Kids Today: The Rise in Children's Academic Skills at Kindergarten Entry

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Abstract

Private and public investments in early childhood education have expanded significantly in recent years. Despite this heightened investment, we have little empirical evidence on whether children today enter school with different skills than they did in the late nineties. Using two large, nationally representative datasets, this paper documents how students entering kindergarten in 2010 compare to those who entered in 1998 in terms of their teacher-reported math, literacy and behavioral skills. Our results indicate that students in the more recent cohort entered kindergarten with stronger math and literacy skills. Results for behavioral outcomes were mixed. Increases in academic skills over this period were particularly pronounced among black children. Implications for policy are discussed.

Keywords: achievement; achievement gap; child development; descriptive analysis; early childhood; school readiness

Kids today: The rise in children's academic skills at kindergarten entry

Over the past two decades, public and private investment in early childhood education has grown rapidly. Between 2002 and 2015, inflation-adjusted state spending on preschool initiatives nearly doubled from $3.3 to $6.2 billion, and since the early nineties the number of children in public preschool has nearly doubled as well (Barnett et al., 2016; Barnett, Robin, Hustedt, & Schulman, 2003; U.S. Census Bureau, 2015). Parents of young children now also spend substantially more money and time on resources and activities aimed at enriching the development of their young children (Bassok, Finch, Lee, Reardon, & Waldfogel, 2016; Kornrich, 2016). Despite the unprecedented interest and investment in early education, we have little empirical evidence on whether children entering kindergarten in recent years have stronger math, literacy, and behavioral skills at school entry than they did in the past. This is a critical question, given that these skills are strongly predictive of later life outcomes and that investments in early childhood education are often motivated by a desire to counteract the emergence of early achievement gaps.

Datasets like the National Assessment of Educational Progress (NAEP) have long allowed for comparisons over time in the academic achievement of elementary, middle, and high school aged students, but until now we have had no national data that would allow for comparisons across cohorts of children *at kindergarten entry*. The current paper aims to fill this gap. Using two nationally representative samples of children entering kindergarten in 1998 and 2010 this paper addresses three related research questions:

1. To what extent do children who entered kindergarten in 2010 differ from those who entered school in 1998 with respect to teacher-reported measures of math, literacy, & behavior?

2. Do changes over this period in preschool participation, parenting practices, kindergarten characteristics, or demographic factors explain observed changes in children's early skills?

3. Do changes over time in young children's skills differ across racial and socioeconomic subgroups, leading to changes in school-entry achievement gaps?

Background

Children's early academic skills are strongly predictive of outcomes well into the future, including college attendance, home ownership, earnings, and retirement savings (Chetty et al., 2011). It is also well documented that by kindergarten entry there are large achievement gaps based on race and income, and that these gaps persist as children proceed through school (Fryer & Levitt, 2004; Reardon, 2011).

Over the past three decades a large body of evidence from education, developmental psychology, neuroscience, and economics has demonstrated that early childhood is a particularly malleable time in the life course and that interventions targeted towards this period can have long-lasting and cost-effective impacts (Bassok & Loeb, 2015; Heckman, 2006; Shonkoff & Phillips, 2000). Bioecological theory suggests that optimal development occurs when children experience consistent and supportive interactions with the people and objects in their immediate environment (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 2006). By providing a stimulating environment for children in the years before kindergarten, early interventions can potentially prevent gaps from developing, or mitigate their severity. Indeed, a large body of evidence suggests early childhood programs can have important short- and long-term benefits (Camilli, Vargas, Ryan, & Barnett, 2010; Campbell et al., 2012; Deming, 2009; Schweinhart et al., 2005; Weiland & Yoshikawa, 2013).

Growing understanding of both the importance of early childhood in the life course *and* the documented benefits of high-quality preschool interventions has led to a sharp increase in public support for early childhood opportunities. One plausible, though untested, hypothesis is

that the rapid expansion of public preschool since the late nineties has led to an improvement in children's early skills.

The existing evidence, while limited, does support the notion that children are entering schools with stronger academic skills than they once were. Using repeated nationally representative surveys of parents with children ages 3-6, a recent report documented large increases between 1993 and 2012 in the percentage of parents that said their child could recognize all the letters in the alphabet and the percentage that said their child could count to 20 (Child Trends, 2015). Although that study relied solely on parent reports of relatively crude measures of children's early skills, the findings suggest that children acquire basic academic skills at an earlier age than they once did. Similarly, recent reports from three states indicate that children are more "school ready" (based on structured assessments at school entry) than they were about a decade ago (Maryland State Department of Education, 2014; Minnesota Department of Education, 2011; Virginia Performs, 2015).

To date, however, there has not been a systematic empirical study documenting changes in children's skills at school entry at the national level. This is the primary goal of the current study. In addition, we examine whether these changes have differed across groups of children. Because the majority of public early childhood programs are targeted towards low-income students (Barnett et al., 2015), and because socio-economic gaps in a host of early childhood parental investments have narrowed since the late nineties (Bassok, Finch, et al., 2016), we expect that improvements in children's academic skills at kindergarten entry would be particularly pronounced among low-income and minority children.

Indeed, Reardon and Portilla (2016) demonstrate that racial and income-based gaps in reading and math scores at school entry have narrowed between 1998 and 2010. Note, however,

that the narrowing achievement *gaps* documented in that study tell us nothing about changes in the *levels* of academic skills at school entry (i.e. gaps could narrow even if, on average, skills have dropped or stayed the same). In the current study, we explore whether non-white and poor children experienced greater changes in early skills than their peers.

Finally, this study tracks changes in children's behavioral skills at school entry. We do this, in part, to account for the possibility that children's academic skills have increased *at the expense* of other important skills. Bassok, Latham, & Rorem (2016) showed that between 1998 and 2010 there was a large increase in the time kindergarten teachers spent on academic skills, and a related reduction in time spent on art, music, and child-selected activities. Other recent work has shown that the heightened focus on academics begins even before kindergarten (Walter & Lippard, 2016). Researchers and the popular media have hypothesized that this rise in exposure to structured literacy or math curriculum in early childhood may be associated with stress, problem behaviors, or other unintended behavioral consequences (Christakis, 2016; Stipek et al., 1998; Stipek, Feiler, Daniels, & Milburn, 1995).

In addition, research demonstrates a small, *negative* association between child care participation and children's behavior (though this relationship is moderated by the age of children as well as the intensity and quality of care) (Belsky et al., 2007; Loeb, Bridges, Bassok, Fuller, & Rumberger, 2007; Magnuson, Ruhm, & Waldfogel, 2007). It is plausible that either the expanded access to preschool programs and/or the heightened focus on academic instruction have had negative consequences for children's behavior.

On the other hand, more exposure to preschool in the year before kindergarten might make children better prepared to meet classroom norms and behavioral expectations. Further, improvements in preschool quality over time (Aikens et al., 2016) may have led to improvements

in children's behavioral outcomes. It may be the case, then, that children's social skills have improved over time and that these improvements may mediate increases in academic skills. Given these competing hypotheses, it is difficult to provide clear directional hypotheses about the changes to children's behavior over time. Still, given the link between early behavior skills such as emotion regulation, persistence, and attentiveness and a host of subsequent schooling and life outcomes, it is important to assess whether these skills have changed over time (Duncan et al., 2007; Duncan & Magnuson, 2011; Li-Grining, Votruba-Drzal, Maldonado-Carreño, & Haas, 2010). We provide descriptive evidence on this question.

