# ALL-DAY KINDERGARTEN AND COGNITIVE OUTCOMES OF RACIAL MINORITY STUDENTS IN THE US

By

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*ABSTRACT*

*The study explored the longitudinal effects of all-day kindergarten program on the academic performance of students from diverse racial backgrounds and social class from kindergarten to the end of first grade. The study used three measures of reading and math scores from a nationally representative database of the USA, the Early Childhood Longitudinal Study (ECLS). A series of longitudinal multilevel models with various specifications were estimated. The results indicated that all-day kindergarten students began with significantly higher reading scores compared with half-day kindergarten students but there was no significant difference in the growth pattern. Importantly, students from low SES families and Hispanic background displayed enhanced reading achievement in all-day kindergarten.*

*KeyWords: All-Day Kindergarten, Racial Groups, Academic Performance, Social Class, Longitudinal Analysis, Hierarchical Linear Modeling.*

## INTRODUCTION

Ever since Margarete Schurz introduced the Froebel kindergarten in the United State in 1856, American kindergartens have continually adapted to accommodate the changing perspectives on children's developmental needs and the parental economic demands. In early traditional kindergartens, the most beneficial program was identified as the one easing the transition from home to school smoothly. The only tasks that children need to do in traditional kindergartens is to spend 2 1/2 to 3 hours playing and adjusting themselves to a new social setting (Nelson, 2000). Nowadays kindergarten emphasizes academic achievement and school readiness which had been a goal of the first grade's curriculum in the past. Kindergarten children are expected to pay attention to regular academic instructions which cover reading, writing, mathematics, and science structured lessons. The highly-structured, segmented academic daily routines have spread to all-day kindergarten in the United States. In all-day kindergarten, students typically stay 5 to 6 hours per day and attend 5 days per week (Rudolph & Cohen, 1984).

Proponents of all-day kindergarten claim, however, that all-day kindergarten is worth being funded (Vecchiotti 2003). They say that all-day kindergarten is a potentially cost-effective program for reducing negative effects of educationally deprived childhood and increasing potential educational benefits. Working parents can be free from the burden of arranging day-care after half-day kindergarten (Elicker & Mathur, 1997; Nelson, 2000); teachers have more time to teach and individualize their instruction (Elicker & Mathur, 1997; Hough & Bryde, 1996). Children would spend more time on learning and acquiring early academic skills in all-day kindergarten and the extended learning can lead to successful in later grades because the material taught in kindergarten tends to be sequential in nature (Damian, 1997; DeCicca, 2007; Walston & West, 2004). Moreover, children develop social skills, including conflict resolution strategies because children in all-day kindergarten were engaged in more child-to-child interactions and that they made significantly greater progress in learning social skills (Elicker & Mathur, 1997; Hough & Bryde, 1996; Miller, 2002). According to the supporters, all-day kindergarten is

necessary to close the disparity in achievement (Weast, 2001).

Consistent with the argument of proponents of all-day kindergarten, the previous studies on the effects of all-day kindergarten have shown overall positive advantages on student's academic achievements in such domains as mathematical reasoning and concepts, oral-language development, literacy skills, and problem-solving (Clark, 2001; Cryan, Sheehan, Wiechel, & Bandy-Hedden, 1992; da Costa & Bell, 2001; Elicker& Mathur, 1997; Fusaro, 1997; Hough & Bryde, 1996; Johnson, 1993; Nelson, 2000) and are better prepared for 1st grade (Clark & Kirk, 2000; Elicker & Mathur, 1997; Feldman, 2001; Johnson, 1993; Ohio State Legislative Office of Education Oversight, 1997) when compared to half-day kindergarten.

