1998–2017).

Step 1: Conventional growth curve analysis. A series of latent growth curve model analyses were conducted to find the best-fitting model representing students' reading development trajectories across seven time points, from kindergarten through third grade. Both linear and nonlinear growth patterns were examined as several studies have reported that students' reading growth, especially in the early grades, tends to be nonlinear (Christ et al., 2010; Kamata et al., 2013; Wang et al., 2008). Nonlinear growth was modeled using curvilinear and piecewise growth models. To find the best-fitting model, a series of models were tested based on the evaluation of information criteria (AIC, BIC, adjusted BIC), Standardized Root Mean Square Residual (SRMR), and log-likelihood values. In addition, summer losses were modeled as a single time-point change by freeing the intercept for the fall time period following summer to have a mean change (Borman & Dowling, 2006). Summer effects were estimated for (1) the summer between the spring of kindergarten and fall of first grade; and (2) the summer between the spring of first grade and fall of second grade.

The best-fitting model (see Figure 1) segmented reading development from kindergarten through third grade based on three distinct pieces with the two summer losses modeled. The first piece represents the reading growth rate from the fall of kindergarten through the spring of first grade. The second piece represents growth in second grade, and the third piece is the growth slope in third grade. The variance of the third piece (i.e., the slope representing the third-grade growth) was constrained to zero because it had low variance, and by doing so, the model became more parsimonious. For the model comparison results, see Table B1.

Figure 1. Final Latent Piecewise Latent Growth Curve Model



Step 2: Growth Mixture Model analysis. The best-fitting growth curve model described in the previous section was supplemented with a GMM analysis to identify potential latent classes of students with different growth trajectories. The basic assumption of conventional growth modeling is that the population shares homogeneous growth patterns. However, it may not be reasonable to assume that all students share the same trajectories over time or that heterogeneity is only related to known factors, such as students' demographic backgrounds (Duke & Carlise, 2011; Jung & Wickrama, 2008). GMM identifies students who share the same growth trajectories and classifies them into various latent classes that are mutually exclusive based on their distinctive growth patterns. Thus, GMM can identify subgroups of students that may be associated with unknown sources of heterogeneity (Nylund et al., 2007).

Using the best-fitting growth curve model with three growth segments, a fixed slope of 3, and summer effects, the GMMs were fitted with one to six classes. The one-class GMM was identical to the growth curve model. The two- to six-class GMMs were fitted with the

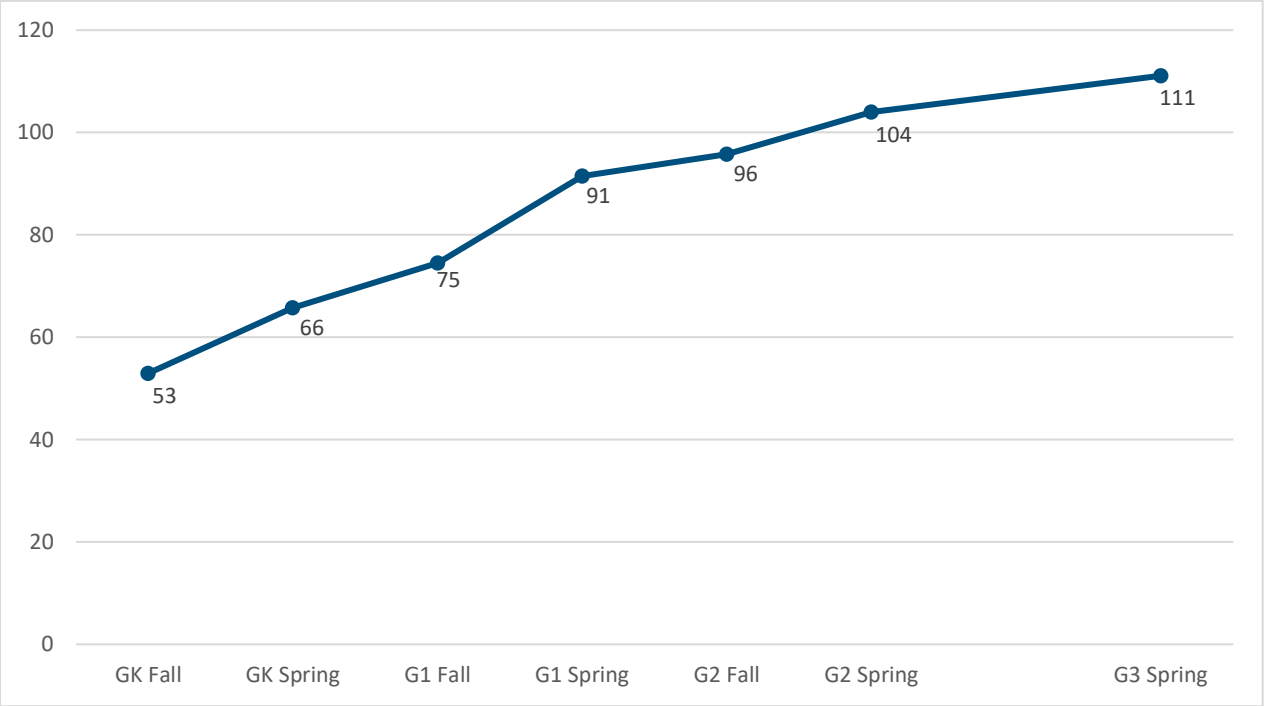
specification that the variance-covariance matrix of the intercept and slope latent variables across all classes were fixed. This assumption was made to reduce estimation difficulty and estimate a parsimonious model. Based on the consideration of model fit information, entropy, the Vuong-Lo-Mendell-Rubin likelihood ratio test, the Lo-Mendell-Rubin Adjusted LRT test, and the interpretability of latent classes, a five-latent class model was selected as the final model (see Table B1 for details).

Step 3: Association between GMM latent classes and contextual information. To describe the characteristics of each latent class from the GMM analysis and to identify contextual factors that are related to students' reading growth trajectories, frequency and descriptive analyses were conducted for contextual variables, with the GMM latent class membership as a grouping variable.

Analysis Results

As previously described, the piecewise growth model with the three segments of reading growth from kindergarten through third grade best fit the data. As Table 2 and Figure 2 show, students demonstrated the most growth in reading from kindergarten through first grade (approximately a 13-point gain every 6-month period). Growth slowed during the second grade (approximately a 6-point gain every 6-month period) and slowed even further during the third grade (approximately a 4-point gain every 6-month period). There was a reading loss over the summer between kindergarten and first grade of about 4 points (with a standard deviation of about 0.29) and of about 2 points (with a standard deviation of approximately 0.13) over the summer between first and second grade.

Figure 2. Model-Estimated Means of Reading Assessment Scores: Piecewise Latent Growth Curve Model Analysis



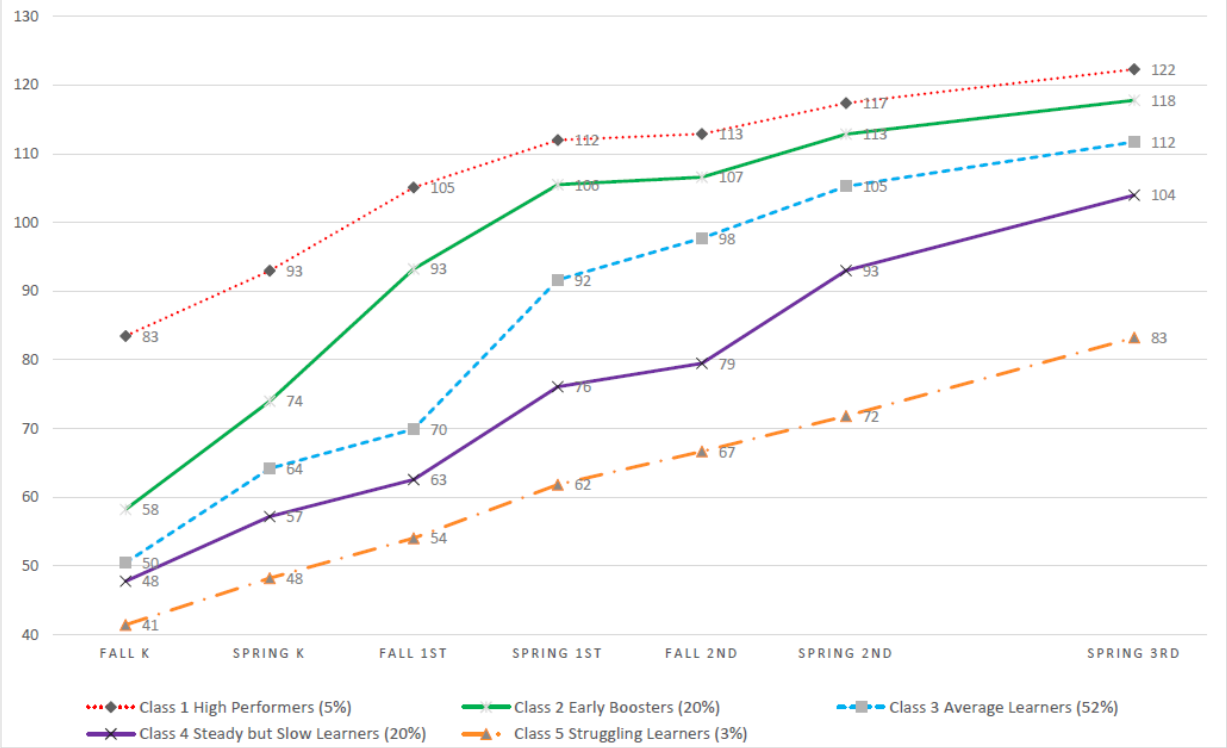
NOTE: Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Using the model described as a baseline model, the GMM analysis was conducted to explore distinctive reading development trajectories. As previously mentioned, the five-class GMM fit the data the best. As Figure 3 and Table 2 show, the five latent classes exhibit distinctive reading development trajectories. The first class (*High Performers*), consisting of approximately 5.5 percent of the sample included in the analysis, exhibited high performance (approximately 3 standard deviations above the average) at the initial time point (fall of kindergarten) and showed relatively high growth in kindergarten and first grade, but slower growth in second and third grades. This group also showed a reading achievement gain in the first summer and a small loss in the second summer. The second class (*Early Boosters*), consisting of approximately 19.9 percent of the sample, exhibited high growth in kindergarten and first grade with a reading gain over the first summer. However, its growth slowed in second and third grades, with a small loss in the second summer. The next group (*Average Learners*), approximately 51.7 percent of students, performed about 30 score points[11] lower than the first class in the fall of kindergarten and demonstrated fast growth in kindergarten and first grade and a large loss in the first summer. The fourth class (*Steady but Slow Learners*), consisting of approximately

[11] One standard deviation is equal to approximately 11 score points in the ECLS-K:2011 kindergarten fall reading assessment.

19.8 percent of the sample, performed around the average (about 0.18 standard deviation below it) initially (in the fall of kindergarten) but demonstrated steady growth throughout the primary grades. However, the noticeable growth pattern for this group is relatively slow growth from kindergarten through grade 2, especially in comparison to the *Early Boosters* group, and it had a large loss in both summers. The last class (*Struggling Learners*) represents about 3.1 percent of the sample. The initial reading performance of this group was about 1 standard deviation below the mean, and it demonstrated slow growth throughout the first several years of schooling. In particular, it showed much smaller growth in kindergarten and first grade compared to the rest of the sample. At the same time, it did not show any significant summer loss.

Figure 3. Model-Estimated Means for Each Latent Class: Results from Growth Mixture Modeling



NOTE: Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table 2. Conventional Latent Growth Curve and Growth Mixture Model for Reading Achievement: Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten through Grade 3

Growth parameters	Conventional piecewise growth model		Piecewise growth mixture model									
			Class 1 (5.5%) High performers		Class 2 (19.9%) Early boosters		Class 3 (51.7%) Average learners		Class 4 (19.8%) Steady learners		Class 5 (3.1%) Struggling learners	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Intercept	52.97	0.263	83.49	1.70	58.23	0.76	50.47	0.26	47.78	0.50	41.43	1.13
Growth in grades K to 1	12.83	0.093	9.51	0.49	15.76	0.22	13.73	0.16	9.44	0.21	6.81	0.56
Growth in grade 2	6.26	0.101	2.69	0.37	3.68	0.24	6.80	0.17	8.47	0.34	4.99	0.44
Growth in grade 3	3.559	0.082	2.46	0.32	2.47	0.18	3.25	0.12	5.47	0.36	5.71	0.62
Summer loss												
Summer between grade K and grade 1	-4.10	0.171	2.59	0.550	3.49	0.459	-8.01	0.266	-4.07	0.285	-0.99[NS]	0.615
Summer between grade 1 and grade 2	-1.98	0.128	-1.80	0.448	-2.58	0.345	-0.74	0.188	-5.07	0.414	-0.17 [NS]	0.889

NOTE: Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead their expected grade level were excluded from the analytic sample. All parameters are significant (p <.05), unless noted as [NS] (not significant).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

The characteristics of each latent class were further explored using the contextual information collected from students, parents, teachers, and school administrators. Among the contextual variables available in the ECLS-K:2011 dataset, those variables with at least moderate relationships with reading assessment scores were analyzed for this part of the study.

The distribution of sex by latent class from the GMM analysis showed that boys were twice as likely to be classified in the *Struggling Learners* group (69 percent) as girls (31 percent). In terms of race/ethnicity, White and Asian students were overrepresented in the *High Performers* and *Early Boosters* classes, while Hispanic and Black students were overrepresented in the *Steady but Slow Learners* and *Struggling Learners* classes. For language status, the distribution patterns of the latent classes were very similar for native speakers of English and for language-minority (LM) students without limited English proficiency.[12] However, LM students with limited English proficiency were overrepresented in the *Steady but Slow Learners* and *Struggling Learners* classes. Looking at special education status, only 2 to 6 percent of *High Performers*, *Early Boosters*, and *Average Learners* had an Individualized Education Program (IEP), compared to 24 percent of *Steady but Slow Learners* and 65 percent of *Struggling Learners*. Lastly, the analysis of students' SES showed a linear relationship between SES and latent class membership, with the highest SES for *High Performers* (0.58) and the lowest SES for *Struggling Learners* (-0.67). Detailed results are presented in Tables B2–B4.

Average scores for the Numbers Reversed task (measuring students' working memory) by latent class from the GMM analysis showed a linear relationship between students' working memory and latent class membership for the first 2 years of school (i.e., from kindergarten through first grade). However, beginning in second grade, the difference between the average working memory scores of *High Performers* and *Early Boosters* was no longer significant. Another noticeable pattern is that the development of working memory for *Struggling Learners* seemed to lag behind that of other students. At the beginning of kindergarten, the working memory average of *Struggling Learners* was about 0.33 standard deviations lower than that of *Steady but Slow Learners*. This difference appeared to grow larger over the first four years of school, and by the end of third grade, there was a difference of approximately 0.87 standard deviations (see Table B5 for details). In the descriptive analysis of the DCCS variables (measuring students' cognitive flexibility), similar patterns were observed, with *High Performers* demonstrating a higher level of cognitive flexibility; however, differences across latent classes were not as noticeable except for *Struggling Learners* (see Table B6 for details). Similar to the findings for working memory, this group of students showed a significantly lower level of cognitive flexibility across all years.

Among teachers' rating of various student behaviors, three variables were examined as a follow-up GMM analysis based on the magnitude of their bivariate relationship with reading

[12] Teachers' reports of students' native language status (English as native language or not) and teachers' reports of students' enrollment status in programs to learn English skills were used to determine whether students were native speakers of English, language-minority students without limited English proficiency (students whose native language is not English and who are not enrolled in programs to learn English skills), and language-minority students with limited English proficiency (students whose native language is not English and who are enrolled in programs to learn English skills).

scores: Approaches to Learning, Attentional Focusing, and Inhibitory Control. The Approaches to Learning variable measures students' demonstration of learning behaviors. The Attentional Focusing and Inhibitory Control variables measure behaviors related to executive functioning. A descriptive analysis from the GMM analysis shows a linear relationship between all three teacher-related variables and the latent classes, with *High Performers* demonstrating more desired behaviors (e.g., more frequent demonstration of positive learning behaviors, higher ability to focus attention on task-relevant cues). However, the difference between *High Performers* and *Early Boosters* was not significant across all time points. On the other hand, average teacher ratings across the same three variables for *Steady but Slow Learners* and *Struggling Learners* were significantly lower than they were for other groups, especially for *Struggling Learners*, who consistently demonstrated much lower ratings across all three variables (see Tables B7–B9 for details).

An analysis of parent-reported variables with moderate bivariate relationships with reading scores suggests that the parents of *High Performers* and *Early Boosters* reported that they or other family members read books to their children more frequently than the parents or other family members of *Steady but Slow Learners* and *Struggling Learners*. Also, *High Performers* and *Early Boosters* tended to read more outside of school, both in terms of frequency and duration, and visited libraries more frequently than *Steady but Slow Learners* and *Struggling Learners*. Lastly, a higher percentage of *High Performers* attended center-based care programs (e.g., day care, preschool, or prekindergarten) on a regular basis compared to the other groups, including *Early Boosters,* before the beginning of kindergarten.

An analysis of school contextual information shows that a higher percentage of *Struggling Learners* than *High Performers* attended schools receiving Title I funding, but kindergarten program length (e.g., half day vs. full day) was not related to latent classes from the GMM analysis.

Study Part II: Exploration of Students' Reading Skill Profiles

In the second part of the study, students' responses to the reading assessment items measuring various subskills of reading collected from kindergarten through second grade were analyzed to identify distinctive reading skill profiles. Understanding reading skill profiles provides an additional insight about which reading subskills are critical for adequate development of early reading skills and can potentially provide early indicators for students who may face reading difficulties in later years.