Method

Data

Through its Early Childhood Longitudinal Study (ECLS) program, the National Center for Education Statistics (NCES) has tracked two large, nationally representative cohorts of children, starting kindergarten in 1998 and 2010, respectively.[1] Both datasets include direct student assessments of children as well as parent and teacher surveys in the fall and spring of the kindergarten year, and a school administrator survey in the spring (Tourangeau, Nord, Lê, Sorongon, & Najarian, 2009; West, Denton, & Reaney, 2001). Because the studies include many overlapping and comparable measures, the combined datasets provide a unique opportunity to assess whether there have been nationwide changes in children's skills at school entry, both for the overall population and for specific subgroups, over a period characterized by heightened investment in early childhood.

[1] The more recent ECLS-K cohort began collecting data from students in the fall of 2010 but is officially referred to as the ECLS-K 2011. This paper, however, uses data collected in the fall, so the years of the study are more accurately reported as 1998 and 2010.

We limit our analysis to first-time kindergarteners in each cohort. We also limit our analysis to children with non-missing outcome data, and construct two separate samples when considering academic and behavioral outcomes. The academic sample includes approximately 16,050 students from 1998 and 13,500 from 2010, and the behavioral samples include approximately 14,750 and 11,900 students from 1998 and 2010 respectively (all sample sizes rounded to the nearest 50 in accordance with NCES guidelines).

Teacher-reported measures of early skills. Ideally, to analyze changes in skills over time we would compare direct assessments across the two ECLS-K cohorts. Although direct assessments were collected in both 1998 and 2010, these assessments are not directly comparable (Tourangeau et al., 2013). Instead, this analysis compares *teacher reports* of student math and literacy skills, as well as teacher reports of student behavior. Existing research demonstrates that teacher assessments of students' cognitive skills are strongly correlated with both current and future direct assessments (Hecht & Greenfield, 2001; Hoge & Coladarci, 1989; Teisl, Mazzocco, & Myers, 2001). This pattern holds in both waves of the ECLS-K as shown in Appendix A.

Importantly, we should be cautious when using teacher assessments to measure children's "true" ability. Research has shown that a portion of the variation in teacher assessments of young children is explained by both teacher characteristics (e.g. education levels, experience) and child characteristics (e.g. race, socioeconomic status [SES]) (Kilday, Kinzie, Mashburn, & Whittaker, 2012; Mashburn, Hamre, Downer, & Pianta, 2006). Despite this, teacher assessments are the most widely-used, cost-effective, and efficient method for assessing young children. In fact, teachers' extensive interactions with children may allow them unique insights and knowledge not captured by direct assessments (Epstein, Schweinhart, DeBruin-Parecki, & Robin, 2004).

An additional concern when using teacher assessments to estimate *changes* in children's skills over time is that teachers themselves may have systematically changed in terms of how they perceive or assess students. Some of the outcomes we examine (detailed below) are open to interpretation and thus could lead teachers to rate students differently in the context of changing student norms and expectations. Although, we cannot directly rule out this possibility, in our discussion we provide some indirect evidence that this is not likely to be driving our results. We argue that although comparable direct assessments would provide more definitive evidence about changes over time in children's early skills, no such data exists. Teacher-reported data allows us an imperfect but compelling way to track nationwide trends in these early skills for the first time.

Academic outcomes. Both ECLS-K datasets include teacher-reported measures of student proficiency across a broad range of math and literacy skills. In the first months of kindergarten (September-December), teachers were asked to rate each child's proficiency in the following 14 domains on a scale from 1 ("Child has not yet demonstrated skill") to 5 ("Child demonstrates skill competently and consistently"):[2]

Math skills

- Sorts math materials by various rules and attributes
- Orders groups of objects (by height, color, etc.)
- Understands relative quantities
- Solves problems using numbers
- Understands graphing activities

[2] We omit students from our analysis if their teachers reported that topics had not yet been introduced in their classrooms because teachers in these cases have not had a chance to assess student proficiency. However, this exclusion could bias our results if these types of students were less proficient than students for whom teachers provided ratings. We performed a bounding exercise to explore the extent to which this could be driving our results. Here, we assumed that all students who were missing data for a given skill were rated at the lowest level of proficiency. We then re-ran our analysis and present results in Appendix F. The results for literacy are quite similar to our main results, suggesting that these results are unlikely to suffer from this type of bias. Estimates for differences in math across time are about 60% as large as our main results. Notably, even using this extremely conservative assumption, we find meaningful differences over time in student literacy and math abilities.

- Uses instruments accurately for measuring
- Uses a variety of strategies to solve math problems

Language and literacy skills ("Literacy")

- Uses complex sentence structures
- Understands and interprets stories read to him/her
- Easily names all upper and lower case letters
- Predicts what will happen next in stories
- Reads simple books independently
- Demonstrates early writing behaviors
- Understands conventions of print

For each subject, we construct three summary measures to indicate student proficiency. First, as a measure of students' *overall* proficiency in math and literacy, we take a simple mean across the items within each subject (e.g. the average of all 7 math skills is the "overall math" proficiency). In addition to these overall measures, we define two indicator variables ("low proficiency" and "high proficiency") to identify whether students were in the tails of the distributions. Specifically, a student was classified as "low proficiency" for a given subject if that student was rated either a 1 or 2 on at least half of the skills considered (i.e. at least 4 of 7). Similarly, a student was classified as "high proficiency" if that student was rated either a 4 or 5 on at least half of the skills.[3]

Behavioral outcomes. In the fall of the kindergarten year, teachers completed an adapted version of the Social Skills Rating System (SSRS) (Gresham & Elliott, 1990), a widely used assessment of social and emotional development (Claessens, Duncan, & Engel, 2009; Loeb et al., 2007; Magnuson et al., 2007). Respondents were asked to rate the frequency of student behaviors

[3] Because teacher assessments were collected during the first few months of kindergarten, they are not "pure" measures of student knowledge at school entry and may capture, in part, skills gained during the beginning of the school year. This concern is lessened when comparing across cohorts because the data collection period is extremely similar across the two studies. All of our estimates also control for the amount of time that children spent in kindergarten before assessment.

on a scale from 1 ("Never exhibits behavior") to 4 ("Exhibits behavior frequently"). These items were combined into five "subscales," which we report along with the number of items and the subscale reliability coefficients. The five subscales were self-control (4 items, reliably coefficient (RC)=.85), interpersonal skills (5 items, RC=.88), externalizing problem behavior (5 items, RC=.89), internalizing problem behavior (4 items, RC=.80) and approaches to learning (6 items in 1998, RC=.89; 7 items in 2010, RC=.91).[4]

These behavioral measures have skewed distributions; teachers report that kindergarteners are generally well-behaved. Following Grimm et al. (2010), we therefore dichotomize our behavioral measures as follows. For the three measures that indicate positive behavior (i.e. self-control, interpersonal behavior, approaches to learning) we construct indicators for whether a student was at least 1 standard deviation (*SD*) *below* the 1998 mean. For the two outcomes that indicate negative behavior (i.e. internalizing and externalizing) we construct indicators for whether a student was at least 1 *SD above* the 1998 mean.