Reflecting the benefits of all-day programs, the number of all-day kindergarten in the United States, which first opened its doors in 1960, has substantially increased. In 1999, 56 % of all kindergarten programs were all-day programs. Many schools have switched from half-day to all-day kindergarten programs in recent years, and many more are likely to do so (Elkind, 2001; Fusaro, 1997; Weast, 2001). There are many reasons for the growth of all-day kindergarten, including greater emphasis on academic achievement, higher accountability in schools, and a push for early start. Social reasons such as growing need for child-care have also provided an impetus for the growth of all-day kindergarten. Many more mothers are in labor force and all-day kindergarten is a safe and preferred alternative to other forms of child-care. Educational policy makers have also argued in favor of all-day kindergarten for working class and language minority children.

There are still many important policy issues embedded in the debate over the pros and cons of all-day programs. The shift from a half-day to an all-day kindergarten program can be extremely expensive. The change to an all-day program requires a substantial increase in the kindergarten budget for teacher's salaries and additional classrooms and other resources. Not only are the all-day programs more expensive, they require more human resources, and make increased educational demands on young children. Thus, it is important to critically examine the benefits of all-day versus half-day programs and gather data based evidence on academic effects of all-day programs on children not only in short time frame but also long-term effects of all-day attendance.

Although there is growing literature on the all-day kindergarten, much of that work consists of policy briefs and concept papers. The effects of all-day kindergarten on student achievement have not been established on the basis of empirical evidence using nationally representative large-scale database. Few studies have compared the two program types and their differential effects on children. The studies on long-term effects of all-day kindergarten that track the cognitive growth in early grades are even fewer. Due to insufficient longitudinal research on the efficacy of all-day kindergarten program on children's academic achievement, there is limited evidence on the long-term benefits of all-day kindergarten for most children. Many quantitative studies have shown inconsistent findings due to small samples, cross sectional data and less reliable outcome measures, thus lacking in generalizability.

The present study overcomes some of these limitations of earlier research and presents longitudinal growth models of children's academic achievement in reading and mathematics, examining differences in all-day and half-day kindergarten program. The study examines the long-term effects of kindergarten program type and assesses the academic outcomes of the children for the two types of programs.

Valid longitudinal research requires a well-designed study that includes the use of appropriate data and methods. The database should offer three or more repeated observations, and each observation should be measured on a comparable scale (Hox, 2002). In this regard, the database of the Early Childhood Longitudinal Study –Kindergarten Cohort (ECLS-K) from the National Center for Education Statistics (NCES) is particularly suitable, because the database contains six waves in each subject area for a longitudinal analysis, and a large sample for a multilevel analysis. Taking advantage of these benefits, the study conducted a series of three-level longitudinal

multilevel analyses examining the long-term effects of all-day kindergarten program on academic achievement, as well as measuring student academic growth.

In addition, the study included race and social class in the analyses. The study investigated the differential effects of all-day versus half-day kindergarten attendance for children of different racial and social class. More specifically, the paper examined if the long-term effects of kindergarten program on student's academic performance vary by racial groups and social class controlling for students' age and gender from the fall semester of kindergarten to the end of first grade.

Literature Review

Comparative studies of kindergarten program types have demonstrated that all-day programs bring children advantages in such academic domains as oral-language development, literacy skills, mathematical reasoning and concepts, and problem-solving (Chmelynski, 1998; da Costa & Bell, 2000; Fusaro, 1997; Lee, Burkam, Ready, Honigman, and Meisels, 2006; Wang & Johnstone, 1999). Other researchers have shown that all-day kindergarten programs effectively boost the academic achievement of low-income (Nelson, 2000; Magnusona, Ruhmb, & Waldfogelc, 2007; Zvoch, Reynolds, & Parker, 2008) and educationally deprived children (da Costa & Bell, 2001).

All-day kindergarten has positive long-term effects as well. They are more beneficial than half-day programs when it comes to enhancing children's readiness for the later grades. For instance, all-day kindergarten students are better prepared for first grade (Nelson, 2000) and are less likely to be retained in a grade (Gullo, 2000; Zvoch, Reynolds, & Parker, 2008). Gullo (2000) compared second-graders' academic outcomes and found that all-day kindergarten children scored significantly higher in math and reading on the Iowa Test of Basic Skills, as compared to half-day kindergarten children. da Costa and Bell (2000) also found that all-day kindergarten children exhibited higher levels of problem-solving, language literacy, and reading prerequisite skills.