As previously described, the ECLS-K:2011 reading assessment was conducted in two stages: Stage 1 (routing) included common items to make an initial determination of reading ability; based on their Stage 1 performance, students were routed to one of three Stage 2 blocks (low, medium, or high difficulty), which included ability-appropriate items.

Analytic Method

To differentiate students in terms of their performance on the various reading skills measured in the ECLS-K:2011 reading assessments, stage 1 (routing) items at each time point were analyzed in a latent class analysis (LCA) to obtain finer-grained information about students' performance on the items in each subconstruct. Ideally, all items in both stages 1 and 2 would be included in the LCA. However, doing so would add considerable challenges to the estimation and interpretation of the latent classes due to the sparseness of the item responses in stage 2. As a result, only items in stage 1 were included in the LCA. The final number of classes was determined based on fit indices, including Akaike, Bayesian, and sample size-adjusted Bayesian information criteria (AIC, BIC, and sample-size adjusted BIC), the Lo-Mendell-Rubin likelihood ratio test (LMRT) (Lo et al., 2001), and the Bootstrapped Likelihood Ratio Test (BLRT) (McLachlan & Peel, 2000). When the latent classes were enumerated, the characteristics of the identified classes were described to see if meaningful interpretations could be made about the skill profiles of students at each grade.

For the LCA, the reading item specifications provided in the ECLS-K:2011 psychometric report were used to determine students' performance on the various subconstructs (Najarian et al., 2018b). The item-level LCA was conducted up to second grade because the ECLS-K:2011 psychometric report was only available up to the second-grade items when the analysis was conducted.

It is important to note that the Stage 1 items are a subset of the entire set of ECLS-K:2011 reading assessment items. Therefore, these items do not include a balanced representation of reading subskills and difficulty level. In other words, students at each measurement occasion received a greater number of items measuring certain subskills and only a few items for other subskills, and the difficulty of these items may have been skewed (e.g., more easy items than difficult items). For the item distribution of the entire ECLS-K:2011 reading assessment items, see Table C-1.

Analysis Results

Using Stage 1 items (common items) only, the LCA analysis was conducted to identify unique patterns of students' reading subskills over four measurement occasions (kindergarten fall, kindergarten spring, grade 1 spring, and grade 2 spring). The distribution of Stage 1 items based on ECLS-K:2011 classification is listed in Table 3. For more robust analysis, the full sample was used instead of the fall subsample.

Table 3. Distribution of Items in Stage 1 for Each Reading Subconstruct: Early Childhood Longitudinal Study, Kindergarten Class of 2010-11, Kindergarten through Grade 2

Construct	Grade K		Grade 1, Spring		Grade 2, Spring	
	Count	Percent	Count	Percent	Count	Percent
Print Convention	0	0	0	0	0	0
Alphabetic Principle	7	18	7	15	0	0
Phonological Awareness	22	58	22	46	2	7
Comprehension	4	11	11	23	19	66
Sight Words	5	13	8	17	8	28
Vocabulary	0	0	0	0	0	0
Total	38	100	48	100	29	100

NOTE: The item distribution in Stage 1 (the router block) does not represent the distribution of the complete set of Kindergarten Class of 2010-11 (ECLS-K:2011) items. Additionally, since the ECLS-K:2011 reading assessment was not designed to measure students' reading subskills, the depth and breadth of items targeting each construct may not yield accurate measurement of students' reading subskills.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), first- and second-grade psychometric report (Najarian et al., 2018b).

LCA results are presented in figures 4 to 7, exhibiting distinct patterns of students' reading subskills. In each figure, the *Y* axis represents the probability of responding correctly to the items measuring the subskills. The average reading scores for each latent class are shown at the bottom of each figure. To provide additional context for these average scores, the population mean reading scores and standard deviations at each time point are shown in Table 4.

Table 4. Population Means and Standard Deviations of ECLS-K:2011 Reading Scores over Four Measurement Occasions

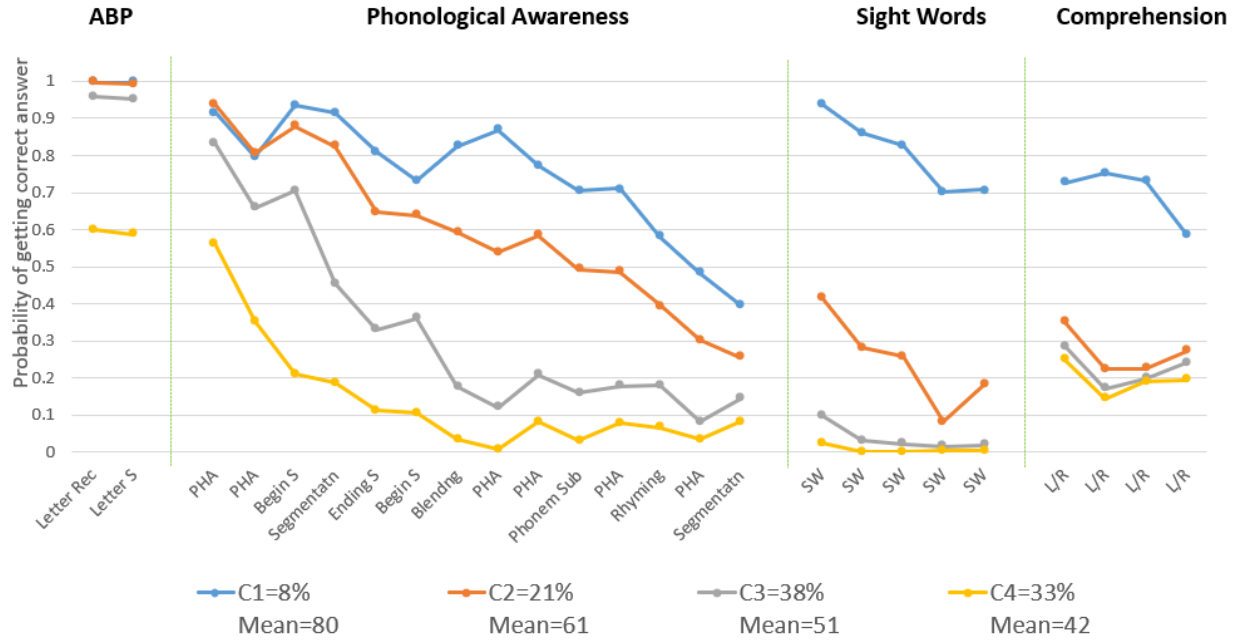
	Fall Kindergarten	Spring Kindergarten	Spring Grade 1	Spring Grade 2
Mean	51	65	89	102
Standard Deviation	11	13	16	13

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

In the fall of kindergarten, the average reading score was close to the average for class 3; therefore, class 3 is considered the average group. Figure 4 shows that other than the students in class 4, which is below the average group, almost all students tended to show a mastery of

alphabetic principle (i.e., recognition of letters and sounds) by the beginning of kindergarten. Regarding phonological awareness (i.e., the manipulation of spoken word parts, including phonemes, syllables, onsets, and rhymes) (Najarian et al., 2018b), the two classes above the average group showed high phonological awareness skills (a higher percentage correct of the phonological awareness router items) by the beginning of kindergarten, whereas students in class 4 showed difficulty in the acquisition of phonological awareness as they entered kindergarten. The average group showed difficulty in some, but not all phonological awareness items. In comparison, most students did not show a mastery of sight words (i.e., recognition of high-frequency words that children are likely to encounter every day) or comprehension, modeled after the NAEP 2009 reading framework, including locate/recall, integrate/interpret, and critique/evaluate content categories (National Assessment Governing Board, 2008), by the beginning of kindergarten.

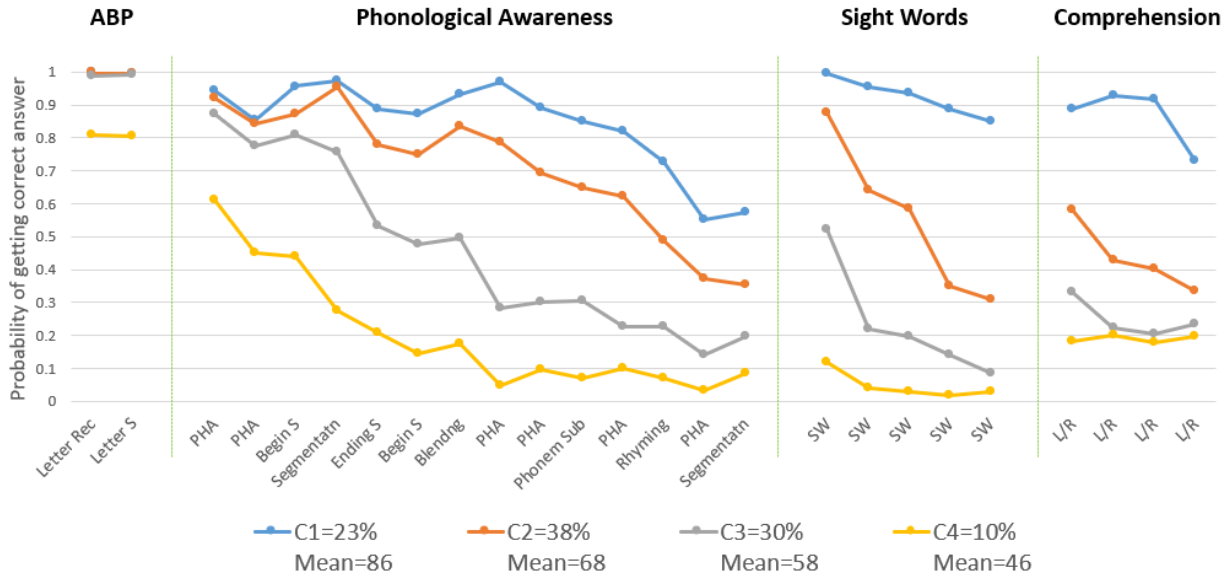
Figure 4. Latent Class Analysis with Grade K (Fall) Stage 1 Items Only



NOTE: ABP=Alphabetic Principle. The ECLS-K:2011 reading assessment is not designed to measure students' reading subskills; therefore, the depth and breadth of items targeting each construct may not yield accurate measurement of students' reading subskills. Additionally, the results shown in this figure are based on the analysis of the Stage 1 items, which are a subset of the ECLS-K:2011 reading assessment items. Therefore, these items do not include a balanced representation of reading subskills and difficulty level. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Item descriptions and item classification of target reading skills are based on the information provided in the ECLS-K:2011 psychometric report (Najarian et al., 2018b).
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) Kindergarten–Third Grade Restricted-Use Data File.

In the spring of kindergarten, the average reading score was close to the average for class 2; therefore, class 2 is considered the average group. Note that the class grouping shown in Figure 5 is based only on student performance in the spring of kindergarten. Thus, the grouping shown here may not necessarily be the same as it would be in the fall of kindergarten. For instance, students identified as belonging to class 3 in the fall of kindergarten might belong to class 2 in the spring of kindergarten. The figure shows that almost all students showed a mastery of alphabetic principle toward the end of kindergarten, as almost 100 percent of the alphabetic principle router items were correct. Students in the average group showed a higher percentage of correct responses for most phonological awareness router items, which enabled them to read unfamiliar words quickly and accurately. Aligned with the enhanced phonological awareness, they also showed dramatic improvement on sight words and some of the easier comprehension items. The two classes (class 3 and class 4) that are below the average group were still struggling with sight words and comprehension in the spring of kindergarten. In particular, students in class 4 did not show a mastery of alphabetic principle and phonological awareness in kindergarten, which may hinder their further development in comprehension skills since decoding is the key to reading fluency, as it allows students to focus their attention on the meaning of texts.

Figure 5. Latent Class Analysis with Grade K (Spring) Stage 1 Items Only

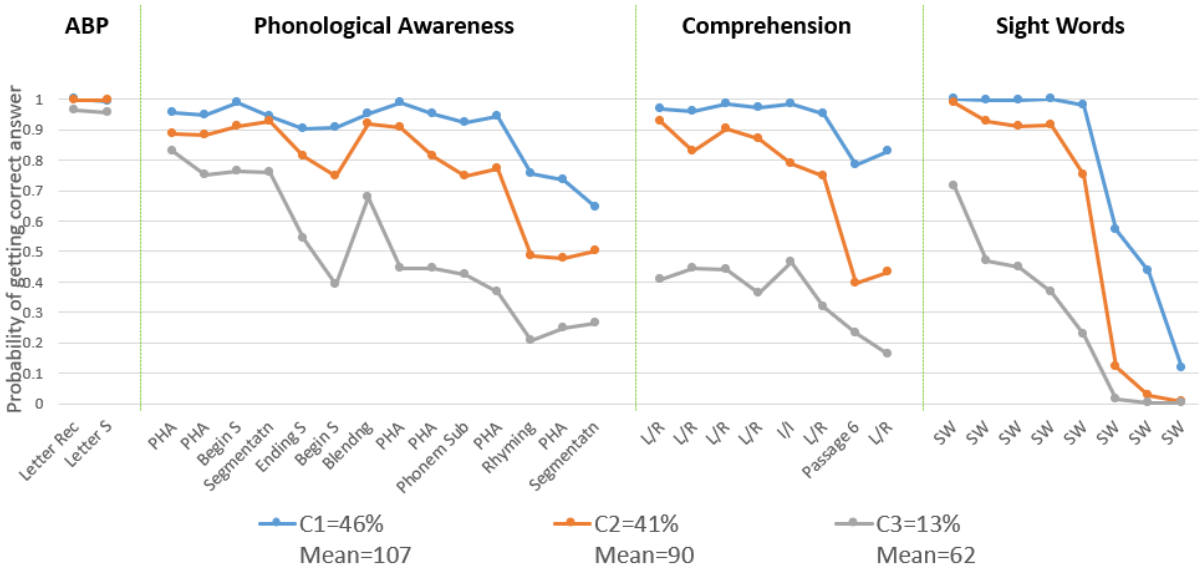


NOTE: ABP=Alphabetic Principle. The ECLS-K:2011 reading assessment is not designed to measure students' reading subskills; therefore, the depth and breadth of items targeting each construct may not yield accurate measurement of students' reading subskills. Additionally, the results shown in this figure are based on the analysis of the Stage 1 items, which are a subset of the ECLS-K:2011 reading assessment items. Therefore, these items do not include a balanced representation of reading subskills and difficulty level. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Item descriptions and item classification of target reading skills are based on the information provided in the ECLS-K:2011 psychometric report (Najarian et al., 2018b).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) Kindergarten–Third Grade Restricted-Use Data File.

In the spring of grade 1, class 2 remained the average group as its reading score was close to the average. Toward the end of grade 1, almost all students showed a mastery of phonological awareness (a higher percent correct of phonological awareness router items); however, students in class 3 continued to show difficulty with the more advanced phonological awareness items. The average and above-average groups showed improvements in comprehension and sight words, but the below-average group still showed a lack of proficiency on these two constructs.

Figure 6. Latent Class Analysis with Grade 1 (Spring) Stage 1 Items Only



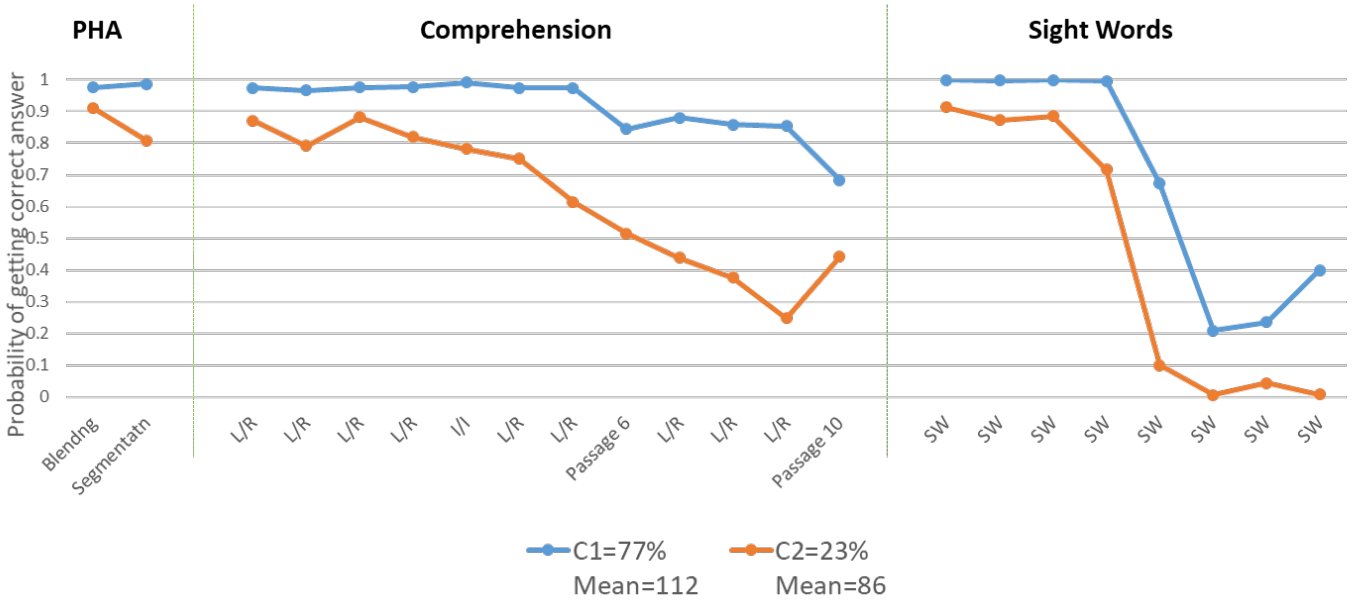
NOTE: ABP=Alphabetic Principle. The ECLS-K:2011 reading assessment is not designed to measure students' reading subskills; therefore, the depth and breadth of items targeting each construct may not yield accurate measurement of students' reading subskills. Additionally, the results shown in this figure are based on the analysis of the Stage 1 items, which are a subset of the ECLS-K:2011 reading assessment items. Therefore, these items do not include a balanced representation of reading subskills and difficulty level. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Item descriptions and item classification of target reading skills are based on the information provided in the ECLS-K:2011 psychometric report (Najarian et al., 2018b).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) Kindergarten–Third Grade Restricted-Use Data File.