Early childhood experiences. To measure access and exposure to early childhood education, we use several parent-reported measures of the care their children received in the year prior to kindergarten. Our primary measure is an indicator for whether a child attended a *public preschool* program, since investment in public programs rose over the study period and may have an important impact on children's early skill development. Following Bassok et al. (2016), we define public preschool as any publicly-funded, classroom-based early childhood program including any state sponsored prekindergarten, Head Start program, or subsidized center-based care.

[4] Reliability coefficients were quite similar across cohorts, so we report pooled coefficients here for all subscales except one (approaches to learning), which differed slightly in the number of items across cohorts.

In some analyses we also include several other measures related to care in the year before kindergarten, including whether a child attended any "formal" classroom-based program in the year before kindergarten (including both private and public programs) and the number of hours a child spent in formal care each week. We include an indicator for whether a child attended kindergarten and prekindergarten in the same building. Earlier studies found that the association between preschool participation and children's early skills was more pronounced for this group, and hypothesized these programs may be of higher quality, or may facilitate a smoother transition to kindergarten (Magnuson et al., 2007). Finally, we consider principal reports of whether the child's kindergarten school also offers prekindergarten.

Appendix B provides descriptive statistics for these and all other variables included in our analysis, separately by cohort. As expected, we note substantial increases in publicly-funded preschool and in elementary schools offering kindergarten programs. There are not meaningful changes in formal care use across cohorts.

Additional covariates. We disaggregate our analysis by race and a measure of SES constructed from parental income, education, and occupational prestige, which we divide into quintiles.

Although this manuscript is motivated by the rapid expansion of public early childhood education opportunities, many other factors changed over the study period, and in a final set of analyses we assess whether changes in three other sets of covariates explain changes in children's early skills: demographic characteristics of children and families, children's home learning environment and parental interactions, and teacher characteristics.

Because demographic changes may be associated with changes over time in children's early skills, we account for age (both at kindergarten entry and at assessment), gender, U.S. birth

and citizenship, and whether English is the primary language (or spoken at all) in children's homes. We also account for the region of the country in which children reside. Appendix B highlights changes in these variables over time.

As discussed above, parental investments in their young children increased substantially over the study period, and these increases were disproportionately driven by low-income families (Bassok, Finch, et al., 2016). These changes may have had meaningful implications for children's early skills, and to address this we include a host of measures of children's home environments. Specifically, parents reported how often they engaged in certain activities with their children (e.g. reading books, playing games, doing chores) as well as how often and in what ways their children interacted with computers. They also reported their beliefs around which skills are important for kindergarten. Appendix B highlights increases over time across many of these measures.

Finally, previous research has highlighted the association between teacher characteristics and their assessments of child outcomes in early childhood settings (Mashburn et al., 2006). To account for this, we include detailed information about kindergarten teacher demographics, teaching experience, and education.

Analysis

We compare measures of children's early skills over time using Ordinary Least Squares (OLS) (and Linear Probability Models for dichotomous outcomes).[5] Following Allison (2012),

[5] Some of our outcomes are dichotomous and are thus most appropriately modeled using a limited dependent variable specification. We have estimated logit models for all dichotomous outcomes considered in this paper and the results are strikingly similar to those from the OLS models. We present OLS estimates to facilitate easier interpretation.

all models are estimated on 20 imputed datasets, and we imputed independent, but not dependent variables. To describe changes over time in our measures, we specify the following model:

$$y_i = \beta_0 + \beta_1 ECLS2010_i + \beta_2 Age_i + \varepsilon_i \quad (0)$$

Here, y_i represents an outcome for student *i*, and $ECLS2010_i$ is an indicator set to 0 or 1 if student *i* was in the 1998 or 2010 cohort respectively. Age_i represents student *i*'s age in months at kindergarten entry. We also control for the time elapsed between kindergarten entry and the child assessment, to account for any differences across children and cohorts in the timing of assessments. ε_i represents an error term with mean 0. β_1 is the coefficient of interest, and it provides an estimate of the (age-adjusted) difference across cohorts for each outcome variable. We employ probability weights that adjust for non-response, making the results nationally representative. Standard errors are clustered at the teacher level.

After describing the raw magnitude of changes over time, we explore how the results differ when accounting for changes in demographics across cohorts. Here, we estimate the following model:

$$y_i = \beta_0 + \beta_1 ECLS2010_i + \beta_2 Age_i + \beta_3 Demographics_i' + \varepsilon_i \quad (1)$$

where $Demographics_i'$ is a vector that includes race, SES, ELL status, and whether the child is U.S. born or a U.S. citizen. We use β_1 from model (1) as the starting point from which we will try to account for differences across cohorts using observable measures of preschool attendance, the home environment, and kindergarten teacher characteristics. Specifically, we estimate the following series of models:

$$y_i = \beta_0 + \beta_1 ECLS2010_i + \beta_2 Age_i + \beta_3 Demographics_i' + \beta_4 Preschool_i' + \varepsilon_i \quad (2)$$

$$y_i = \beta_0 + \beta_1 ECLS2010_i + \beta_2 Age_i + \beta_3 Demographics_i' + \beta_4 Preschool_i' + \beta_5 Home\_env_i + \beta_6 K\_tch\_chars_i' + \varepsilon_i \quad (3)$$

Here, *Preschool$_i$'* is a vector that includes variables relating to the child's care experiences in the year before kindergarten. *Home_env$_i$'* includes parent beliefs about the importance of different skills for kindergarten readiness, activities in which the child participates, and measures of computer availability and use. *K_tch_chars$_i$'* includes information about kindergarten teachers' background and qualifications. To the extent that we find differences in β_1 between model (1) and models (2) or (3), this would suggest that changes in student outcomes were explained, at least partly, by the included covariates. Finally, we examine whether differences across cohorts vary by race and socioeconomic status. Here, we estimate models of the form:

$$y_i = \beta_0 + \beta_1 ECLS2010_i + \beta_2 Age_i + \beta_3 Race_i' + \beta_4 ECLS2010_i * Race_i' + \varepsilon_i \quad (4)$$

$$y_i = \beta_0 + \beta_1 ECLS2010_i + \beta_2 Age_i + \beta_3 SESQ1_i + \beta_4 ECLS2010_i * SESQ1_i + \varepsilon_i \quad (5)$$

In model (4), *Race$_i$'* includes indicators for whether a student is black, Hispanic, Asian, or other nonwhite (omitting white). We also include interactions between these indicators and the 2010 cohort, to explore whether changes over time differed depending on race/ethnicity. In model (5) we include an indicator for whether a student was in the lowest SES quintile (i.e. the poorest children), and also interact that indicator with the 2010 cohort. Across both models, the coefficients of interest are the β_4s, which estimate the extent to which differences in children's early skills between cohorts differed by race/ethnicity and SES. These coefficients can be interpreted as changes in skills relative to white students and students in the top four SES quintiles, respectively.

Results

Changes in academic skills at school-entry

Figure 1 presents the distribution for four sample measures of kindergarten academic skills (e.g. easily names upper/lowercase letters, understands relative quantities). The grey bars and

unshaded bars show the distribution of these skills in 1998 and 2010 respectively. For all four skills we observe the distribution shifting to the right, indicating that in 2010 teachers reported stronger student academic skills than in 1998. The pattern is particularly pronounced for letter recognition. Appendix C shows analogous figures for all the literacy and math outcomes considered, and shows that to varying degrees this pattern is consistent across all items.