Positive outcomes for all-day kindergarten programs are generally attributed to the additional hours, which create a more substantial learning environment. In fact, schedules of all-day kindergarten tend to be more relaxed, to have more repetition of the same content, to offer more remedial instruction, and to put greater emphasis on literacy and numeracy (da Costa & Bell, 2001). Kindergarten teachers in the study of Nelson (2000) evaluated all-day kindergarten positively, because the additional time allowed them to become more familiar with their students' developmental needs and to create individualized instruction plans (Chmelynski, 1998; da Costa & Bell, 2001). Studies carried out by Elicker and Mathur (1997) and by da Costa and Bell (2001) arrived at similar positive all-day kindergarten effects with controlled SES effects. All-day kindergarten children were rated significantly higher than half-day kindergarten children with respect to kindergarten report-card progress and readiness for the first grade. The researchers reasoned that these results were due to the more flexible, child-initiated, in-depth, and creative activities found in all-day kindergarten.

Natale (2001), on the other hand, has warned that some aspects of all-day kindergarten are harmful to young children. Excessively long hours of schooling can be particularly burdensome, and heavy academic schedules suppress children's creativity and natural inquisitiveness. In another study, some parents expressed concern about length of time in the classroom, noting young children's intrinsically limited energy levels (Towers, 1991). da Costa and Bell (2001) found that through interviews with kindergarten teachers, half-day kindergarten do a better job of serving children of various ethnic backgrounds with a broad range of socioeconomic needs. Saam and Nowak (2005) also found that the students in all-day kindergarten did not show better performance on language art and math scores than those in half-day kindergarten, nor did all-day kindergarten students from low SES background receive any benefit, using the data collected from the third-grade students who were previously enrolled in either all-day or half-day kindergarten.

It is evident that research findings are inconsistent and the

debate on the advantages and disadvantages of all-day versus half-day kindergarten is far from settled. There is clearly need for more research on the outcomes of kindergarten program type, using large scale national data.

## Method

### *Data and Weights*

This study used the ECLS-K database to examine the longitudinal growth of children's academic achievement. The ECLS-K was designed to provide assessment of the various developmental aspects of children from the onset of their formal schooling through their progress during the elementary school years. It also provides data on the quality of kindergarten programs and elementary schools, and thus it allows educational researchers to study children's developmental experiences in the early school contexts. Data collection method was a multistage probability sample design in which the primary sampling units were geographic areas consisting of counties. The second-stage units were schools within sampled counties and the final stage units were students within schools. Base year data were collected from the kindergarten children in the fall of 1998 and spring of 1999 (NCES, 2001). Six waves of data collection were completed in spring 2003.

This study used three waves of data to examine if the effects of all-day kindergarten program last until the end of first grade. The choice of three waves was mainly due to the available weight for longitudinal data analysis and sample sizes. The three waves of data used for this study represent:

- A baseline measure, fall kindergarten 1998;
- A first follow-up, spring kindergarten 1999;
- A second follow-up, spring first grade 2000.

Using these three waves of data, the study had two practical benefits. First, the study was based on a valid representation of national population of students using a longitudinal weight for the student level (C124CW0) which had high non-zero weights (87%). Although there was another available weight using four waves (C1_4CW0), the non-zero weights were about 27% with four waves of data, which might lead to invalid conclusions. The authors of the technical manuals (NCES, 2002) have warned that any longitudinal analysis that uses data from four waves including the fall-first grade data will be limited to a 27 percent subsample of children and thus, would lead to misleading results. Secondly, the application of the weight avoided the problems caused by over-representation of the Asian group in the ECLS-K dataset.