In the spring of grade 2, two classes were identified, and the average reading score was closer to the class 1 average. Alphabetic principle was not assessed in grade 2. Both classes showed full mastery of phonological awareness, with both scoring about 80 percent correct on the phonological awareness router items administered at the end of the grade. The average group showed a mastery of comprehension, including the more advanced integrate/interpret items, which require students to make complex inferences within and across texts. In contrast, the below-average group still showed a lack of proficiency on the more difficult comprehension items. Both groups showed a mastery of the easy sight words items but not the more difficult

ones. It is worth noting that since only Stage 1 items (i.e., the routing block) were included in the analysis, the full spectra of item difficulty may not be sufficiently captured by grade 2. Therefore, as most students had mastered foundational reading skills, the skill profile distinction we observed became coarser in grade 2.

Figure 7. Latent Class Analysis with Grade 2 (Spring) Stage 1 Items Only



NOTE: PHA=Phonological Awareness. The ECLS-K:2011 reading assessment is not designed to measure students' reading subskills; therefore, the depth and breadth of items targeting each construct may not yield accurate measurement of students' reading subskills. Additionally, the results shown in this figure are based on the analysis of the Stage 1 items, which are a subset of the ECLS-K:2011 reading assessment items. Therefore, these items do not include a balanced representation of reading subskills and difficulty level. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Item descriptions and item classification of target reading skills are based on the information provided in the ECLS-K:2011 psychometric report (Najarian et al., 2018b).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) Kindergarten–Third Grade Restricted-Use Data File.

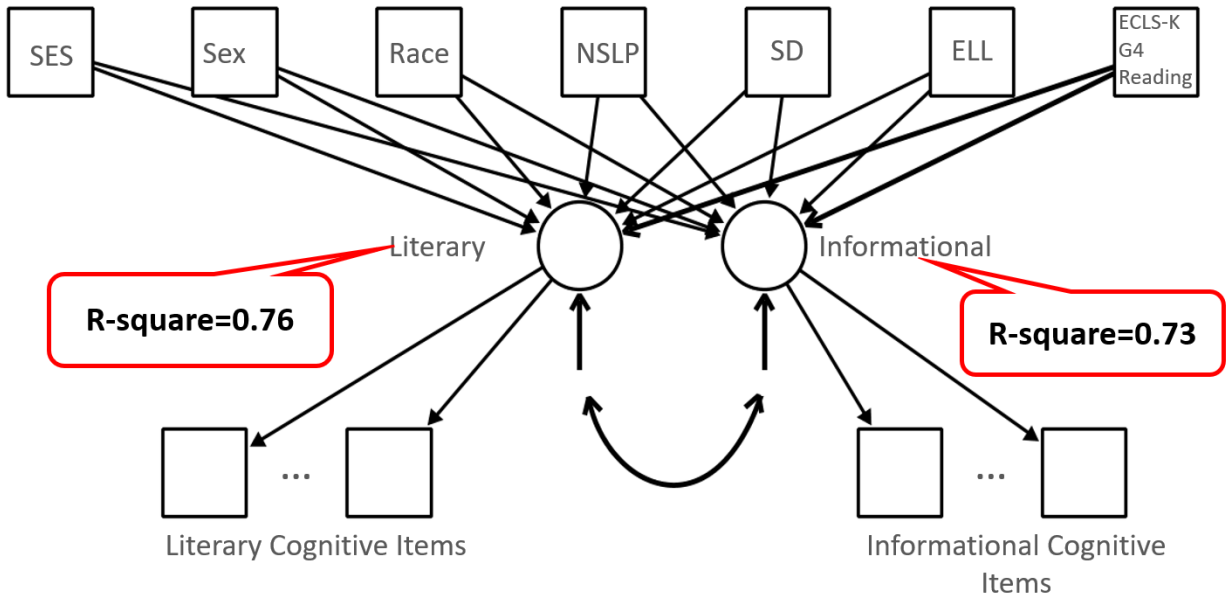
Study Part III: Projecting NAEP Scores Using the ECLS-K:2011 and NAEP Overlap Sample

For a more robust analysis of the relationships between students' reading growth patterns, reading subskill development patterns, and NAEP grade 4 reading assessment performance, NAEP reading scores were computed for the entire ECLS-K:2011 sample using the special overlap sample that participated in ECLS-K:2011 and the NAEP 2015 reading assessment.

To project the NAEP reading scores, a statistical link was established using the following three steps.

- First, an unconditional two-dimensional (i.e., two NAEP grade 4 reading subscales: Literary and Informational) IRT model was fitted to the NAEP 2015 grade 4 reading item response data for the overlap sample using the NAEP operational item parameter estimates, while the means, variances, and covariances of the two subscales were freely estimated.
- Second, seven covariates (ECLS-K:2011 grade 4 reading assessment scores and six contextual student variables) (see Figure 8) were added to the IRT model to predict students' latent Literary and Informational subscale scores. As Figure 8 shows, the model to predict NAEP reading scores was very robust, with variance explained (*R*-squared) between 0.73 (for the NAEP Informational subscale) and 0.76 (for the NAEP Literary subscale).
- Third, the same regression model was run again with the full ECLS-K:2011 sample using the regression coefficients obtained from the second step as starting values via a Metropolis-Hastings Robins-Monro (MH-RM) algorithm in flexMIRT; this yielded nearly identical regression coefficients to those from the second step. A total of 20 sets of plausible values representing NAEP reading performance were generated for the full ECLS-K:2011 sample from the posterior distributions of the full-sample model in this step. These plausible values were used for the subsequent analyses that examined how students' reading skill growth patterns from kindergarten through third grade were related to NAEP grade 4 reading performance. For detailed results, see Tables B10–B12.

Figure 8. Path Diagram of a Conditional Model to Predict NAEP Grade 4 Reading Scores for the ECLS-K:2011 Sample Using the Overlap Sample of ECLS-K:2011 and the NAEP 2015 Grade 4 Reading Assessment



NOTE: NSLP=National School Lunch Program eligibility status; SD: Students of disability status; ELL=English language learner status.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011) Kindergarten–Fourth Grade Restricted-Use Data File and National Assessment of Educational Progress (NAEP), 2015 Grade 4 Reading Assessment.

Study Part IV: Comparison between the Study 1 and 2 Results and NAEP Performance

As a final step in this study, we examined the relationships between students' performance on the NAEP grade 4 reading assessment and the latent classes representing distinctive reading growth trajectory patterns and reading skill profiles identified in Study Parts I and II. In particular, we focused on reading skill development patterns and skill profiles related to students' below *NAEP Basic* performance on the NAEP reading assessment.

Analytic Method

First, the average NAEP grade 4 reading scores were estimated and compared for each of the latent classes (representing distinctive reading growth trajectory patterns) from the Growth Mixture Model (GMM). Then, the percentage distribution of NAEP achievement levels was compared across the five GMM latent classes.

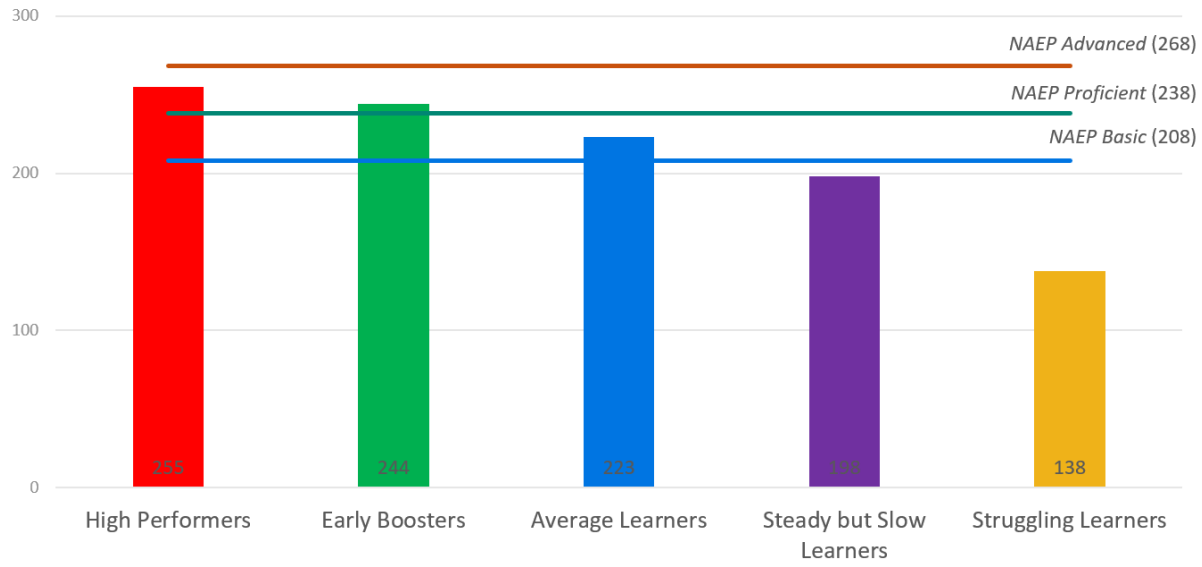
For the latent classes identified in the item-level Latent Class Analysis (LCA) (representing reading skill profiles), those at each two adjacent time points were cross-tabulated to investigate how students' class membership shifted across time. Furthermore, the percentage

distribution of NAEP achievement levels was compared to the LCA latent classes identified at each time point. Lastly, the item-level LCA latent classes were cross-tabulated with the GMM latent classes to examine the relationship between overall reading development trajectories and reading skill profiles from kindergarten through grade 2.

Analysis Results

The average NAEP grade 4 reading scores were estimated for each of the GMM latent classes. As Figure 9 shows, the average NAEP reading scores for *High Performers* and *Early Boosters* were 255 and 244, respectively, which are above the *NAEP Proficient* cut score but below the *NAEP Advanced* level. The average score for *Average Learners* was 223, which is above the *NAEP Basic* level but below the *NAEP Proficient* level. The average scores for both *Steady but Slow Learners* and *Struggling Learners* fell below the *NAEP Basic* achievement level. The comparisons of estimated NAEP reading scores across the five latent classes were statistically significant ($p < .05$).

Figure 9. Average Projected NAEP Grade 4 Reading Score by Growth Mixture Model Latent Class



NOTE: Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of the expected grade level were excluded from the analytic sample. Average projected NAEP reading scores for each class are significantly different from each other ($p < .05$). NAEP grade 4 reading assessment scores range from 0 to 500.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File and National Assessment of Educational Progress (NAEP), 2015 Grade 4 Reading Assessment.

Regarding the percentage distribution of students by NAEP grade 4 reading achievement level (based on the projected NAEP score for each latent class), *Average Learners* exhibited a similar

achievement-level distribution as public school students at the national level, with 1 out of 3 projected to perform at *NAEP Proficient* or above (25 percent at *NAEP Proficient* and 6 percent at *NAEP Advanced*) (see table 5). Almost all *High Performers* (79 percent) and more than half of *Early Boosters* (61 percent) were projected to perform at or above the *NAEP Proficient* level. In contrast, almost all *Struggling Learners* (95 percent) and more than half of *Steady but Slow Learners* (64 percent) were projected to perform below *NAEP Basic*.

Table 5. Percentage Distribution of NAEP Grade 4 Reading Achievement Levels by Latent Class from the Growth Mixture Model Analysis

	Grade 4 National Public	High Performers	Early Boosters	Average Learners	Steady but Slow Learners	Struggling Learners
Below *NAEP Basic*	32	3	10	30	64	95
NAEP Basic	33	18	28	40	29	5
NAEP Proficient	27	51	43	25	7	0
NAEP Advanced	8	28	18	6	0	0

NOTE: Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of the expected grade level were excluded from the analytic sample. Grade 4 national public results are based on the 2015 NAEP reading assessment. Columns add up to totals. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File and National Assessment of Educational Progress (NAEP), 2015 Grade 4 Reading Assessment.

The percentage distribution of students by NAEP grade 4 reading achievement level, based on the projected NAEP scores for each latent class from the LCA (representing reading skill profiles), is displayed in Table 6. About 57 percent of students in Class 4 in the fall kindergarten analysis (a group that did not show mastery of alphabetic principle at the beginning of kindergarten) were projected to perform below *NAEP Basic*. When looking at the end-of-kindergarten and the first-grade LCA results, 50 percent of Class 3 and 79 percent of Class 4 students in the spring kindergarten analysis and about 85 percent of Class 3 in the spring first grade analysis (a group that shows inadequate development in phonological awareness and an inability to correctly recognize relatively easy sight words) were projected to perform below *NAEP Basic*. As Table 6 shows, students classified into an LCA class with poor reading subskills (Class 4 in kindergarten; Classes 3 and 2 in the first and second grades, respectively) were more likely to be projected to perform below *NAEP Basic*. It is striking to see that students' reading subskills as early as the beginning of kindergarten seem to be strong indicators of their reading performance in the fourth grade.

Table 6. Percentage Distribution of NAEP Grade 4 Reading Achievement Levels by Latent Class from the Latent Class Analysis by Testing Occasion

Testing Occasion	Latent Class	NAEP Achievement Level (%)			
		Below *NAEP Basic* (25%)	*NAEP Basic* (36%)	*NAEP Proficient* (33%)	*NAEP Advanced* (7%)
Grade K Fall	Class 1 (M=80; 8%)	2	17	58	23
	Class 2 (M=61; 21%)	10	35	46	9
	Class 3 (M=51; 38%)	26	44	27	3
	Class 4 (M=42; 33%)	57	32	10	1
Grade K Spring	Class 1 (M=86; 23%)	4	26	55	16
	Class 2 (M=68; 38%)	20	45	32	4
	Class 3 (M=58; 30%)	50	39	11	0
	Class 4 (M=46; 10%)	79	17	4	0
Grade 1 Spring	Class 1 (M=107; 46%)	7	35	48	10
	Class 2 (M=90; 41%)	43	44	13	1
	Class 3 (M=62; 13%)	85	13	2	0
Grade 2 Spring	C1 (M=112; 77%)	17	40	36	7
	C2 (M=86; 23%)	75	22	3	0

NOTE: M=Mean reading score. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The class shown in bold italics represents the average performers for each assessment period. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File and National Assessment of Educational Progress (NAEP), 2015 Grade 4 Reading Assessment.

The cross-tabulation results of the LCA latent class membership across time points (see Tables 7–12) suggest that mobility in the LCA class membership between time points is challenging. For example, among students classified in the low-performing LCA class (Class 4) in the fall of kindergarten, only 20 percent were classified in the average group (Class 2) in the spring of kindergarten (see Table 7), and a similar pattern is observed when comparing the LCA membership between the end of first and second grades (see Table 9).

Table 7. Cross-tabulation between Grade K Fall and Spring: Latent Class Analysis Membership

	Grade K Spring (%)			
Grade K Fall	Class 1 (M=86)	***Class 2 (M=68)***	**Class 3 (M=58)**	Class 4 (M=46)
Class 1 (M=80)	90	9	1	0
Class 2 (M=61)	46	49	5	0
Class 3 (M=51)	12	50	35	3
Class 4 (M=42)	2	21	50	28

NOTE: M=Mean reading score. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The class shown in bold italics represents the average performers for each assessment period. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table 8. Cross-tabulation between Grade K Spring and Grade 1 Spring: Latent Class Analysis Membership

	Grade 1 Spring (%)		
Grade K Spring	Class 1 (M=107)	***Class 2 (M=90)***	Class 3 (M=62)
Class 1 (M=86)	93	7	0
Class 2 (M=68)	54	45	2
Class 3 (M=58)	17	65	18
Class 4 (M=46)	3	30	68

NOTE: M=Mean reading score. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The class shown in bold italics represents the average performers for each assessment period. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table 9. Cross-tabulation between Grade 1 Spring and Grade 2 Spring: Latent Class Analysis Membership

	Grade 2 Spring (%)	
Grade 1 Spring	***Class 1 (M=112)***	Class 2 (M=86)
Class 1 (M=107)	97	3
Class 2 (M=90)	72	28
Class 3 (M=62)	15	85

NOTE: M=Mean reading score. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The class shown in bold italics represents the average performers for each assessment period. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), First Grade–Third Grade Restricted-Use Data File.

The cross-tabulations between LCA latent classes (reading skill profiles) and GMM latent classes (reading growth trajectory patterns) across time points are shown in Tables 10–13. The results show that *High Performers* from the GMM were also identified as high achievers in the LCA across all time points. Looking first at the *Early Boosters*, only 13 percent were classified to the high-performing LCA class (Class 1) at the beginning of kindergarten, compared to 59 percent at the end of kindergarten. By the end of first grade, the percentage of Early Boosters in the high-performing class had increased to 90 percent, indicating an accelerated reading subskill development during the first 2 years of school, especially in phonological awareness and sight words. Most *Average Learners* were classified in an average-performing LCA class throughout the time period. Among *Slow but Steady Learners*, about half were classified in the low-performing LCA class (Class 4) at the beginning of kindergarten and 75 percent in the below-average LCA classes (Classes 3 and 4) by the end of kindergarten. Lastly, *Struggling Learners* were also identified as low-skilled readers by the LCA across all four time points.