In Table 1 - Panel A we present regression analysis of changes in math and literacy skills. Model 0 shows results that control only for student age at kindergarten entry and time elapsed between kindergarten entry and child assessment. This model addresses our first research question about "raw" changes in children's school-entry skills over time. The results mirror the patterns shown in Figure 1. Strikingly, students in the 2010 cohort were rated about .25 *SD* higher on both math and literacy skills than their 1998 counterparts. In both math and literacy, we see drops in the percentage of children who were classified as "low proficiency" and increases in the percent that were "high proficiency".

Next, we assess the extent to which these changes are explained by observable covariates. Controlling for demographic characteristics (Model 1) did not explain the changes over time; rather, differences across cohorts are slightly larger in these models. Counter to our expectations, including measures of preschool participation did not account for *any* of the differences across time for either math or literacy. We first ran models (not presented) in which we added the indicator for public preschool participation to Model 1. Doing so left the results presented in Model 1 virtually unchanged. Model 2 shows results from models that include our full set of preschool variables (e.g. hours of preschool, co-location in a school), which also leave the results essentially unchanged.

Finally, adding a rich set of controls for home environment and kindergarten teacher characteristics (Model 3) accounted for roughly 1/5 to 1/3 of the demographic-adjusted differences across cohorts.

Changes in behavior at school entry

Table 1 - Panel B shows changes in teacher-reported behavioral measures over time. Here, we find no changes in interpersonal skills or externalizing problem behaviors. However, teachers reported that children in 2010 showed poorer approaches to learning, which measures children's ability to pay attention or adapt to changes in routines. There was also a small and marginally significant increase in teachers indicating children have poor self-control. Conversely, they reported that children in 2010 were less likely to demonstrate internalizing problem behaviors, which measure children's shyness or loneliness. Including a rich set of covariates did not explain any of these differences over time.

Differences in patterns by race and socio-economic status

Figure 2 shows changes over time in teacher-reported math proficiency, disaggregated by race and SES. We present the percentage of children that were low proficiency and high proficiency in each cohort. Appendix D provides an analogous figure for literacy. A few patterns emerge. First, across cohorts and across both math and literacy, white children were rated as having higher kindergarten skills relative to black and Hispanic children (i.e. more children are classified as "high proficiency" and fewer as "low proficiency"), and similarly, children in the top four SES quintiles were rated substantially higher than those in the bottom quintile. The figures also indicate that teachers rated the skills of *all* subgroups higher in 2010 than in 1998.

Notably, the changes shown in this figure are more pronounced among black children than among other groups. For example, the percentage of children who were classified as low

proficiency in math dropped by 15 points among black children, almost twice as much as the 8 percentage point decrease among white children. Conversely, the percentage of black children who were classified as high proficiency increased by 13 percentage points, compared to 9 percentage points for white children.

In Table 2 we formally examine differences in math and literacy proficiency across subgroups within a regression framework. The top panel explores how changes differ by race/ethnicity. These findings mirror those from Figure 2. In particular, all groups of children were rated higher in the more recent cohort, and the magnitude of changes for black children was disproportionately large for both literacy and math skills. There is more modest, suggestive evidence of disproportionate changes among Hispanic students. In math, Hispanic children improved at a higher rate relative to their white peers. We also see marginally significant evidence that Hispanic children exited the "low proficiency" group at higher rates than their white peers.

The bottom panel of Table 2 shows how changes over time in math and literacy proficiency differ for the poorest children. We find no evidence that children in the lowest socioeconomic quintile showed greater gains over this period. Similarly, there is no evidence of differences across race or socioeconomic status with respect to behavioral changes (results available upon request).

Discussion and Conclusions

This study provides the first nationally representative examination of changes in young children's skills over time across both academic and behavioral measures. Our first key finding is that, compared to the late nineties, children are entering kindergarten more proficient across a variety of math and literacy skills, as measured by teacher assessments. These changes are

sizable. One way to think about their magnitude is relative to the growth observed from the fall to the spring of kindergarten for the 1998 cohort. In 1998, students' average score on the overall math measure was 2.51 in the fall and 3.62 in the spring. Students in 2010 started kindergarten at an average score of 2.70 in the fall. This suggests that students arriving at kindergarten in 2010 had already learned about 17 percent of what they previously would have learned in kindergarten. For literacy, the change is just slightly smaller.

A second key finding pertains to racial inequality with respect to school entry skills. The increases in math and literacy proficiency we document were apparent across *all* groups of students regardless of race or SES, and throughout the distribution of school entry skills. However, we find particularly large gains in math and literacy proficiency among black children, relative to their white peers. We also find suggestive evidence that literacy and math skills increased more among Hispanic children relative to their white peers.

Our findings are consistent with recent research that documents narrowing of racial gaps in skills at school entry gaps using *direct measures of cognitive skills* (Reardon & Portilla, 2016). Taken together, the current paper and Reardon and Portilla (2016) suggest that since the late nineties racial gaps in children's early skills have narrowed and *simultaneously* that the skills and knowledge children possess when entering school have increased across the board.

Finally, we explored whether increased math and literacy skills at kindergarten entry might have come at a cost in the form of worse behavioral outcomes. Our results here are mixed. We find no differences in teacher-reported behavioral outcomes for interpersonal skills or externalizing behavior and document a *reduction* in internalizing problem behavior. Teachers did, however, rate the 2010 cohort somewhat less favorably with respect to their "approaches to learning," a measure that captures children's eagerness to learn, along with their ability to work

independently, persist in completing tasks, and pay attention. This pattern is concerning given that several studies have shown that this same measure of children's attention is consistently associated with children's later skills as they proceed through school (Claessens et al., 2009; Duncan et al., 2007). We also document a slight (and marginally statistically significant) drop in children's self-control.

One potential explanation for these patterns is the changing nature of kindergarten classrooms. In 2010, kindergarteners spent far more time using textbooks and worksheets, being assessed using standardized tests, and participating in teacher-directed instruction than did kindergarteners in 1998 (Bassok, Latham, & Rorem, 2016). They also had far fewer opportunities for child-selected activities, art, music, and hands-on exploration. Perhaps then, kindergarten in 2010 required higher levels of focus, persistence, and attention than in the earlier period. It may be that these changes in daily tasks and expectations had an impact on child behaviors. It may also be that teachers in 2010 were observing and rating children in a different context than were teachers in the late nineties. That said, it is not immediately clear what might be driving the drop in internalizing problem behaviors, or why we observe improvements in one behavioral measure but declines in others.

Implications & Next Steps

This study was motivated by the rapid increase in public and private investments in early childhood education. We hypothesized that the heightened awareness of the importance of early childhood over the past two decades may have led to meaningful changes in young children's lives and in turn improved their skills early in life. We find compelling evidence that teacher-reported measures of children's skills at school entry have increased substantially between 1998 and 2010. Given the strong associations between children's academic skills at school entry and

their later-life outcomes (Chetty et al., 2011; Duncan et al., 2007), our findings are encouraging and may imply long-lasting benefits.