In this study, the school effect was considered at the kindergarten year by using only school identification numbers of kindergarten. In this way, the study was able to avoid a confounding effect caused by students who moved schools from kindergarten to first grade. This study also deleted those cases which contained all missing values on the three waves of the dependent variable, because longitudinal multilevel analysis is flexible enough to use available cases and does not require complete case data. The data used for the study totaled 17,350 students, and 1,015 schools.

### *Longitudinal Multilevel Analyses*

For the present study, the study adopted longitudinal multilevel analysis (often called Hierarchical Linear Model: HLM) as the major analysis tool. The statistical and conceptual strengths of using multilevel analysis with nested data have been demonstrated by researchers such as Raudenbush and Bryk (2002), and Kreft and de Leeuw (1998). A major benefit of multilevel analysis is that it helps researchers to explore various contextual effects, for example, the effects of sharing a common environment. By allowing for two or more different levels, multilevel analysis also makes it possible for researchers to examine interaction effects across different levels as well as separate effects at each level. Multilevel analysis allows researchers to partition variance and covariance among the different levels, and to focus their hypotheses at the appropriate levels. A series of the General linear Model (GLM) analyses was conducted to examine the fixed effects of the predictor variables and simple graphical presentations. Descriptive statistics are presented in Tables 1 and 2.

Analyzing longitudinal data through a multilevel analysis

| | | Frequency | Mean | Standard Deviation |
|---|---|---|---|---|
| Reading IRT Score | Fall Kindergarten | 14528 | 23.226 | 8.789 |
| | Spring Kindergarten | 16124 | 33.293 | 10.996 |
| | Spring First Grade | 16336 | 55.712 | 13.867 |
| Math IRT Score | Fall Kindergarten | 15366 | 19.814 | 7.253 |
| | Spring Kindergarten | 16733 | 27.848 | 8.760 |
| | Spring First Grade | 16635 | 43.314 | 9.218 |
| SES | | 20141 | 0.005 | 0.803 |
| Age in months at Fall Kindergarten | | 19114 | 68.408 | 4.345 |

Table 1.Descriptive Statistics of Reading IRT Scores, Math IRT Scores, SES, and Age

| | | Half-Day | All-Day | Total |
|---|---|---|---|---|
| Ethnic Groups | Caucasian | 5554 (47.3%) | 6178(52.7%) | 11732 (100%) |
| | African-American | 655 (20.4%) | 2553 (79.6%) | 3208 (100%) |
| | Hispanic | 1870 (49.9%) | 1881 (50.1%) | 3751 (100%) |
| | Asian | 768 (56.4%) | 593 (43.6%) | 1361 (100%) |
| | Total | 8847 (44.1%) | 11205 (55.9%) | 20052 (100%) |
| Gender | Male | 4806 (44.3%) | 6045 (55.7%) | 10851 (100%) |
| | Female | 4471 (43.1%) | 5899 (56.9%) | 10370 (100%) |
| | Total | 9277 (43.7%) | 11944 (56.3%) | 21221 (100%) |

Table 2. Frequencies and Percentages of Students of Half-day and All-Day Kindergartens by Race and Gender

offers researchers great advantages. The approach has been shown to overcome several methodological limitations associated with traditional repeated measures designs. For example, it is free from the strong assumption of compound symmetry of repeated measures. Also, multilevel analysis allows for unbiased parameter estimation even when the data show a high degree of correlation within the levels. Multilevel analysis is highly flexible with respect to the number and spacing of observations, in the sense that it does not require equal spacing or an equal number of observations (Heck & Thomas, 2000; Hox, 2002; Kreft & de Leeuw, 1998; Lee, 2000; Raudenbush & Bryk, 2002). This flexibility makes longitudinal multilevel analysis a breakthrough when it comes to the handling of missing data, which has been a major problem for longitudinal data analysis.