Table 10. Cross-tabulation between Grade K Fall Latent Class Analysis Membership and Growth Mixture Model Latent Classes

	Grade K Fall			
	Class 1 (M=80)	Class 2 (M=61)	***Class 3 (M=51)***	Class 4 (M=42)
High Performers	98	2	0	0
Early Boosters	13	46	33	8
Average Learners	2	19	49	30
Slow but Steady Learners	1	8	38	53
Struggling Learners	0	1	17	82

NOTE: M=Mean reading score. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The class shown in bold italics represents the average performers for each assessment period. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table 11. Cross-tabulation between Grade K Spring Latent Class Analysis Membership and Growth Mixture Model Latent Classes

	Grade K Spring			
	Class 1 (M=86)	***Class 2 (M=68)***	Class 3 (M=58)	Class 4 (M=46)
High Performers	97	3	0	0
Early Boosters	59	34	6	2
Average Learners	11	50	36	4
Slow but Steady Learners	1	24	53	22
Struggling Learners	0	3	37	59

NOTE: M=Mean reading score. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The class shown in bold italics represents the average performers for each assessment period. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table 12. Cross-tabulation between Grade 1 Spring Latent Class Analysis Membership and Growth Mixture Model Latent Classes

	Grade 1 Spring		
	Class 1 (M=107)	***Class 2 (M=90)***	Class 3 (M=62)
High Performers	97	3	0
Early Boosters	90	10	0
Average Learners	48	50	2
Slow but Steady Learners	4	65	31
Struggling Learners	0	13	87

NOTE: M=Mean reading score. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The class shown in bold italics represents the average performers for each assessment period. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table 13. Cross-tabulation between Grade 2 Spring Latent Class Analysis Membership and Growth Mixture Model Latent Classes

	Grade 2 Spring	
	Class 1 (M=112)	**Class 2 (M=86)**
High Performers	99	1
Early Boosters	97	3
Average Learners	89	11
Slow but Steady Learners	39	61
Struggling Learners	1	99

NOTE: Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. The class shown in bold italics represents the average performers for each assessment period. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Discussion

The primary purposes of this study were (a) to investigate the reading growth trajectories of young readers from kindergarten through third grade using a nationally representative sample; and (b) to examine how these growth trajectories are related to later reading achievement, as measured by the grade 4 NAEP reading assessment. The results from the study suggest that students' reading development trajectories vary significantly and that each trajectory exhibits unique patterns. They also show that examining students' reading growth patterns may provide useful information about student reading skills that can supplement information from a single time-point assessment. Information from repeated measures on students' reading growth in the early grades could be especially important to provide a better understanding of students' status and trajectory to teachers so that they can provide additional support as early as possible when needed to help students' long-term reading development.

Early Reading Development

The current study reinforces the findings from previous research about the nonlinear nature of early reading development (Ardoin & Christ, 2008; Nese et al., 2012). In general, students exhibited fast and rapid reading growth from kindergarten through first grade (with approximately a 13-point increase over the 6-month measurement intervals) that slowed to a gradual decrease in second grade (approximately a 6-point increase over the 6-month measurement interval) and third grade (approximately a 4-point increase over the 6-month measurement interval).

This study used growth mixture modeling (GMM) to further explore the heterogeneity of students' early reading development patterns. The GMM technique has been used in previous studies to examine variations in reading development patterns—often reporting students with high initial reading skills and relatively slow growth, students with low initial reading skills and slow growth, and students with average skills—that are further differentiated by rapidness of growth (Boscardin et al., 2008; Hafner et al., 2008). The current study found five groups of students with unique reading development patterns. The five groups are characterized as

- *High Performers* (5 percent of students representing high reading skills at the beginning of kindergarten);
- *Early Boosters* (20 percent of students representing rapid growth between kindergarten and first grade);
- *Average Learners* (52 percent of students representing average initial reading skills and reading growth);
- *Steady but Slow Learners* (20 percent of students representing average initial reading skills but slow reading growth between kindergarten and first grade); and
- *Struggling Learners* (3 percent of students representing low initial reading skills and inadequate reading growth during the first 4 years of school).

These distinctive reading growth patterns highlight the importance of a strong foundation and growth in early reading skills, especially in kindergarten and first grade. While *Steady but Slow Learners* have an average reading score that is less than 0.2 standard deviations lower than that of *Average Learners* at the beginning of kindergarten, they do not make adequate progress during kindergarten and first grade. The result is that *Steady but Slow Learners* have an average score that is 0.7 standard deviations lower than that of *Average Learners* by the end of third grade, despite faster growth during second and third grades.

The performance gap among these five groups is more apparent when looking at projected achievement levels on the grade 4 NAEP reading assessment. While 80 percent and 60 percent of *High Performers* and *Early Boosters* were projected to perform at or above *NAEP Proficient*, only 7 percent of *Steady but Slow Learners* were projected to do so. In fact, none of the *Steady but Slow Learners* were projected to perform at *NAEP Advanced*. Conversely, only 3 percent and 10 percent of *High Performers* and *Early Boosters,* respectively, were projected to perform below *NAEP Basic*, compared to 64 percent of *Steady but Slow Learners* and 95 percent of *Struggling Learners*. This implies that students' fourth-grade reading skills can be predicted based on their reading skills and growth during kindergarten and first grade.

These findings make a significant contribution to the early reading literature. They provide empirical evidence at the national level of the importance of monitoring students' reading progress not only within the school year, but across it, especially from kindergarten through first grade, as students' early reading development is closely related to their later reading skills (Boscardin et al., 2008; Muthen et al., 1998). Monitoring students' progress during the first 2 years of school can improve the accuracy of early identification of students with reading difficulty, reduce the number of late-emerging poor readers, and help to provide systematic instructional support for reading development (Hafner et al., 2008; Torgesen, 2002).

Factors Related to Early Reading Development

The current study analyzed contextual information collected from ECLS-K:2011 to identify factors related to early reading development, including student demographic characteristics, teachers' ratings of students' readiness to learn and other cognitive and behavioral aspects, parents' reporting of home activities related to literacy development, and students' cognitive flexibility and working memory skills.

The relationships between students' demographic characteristics and reading development found in the current study are similar to those that have been reported in the literature. For example, Mesite (2019) reported that young boys tend to struggle more with reading development and exhibit slower reading growth, and the current study found that boys were overrepresented in the *Steady but Slow Learners* and *Struggling Learner* groups. In terms of English proficiency, we found that students who are not native English speakers but who are fully English proficient at the start of kindergarten exhibited growth trajectories similar to those of their native English-speaking peers. However, students with limited English proficiency were almost twice as likely to be classified as *Steady but Slow Learners* as their native English-

speaking peers. Similarly, Hafner et al. (2008) reported that students with limited English proficiency were more likely to show slower growth and lower initial reading skills. These findings indicate the importance of providing holistic language and reading instruction to support the development of students' language and reading skills as well as of frequent progress monitoring.

Another factor that is salient to students' reading development is their socioeconomic status (SES), which is a combination of their parents' occupational prestige scores, income, and education level. We found that students from high-SES families were more likely to be in the *High Performer* or *Early Booster* classes, while students from low-SES families were more likely to be in the *Steady but Slow Learner* or *Struggling Learner* classes. Students classified as *Steady but Slow Learners* and *Struggling Learners* were also more likely to attend Title I schools and attend center-based care programs, such as day care, less frequently than their counterparts in the higher performing classes. Similar findings have been reported frequently in the literature. For example, Logan and Petscher (2010) found that students who are at risk of reading difficulties in the early grades (e.g., with low initial reading skills and slow growth) tend to be concentrated in high-poverty areas with high numbers of Title I schools and higher percentages of students receiving free or reduced-priced lunch.

As many low-SES families have limited resources to support children's reading development (e.g., with trips to the library or bookstore or by providing continuous exposure to various reading materials and opportunities to read), it is important for schools to provide such support. In addition to individual instructional support, schools should consider designing schoolwide support programs to expand the benefits of early reading instruction, especially if they have a high density of low-SES students.

Other Skills Related to Early Reading Development

The ECLS-K:2011 study measured important executive function skills—cognitive flexibility and working memory—that are closely related to academic learning. The current study shows that working memory in kindergarten, in particular, has a strong relationship with reading skills, with correlations ranging from 0.46 (between working memory in the fall of kindergarten and second-grade reading) to 0.51 (between working memory in the fall of kindergarten and reading in the spring of kindergarten). The comparisons of working memory scores across the five groups of reading growth patterns are statistically significant (higher working memory scores for students with higher reading skills and faster growth) across all seven measurement occasions, except for the comparisons between *High Performers* and *Early Boosters* starting in second grade.

Chang (2020) also reported that working memory accounted for the highest variance in children's reading comprehension among the three executive function skills (cognitive flexibility, working memory, and inhibitory control) measured in the ECLS-K:2011. Another study of young children's cognitive and academic development (Waters et al., 2021) found that working memory and parents' education are most predictive of reading development.

As reading is a complex cognitive activity, proper working memory enables students to allocate more cognitive resources to word decoding and comprehension (Hoover & Gough, 1990; van Wingerden et al., 2018). Therefore, without proper working memory skills, it is difficult for young children to show adequate reading development.

Another factor that is closely related to reading development is children's readiness to learn and their enthusiasm, engagement, and self-regulation in the classroom, which is reported using the teacher rating of "Approaches to Learning." This scale includes a selected set of learning behaviors (e.g., keeps belongings organized, shows eagerness to learn new things, works independently, and easily adapts to changes in routine). The correlation between teachers' reporting of "Approaches to Learning" and reading scores is moderately strong across the first 4 years of schooling, ranging from 0.32 (in the fall of kindergarten) to 0.45 (in second grade), indicating the importance of students' "readiness behaviors" in the classroom (Elliott, 2019). However, it should be noted that "Approaches to Learning" scale scores are based on teachers' ratings and that they might be a reflection of students' academic performance. In other words, teachers' ratings of students' "Approaches to Learning" behaviors may be influenced by students' academic performance and not independent of it. Regardless, it is clear that students with low initial reading skills and slow growth (i.e., *Struggling Learners*) consistently show lower scores on the "Approaches to Learning" scale.

Importance of Foundational Reading Skill Development Prior to Kindergarten

One of the most useful findings from the current study may be the reading skill profile analysis developed from the item-level Latent Class Analysis (LCA). Overall, the skill profile analysis results across four time points (fall and spring of kindergarten and spring of first and second grades) show the importance of the foundational reading skills necessary for young readers' adequate reading growth and later reading outcomes, which has been noted in the literature as well (Boscardin et al., 2008). Looking at the kindergarten results, low-skilled readers have difficulty with the alphabetic principle (ABP) while other students show full mastery of it either at the beginning, or by the end, of kindergarten. Approximately 60 percent of low-skilled readers correctly answered items in the ABP domain in the fall of kindergarten, compared to approximately 80 percent by the spring of that year. In contrast, other students began kindergarten with nearly 100 percent mastery in this domain.

The skill profile analysis also shows that average-skilled readers' comprehension and phonological awareness skills appeared to improve during kindergarten, and high-skilled readers' sight word skills seemed to distinguish them from other readers. By the end of first grade, both average- and high-skilled readers showed close to full mastery of phonological awareness and sight words, while low-skilled readers struggled in these domains. By the end of second grade, the differentiation of skill profiles seems limited, as they are distinguished mostly by comprehension skills.

The relationship between the skill profiles from each time point and fourth-grade NAEP achievement levels highlights the importance of foundational reading skills in the early grades.

For example, almost 6 out of 10 students who began kindergarten without a mastery of ABP were projected to perform below the *NAEP Basic* level in grade 4, as were 8 out of 10 students who had not mastered ABP by the end of first grade. In contrast, about 80 percent of students beginning kindergarten with stronger foundational reading skills were projected to perform at the *NAEP Proficient* level or above in grade 4. Another important foundational reading skill for young children is phonological awareness (Boscardin et al., 2008; Double et al., 2019; National Reading Panel, 2000). Eighty-five percent of students without a mastery of phonological awareness by the end of first grade showed a high probability of performing below the *NAEP Basic* level in grade 4, and only about 2 percent performed at the *NAEP Proficient* level or above.

Although the study was not intended to evaluate the effect of pre-kindergarten education on children's reading development, the reading skill profile analysis showed that students who were projected to perform at *NAEP Proficient* or above on the grade 4 NAEP reading assessment began kindergarten with a full mastery of ABP and higher skills of phonological awareness. Conversely, more than half of children who began kindergarten without mastering ABP were projected to perform below the *NAEP Basic* level. This suggests the importance of children's education prior to kindergarten (Huang et al., 2012; Zimmerman et al., 2008) and implies that high-quality early childhood education can improve the development of children's foundational reading skills, which are the key predictors of reading skill development and later reading performance.

Limitations

The current study has two major limitations. The first is related to the ECLS-K:2011 reading assessment. Although the ECLS-K:2011 reading assessment items are grouped into specified content areas (e.g., basic skills such as phonological awareness and vocabulary), the reading scores are analyzed under the assumption of unidimensionality (Najarian et al., 2018a), meaning that reading ability is looked at as a single construct rather than as one with multiple traits, such as word recognition and vocabulary (Kintsch & Kintsch, 2005). Therefore, the ECLS-K:2011 reading assessment items may not represent the full depth and breadth of each domain of foundational reading skills. Thus, the results from the reading skill profile analysis should be interpreted cautiously and with an awareness that the entire spectrum of children's reading skills for each domain may have not been explored.

Another limitation is related to the use of the ECLS-K:2011 Kindergarten–third grade data file instead of the most recently released data file (the ECLS-K:2011 Kindergarten–fifth grade data file). We used the kindergarten–third grade file because it was the most recently released file at the time of our analysis. However, since assessment scores are recalibrated after each data collection, some of our results may not be replicated if the analysis is conducted using the kindergarten–fifth grade data file.

Conclusion

The early identification of students who may be at risk of reading difficulties and the frequent monitoring of students' reading progress have been heavily emphasized in the literature as a way to maximize the effectiveness of reading instruction and minimize the number of students with reading difficulties.

Although the current study could not account for some important contextual information—for instance, on instructional programs and quality of instruction—the findings highlight the importance of monitoring reading growth and students' foundational reading skill development patterns using data collected from a nationally representative sample. Future studies should account for these important instructional data to further inform policy and practices for effective early reading development.

The findings from the current study also suggest that the design of reading interventions and instructional policies should take into account school and family characteristics as well as individual student characteristics, especially when serving students from disadvantaged backgrounds. Lastly, to increase the effectiveness of reading instruction, young children may also need support for other learning-related cognitive skills and behaviors, as they are closely related to reading development.

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Appendix A. Descriptive Statistics and Correlations

Table A1. ECLS-K:2011 Reading Scores from Kindergarten through Third Grade

	Weighted fall subsample (Unweighted n=6,100; w=W7CF7P_2T170[a])			Weighted analytic sample (Unweighted n=5,700; w=W7CF7P_2T170 [a])		
	Population size=3,923,800			Population size=3,742,100		
	Weighted mean	SE	Weighted count[b]	Weighted mean	SE	Weighted count[b]
Grade K Fall	52.16	0.57	3,908,600	52.62	0.55	3,732,400
Grade K Spring	66.01	0.62	3,911,100	66.69	0.53	3,736,700
Grade 1 Fall	73.77	0.83	3,902,100	74.60	0.78	3,730,400
Grade 1 Spring	90.16	0.97	3,909,300	91.29	0.95	3,734,700
Grade 2 Fall	94.75	0.93	3,903,800	95.80	0.90	3,731,700
Grade 2 Spring	103.00	0.80	3,910,600	104.01	0.75	3,736,000
Grade 3 Spring	110.38	0.69	3,904,500	111.16	0.62	3,729,800

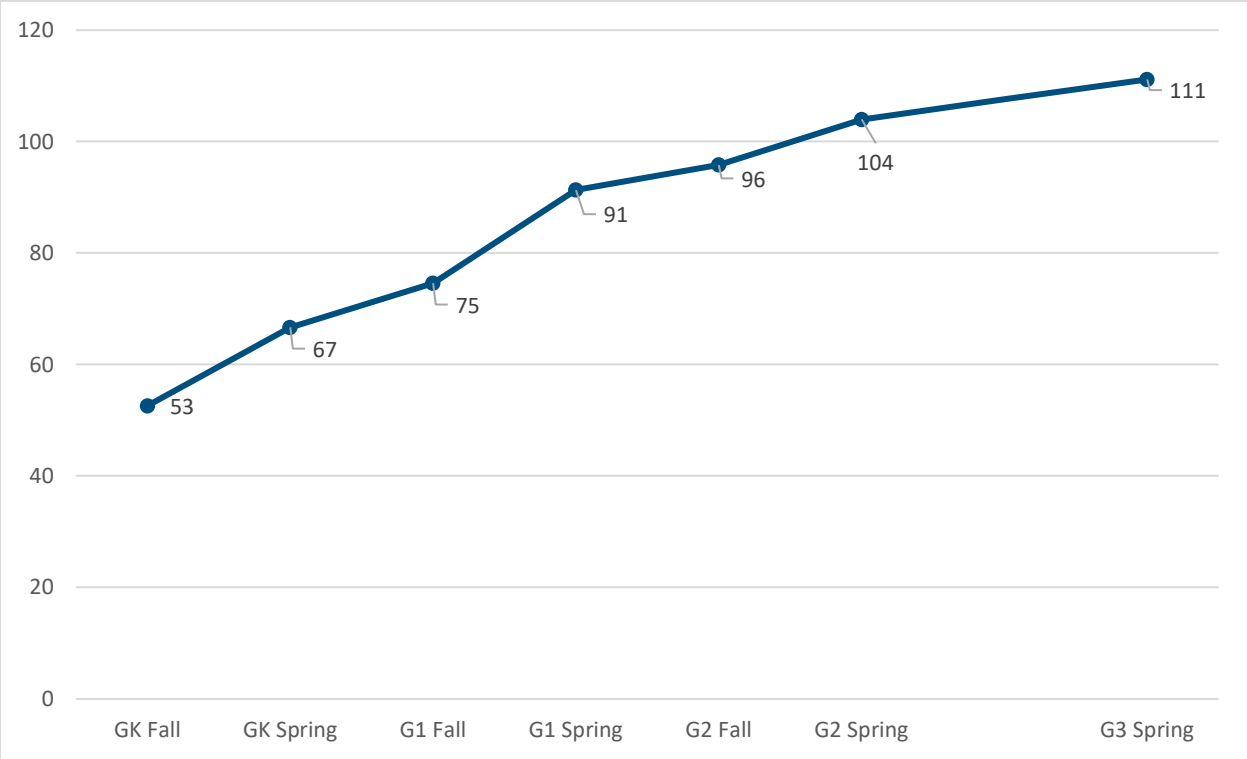
[a] Weight "W7CF7P_2T170" adjusts for nonresponse associated with child assessment and questionnaire data as well as teacher data from all seven time points (from kindergarten through grade 3) and parent questionnaire data from the fall or spring of kindergarten (40 replicated weights).