One important question is whether these findings could be driven by changes in the way teachers interpret the questions or define proficiency on these skills over time, rather than by actual changes in student skills. Although we cannot definitively address that question, several pieces of evidence lessen our concern that our results are driven by such changes. First, over our study period, kindergarten teachers reported a heightened focus on academic skills and much higher expectations for what children should know at school entry (Bassok, Latham, et al., 2016). Given these changes, we would expect that if anything, teachers would evaluate students more harshly in the more recent cohort, which would bias our results toward finding that students performed *worse* in 2010. We find the reverse.

In addition, a few recent reports corroborate our findings. In particular, state reports from Maryland, Minnesota, and Virginia, all of which use assessments that are comparable over time, show improvements in student math and literacy skills across a similar timeframe (Maryland State Department of Education, 2014; Minnesota Department of Education, 2011; Virginia Performs, 2015). Further, a recent report using parent responses from the National Household Education Survey across the years 1993-2012 found large increases in student skills consistent with what we find here (Child Trends, 2015). Taken together, these reports give us confidence that the changes we observe are capturing real changes in early student skills. The current paper therefore provides an important first step towards understanding whether children's skills at kindergarten entry have changed. Hopefully, in the future direct assessment data that is comparable over time will allow us to answer this question more definitively.

Another important question is what caused the observed changes. We had hypothesized that improved access to public preschool may be an important part of the story. Our measures of preschool participation failed to explain *any* of the observed changes in children's early skills. This result was counter to our expectation but may not be surprising given that, while participation in public preschool rose over the period considered, overall rates of participation in formal care were unchanged (Bassok, Finch, et al., 2016).

One potential explanation is that the changes we observe are driven not by changes over time in *access* to preschool but by changes in the *quality* of the early childhood experiences children have (in preschool centers, family childcare homes, or elsewhere), or by changes in the academic focus of these settings. Many states have recently introduced early learning standards, more restrictive quality regulations for early childhood education providers, and Quality Rating and Improvement Systems (QRIS), accountability systems that incentivize quality improvements in early childhood settings (The Build Initiative & Child Trends, 2015). Indeed, research shows that Head Start programs have steadily improved over time, both with respect to teacher qualifications and the quality of teacher-child interactions (Aikens et al., 2016; Bassok, 2013). These quality improvements *may* contribute to the differential improvements we observe among black children. Unfortunately, the ECLS-K data do not provide any information about the quality or focus of children's early settings, so we were unable to directly test this hypothesis.

The rich ECLS data did allow us to examine the extent to which children's early home environments and kindergarten teacher characteristics explain changes over time in children's early skills. When we include all of these covariates, we are able to explain about a fifth of the demographics-adjusted change in math skills and a third of the change in literacy skills. While this is a substantial portion of the change, it raises important questions about what other factors

may be driving the increases in young children's skills over time. A better understanding of the mechanism driving the observed shifts is essential for understanding how to target new public initiatives or modify existing ones. More research is also needed to assess whether the changes we observed persist as children progress through school, and whether they are apparent when considering direct assessments. We cannot fully answer this question until the new ECLS cohort advances through school and a cross-walk is available to make comparisons of the direct assessments across cohorts. That said, we find that differences across cohorts in teacher-rated early academic skills are *even larger* at the end of kindergarten than they are at the beginning (results available upon request).

In addition, the increases observed in the current study are largely mirrored in increasing fourth grade reading and math scores on the National Assessment of Educational Progress (U.S. Department of Education, 2013). These patterns, combined with state reports of rising skills at school entry over time, bolster our confidence that the teacher-reported measures are capturing "true" changes in children's knowledge at school entry.

These findings have important implications for the way we structure children's early learning experiences. If children are entering kindergarten with a different set of skills than in previous years, it is essential that teachers are responsive to these changes. For instance, recent work suggests that the bulk of kindergarten instruction is spent on skills that children already know (Engel, Claessens, & Finch, 2013; Engel, Claessens, Watts, & Farkas, 2016). Our findings *do not* imply that kindergarten needs to become more academically-oriented or fast-paced. Many open questions remain about the impact of kindergarten curricula and pedagogy on children's development. What our results *do* imply is a need to better understand what skills children

already have at school entry, and how kindergarten can support their development both academically and more broadly.

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Table 1. Differences in teacher-rated student outcomes, across cohorts (OLS estimates)

Panel A - Math and literacy proficiency	(0)	(1)	(2)	(3)
Math				
Overall†	0.25***	0.28***	0.28***	0.23***
	(0.03)	(0.02)	(0.02)	(0.02)
Low proficiency	-0.09***	-0.11***	-0.11***	-0.09***
	(0.01)	(0.01)	(0.01)	(0.01)
High proficiency	0.09***	0.10***	0.10***	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)
Literacy				
Overall†	0.23***	0.26***	0.27***	0.19***
	(0.02)	(0.02)	(0.02)	(0.02)
Low proficiency	-0.09***	-0.10***	-0.11***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.01)
High proficiency	0.05***	0.06***	0.06***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
N	29700	29700	29700	29700
Age	X	X	X	X
Demographics		X	X	X
Preschool variables			X	X
Home environment variables				X
Teacher/class characteristics				X

Panel B - Behavioral outcomes	(0)	(1)	(2)	(3)
Poor self-control	0.01*	0.02*	0.01	0.01+
	(0.01)	(0.01)	(0.01)	(0.01)
Poor interpersonal behavior	-0.01	-0.01	-0.01+	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
Poor approaches to learning	0.06***	0.05***	0.05***	0.07***
	(0.01)	(0.01)	(0.01)	(0.01)
High externalizing behavior	0.00	0.00	-0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
High internalizing behavior	-0.02***	-0.02***	-0.03***	-0.02***
	(0.01)	(0.01)	(0.01)	(0.01)
N	26800	26800	26800	26800
Age	X	X	X	X
Demographics		X	X	X
Preschool variables			X	X
Home environment variables				X
Teacher/class characteristics				X

Note. Each coefficient comes from a separate regression where an outcome was regressed on an indicator for the 2010 cohort. Standard errors are clustered at the teacher level. †Measure has been standardized to have mean 0 and SD 1. + p <.1 * p <.05 ** p<.01 ***p<.001

Table 2. Differences in teacher-rated math and literacy proficiency across cohorts, by race and SES (OLS estimates)

Panel A. Differences by race

	Math			Literacy		
	Overall†	Low	High	Overall†	Low	High
2010 cohort	0.22***	-0.08***	0.08***	0.22***	-0.08***	0.05***
	(0.03)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)
Black*2010	0.12*	-0.06*	0.03+	0.09+	-0.05*	0.04*
	(0.05)	(0.02)	(0.02)	(0.05)	(0.02)	(0.02)
Hispanic*2010	0.08*	-0.03+	0.01	0.04	-0.03+	0.00
	(0.04)	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)
Asian*2010	0.06	-0.01	0.00	0.08	0.00	0.02
	(0.09)	(0.04)	(0.03)	(0.08)	(0.04)	(0.03)
N	29700	29700	29700	29700	29700	29700