The major benefit of using a multilevel analysis for the study was that it helped us to explore the long-term kindergarten program effects on students from various backgrounds. The second advantage was that the study was able to maximize the sample sizes because a multilevel analysis does not require equal spacing or an equal number of observations (Hox, 2002; Raudenbush & Bryk, 2002).

### *Model Specification and Variables*

For the present study, a linear model with the Time variable was specified as the baseline model to avoid inflated error rates at Level 1 (Snijders & Bosker, 1999). In the baseline model, the initial status was estimated first, and then the growth trajectory was estimated using multiple observations of each individual and the Time variable. Thus, three observations were nested within each individual. This study used three-level multilevel longitudinal models, in which the study examined the effects of an all-day kindergarten at the school level which interact with students' individual contextual effects of race, SES, age and gender along with the longitudinal growth of students' academic performance.

### *Level 1 (Growth level)*

The first level model involved the growth of academic achievement, which was specified by using the Time variable. Each student's growth in terms of academic achievement was measured in two subject areas, reading and mathematics. In each subject area, an Item Response Theory (IRT) scale score was used as a dependent variable. An IRT scale score is an estimated ability index rather than the sum of the correct answers. It is derived from an item characteristic curve which shows how the probability of a positive answer relates to the difficulty of a test item and an examinee's ability. One of the benefits of an IRT score is that the information about an examinee's ability and the item characteristic (i.e., item difficulty) can be separated. Thus, it ensures that the scores at different time points are measured on a comparable scale, which is an important condition for a longitudinal dataset. Moreover, the IRT scale score is expected to have some advantages over the other scores with respect to analyzing change since it accounts for guessing and dependent omissions.

The Level 1 model was specified as

$$Y=\pi 0+\pi 1T+e$$

where Y dependent variable; T is a time point; $\pi 0$ is the

initial value of the dependent variable; $\pi 1$ is a linear growth parameter; and $e$ is an error.

*Level 2 (Individual Level)*

The second level for 2-level model included the effects of the following predictor variables: the student's gender (GENDER), their age at the onset of schooling (AGE), socioeconomic status (SES), and three racial groups (AFRN: African-American, HSPN: Hispanic, and ASAN: Asian). Here, the Caucasian group (CCSN) was the reference group. After the significance of the random components was verified, the variables were included in the model.

The student's gender (GENDER) was coded 0 for male and 1 for female. The two continuous variables, SES and AGE, were grand mean centered by subtracting the overall mean of the variable from all values of the variable. The grand mean centering allowed us to avoid collinearity and have clear interpretation of the intercept (initial score) and the slope (growth rate). The race variables were dummy-coded for the three racial groups. For example, AFRN was coded 1 for the African-American group and 0 for the other racial groups. For these categorical variables, the Caucasian group was the comparison group. Thus, the outcomes of the three racial groups (African-American, Hispanic, and Asian) were interpreted by comparing to the outcomes of the Caucasian group. The race variables were group-mean centered by subtracting the group mean of the variable from all values of the variable.

The final Level 2 model was as follows:

$$\pi_0=\beta_{00}+\beta_{01}(AGE)+\beta_{02}(GENDER)+\beta_{03}(SES)+\beta_{04}(AFRN)+\beta_{05}(HSPN)+\beta_{06}(ASAN)+r_0,$$

$$\pi_1=\beta_{10}+\beta_{11}(AGE)+\beta_{12}(GENDER)+\beta 1_3(SES)+\beta_{14}(AFRN)+\beta_{15}(HSPN)+\beta_{16}(ASAN)+r_1.$$

where $\beta_{00}$ is the intercept and indicates the grand mean of initial scores; $\beta_{10}$ is the grand mean of slope coefficients; $\beta_{01},\beta_{02},\beta_{03},\beta_{04},\beta_{05},\beta_{06},\beta_{11},\beta_{12},\beta_{13},\beta_{14},\beta_{15}$ and $\beta_{16}$ represent the effects of AGE, GENDER, SES, AFRN, HSPN, and ASAN on $\pi_0$ and $\pi_1$; and $r_0$ and $r_1$ are random errors.