[b] Counts reported in this table (number of students) are rounded to the nearest hundredth.

NOTE: The possible range of scores was 0 to 141. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Figure A1. Observed Means of Direct Reading Assessments from Kindergarten through Third Grade: Weighted Analytic Sample



NOTE: Estimates weighted by W7CF7P_2T170. The possible range of scores was 0 to 141. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A2. ECLS-K:2011 Executive Functioning Measures from Kindergarten through Third Grade

	Weighted fall subsample (Unweighted n=6,100; w=W7CF7P_2T170[a])			Weighted analytic sample (Unweighted n=5,700; w=W7CF7P_2T170 [a])		
	Population size=3,923,800			Population size=3,742,100		
	Weighted mean	SE	Weighted count[b]	Weighted mean	SE	Weighted count[b]
Numbers Reversed task						
Grade K Fall	435.08	1.74	3,901,500	436.28	1.67	3,725,700
Grade K Spring	451.20	1.03	3,910,600	452.52	0.95	3,736,200
Grade 1 Fall	459.59	1.36	3,909,400	460.94	1.25	3,737,000
Grade 1 Spring	470.86	1.20	3,908,400	472.09	1.09	3,734,900
Grade 2 Fall	474.57	0.77	3,910,600	475.61	0.64	3,736,000
Grade 2 Spring	481.87	0.75	3,910,600	482.87	0.71	3,736,000
Grade 3 Spring	490.38	0.50	3,905,600	491.29	0.42	3,730,900
DCCS [c]						
Grade K Fall	14.44	0.11	3,901,500	14.51	0.11	3,725,700
Grade K Spring	15.38	0.07	3,910,600	15.44	0.08	3,736,200
Grade 1 Fall	15.89	0.09	3,909,400	15.96	0.08	3,737,000
Grade 1 Spring	16.33	0.09	3,908,400	16.38	0.09	3,734,900
Grade 2 Fall	6.40	0.06	3,897,500	6.44	0.06	3,726,500
Grade 2 Spring	6.98	0.03	3,899,300	7.01	0.03	3,724,700
Grade 3 Spring	7.29	0.03	3,889,000	7.32	0.03	3,716,200

[a] Weight "W7CF7P_2T170" adjusts for nonresponse associated with child assessment and questionnaire data as well as teacher data from all seven time points (from kindergarten through grade 3) and parent questionnaire data from the fall or spring of kindergarten (40 replicated weights).
[b] Counts reported in this table (number of students) are rounded to the nearest hundredth.
[c] The administration mode for the Dimensional Change Card Sort (DCCS) changed from a physical to a computerized version in the fall second-grade, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details).
NOTE: The possible range of scores for the Numbers Reversed task (the W-Ability score) was 393 to 603. The possible range of scores for the DCCS was 0 to 18 for kindergarten and first grade and 0 to 10 for second and third grades. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A3. Correlations between Reading and Executive Functioning Measures: Weighted Analytic Sample

	Grade K Fall: Reading	Grade K Spring: Reading	Grade 1 Fall: Reading	Grade 1 Spring: Reading	Grade 2 Fall: Reading	Grade 2 Spring: Reading	Grade 3 Spring: Reading
Grade K Fall: Reading	1.00						
Grade K Spring: Reading	0.80	1.00					
Grade 1 Fall: Reading	0.75	0.86	1.00				
Grade 1 Spring: Reading	0.64	0.78	0.83	1.00			
Grade 2 Fall: Reading	0.60	0.72	0.78	0.88	1.00		
Grade 2 Spring: Reading	0.56	0.68	0.73	0.83	0.88	1.00	
Grade 3 Spring: Reading	0.53	0.62	0.65	0.75	0.78	0.82	1.00
Grade K Fall: Numbers Reversed	0.49	0.51	0.50	0.51	0.48	0.46	0.47
Grade K Spring: Numbers Reversed	0.40	0.48	0.45	0.50	0.47	0.49	0.48
Grade 1 Fall: Numbers Reversed	0.37	0.44	0.46	0.47	0.46	0.47	0.46
Grade 1 Spring: Numbers Reversed	0.32	0.40	0.38	0.47	0.44	0.44	0.43
Grade 2 Fall: Numbers Reversed	0.33	0.39	0.40	0.45	0.46	0.45	0.45
Grade 2 Spring: Numbers Reversed	0.31	0.39	0.39	0.43	0.41	0.43	0.41
Grade 3 Spring: Numbers Reversed	0.29	0.36	0.39	0.44	0.42	0.44	0.43

	Grade K Fall: Reading	Grade K Spring: Reading	Grade 1 Fall: Reading	Grade 1 Spring: Reading	Grade 2 Fall: Reading	Grade 2 Spring: Reading	Grade 3 Spring: Reading
Grade K Fall: DCCS[a]	0.26	0.26	0.22	0.26	0.24	0.25	0.27
Grade K Spring: DCCS	0.23	0.26	0.25	0.28	0.27	0.30	0.30
Grade 1 Fall: DCCS	0.23	0.27	0.27	0.30	0.28	0.31	0.33
Grade 1 Spring: DCCS	0.21	0.24	0.23	0.29	0.27	0.28	0.29
Grade 2 Fall: DCCS	0.26	0.33	0.31	0.35	0.34	0.37	0.39
Grade 2 Spring: DCCS	0.21	0.28	0.27	0.31	0.29	0.33	0.35
Grade 3 Spring: DCCS	0.20	0.26	0.27	0.29	0.29	0.32	0.35

[a] The administration mode for the Dimensional Change Card Sort (DCCS) task changed from a physical to a computerized version, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details).

NOTE: Estimates weighted by W7CF7P_2T170. The possible range of reading scores was 0 to 141. The possible range of scores for the Numbers Reversed task (the W-Ability score) was 393 to 603. The possible range of scores for the DCCS was 0 to 18 for kindergarten and first grade and 0 to 10 for second and third grades. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A4. Descriptive Statistics of Teacher- and Parent-Reported Social Skills and Correlations with Direct Assessments: Kindergarten

Measure (value range)	Rating source	Weighted mean[a]	SE	Correlation					
				Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Approaches to Learning (0-3)	Fall: Parent-Reported	2.20	0.01	0.16	0.15	0.15	0.16	0.10	0.07
	Spring: Parent-Reported	2.15	0.03	0.15	0.18	0.12	0.16	0.13	0.07
	Fall: Teacher-Reported	2.00	0.03	0.32	0.35	0.28	0.29	0.19	0.15
	Spring: Teacher-Reported	2.18	0.03	0.27	0.35	0.24	0.27	0.16	0.17
Self-Control (0-3)	Fall: Parent-Reported	1.88	0.02	0.09	0.10	0.08	0.03	0.05	0.03
	Spring: Parent-Reported	1.95	0.02	0.06	0.08	0.02	0.04	0.03	0.03
	Fall: Teacher-Reported	2.11	0.03	0.16	0.19	0.17	0.16	0.13	0.08
	Spring: Teacher-Reported	2.23	0.03	0.12	0.15	0.13	0.14	0.09	0.10
Social Interaction & Interpersonal (0-3)	Fall: Parent-Reported	2.45	0.02	0.10	0.06	0.12	0.07	0.05	0.07
	Spring: Parent-Reported	2.45	0.02	0.10	0.10	0.09	0.09	0.07	0.06
	Fall: Teacher-Reported	2.06	0.03	0.20	0.22	0.18	0.17	0.13	0.11
	Spring: Teacher-Reported	2.21	0.03	0.16	0.19	0.17	0.17	0.11	0.13
Impulsive/ Overactive (0-3)	Fall: Parent-Reported	1.00	0.02	-0.11	-0.11	-0.08	-0.08	-0.07	-0.03
	Spring: Parent-Reported	0.88	0.02	-0.08	-0.10	-0.03	-0.07	-0.06	-0.02
Externalizing Problem Behavior (0-3)	Fall: Teacher-Reported	0.57	0.02	-0.12	-0.18	-0.13	-0.13	-0.09	-0.04
	Spring: Teacher-Reported	0.59	0.02	-0.10	-0.14	-0.12	-0.14	-0.05	-0.09

Measure (value range)	Rating source	Weighted mean[a]	SE	Correlation					
				Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Internalizing Problem Behavior (0-3)	Fall: Teacher-Reported	0.45	0.01	-0.08	-0.12	-0.09	-0.10	-0.07	-0.06
	Spring: Teacher-Reported	0.48	0.01	-0.05	-0.10	-0.11	-0.13	-0.04	-0.12
Attentional Focusing (0-6)	Fall: Teacher-Reported	3.80	0.03	0.31	0.33	0.27	0.27	0.15	0.13
	Spring: Teacher-Reported	4.05	0.05	0.28	0.33	0.23	0.27	0.15	0.15
Inhibitory Control (0-6)	Fall: Teacher-Reported	4.02	0.04	0.24	0.28	0.24	0.24	0.14	0.10
	Spring: Teacher-Reported	4.20	0.05	0.21	0.27	0.18	0.23	0.12	0.14

[a] The administration mode for the Dimensional Change Card Sort (DCCS) task changed from a physical to a computerized version, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details).

NOTE: Estimates weighted by W7CF7P_2T170. Scale scores were recoded by subtracting 1 from the original scores. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. NR=Numbers Reversed task; DCCS= Dimensional Change Card Sort. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A5. Descriptive Statistics of Teacher-Reported Literacy Skills and Correlations with Direct Assessments: Kindergarten

	Weighted mean	SE	Correlation					
			Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Language & Literacy Academic Rating (0-4)[b]								
Uses complex sentence structure								
Fall	1.90	0.07	0.43	0.38	0.31	0.27	0.19	0.21
Spring	2.90	0.07	0.40	0.44	0.31	0.32	0.24	0.22
Interprets story read to him/her								
Fall	1.96	0.05	0.45	0.39	0.34	0.28	0.21	0.20
Spring	3.03	0.05	0.42	0.47	0.35	0.34	0.26	0.24
Child names upper and lower case								
Fall	2.34	0.07	0.56	0.47	0.34	0.30	0.20	0.17
Spring	3.63	0.04	0.36	0.40	0.26	0.29	0.17	0.16
Predicts what happens in stories								
Fall	2.05	0.04	0.48	0.41	0.34	0.29	0.20	0.20
Spring	3.24	0.05	0.41	0.44	0.32	0.32	0.24	0.23
Reads simple books independently								
Fall	1.36	0.08	0.58	0.49	0.32	0.26	0.17	0.12
Spring	3.03	0.06	0.47	0.53	0.33	0.36	0.20	0.20
Uses different strategies with unfamiliar words								
Fall	1.21	0.07	0.57	0.46	0.30	0.26	0.18	0.13
Spring	2.80	0.05	0.48	0.55	0.34	0.37	0.22	0.20
Shows early writing behaviors								
Fall	1.38	0.06	0.56	0.45	0.32	0.27	0.20	0.15
Spring	3.04	0.05	0.43	0.48	0.31	0.34	0.21	0.20
Child composes simple stories								
Fall	0.91	0.05	0.44	0.37	0.27	0.22	0.20	0.10
Spring	2.56	0.07	0.40	0.47	0.29	0.33	0.23	0.20
Understands conventions of print								
Fall	1.32	0.05	0.48	0.37	0.25	0.21	0.16	0.10
Spring	2.90	0.04	0.40	0.45	0.28	0.31	0.19	0.16

	Weighted Mean	SE	Correlation					
			Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Overall Language & Literacy Skills (0-4)[c]								
Spring	2.29	0.02	0.59	0.64	0.41	0.42	0.20	0.23

[a] The administration mode for the Dimensional Change Card Sort (DCCS) task changed from a physical to a computerized version, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details).

[b] Scale is recoded to range from 0 (not yet) to 4 (proficient).

[c] Scale is recoded to range from 0 (far below average) to 4 (far above average).

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. NR=Numbers Reversed task; DCCS=Dimensional Change Card Sort. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A6. Descriptive Statistics of Teacher- and Parent-Reported Contextual and Instructional Variables and Correlations with Reading Assessments: Kindergarten

	Weighted mean	SE	Correlation	
			Fall	Spring
Parent-Reported Contextual Variables: Fall				
How important a child knows letters (0-4)[a]	3.14	0.03	0.08	0.06
What degree expected of child (1-7)[b]	5.29	0.06	0.07	0.02
How often you tell stories (0-3)[c]	2.05	0.05	0.06	0.09
How often practice reading/writing/numbers (0-3)[c]	2.53	0.02	0.04	0.03
Read books to child (0-3)[c]	2.35	0.05	0.16	0.18
Read to child in non-English language (0-3)[c]	0.86	0.05	-0.12	-0.15
How long read to child (in minutes)	20.04	0.25	0.00	-0.03
How often reads picture books (0-3)[d]	2.27	0.03	0.09	0.11
Frequency of reading outside of school (0-3)[d]	2.02	0.02	0.16	0.16
Parent-Reported Contextual Variables: Spring				
Frequency of reading outside of school (0-3)[d]	2.18	0.03	0.18	0.25
Visited a library (1=yes, 0=no)	0.61	0.02	0.07	0.11
Visited a bookstore (1=yes, 0=no)	0.56	0.02	0.09	0.07
Teacher-Reported Contextual Variables: Spring				
Individual tutored read/language arts (%)	8.34	0.88	-0.22	-0.23
Gifted program in read/language arts (%)	2.34	0.53	0.25	0.22
How often reading and language art (0-6)[e]	5.95	0.02	0.02	0.01
Time for reading and language arts (0-7)[f]	4.51	0.12	-0.14	-0.06
Time on read/language arts homework (0-4)[g]	1.51	0.08	0.01	-0.02
Teacher-Reported Frequency of English Language Arts (ELA) Activities: Spring (0-5)[h]				
Writing alphabet	4.54	0.04	0.01	-0.03
New vocabulary	4.47	0.04	-0.03	-0.01
Dictate stories	2.93	0.09	-0.01	0.01
Work on phonics	4.91	0.01	-0.04	-0.02
Story/see print	4.53	0.04	-0.06	-0.07
Story/don't see print	3.39	0.10	0.02	0.04

	Weighted mean	SE	Correlation	
			Fall	Spring
Retell stories	3.73	0.04	-0.02	-0.01
Read aloud	4.44	0.05	0.01	0.01
Basal reading texts	2.43	0.08	0.03	0.01
Read silently	3.70	0.06	0.05	0.07
Reading workbooks/sheets	3.95	0.06	0.01	-0.05
Write from dictation	3.03	0.08	-0.02	-0.04
Write with invented spellings	4.38	0.06	-0.01	0.03
Chose books to read	4.33	0.06	0.01	0.04
Write stories/report	3.05	0.08	-0.02	0.01
Work related to book	3.15	0.08	-0.03	-0.02
Perform plays/skits	1.00	0.04	-0.02	-0.04
Write in journal	3.14	0.04	-0.01	-0.01
Mixed ELA level groups	3.86	0.05	-0.01	-0.02
LEA peer tutoring	2.58	0.15	-0.01	-0.01
Controlled vocabulary	4.06	0.06	0.02	0.01
Phonetic text	4.19	0.05	0.02	-0.01
Patterned text	4.22	0.05	-0.02	-0.03
Teacher-Reported Frequency of Resource Use to Teach Reading: Spring (0-3)[i]				
Basal reading series	1.60	0.06	0.00	0.01
Child news/magazines	0.86	0.04	0.04	0.04
Reading kits	1.88	0.12	0.00	-0.03
Computer software	1.74	0.05	-0.01	-0.02
Trade books	2.43	0.06	0.00	-0.01
Other material	2.05	0.04	-0.01	-0.03

[a] Scale is recoded to range from 0 (not important) to 4 (essential).

[b] Scale ranges from 1 (to receive less than high school diploma) to 7 (to finish a Ph.D., MD, or other advanced degree).

[c] Scale is recoded to range from 0 (not at all) to 3 (every day).

[d] Scale is recoded to range from 0 (never) to 3 (every day).

[e] Scale is recoded to range from 0 (never) to 6 (5 days a week).

[f] Scale is recoded to range from 0 (not applicable/never) to 7 (3 or more hours).

[g] Scale is recoded to range from 0 (I never assign homework) to 4 (more than 30 minutes).