Panel B. Differences by SES

	Math			Literacy		
	Overall†	Low	High	Overall†	Low	High
2010 cohort	0.24***	-0.09***	0.09***	0.23***	-0.08***	0.06***
	(0.03)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)
SESQ1*2010	0.05	-0.02	0.00	0.00	-0.02	-0.01
	(0.04)	(0.02)	(0.01)	(0.03)	(0.02)	(0.01)
N	29700	29700	29700	29700	29700	29700

Note. Each coefficient comes from a separate regression where outcomes were regressed on an indicator for the 2010 cohort and interactions between this indicator and either race (omitting white) or the lowest SES quintile (omitting the top four quintiles). Regressions that use race indicators also included "other race" as a category (results not shown). All regressions control for both children's age at kindergarten entry and the time spent in kindergarten prior to assessment. Standard errors are clustered at the teacher level.
†Measure has been standardized to have mean 0 and SD 1.
+ p <.1 * p <.05 ** p <.01 *** p <.001

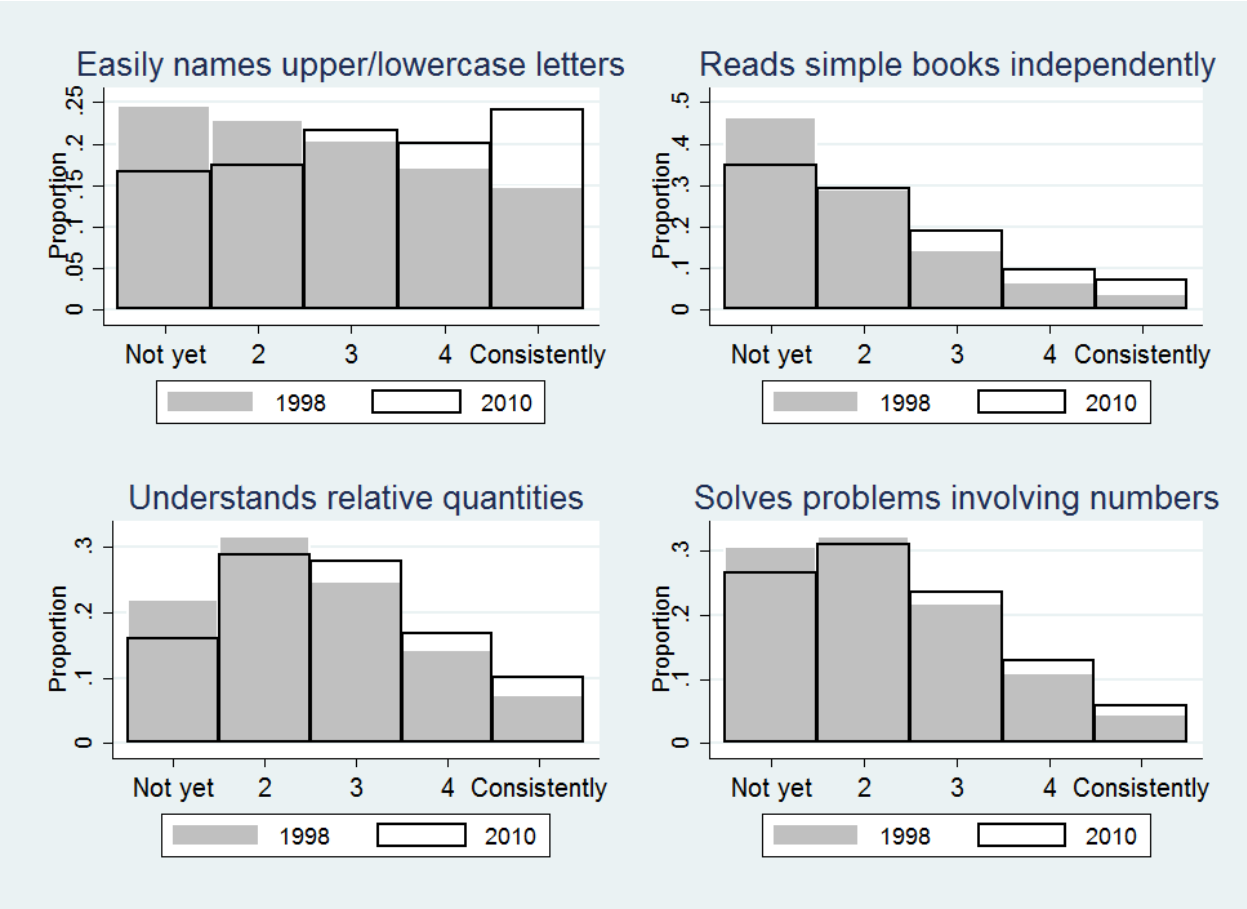


Figure 1. Distribution of selected teacher-reported literacy and math skills