*Level 3 (School Level)*

The kindergarten program type was specified with grand-mean centering at Level 3. The ECLS dataset contained three types of kindergarten programs: morning, afternoon, and all-day kindergarten. The study identified both morning and afternoon kindergarten as half-day programs and compared them with all-day programs by assigning dummy codes of 0 and 1. The new variable was named ALLDAY.

The authors specified the random components only with the intercept and the slope because the other random components were not significant. The intercept and the slope coefficients were assumed to vary across individuals at Level 3. However, to determine the significance of the random components, the models with a fixed intercept and slope were analyzed. The random components of $\beta_{03}$ (SES intercept), $\beta_{06}$ (ASAN intercept), $\beta_{14}$ (AFRN slope), and $\beta_{16}$ (ASAN slope) in reading and $\beta_{01}$(AGE slope), $\beta_{06}$ (ASAN intercept), $\beta_{14}$ (AFRN slope), and $\beta_{16}$ (ASAN slope) in math were insignificant, therefore those coefficients were specified as fixed.

The four example specifications of final model at Level 3 are

$$\beta_{00}=\gamma_{000}+\gamma_{001}(ALLDAY)+\mu_{00}$$

$$\beta_{01}=\gamma_{010}+\gamma_{011}(ALLDAY)+\mu_{01}.....$$

$$\beta_{15}=\gamma_{150}+\gamma_{151}(ALLDAY)+\mu_{15}$$

$$\beta_{16}=\gamma_{160}+\gamma_{161}(ALLDAY)$$

where $\gamma_{000}$ is the intercept and indicates the grand mean of initial scores; $\gamma_{010}$ is the grand mean of slope coefficie nts; $\gamma_{001},\gamma_{011},.....\gamma_{161}$ represent the effects of ALLDAY; and $\mu_{00}$, $\mu_{01}$, …, $\mu_{15}$ are random errors. The random components of $\beta_{01},\beta_{04},\beta_{14}$ and $\beta_{16}$ in reading and $\beta_{01},\beta_{06},\beta_{14}$ and $\beta_{16}$ in math were insignificant, therefore those coefficients were specified as fixed.

**Results**

*All-Day Kindergarten Effects on Student Performance*

The first section focused on the significant effects of all-day kindergarten in reading and math areas. Discussion about the other effects without regard to all-day programs followed in the next section.

*Reading Scores*

When the overall reading scores of the fall semester of the

kindergarten year were compared, the students who attended all-day kindergarten showed higher levels of achievement than those who attended half-day kindergarten. As shown in Table 3, the multilevel analysis produced an estimated intercept for the variable ALLDAY, $\gamma_{001}$ =1.433, which is statistically significant (t=3.682, p < 0.01). That is, the effect of all-day kindergarten on the estimated reading score during the fall semester of their kindergarten year was 1.433 points higher than that of half-day kindergarten.

The long-term effects of all-day kindergarten on reading achievement are shown in the ALLDAY slope in Table 3. The study did not find a significant effect of all-day program on a student's reading achievement. The estimated coefficient for the growth rate of ALLDAY was $\gamma_{050}$ = -0.085(p > 0.05). In other words, all-day kindergarteners who demonstrated significantly higher initial reading scores showed non-significant growth later.

In the analysis of all-day kindergarten effects for different SES groups, an important effect of all-day kindergarten for low SES children was noted. In the initial reading scores, the effect of all-day kindergarten showed a significant negative coefficient for SES ($\gamma_{031}$ = -1.269,p < 0.05). indicating the students from low SES families tended to show high initial reading performance in the fall semester of kindergarten. Therefore, students from low SES families indicated higher performance when they were in all-day kindergarten at the first semester of formal schooling. This finding matched with the findings of prior researchers that all-day programs were beneficial for children of low-income families (Fusaro, 1997; Johnson, 1993; Ohio State Legislative Office of Education Oversight, 1997; Weast, 2001).