[h] Scale is recoded to range from 0 (never) to 5 (daily).
[i] Scale is recoded to range from 0 (never or hardly ever) to 3 (almost every day).
NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A7. Descriptive Statistics of Teacher-Reported Frequency of English Language Arts Skills Taught in Class and Correlations with Reading Assessments: Kindergarten

	Percentage not taught (SE) 1: Taught at higher grade 2: Should already know	Weighted mean	SE	Correlation	
				Fall	Spring
Convention of print[a]	1: 0 (omitted) 2: 4.05 (0.84)	3.57	0.04	-0.05	-0.03
Alphabet and letter recognition	1: 0 (omitted) 2: 1.37 (0.40)	3.89	0.02	0.03	0.01
Matching letters to sounds	1: 0 (omitted) 2: 0.57 (0.23)	3.89	0.02	0.02	-0.01
Writing own name	1: 1.28 (0.55) 2: 3.14 (0.63)	3.78	0.03	0.02	0.01
Rhyming words and word families	1: 0 (omitted) 2: 0.54 (0.21)	3.13	0.06	-0.05	-0.06
Blended sounds to say word	1: 0 (omitted) 2: 0 (omitted)	3.71	0.02	0.01	0.02
Manipulate syllables in a word	1: 10.55 (1.69) 2: 0.26 (0.23)	2.47	0.06	-0.04	-0.07
Reading multi-syllable words	1: 26.12 (2.10) 2: 0 (omitted)	2.42	0.09	-0.03	-0.06
Common prepositions	1: 5.42 (0.86) 2: 3.03 (0.85)	2.37	0.06	-0.03	-0.07
Identify main idea of story	1: 3.11 (0.67) 2: 0.02 (0.02)	2.89	0.07	-0.04	-0.08
Make predictions based on text	1: 1.17 (0.46) 2: 0.02 (0.02)	3.28	0.05	-0.10	-0.10
Use cues for comprehension	1: 3.52 (0.67) 2: 0 (omitted)	3.18	0.05	-0.04	-0.04
Communicate ideas orally	1: 0.87 (0.34) 2: 0.04 (0.04)	3.56	0.05	-0.02	-0.03
Follow complex directions	1: 0.59 (0.24) 2: 0.29 (0.20)	3.58	0.06	0.03	-0.01
Use capitalization/punctuation	1: 0.76 (0.29) 2: 0 (omitted)	3.56	0.05	-0.04	-0.02

	Percentage not taught (SE) 1: Taught at higher grade 2: Should already know	Weighted mean	SE	Correlation	
				Fall	Spring
Compose/write complete sentences	1: 3.56 (0.75) 2: 0.11 (0.08)	3.34	0.05	-0.03	0.03
Story has beginning/middle/end	1: 26.83 (2.33) 2: 0.13 (0.12)	2.17	0.11	-0.07	-0.06
Conventional spelling	1: 15.87 (1.46) 2: 0 (omitted)	3.00	0.07	-0.06	-0.03
Alphabetizing	1: 40.68 (2.19) 2: 0.28 (0.19)	1.71	0.10	-0.03	-0.04
Reading aloud fluently	1: 8.03 (1.14) 2: 0.11 (0.08)	3.13	0.05	0.02	0.04

[a] Scale is recoded to range from 0 (once a month or less) to 4 (daily) for mean reporting and correlation analysis. See Tourangeau et al. (2015) for original variable descriptions.

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A8. Descriptive Statistics of Teacher- and Parent-Reported Social Skills and Correlations with Direct Assessments: First Grade

	Weighted mean	SE	Correlation					
			Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Approaches to Learning (0-3)								
Spring: Parent-Reported	2.09	0.02	0.16	0.21	0.17	0.16	0.08	0.11
Fall: Teacher-Reported	2.08	0.02	0.41	0.43	0.31	0.26	0.20	0.17
Spring: Teacher-Reported	2.09	0.02	0.38	0.43	0.28	0.25	0.18	0.15
Self-Control (0-3)								
Spring: Parent-Reported	2.02	0.02	0.16	0.16	0.11	0.06	0.06	0.05
Fall: Teacher-Reported	2.22	0.02	0.22	0.25	0.20	0.16	0.16	0.10
Spring: Teacher-Reported	2.22	0.02	0.18	0.21	0.17	0.11	0.12	0.11
Social Interaction & Interpersonal (0-3)								
Spring: Parent-Reported	2.44	0.02	0.06	0.11	0.14	0.14	0.07	0.07
Fall: Teacher-Reported	2.14	0.02	0.25	0.28	0.22	0.16	0.20	0.12
Spring: Teacher-Reported	2.16	0.02	0.21	0.25	0.18	0.14	0.17	0.13
Impulsive/Overactive (0-3)								
Spring: Parent-Reported	0.87	0.02	-0.12	-0.12	-0.10	-0.08	-0.08	-0.08
Externalizing Problem Behavior (0-3)								
Fall: Teacher-Reported	0.65	0.01	-0.18	-0.21	-0.17	-0.13	-0.11	-0.09
Spring: Teacher-Reported	0.72	0.01	-0.17	-0.19	-0.12	-0.10	-0.12	-0.08
Internalizing Problem Behavior (0-3)								

	Weighted mean	SE	Correlation					
			Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Fall: Teacher-Reported	0.46	0.01	-0.20	-0.24	-0.14	-0.15	-0.08	-0.06
Spring: Teacher-Reported	0.53	0.01	-0.18	-0.21	-0.16	-0.13	-0.10	-0.06
Attentional Focusing (0-6)								
Spring: Teacher-Reported	3.86	0.02	0.36	0.41	0.26	0.24	0.16	0.15
Inhibitory Control (0-6)								
Spring: Teacher-Reported	4.10	0.02	0.29	0.33	0.22	0.20	0.14	0.14

[a] The administration mode for the Dimensional Change Card Sort (DCCS) task changed from a physical to a computerized version, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details).

NOTE: Estimates weighted by W7CF7P_2T170. Scale scores were recoded by subtracting 1 from the original scores. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. NR=Numbers Reversed task; DCCS=Dimensional Change Card Sort. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A9. Descriptive Statistics of Teacher-Reported Literacy Skills and Correlations with Direct Assessments: First Grade

	Weighted mean	SE	Correlation					
			Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Language & Literacy Academic Rating (0-4)[b]								
Contributes to class discussion								
Fall	2.51	0.04	0.46	0.47	0.34	0.30	0.21	0.17
Spring	3.00	0.04	0.45	0.51	0.34	0.29	0.22	0.20
Demonstrates beginning writing skills								
Fall	2.37	0.04	0.55	0.54	0.38	0.35	0.21	0.17
Spring	3.00	0.05	0.54	0.61	0.38	0.36	0.24	0.20
Language & Literacy Academic Rating: Spring (0-4)[b]								
Interprets story read to him/her	2.97	0.04	0.50	0.56	0.37	0.33	0.23	0.22
Reads words with regular vowels	3.22	0.05	0.56	0.66	0.36	0.36	0.22	0.20
Reads words with irregular vowels	2.82	0.06	0.63	0.70	0.38	0.33	0.20	0.18
Reads 1st-grade book independently	3.07	0.05	0.59	0.68	0.39	0.36	0.25	0.23
Reads 1st-grade books fluently	2.99	0.04	0.61	0.70	0.38	0.36	0.24	0.20
Composes clear story	2.64	0.05	0.56	0.61	0.38	0.34	0.24	0.22
Understands conventions of print	2.82	0.05	0.52	0.58	0.37	0.33	0.21	0.19
Overall Language & Literacy Skills (0-4)[c]								
Spring	2.24	0.03	0.72	0.74	0.40	0.37	0.23	0.20

[a] The administration mode for the Dimensional Change Card Sort (DCCS) task changed from a physical to a computerized version, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details).

[b] Scale is recoded to range from 0 (not yet) to 4 (proficient).

[c] Scale is recoded to range from 0 (far below average) to 4 (far above average).

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. NR=Numbers Reversed task; DCCS=Dimensional Change Card Sort. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A10. Descriptive Statistics of Teacher- and Parent-Reported Contextual and Instructional Variables and Correlations with Reading Assessments: First Grade

	Weighted mean	SE	Correlation	
			Fall	Spring
Parent-Reported Contextual Variables: Fall				
Story hour library/bookstore (1=yes, 0=no)[a]	0.26	0.02	0.09	0.07
Read books to child (0-3)[b]	2.22	0.04	0.08	0.11
Do writing activity with child (0-3) [b]	1.65	0.02	-0.02	-0.04
Child read books on own (0-3) [b]	1.98	0.03	0.16	0.14
Number of visits to library/bookstore	6.18	0.31	0.07	0.09
Parent-Reported Contextual Variables: Spring				
Read books to child (0-3)[c]	1.93	0.04	-0.08	-0.02
Read to child in non-English language (0-3)[c]	0.79	0.03	-0.15	-0.16
How long read to child (in minutes)	20.58	0.33	-0.03	-0.04
Visited the library/bookstore (1=yes, 0=no)[c]	0.67	0.02	0.18	0.19
Frequency of reading outside of school (0-3)[d]	2.12	0.04	0.19	0.22
How long read outside school (in minutes)	18.48	0.30	0.20	0.19
Teacher-Reported Contextual Variables: Spring				
Individual tutored read/language arts (%)	13.30	1.45	-0.34	-0.35
Gifted program in read/language arts (%)	4.62	1.14	0.21	0.21
How often reading and language art (0-6)[e]	5.89	0.04	-0.00	-0.00
Time for reading and language arts (0-7)[f]	4.88	0.08	-0.09	-0.05
Reading specialist for at risk (1=yes, 0=no)[a]	0.67	0.03	-0.07	0.02
Time on reading homework (0-4)[g]	2.02	0.05	-0.07	-0.08
Read-criteria for at risk (0-4)[h]	3.28	0.04	-0.01	0.01
Read-criteria for intervention (0-4)[h]	2.97	0.07	0.00	0.05
Professional development in reading instruction (0-4)[i]	1.79	0.11	-0.11	-0.11
Professional development in reading risk fail (0-4)[i]	1.79	0.12	-0.11	-0.12
Professional development in reading implementation (0-4)[i]	1.61	0.09	-0.10	-0.09
Staff for reading instruction (0-2)[j]	1.41	0.03	-0.11	-0.08

	Weighted mean	SE	Correlation	
			Fall	Spring
Teacher-Reported Frequency of Reading Skills & Concepts Taught: Spring (0-5)[k]				
Identify main ideas in a story	4.12	0.04	0.04	0.06
Retell stories	4.35	0.04	0.05	0.07
Describe characters/events	4.41	0.03	0.06	0.08
Identify feelings/senses words	3.48	0.07	0.05	0.04
Identify who is telling a story	3.19	0.05	0.09	0.07
Identify main idea in informational text	3.94	0.04	0.06	0.06
Identify reasons to support point	2.92	0.07	0.05	0.04
Describe similarities and differences between two texts	3.39	0.05	0.06	0.06
Recognize fiction non-fiction	4.17	0.06	0.01	0.04
Read informational text	3.96	0.05	0.01	0.02
Read prose/poetry	3.17	0.09	0.02	0.03
Segment words into phonemes	4.65	0.03	-0.07	-0.06
Manipulate phonemes to form words	4.63	0.04	-0.06	-0.04
Break spoken words into sounds	4.71	0.04	-0.04	-0.03
Blend sounds to form words	4.78	0.04	-0.04	-0.04
Read irregularly spelled words	4.53	0.03	0.01	0.02
Read pace/intonation/expression	4.66	0.04	0.00	0.03
Read accurately and fluently	4.71	0.03	0.02	0.05
Use glossaries and references	3.25	0.07	0.02	0.02
Use sentence context gain meaning	3.95	0.07	0.02	0.02
Identify character, setting, plot	4.44	0.04	0.02	0.03
Generate questions about characters, setting, and plot	4.22	0.04	0.05	0.05
Predict what might occur	4.50	0.04	0.03	0.04
Write opinion piece	2.42	0.07	0.05	0.06
Write informational piece	3.03	0.06	0.07	0.07
Write narrative	3.54	0.07	0.06	0.08
Teacher-Reported Frequency of Resource Use to Teach Reading: Spring (0-3)[l]				
Basal series	2.14	0.13	-0.04	-0.03

	Weighted mean	SE	Correlation	
			Fall	Spring
Leveled reading books	2.77	0.03	-0.01	0.01
News/magazines	0.78	0.06	0.04	0.03
Reading kits	1.22	0.07	-0.04	-0.06
Computer software	1.50	0.08	0.04	0.00
Trade books	2.21	0.05	0.02	0.02
Other subject matter	2.05	0.06	-0.01	-0.03
Manipulatives	2.37	0.04	-0.06	-0.08
Big books	1.68	0.06	-0.06	-0.05
Decodable books	2.16	0.06	-0.05	-0.05
Read-along/audio books	1.75	0.09	-0.02	0.01
Anthology	1.61	0.06	-0.02	-0.02

[a] Scale is recoded to 1=yes and 0=no.
[b] Scale ranges from 0 (never) to 3 (3-6 times a week).
[c] Scale is recoded to range from 0 (not at all) to 3 (every day).
[d] Scale is recoded to range from 0 (never) to 3 (every day).
[e] Scale is recoded to range from 0 (never) to 6 (5 days a week).
[f] Scale is recoded to range from 0 (not applicable/never) to 7 (3 or more hours).
[g] Scale is recoded to range from 0 (I never assign homework) to 4 (more than 30 minutes).
[h] Scale is recoded to range from 0 (strongly disagree) to 4 (strongly agree).
[i] Scale is recoded to range from 0 (never) to 4 (more than 4 times).
[j] Scale is recoded to range from 0 (resource not available) to 2 (support received).
[k] Scale is recoded to range from 0 (not taught) to 5 (on more than 80 days).
[l] Scale is recoded to range from 0 (never or hardly ever) to 3 (almost every day).
NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of the expected grade level were excluded from the analytic sample. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A11. Descriptive Statistics of Teacher- and Parent-Reported Social Skills and Correlations with Direct Assessments: Second Grade

	Weighted mean	SE	Correlation					
			Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Approaches to Learning (0-3)								
Fall: Teacher-Reported	2.10	0.02	0.45	0.42	0.27	0.27	0.29	0.24
Spring: Teacher-Reported	2.09	0.01	0.42	0.41	0.28	0.28	0.29	0.24
Self-Control (0-3)								
Fall: Teacher-Reported	2.26	0.02	0.22	0.21	0.13	0.14	0.18	0.14
Spring: Teacher-Reported	2.22	0.01	0.21	0.21	0.15	0.17	0.17	0.14
Social Interaction & Interpersonal (0-3)								
Fall: Teacher-Reported	2.16	0.02	0.27	0.26	0.17	0.17	0.20	0.17
Spring: Teacher-Reported	2.14	0.02	0.26	0.26	0.19	0.18	0.19	0.15
Externalizing Problem Behavior (0-3)								
Fall: Teacher-Reported	0.62	0.02	-0.18	-0.16	-0.13	-0.12	-0.16	-0.12
Spring: Teacher-Reported	0.72	0.02	-0.17	-0.17	-0.15	-0.13	-0.14	-0.12
Internalizing Problem Behavior (0-3)								
Fall: Teacher-Reported	0.48	0.02	-0.20	-0.17	-0.11	-0.11	-0.16	-0.13
Spring: Teacher-Reported	0.57	0.02	-0.23	-0.20	-0.15	-0.14	-0.16	-0.09
Attentional Focusing (0-4)								
Spring: Teacher-Reported	2.48	0.03	0.40	0.39	0.27	0.27	0.26	0.23

	Weighted mean	SE	Correlation					
			Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Inhibitory Control (0-4)								
Spring: Teacher-Reported	2.67	0.03	0.31	0.30	0.22	0.20	0.21	0.18

[a] The administration mode for the Dimensional Change Card Sort (DCCS) task changed from a physical to a computerized version, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details).

NOTE: Estimates weighted by W7CF7P_2T170. Scale scores were recoded by subtracting 1 from the original scores. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. NR=Numbers Reversed task; DCCS=Dimensional Change Card Sort. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A12. Descriptive Statistics of Teacher-Reported Literacy Skills and Correlations with Direct Assessments: Second Grade

	Weighted mean	SE	Correlation					
			Fall: Reading	Spring: Reading	Fall: NR	Spring: NR	Fall: DCCS[a]	Spring: DCCS
Language & Literacy Academic Rating: Fall (0-4)[b] DC								
Contributes to class discussion	2.66	0.04	0.51	0.48	0.26	0.24	0.30	0.23
Composes clear story	2.27	0.04	0.56	0.52	0.28	0.30	0.29	0.26
Understands conventions of print	2.45	0.05	0.52	0.49	0.26	0.29	0.27	0.27
Demonstrates beginning writing skills	2.69	0.05	0.58	0.53	0.28	0.30	0.29	0.27
Overall Language & Literacy Skills: Spring (0-2)[c]								
Reading skills	1.10	0.02	0.71	0.67	0.36	0.34	0.31	0.26
Writing skills	0.94	0.02	0.64	0.60	0.35	0.33	0.31	0.25
Oral language skills	1.13	0.01	0.55	0.54	0.32	0.29	0.29	0.23

[a] The administration mode for the Dimensional Change Card Sort (DCCS) task changed from a physical to a computerized version, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details).

[b] Scale is recoded to range from 0 (not yet) to 4 (proficient).

[c] Scale is recoded to range from 0 (below grade level) to 4 (above grade level).