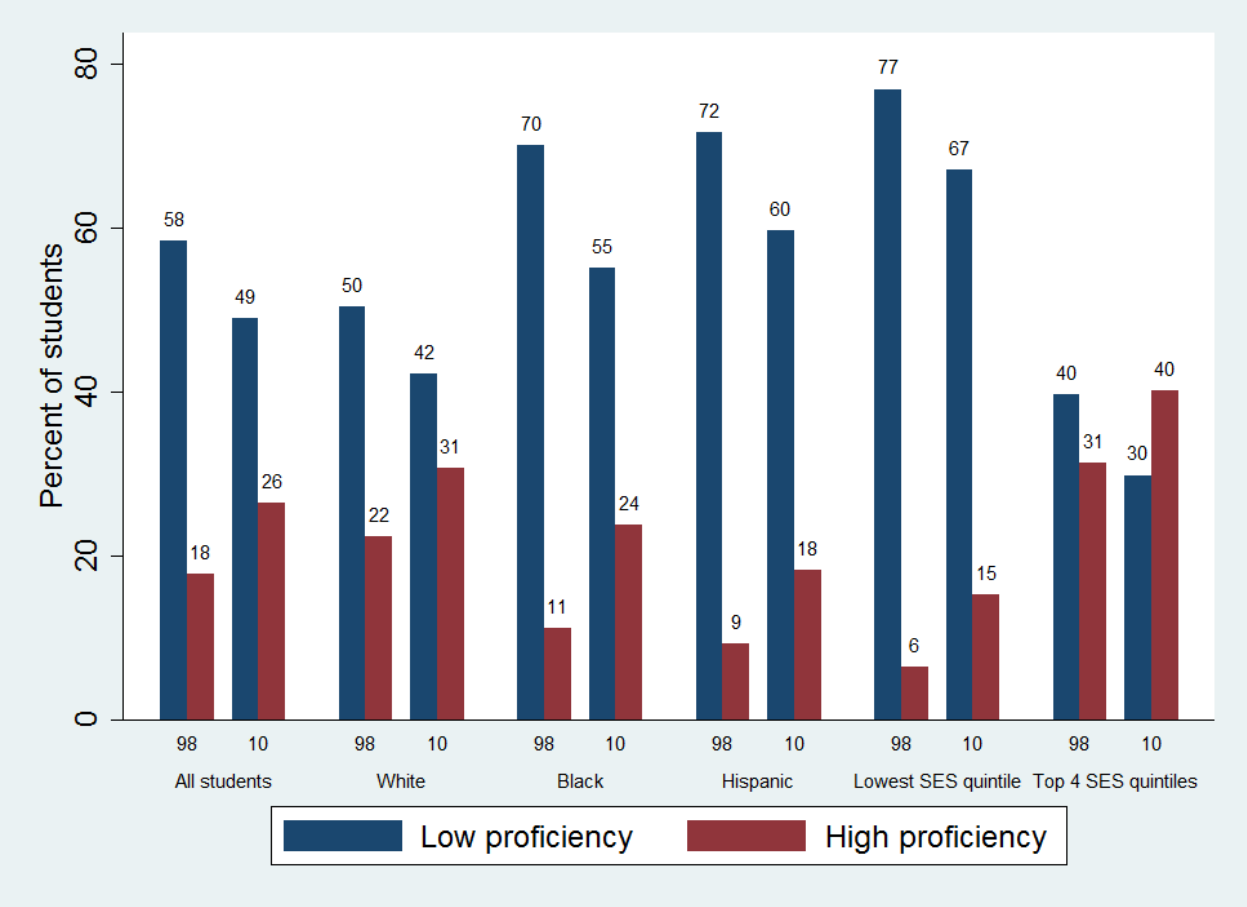


Figure 2. Percentage of students who were low and high proficiency in math across cohorts

Appendix A. Correlations between teacher-reported measures and direct student assessments

	Direct assessments				
	ECLS-K 2010	**ECLS-K 1998**			
Teacher-reported math proficiency	Kindergarten	Kindergarten	Third grade	Fifth grade	Eighth grade
Overall	0.51	0.47	0.39	0.38	0.36
High proficiency	0.38	0.33	0.26	0.25	0.24
Low proficiency	-0.41	-0.38	-0.33	-0.32	-0.30
Direct math assessment	-	1.00	0.68	0.63	0.58
Teacher-reported literacy proficiency	Kindergarten	Kindergarten	Third grade	Fifth grade	Eighth grade
Overall	0.64	0.55	0.44	0.43	0.37
High proficiency	0.48	0.42	0.33	0.31	0.27
Low proficiency	-0.50	-0.43	-0.37	-0.35	-0.31
Direct literacy assessment	-	1.00	0.56	0.52	0.44

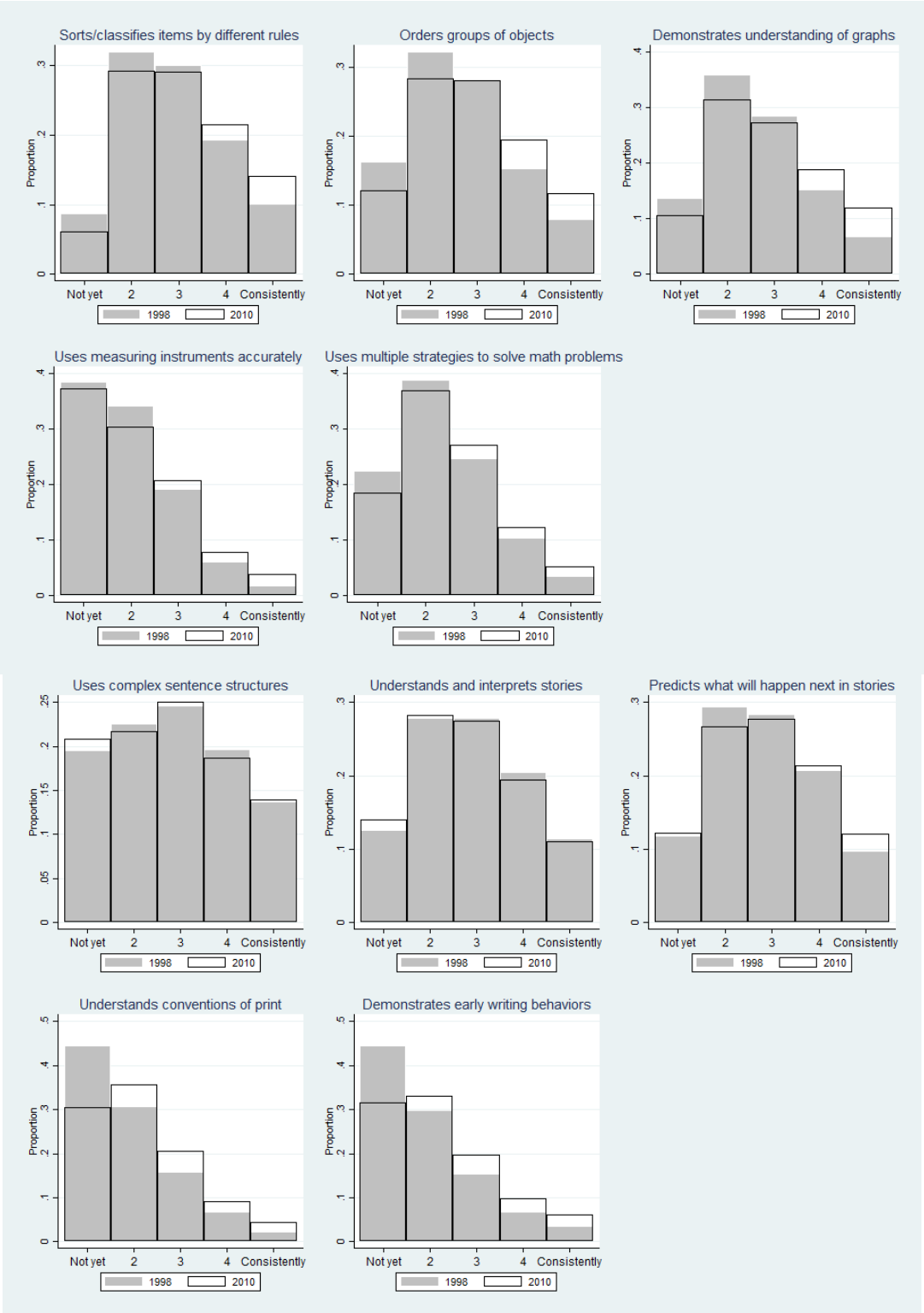
Note. Direct assessments were intended to measures broad student ability in math and literacy. These assessments were administered in the fall of the kindergarten year, and in the spring of the 3rd, 5th, and 8th grade years.