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. NR=Numbers Reversed task; DCCS=Dimensional Change Card Sort. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A13. Descriptive Statistics of Teacher- and Parent-Reported Contextual and Instructional Variables and Correlations with Reading Assessments: Second Grade

	Weighted mean	SE	Correlation	
			Fall	Spring
Parent-Reported Contextual Variables: Fall				
Do writing activity with child (0-3)[a]	1.50	0.03	-0.07	-0.07
Read books to child (0-3)[a]	2.00	0.04	-0.03	-0.03
How long read to child (0-3)[b]	0.78	0.02	0.02	0.02
Child read books on own (0-3)[a]	1.99	0.03	0.16	0.16
Number of visits to library/bookstore	6.12	0.30	0.07	0.06
Story hour library/bookstore (1=yes, 0=no)[c]	0.20	0.02	-0.15	-0.15
Parent-Reported Contextual Variables: Spring				
How often you tell stories (0-3)[d]	1.61	0.04	0.01	0.00
How often practice reading/writing/numbers (0-3)[d]	2.13	0.02	-0.09	-0.09
Read books to child (0-3)[d]	1.59	0.03	-0.11	-0.11
Read to child in non-English language (0-3)[d]	1.29	0.04	-0.04	-0.01
Visited the library/bookstore (1=yes, 0=no)[c]	0.70	0.02	0.16	0.18
Frequency of reading outside of school (0-3)[a]	2.15	0.04	0.18	0.19
How long read outside school (in minutes)	23.26	0.52	0.13	0.12
Teacher-Reported Contextual Variables: Spring				
Individual tutored read/language arts (%)	18.34	1.19	0.23	0.22
Gifted program in read/language arts (%)	6.54	1.03	-0.51	-0.46
How often reading and language art (0-6)[e]	5.84	0.05	0.07	0.06
Time for reading and language arts (0-7)[f]	4.67	0.07	0.00	0.01
Reading specialist for at risk (1=yes, 0=no)[c]	0.66	0.03	-0.03	-0.02
Time on reading homework (0-4)[g]	2.34	0.06	0.00	-0.02
Read-criteria for at risk (0-4)[h]	3.13	0.03	0.01	0.01
Read-criteria for intervention (0-4)[h]	2.80	0.03	-0.03	-0.01
Professional development in reading instruction (0-4)[i]	1.91	0.08	-0.08	-0.08
Professional development in identifying students who are struggling or at risk of reading risk failure (0-4)[i]	1.92	0.09	-0.11	-0.11

	Weighted mean	SE	Correlation	
			Fall	Spring
Professional development in reading implementation (0-4)[i]	1.74	0.09	-0.11	-0.11
Staff for reading instruction (0-2)[j]	1.45	0.05	-0.11	-0.10
Teacher-Reported Frequency of Reading Skills & Concepts Taught: Spring (0-5)[k]				
Identify main ideas in fiction text	3.95	0.07	-0.01	-0.02
Understand key details in text	4.52	0.04	0.00	0.00
Retell stories	4.32	0.05	0.00	-0.01
Identify central message	3.30	0.08	-0.01	-0.02
Describe how characters respond to events	3.87	0.07	0.02	0.02
Identify main topic in informational text	3.87	0.07	0.02	0.00
Describe words rhythm/meaning	2.96	0.12	-0.03	-0.03
Describe structure of story	3.89	0.08	-0.02	-0.03
Identify differences in points of view of characters	3.17	0.08	-0.02	-0.02
Use text features to locate facts	3.68	0.06	0.01	0.00
Distinguish own point of view from others'	2.81	0.09	-0.03	-0.03
Understanding characters/setting/plot	4.05	0.05	0.04	0.04
Compare two versions of story	2.89	0.11	-0.03	-0.03
Explain how images clarify text	3.37	0.07	0.02	0.01
Identify reasons to support point	2.99	0.07	-0.03	-0.03
Read and comprehend literature	4.51	0.03	0.00	0.01
Read informational selection	4.23	0.05	0.06	0.05
Segment words into phonemes	4.01	0.07	0.03	0.03
Manipulate phonemes to form words	3.93	0.09	0.03	0.03
Distinguish long and short vowels	4.05	0.07	0.01	0.00
Decoding regularly spelled two-syllable words	4.26	0.07	0.04	0.02
Read irregularly spelled words	4.14	0.05	0.02	0.02
Meaning of prefix/suffix	3.56	0.06	0.02	0.02
Read accurately and fluently	4.71	0.03	0.00	0.00
Read pace/intonation/expression	4.53	0.03	0.01	0.00
Use sentence-level context	4.37	0.03	0.01	0.01

	Weighted mean	SE	Correlation	
			Fall	Spring
Identify character, setting, plot	4.39	0.05	0.02	0.02
Generate questions about character, setting, and plot	4.24	0.05	0.01	0.02
Predict what might occur	4.44	0.03	0.03	0.02
Write opinion piece	2.70	0.07	-0.05	-0.05
Write informational piece w/topic/details	3.14	0.06	0.02	0.02
Write narrative	3.45	0.06	0.04	0.02
Using temporal words	3.43	0.08	0.02	0.00
Teacher-Reported Frequency of Resource Use to Teach Reading: Spring (0-3)[l]				
Basal series	1.99	0.15	-0.08	-0.05
Leveled reading books	2.67	0.05	-0.07	-0.07
News/magazines	0.86	0.05	-0.03	-0.03
Reading kits	1.18	0.07	-0.08	-0.08
Comp software	1.46	0.08	-0.09	-0.08
Trade books	2.35	0.07	0.02	0.04
Other subject matter	2.09	0.06	0.01	0.01
Manipulatives	1.95	0.08	-0.07	-0.06
Big books	0.83	0.07	-0.03	-0.04
Decodable books	1.37	0.10	-0.11	-0.11
Read-along/audio books	1.15	0.07	0.00	-0.01
Anthology	1.51	0.08	0.00	-0.01

[a] Scale is recoded to range from 0 (never) to 3 (every day).
[b] Scale is recoded to range from 0 (5 minutes or less) to 3 (46 minutes or more).
[c] Scale is recoded to 1=yes and 0=no.
[d] Scale is recoded to range from 0 (not at all) to 3 (every day).
[e] Scale is recoded to range from 0 (never) to 6 (5 days a week).
[f] Scale is recoded to range from 0 (not applicable/never) to 7 (3 or more hours).
[g] Scale is recoded to range from 0 (I never assign homework) to 4 (more than 30 minutes).
[h] Scale is recoded to range from 0 (strongly disagree) to 4 (strongly agree).
[i] Scale is recoded to range from 0 (never) to 4 (more than 4 times).
[j] Scale is recoded to range from 0 (resource not available) to 2 (support received).
[k] Scale is recoded to range from 0 (not taught) to 5 (on more than 80 days).
[l] Scale is recoded to range from 0 (never or hardly ever) to 3 (almost every day).

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A14. Descriptive Statistics of Teacher- and Parent-Reported Social and Literacy Skills and Correlations with Direct Assessments: Third Grade

	Weighted mean	SE	Correlation		
			Spring: Reading	Spring: NR	Spring: DCCS[a]
Social Skills: Teacher-Reported (0-3)					
Approaches to Learning	2.07	0.02	0.39	0.28	0.23
Self-Control	2.25	0.02	0.20	0.14	0.08
Social Interaction & Interpersonal	2.12	0.02	0.22	0.15	0.11
Externalizing Problem Behavior	0.68	0.01	-0.18	-0.12	-0.08
Internalizing Problem Behavior	0.57	0.02	-0.16	-0.16	-0.10
Attentional Focusing	2.49	0.03	0.38	0.25	0.22
Inhibitory Control	2.69	0.02	0.31	0.20	0.15
Working Memory (0-2)[b]					
Parent-Reported	0.70	0.02	-0.11	-0.10	-0.07
Teacher-Reported	0.57	0.02	-0.38	-0.25	-0.23
Overall Language & Literacy Skills (0-2)[c]					
Reading Skills	1.05	0.026	0.66	0.36	0.28
Writing Skills	0.89	0.019	0.58	0.35	0.27
Oral Language Skills	1.11	0.012	0.52	0.31	0.25

[a] Scales are recoded where necessary, and value ranges are included in parentheses (see Tourangeau et al. [2015] for details).

[b] Higher scores indicate worse working memory.

[c] Scale is recoded to range from 0 (below grade level) to 2 (above grade level).

NOTE: Estimates weighted by W7CF7P_2T170. Scale scores were recoded by subtracting 1 from the original scores. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. NR=Numbers Reversed task; DCCS=Dimensional Change Card Sort. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A15. Descriptive Statistics of Teacher- and Parent-Reported Contextual and Instructional Variables and Correlations with Reading Assessments: Third Grade

	Weighted mean	SE	Correlation
Parent-Reported Contextual Variable			
Frequency of reading outside of school (0-3)[a]	2.12	0.05	0.15
How long reading outside school (in minutes)	25.02	0.47	0.16
What degree expected of child (1-7)[b]	5.16	0.08	0.14
Teacher-Reported Contextual Variable			
Individual tutored read/language arts (%)	26.54	1.91	-0.48
Gifted program in read/language arts (%)	7.56	1.15	0.24
How often reading and language art (0-6)[c]	5.86	0.02	0.01
Time for reading and language arts (0-7)[d]	4.51	0.06	-0.10
Reading specialist for at risk (1=yes, 0=no)[e]	0.68	0.03	-0.01
Time on reading homework (0-4)[f]	2.44	0.04	-0.04
Read-criteria for at risk (0-4)[g]	2.97	0.04	-0.03
Read-criteria for intervention (0-4)[g]	2.75	0.05	-0.00
Professional development in reading instruction (0-4)[h]	1.97	0.09	-0.08
Professional development in identifying students who are Struggling or at risk of reading failure (0-4)[h]	1.97	0.08	-0.09
Professional development in reading implementation (0-4)[h]	1.99	0.10	-0.06
Staff for reading instruction (0-2)[i]	1.46	0.03	-0.09
Teacher-Reported Frequency of Reading Skills & Concepts Taught (0-5)[j]			
Identify central message	2.62	0.06	-0.01
How central message conveyed	3.20	0.06	0.03
Identify info answer key details	4.17	0.08	-0.02
Identify main idea of inform text	3.95	0.09	-0.01
Describe words rhythm/meaning	2.37	0.13	0.03
Determine meaning words/phrases	4.02	0.08	-0.03
Use text features to locate facts	3.69	0.10	0.01
Distinguish own point of view from others'	2.75	0.11	0.00

	Weighted mean	SE	Correlation
Compare the themes, settings, and plots	3.04	0.07	-0.06
Explain how images clarify text	3.18	0.07	-0.05
Identify reasons to support point	2.86	0.12	0.01
Read and comprehend literature	4.46	0.07	0.02
Read and comprehend inform text	4.38	0.09	0.01
Decoding multi-syllable words	3.78	0.07	-0.05
Meaning of prefix/suffix	3.37	0.07	-0.05
Explain function of noun/pronoun/adjective	3.52	0.07	0.00
Meaning among similar verbs	3.10	0.08	-0.03
Form and use regular/irregular verbs	2.96	0.06	0.00
Using capitalization appropriately	4.30	0.08	0.00
Consulting reference materials	3.31	0.06	-0.01
Write opinion piece	2.61	0.12	-0.01
Write info piece & develop topic	3.00	0.10	-0.02
Using temporal words	3.07	0.09	-0.04

[a] Scale is recoded to range from 0 (never) to 3 (every day).

[b] Scale ranges from 1 (to receive less than high school diploma) to 7 (to finish a Ph.D., MD, or other advanced degree).

[c] Scale is recoded to range from 0 (never) to 6 (5 days a week).

[d] Scale is recoded to range from 0 (not applicable/never) to 7 (3 or more hours).

[e] Scale is recoded to 1=yes and 0=no.

[f] Scale is recoded to range from 0 (I never assign homework) to 4 (more than 30 minutes).

[g] Scale is recoded to range from 0 (strongly disagree) to 4 (strongly agree).

[h] Scale is recoded to range from 0 (never) to 4 (more than 4 times).

[i] Scale is recoded to range from 0 (resource not available) to 2 (support received).

[j] Scale is recoded to range from 0 (not taught) to 5 (on more than 80 days).

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Scales are recoded where necessary for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table A16. Descriptive Statistics of Child-Reported Motivation Related to Reading: Third Grade

	Weighted mean	SE	Correlation
Child Motivation Related to Reading (0-3)			
I like reading	2.19	0.04	0.18
I am interested in reading	2.08	0.04	0.19
I cannot wait to read each day	1.85	0.03	0.18
I am good at reading	2.25	0.03	0.32
I enjoy doing work in reading	1.95	0.03	0.06

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Scales are recoded for the analysis, and value ranges are included in parentheses (see Tourangeau et al. [2015] for original variable descriptions).
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Appendix B. Additional Results from the Latent Growth Analysis and Growth Mixture Model Analysis

Table B1. Comparison of Model Fit Information

	Model	-2LL	AIC	BIC	Adjusted BIC	RMSEA	SRMR	Entropy	VLMR	LMR-Adjusted
1	Linear Latent Growth Curve Model	-145764.21	291552.42	291632.19	291594.06	0.40	0.79	-	-	-
2	Quadratic Latent Growth Curve Model	-138358.67	276749.33	276855.70	276804.86	0.23	0.18	-	-	-
3	Quadratic Latent Growth Curve Model with fixed Quadratic slope	-139233.13	278496.25	278595.97	278548.31		0.39	-	-	-
4	2 piece Latent Growth Curve Model, summer effect	-137202.81	274441.61	274561.28	274504.08		0.15	-	-	-
5	3 piece Latent Growth Curve Model, Slope 3 not fixed, summer effect	-136326.60	272551.70	272704.60	272631.50	0.14	0.08	-	-	-
6	***3 piece Latent Growth Curve Model, Slope 3 fixed, summer effect***	**-136513.62**	**273065.24**	**273191.55**	**273131.18**		**0.20**	-	-	-
7	3 piece Growth Mixture Model, summer effect, Slope 3 fixed, same var-cov across classes									
	1 Class	-136513.60	273065.20	273191.60	273131.20	-	-	-	-	-

	Model	-2LL	AIC	BIC	Adjusted BIC	RMSEA	SRMR	Entropy	VLMR	LMR-Adjusted
	2 Class	-135493.00	271037.90	271210.80	271128.20	-	-	0.93	*p*<.005	*p*<.005
	3 Class	-134882.00	269830.10	270049.40	269944.60	-	-	0.79	*p*<.005	*p*<.005
	4 Class	-134217.90	268515.80	268781.80	268654.70	-	-	0.81	*p*<.005	*p*<.005
	5 Class	**-133975.20**	**268044.30**	**268356.80**	**268207.40**	**-**	**-**	**0.82**	***p*=0.08**	***p*=0.09**
	6 Class	-133855.50	267819.00	268178.00	268006.40	-	-	0.74	*p*=0.35	*p*=0.36
8	3 piece Growth Mixture Model, summer effect, Slope 3 fixed, different var-cov across classes	-133932.35	267974.70	268340.34	268165.57			0.80	*p*=0.41	*p*=0.41

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. AIC stands for Akaike information criterion; BIC stands for Bayesian information criterion; RMSEA stands for Root Mean Square Error of Approximation; SRMR stands for Standardized Root Mean Residual; VLMR stands for Vuong-Lo-Mendell-Rubin likelihood ratio test; and LMR-adjusted stands for Lo-Mendell-Rubin adjusted likelihood ratio test. Models in bold italics indicate the final model used for the interpretation of results.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B2. Distribution of Latent Classes by Demographic Group

		High Performers (5%)	Early Boosters (20%)	Average Learners (52%)	Steady but Slow Learners (20%)	Struggling Learners (3%)
Sex	Male	6%	18%	52%	20%	4%
	Female	5%	21%	55%	17%	2%
Race/ ethnicity	White	6%	23%	53%	16%	2%
	Black	4%	15%	52%	23%	5%
	Hispanic	3%	13%	55%	24%	5%
	Asian	11%	43%	40%	6%	0%
	Other	5%	15%	59%	19%	1%
English learner status	Native Speaker	6%	20%	54%	18%	2%
	LM, Non-EL	5%	17%	58%	20%	0%
	LM, formerly EL	1%	17%	63%	18%	1%
	LM, late-identified EL	3%	15%	43%	35%	4%
	LM, EL	1%	6%	43%	39%	11%
	Other	4%	27%	55%	12%	3%
Special education status	Non-IEP	6%	22%	56%	15%	1%
	Formerly IEP	3%	15%	62%	21%	0%
	Late-identified IEP	4%	4%	28%	47%	17%
	IEP	1%	5%	43%	36%	15%

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. LM=Language-minority students (i.e., students whose primary home language is not English). EL=English learners receiving additional instructional support to learn English skills. IEP=Individualized Education Program. For English learner status and special education status, students' demographic data collected at kindergarten and grade 3 were used. Non-EL means students were not EL at both kindergarten and grade 3. Non-IEP means students did not have IEP at both kindergarten and grade 3. Formerly EL or formerly IEP means that students were EL or had IEP at kindergarten but not at grade 3. Late-identified EL or late-identified IEP means that students were not EL or did not have IEP at kindergarten but became EL or had IEP at grade 3. EL or IEP means that students were EL or had IEP at both kindergarten and grade 3. "Other" refers to students with missing data for language-related variables. Rows add up to totals for each testing occasion. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B3. Distribution of Demographic Group by Latent Class

		High Performers	Early Boosters	Average Learners	Steady but Slow Learners	Struggling Learners
Sex	Male (51%)	57%	47%	49%	56%	69%
	Female (49%)	43%	53%	51%	44%	31%
Race/ ethnicity	White (52%)	59%	60%	52%	44%	29%
	Black (14%)	11%	10%	14%	17%	24%
	Hispanic (25%)	15%	16%	26%	32%	45%
	Asian (5%)	10%	10%	3%	1%	0%
	Other (5%)	5%	4%	6%	5%	2%
English learner status	Native Speaker (79%)	90%	80%	79%	74%	60%
	LM, Non-EL (1%)	1%	1%	2%	2%	0%
	LM, formerly EL (3%)	6%	3%	3%	3%	1%
	LM, late-identified EL (1%)	0%	1%	1%	1%	1%
	LM, EL (7%)	1%	2%	5%	13%	26%
	Other (9%)	7%	12%	9%	6%	10%
Special education status	Non-IEP (87%)	93%	96%	91%	73%	35%
	Formerly IEP (2%)	1%	2%	3%	3%	0%
	Late-identified IEP (6%)	5%	1%	3%	16%	42%
	IEP (4%)	1%	1%	3%	8%	23%

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. LM=Language-minority students (i.e., students whose primary home language is not English). EL=English learners receiving additional instructional support to learn English skills. IEP=Individualized Education Program. For English learner status and special education status, students' demographic data collected at kindergarten and grade 3 were used. Non-EL means students were not EL at both kindergarten and grade 3. Non-IEP means students did not have IEP at both kindergarten and grade 3. Formerly EL or formerly IEP means that students were EL or had IEP at kindergarten but not at grade 3. Late-identified EL or late-identified IEP means that students were not EL or did not have IEP at kindergarten but became EL or had IEP at grade 3. EL or IEP means that students were EL or had IEP at both kindergarten and grade 3. "Other" refers to students with missing data for language-related variables. Columns add up to totals for each testing occasion. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B4. Average Socioeconomic Status by Latent Class

Class	Mean	SE	Lower Bound CI	Upper Bound CI
High Performers	0.58	0.069	0.44	0.72
Early Boosters	0.16	0.073	0.02	0.30
Average Learners	-0.09	0.044	-0.18	0.00
Slow but Steady Learners	-0.31	0.050	-0.41	-0.21
Struggling Learners	-0.67	0.057	-0.78	-0.56

NOTE: Estimates weighted by W7CF7P_2T170. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample. Socioeconomic status was computed at the household level using data from parent interviews in fall 2010 or spring 2011 based on three components: parents' education, parents' occupational prestige scores, and household income.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B5. Numbers Reversed Average by Latent Class

Testing Occasion	Class	Mean	SE	Lower Bound CI	Upper Bound CI
Grade K Fall	High Performers	462	2.11	457.69	465.97
	Early boosters	451	1.88	447.62	454.98
	Average learners	434	1.63	430.73	437.12
	Steady learners	422	2.56	417.96	427.98
	Struggling learners	412	2.48	407.63	417.36
Grade K Spring	High Performers	474	2.13	470.02	478.38
	Early boosters	464	1.25	461.04	465.95
	Average learners	453	0.77	451.34	454.36
	Steady learners	438	1.62	435.18	441.53
	Struggling learners	420	2.14	415.85	424.22
Grade 1 Fall	High Performers	479	2.02	474.80	482.74
	Early boosters	474	1.30	471.01	476.11
	Average learners	461	1.06	458.57	462.71
	Steady learners	448	1.67	444.69	451.24
	Struggling learners	428	2.96	422.00	433.61
Grade 1 Spring	High Performers	487	1.23	484.18	489.02
	Early boosters	480	0.84	478.74	482.05
	Average learners	473	0.95	471.35	475.09
	Steady learners	460	2.01	456.33	464.22
	Struggling learners	441	3.01	435.17	446.96
Grade 2 Fall	High Performers	487	1.94	483.53	491.14
	Early boosters	485	0.95	483.27	486.99
	Average learners	476	0.61	474.59	476.98
	Steady learners	466	1.02	463.87	467.86
	Struggling learners	446	3.88	438.07	453.28
Grade 2 Spring	High Performers	496	2.55	491.17	501.15
	Early boosters	491	1.24	488.56	493.40
	Average learners	483	0.52	481.75	483.80

Testing Occasion	Class	Mean	SE	Lower Bound CI	Upper Bound CI
	Steady learners	474	1.17	472.02	476.61
	Struggling learners	457	4.15	449.19	465.45
Grade 3 Spring	High Performers	501	2.02	496.90	504.81
	Early boosters	500	1.04	498.25	502.30
	Average learners	491	0.35	490.54	491.90
	Steady learners	483	1.35	480.38	485.68
	Struggling learners	464	4.16	455.75	472.07

NOTE: Estimates weighted by W7CF7P_2T170. The possible range of scores for the Numbers Reversed task (W-Ability score) was 393 to 603. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B6. Dimensional Change Card Sort (DCCS) Average by Latent Class

Testing Occasion	Class	Mean	SE	Lower Bound CI	Upper Bound CI
Grade K Fall	High Performers	15.7	0.18	15.30	16.01
	Early boosters	15.0	0.14	14.73	15.27
	Average learners	14.4	0.12	14.20	14.68
	Steady learners	14.1	0.16	13.81	14.45
	Struggling learners	12.5	0.37	11.77	13.21
Grade K Spring	High Performers	16.4	0.28	15.83	16.95
	Early boosters	16.0	0.14	15.71	16.28
	Average learners	15.4	0.10	15.23	15.61
	Steady learners	15.0	0.12	14.72	15.20
	Struggling learners	13.0	0.33	12.39	13.68
Grade 1 Fall	High Performers	16.8	0.17	16.40	17.09
	Early boosters	16.5	0.09	16.32	16.68
	Average learners	16.0	0.08	15.80	16.12
	Steady learners	15.5	0.16	15.15	15.76
	Struggling learners	13.9	0.37	13.14	14.60
Grade 1 Spring	High Performers	17.1	0.15	16.77	17.34
	Early boosters	16.8	0.09	16.61	16.95
	Average learners	16.4	0.10	16.23	16.61
	Steady learners	15.8	0.13	15.52	16.04
	Struggling learners	15.2	0.37	14.50	15.95
Grade 2 Fall	High Performers	7.1	0.06	6.93	7.18
	Early boosters	6.8	0.07	6.62	6.90
	Average learners	6.5	0.06	6.36	6.60
	Steady learners	6.0	0.08	5.86	6.19
	Struggling learners	4.8	0.20	4.38	5.15
Grade 2 Spring	High Performers	7.4	0.08	7.26	7.56
	Early boosters	7.2	0.04	7.14	7.30
	Average learners	7.1	0.05	6.96	7.14

Testing Occasion	Class	Mean	SE	Lower Bound CI	Upper Bound CI
	Steady learners	6.8	0.07	6.62	6.88
	Struggling learners	5.7	0.20	5.27	6.05
Grade 3 Spring	High Performers	7.7	0.09	7.51	7.85
	Early boosters	7.5	0.07	7.37	7.65
	Average learners	7.3	0.03	7.21	7.34
	Steady learners	7.1	0.06	7.01	7.26
	Struggling learners	6.0	0.30	5.44	6.61

NOTE: Estimates weighted by W7CF7P_2T170. The administration mode for the Dimensional Change Card Sort (DCCS) changed from a physical to a computerized version in the fall second-grade, and the scoring range changed accordingly (see Tourangeau et al. [2015] for details). The possible range of scores for the DCCS was 0 to 18 for kindergarten and first grade and 0 to 10 for second and third grades.
Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B7. Teacher Rating of Students' Approaches to Learning by Latent Class

Testing Occasion	Class	Mean	SE	Lower Bound CI	Upper Bound CI
Grade K Fall	High Performers	2.35	0.040	2.27	2.43
	Early boosters	2.22	0.050	2.12	2.32
	Average learners	2.01	0.020	1.97	2.05
	Steady learners	1.73	0.034	1.67	1.80
	Struggling learners	1.31	0.047	1.21	1.40
Grade K Spring	High Performers	2.47	0.042	2.39	2.55
	Early boosters	2.43	0.035	2.36	2.50
	Average learners	2.18	0.034	2.11	2.24
	Steady learners	1.93	0.035	1.86	2.00
	Struggling learners	1.57	0.070	1.44	1.71
Grade 1 Fall	High Performers	2.42	0.049	2.32	2.51
	Early boosters	2.39	0.023	2.35	2.43
	Average learners	2.09	0.018	2.05	2.13
	Steady learners	1.73	0.023	1.69	1.78
	Struggling learners	1.41	0.089	1.24	1.59
Grade 1 Spring	High Performers	2.39	0.038	2.32	2.47
	Early boosters	2.39	0.021	2.35	2.43
	Average learners	2.11	0.022	2.07	2.15
	Steady learners	1.72	0.033	1.65	1.78
	Struggling learners	1.43	0.033	1.37	1.50
Grade 2 Fall	High Performers	2.47	0.049	2.38	2.57
	Early boosters	2.38	0.027	2.33	2.43
	Average learners	2.13	0.028	2.08	2.19
	Steady learners	1.70	0.030	1.64	1.76
	Struggling learners	1.31	0.050	1.21	1.41

Testing Occasion	Class	Mean	SE	Lower Bound CI	Upper Bound CI
Grade 2 Spring	High Performers	2.40	0.056	2.29	2.51
	Early boosters	2.35	0.020	2.31	2.39
	Average learners	2.12	0.019	2.08	2.16
	Steady learners	1.71	0.044	1.63	1.80
	Struggling learners	1.37	0.035	1.30	1.44
Grade 3 Spring	High Performers	2.32	0.079	2.17	2.48
	Early boosters	2.31	0.046	2.22	2.40
	Average learners	2.10	0.020	2.06	2.14
	Steady learners	1.77	0.040	1.69	1.85
	Struggling learners	1.25	0.055	1.15	1.36

NOTE: Estimates weighted by W7CF7P_2T170. The Approaches to Learning scale ranges from 0 to 3. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B8. Teacher-Reported Attentional Focusing

Testing Occasion	Class	Mean	SE	Lower Bound CI	Upper Bound CI
Grade K Fall	High Performers	5.49	0.068	5.36	5.62
	Early boosters	5.20	0.073	5.06	5.35
	Average learners	4.81	0.034	4.74	4.87
	Steady learners	4.34	0.057	4.22	4.45
	Struggling learners	3.65	0.082	3.49	3.81
Grade K Spring	High Performers	5.71	0.097	5.52	5.90
	Early boosters	5.51	0.048	5.41	5.60
	Average learners	5.04	0.052	4.94	5.15
	Steady learners	4.52	0.057	4.41	4.63
	Struggling learners	4.03	0.153	3.73	4.33
Grade 1 Spring	High Performers	5.39	0.077	5.24	5.54
	Early boosters	5.36	0.051	5.26	5.46
	Average learners	4.90	0.028	4.85	4.96
	Steady learners	4.21	0.066	4.08	4.33
	Struggling learners	3.71	0.081	3.55	3.87
Grade 2 Spring	High Performers	3.93	0.112	3.71	4.15
	Early boosters	3.85	0.053	3.75	3.96
	Average learners	3.55	0.040	3.47	3.63
	Steady learners	2.92	0.051	2.82	3.02
	Struggling learners	2.35	0.085	2.18	2.52
Grade 3 Spring	High Performers	3.94	0.111	3.73	4.16
	Early boosters	3.86	0.058	3.75	3.98
	Average learners	3.54	0.036	3.47	3.61
	Steady learners	3.03	0.062	2.91	3.15
	Struggling learners	2.20	0.066	2.07	2.33

NOTE: Estimates weighted by W7CF7P_2T170. The Attentional Focusing scale ranges from 0 to 6 for kindergarten and first grade and from 0 to 4 for second and third grades. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B9. Teacher-Reported Students' Inhibitory Control by Latent Class

Testing Occasion	Class	Mean	SE	Lower Bound CI	Upper Bound CI
Grade K Fall	High Performers	5.44	0.088	5.27	5.61
	Early boosters	5.37	0.072	5.23	5.52
	Average learners	5.05	0.044	4.96	5.13
	Steady learners	4.60	0.049	4.51	4.70
	Struggling learners	3.90	0.147	3.61	4.19
Grade K Spring	High Performers	5.64	0.073	5.50	5.79
	Early boosters	5.55	0.051	5.45	5.65
	Average learners	5.21	0.050	5.11	5.31
	Steady learners	4.80	0.063	4.68	4.92
	Struggling learners	4.34	0.166	4.01	4.66
Grade 1 Spring	High Performers	5.52	0.065	5.39	5.64
	Early boosters	5.54	0.038	5.47	5.61
	Average learners	5.10	0.024	5.05	5.15
	Steady learners	4.67	0.042	4.59	4.75
	Struggling learners	3.94	0.111	3.73	4.16
Grade 2 Spring	High Performers	3.87	0.077	3.72	4.02
	Early boosters	3.92	0.050	3.82	4.02
	Average learners	3.71	0.031	3.64	3.77
	Steady learners	3.37	0.033	3.31	3.44
	Struggling learners	2.92	0.077	2.77	3.07
Grade 3 Spring	High Performers	3.91	0.114	3.68	4.13
	Early boosters	3.92	0.046	3.83	4.02
	Average learners	3.72	0.025	3.67	3.77
	Steady learners	3.44	0.038	3.36	3.51
	Struggling learners	2.92	0.037	2.85	2.99

NOTE: Estimates weighted by W7CF7P_2T170. The Inhibitory Control scale ranges from 0 to 6 for kindergarten and first grade and from 0 to 4 for second and third grades. Students who repeated kindergarten through third grade, regardless of whether they were first-time kindergartners, and students who advanced ahead of their expected grade level were excluded from the analytic sample.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File.

Table B10. Estimated Mean and Covariances of NAEP Subscales: An Unconditional Two-Dimensional Item Response Theory Analysis Using the Overlap Sample of ECLS-K:2011 and the NAEP 2015 Grade 4 Reading Assessment

	Informational	Literary
Mean	0.081 (0.049)	0.101 (0.045)
Covariance		
Informational	0.732 (0.085)	
Literary	0.607 (0.062)	0.608 (0.072)

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File; and National Assessment of Educational Progress (NAEP), 2015 Grade 4 Reading Assessment.

Table B11. Regression Analysis Results: A Conditional Two-Dimensional Item Response Theory Analysis to Predict NAEP Reading Scores

	Informational		Literary	
	Estimate	SE	Estimate	SE
Intercept	0.068	0.06	0.065	0.067
Sex				
Male	-0.018	0.062	-0.122	0.068
Race/ethnicity				
Black	-0.257	0.101	-0.188	0.125
Asian	-0.008	0.105	0.106	0.144
Hispanic	-0.154	0.081	-0.058	0.095
Other	0.115	0.131	-0.131	0.135
NSLP-eligibility status				
NSLP-eligible	-0.029	0.072	0.026	0.088
Special education status				
Students with IEP	-0.077	0.11	0.01	0.132
English learner status				
English learner	0.037	0.142	0.168	0.132
SES measured in kindergarten	0.077	0.035	0.027	0.043
ECLS-K:2011 Grade 4 Reading	0.753	0.05	0.853	0.064

NOTE: Reference group for the regression analysis is female, White, non-NSLP-eligible students, students without IEP, and not English learners. NSLP=National school lunch program; IEP=Individualized Education Program. The SES (socioeconomic status) variable is a computed continuous variable based on parents' education, occupational prestige scores, and household income. The ECLS-K:2011 fourth-grade reading score was only used for the conditional regression model to project NAEP reading scores for the ECLS-K:2011 sample that was not part of the overall sample (i.e., students who participated in both ECLS-K:2011 and the 2015 NAEP grade 4 reading assessment).

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File; and National Assessment of Educational Progress (NAEP), 2015 Grade 4 Reading Assessment.

Table B12. Regression Analysis Results: Residual Covariance Structure

	Informational	Literary
Informational	0.199 (0.034)	
Literary	0.113 (0.029)	0.149 (0.026)

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File; and National Assessment of Educational Progress (NAEP), 2015 Grade 4 Reading Assessment.

Table B13. Results from the NAEP Score Projection Using the Overlap Sample of ECLS-K:2011 and the NAEP 2015 Grade 4 Reading Assessment

Student Group[1]	NAEP 2015 National			NAEP 2015 scores for the overlap sample			Projected NAEP scores for the overlap sample			ECLS-K:2011 Full Sample Projected NAEP scores		
	Info	Lit	Composite	Info	Lit	Composite	Info	Lit	Composite	Info	Lit	Composite
All	221	224	223	223	228	226	221	226	224	218	223	222
Male	218	221	219	219	223	221	218	221	219	215	218	217
Female	224	228	226	228	232	230	225	232	228	221	228	224
White	231	234	232	228	234	231	229	231	230	228	231	229
Black	204	209	206	200	203	201	194	202	198	197	204	201
Hispanic	206	210	208	215	216	216	208	218	213	203	213	208
Asian	240	242	241	232	236	234	227	237	232	231	239	235
Other	219	223	221	237	238	237	238	232	235	229	222	226
NSLP	207	211	209	212	216	214	207	215	211	205	212	209
Not NSLP	235	238	237	231	236	234	232	234	233	225	228	227
IEP	185	189	187	183	194	189	183	189	186	182	188	185
Not IEP	226	229	228	227	231	229	225	230	227	223	227	225
EL	187	191	189	203	202	202	190	204	197	189	202	195
Not EL	225	228	226	225	230	228	224	228	226	220	224	222

[1] Student group information collected from the NAEP assessment was used except for the ECLS-K:2011 full sample. For these results, student group information collected from the ECLS-K:2011 fourth-grade survey was used.

NOTE: Info=NAEP Informational subscale; Lit=NAEP Literary subscale; NSLP=National School Lunch Program; IEP=Individualized Education Program; EL=English Learner.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), Kindergarten–Third Grade Restricted-Use Data File and National Assessment of Educational Progress (NAEP), 2015 Grade 4 Reading Assessment.

Appendix C. ECLS-K:2011 Reading Assessment Framework Targets by Content Area

Table C1. ECLS-K:2011 Reading Assessment Framework Targets and Items by Content Area

Content Area	Grade K			Grade 1			Grade 2		
	Targeted %	Actual number	Actual %	Targeted %	Actual number	Actual %	Targeted %	Actual number	Actual %
Basic reading skills	50	53	64	40	51	51	20	16	22
Vocabulary	15	11	13	15	12	12	10	10	14
Comprehension									
Locate/recall	20	14	17	20	19	19	30	22	30
Integrate/interpret	10	3	4	20	13	13	30	19	26
Critique/evaluate	5	2	2	5	5	5	10	6	8

SOURCE: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K:2011), first- and second-grade psychometric Report (Najarian et al. 2018b).

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