Appendix B. Covariate descriptive statistics

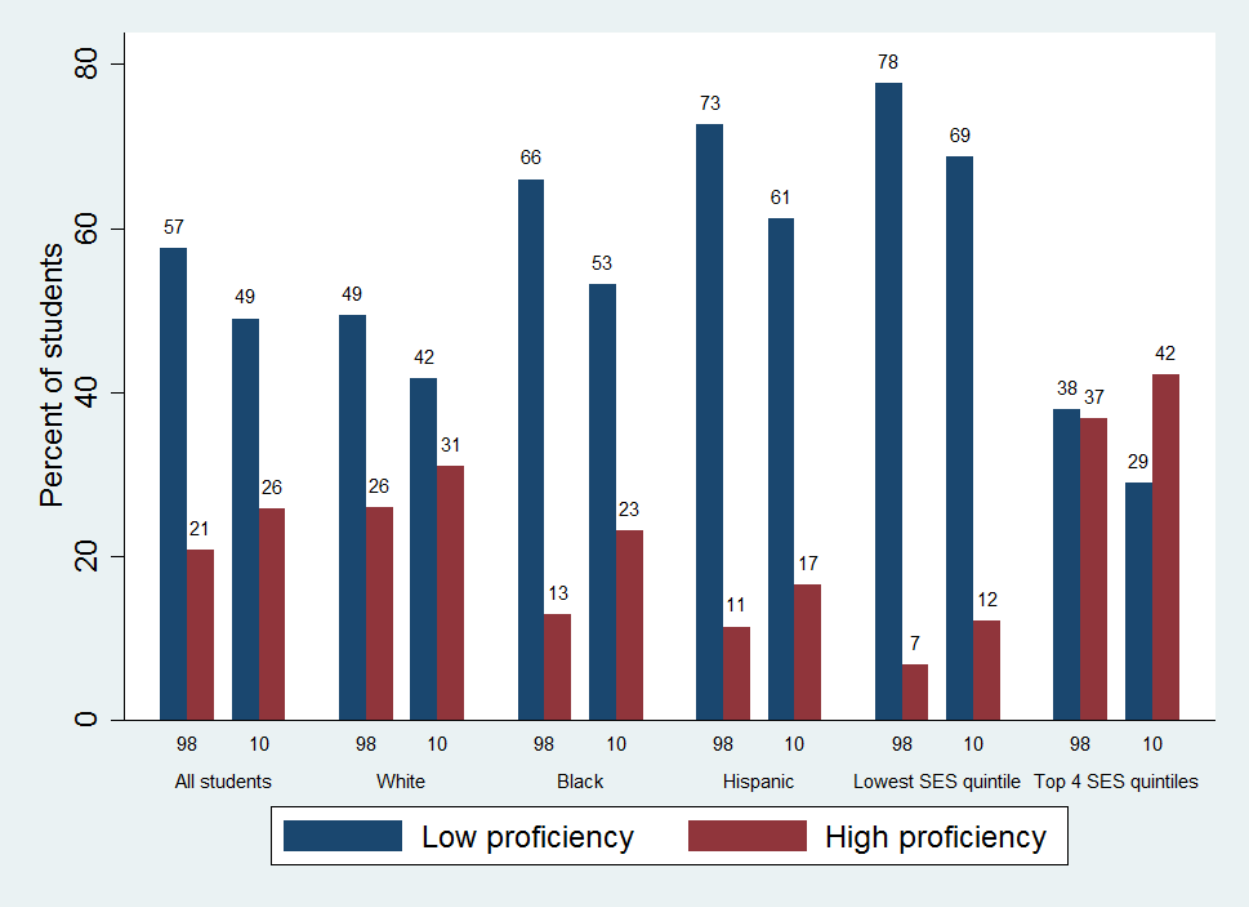
	1998	2010	
Demographics			
White	0.58	0.52	***
Black	0.16	0.13	***
Hispanic	0.19	0.25	***
Asian	0.03	0.04	***
Male	0.51	0.51	
Age in Aug. of kindergarten (mos.)	65.76	65.96	***
Speaks language other than English	0.22	0.24	***
Does not speak English	0.03	0.03	
Not U.S. born	0.03	0.03	
Non-citizen	0.02	0.01	
Public school	0.86	0.89	***
Preschool variables			
Attended formal pre-k care+	0.68	0.67	*
Hrs/wk attended pre-k	14.66	15.56	***
Attended publicly funded pre-k	0.28	0.45	***
Attended pre-k/k in same building	0.12	0.17	***
Attended K in school also offering pre-k	0.36	0.50	***
Home environment variables			
Proportion of parents rating the following skills "very important" or "essential":			
Knowing most of the letters	0.69	0.82	***
Counting to 20	0.61	0.75	***
Taking turns/sharing	0.95	0.95	*
Using a pencil/paintbrush	0.73	0.83	***
Sitting still/paying attention	0.84	0.86	***
Communicating verbally	0.94	0.96	***
Proportion of parents who report doing the following activities with their children every day:			
Reading books	0.45	0.52	***
Telling stories	0.25	0.40	***
Singing songs	0.45	0.45	
Doing chores	0.53	0.52	
Playing games	0.22	0.24	***
Talking about nature/science	0.10	0.12	***
Building something	0.14	0.17	***
Playing sports/exercising	0.22	0.25	***
Computer use			
Child uses computer at home	0.55	0.74	***
Uses computer every day	0.09	0.11	***
Uses computer for educational purposes	0.49	0.64	***
Uses the computer for internet	0.07	0.47	***

	1998	2010	
Kindergarten teacher characteristics			
Male	0.02	0.02	**
Age	41.66	42.12	**
White	0.91	0.91	
Black	0.07	0.06	
Hispanic	0.07	0.10	***
Asian	0.02	0.02	
Bachelor's degree (no graduate)	0.62	0.53	***
Graduate degree	0.37	0.47	***
Years teaching kindergarten	8.99	8.72	***
Years teaching at current school	9.16	9.13	
Certified in elementary education	0.86	0.86	***
Certified in Early childhood educ.	0.54	0.54	*
Took coursework in…			
Early childhood education	0.92	0.86	***
Elementary education	0.97	0.94	***
Special education	0.72	0.72	
English as a second language	0.24	0.38	***
Child development	0.97	0.93	***
Methods of teaching reading	0.98	0.95	***
Methods of teaching math	0.95	0.91	***
Methods of teaching science	0.91	0.82	***
Outcome variables			
Academic			
Overall math	2.51	2.70	***
Low math proficiency	0.57	0.50	***
High math proficiency	0.19	0.26	***
Overall literacy	2.46	2.64	***
Low literacy proficiency	0.24	0.19	***
High literacy proficiency	0.22	0.25	***
Behavioral			
Poor self-control	0.15	0.17	**
Poor interpersonal behavior	0.17	0.16	
Poor approaches to learning	0.17	0.23	***
High externalizing behavior	0.13	0.13	
High internalizing behavior	0.12	0.09	***

Note. +Head Start or Center-based care. * p <.05, ** p <.01, *** p <.001



Appendix C. Distribution of additional teacher-reported math and literacy skills



Appendix D. Percentage of students who were low and high proficiency in literacy across cohorts

Appendix E. Differences in teacher-rated student proficiency, across cohorts (bounded OLS estimates)

	(0)	(1)	(2)	(3)
Math				
Overall†	0.13***	0.16***	0.16***	0.12***
	(0.02)	(0.02)	(0.02)	(0.02)
Low proficiency	-0.07***	-0.08***	-0.08***	-0.06***
	(0.01)	(0.01)	(0.01)	(0.01)
High proficiency	0.05***	0.06***	0.06***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Literacy				
Overall†	0.25***	0.28***	0.28***	0.20***
	(0.02)	(0.02)	(0.02)	(0.02)
Low proficiency	-0.10***	-0.12***	-0.12***	-0.09***
	(0.01)	(0.01)	(0.01)	(0.01)
High proficiency	0.06***	0.07***	0.07***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
N	29700	29700	29700	29700
Age	X	X	X	X
Demographics		X	X	X
Preschool variables			X	X
Home environment variables				X
Teacher/class characteristics				X

Note. Each coefficient comes from a separate regression where an outcome was regressed on an indicator for the 2010 cohort. Standard errors are clustered at the teacher level.
†Measure has been standardized to have mean 0 and SD 1.
+p<.1 * p <.05 ** p <.01 *** p <.001