In the analysis of reading scores for racial groups, the study found a beneficial effect of all-day program for a racial group. Hispanic students who attended all-day kindergarten started with a significantly higher reading performance than Hispanic students who attended half-day kindergarten as shown Figure 1. The HLM analysis showed a coefficient of $\gamma_{051}$ = 2.420(t=2.450,p < 0.05).and the effect size of 0.163. This is an important policy relevant finding, considering the performance gap between Caucasian and Hispanic students. As indicated by the HLM results in Table 3, the initial reading scores of Hispanic students were substantially lower than that of Caucasian students ($\gamma_{050}$ = -3.955,p < 0.01). In other words, Hispanic students, who might lag behind if they did not

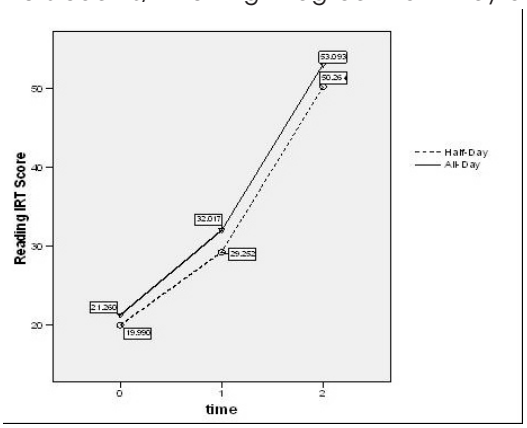


Figure 1. Reading IRT scores of Hispanic students in half-day and all-day kindergartens

| | | Reading Score | | Math Score | |
|---|---|---|---|---|---|
| | | Coefficient | Standard Error | Coefficient | Standard Error |
| Initial Score | | | | | |
| Intercept | Intercept | 20.313** | 0.193 | 18.649** | 0.144 |
| | ALLDAY | 1.433** | 0.389 | 0.327 | 0.284 |
| Age | Intercept | 0.353** | 0.035 | 0.419** | 0.022 |
| | ALLDAY | -0.021 | 0.075 | -0.048 | 0.045 |
| Gender | Intercept | 1.488** | 0.249 | 0.133 | 0.166 |
| | ALLDAY | 0.653 | 0.507 | 0.377 | 0.322 |
| SES | Intercept | 3.610** | 0.229 | 3.085** | 0.165 |
| | ALLDAY | -1.269** | 0.470 | -0.607 | 0.330 |
| African-American | Intercept | -1.477** | 0.514 | -1.924** | 0.339 |
| | ALLDAY | -0.117 | 1.085 | -0.335 | 0.666 |
| Hispanic | Intercept | -3.955** | 0.478 | -1.908** | 0.429 |
| | ALLDAY | 2.420* | 0.988 | 0.857 | 0.886 |
| Asian | Intercept | -2.103* | 0.994 | -1.662* | 0.749 |
| | ALLDAY | -1.282 | 1.983 | -1.634 | 1.493 |
| Growth Rate | | | | | |
| Intercept | Intercept | 16.567** | 0.123 | 11.853** | 0.063 |
| | ALLDAY | -0.085 | 0.252 | -0.059 | 0.128 |
| Age | Intercept | 0.005 | 0.026 | -0.033 | 0.021 |
| | ALLDAY | -0.114* | 0.055 | -0.029 | 0.045 |
| Gender | Intercept | 0.653** | 0.194 | -0.186 | 0.125 |
| | ALLDAY | 0.093 | 0.398 | 0.170 | 0.265 |
| SES | Intercept | 0.620** | 0.109 | 0.156 | 0.110 |
| | ALLDAY | 0.399 | 0.224 | 0.060 | 0.235 |
| African-American | Intercept | -0.572 | 0.316 | -1.031** | 0.259 |
| | ALLDAY | -0.184 | 0.617 | 0.934 | 0.548 |
| Hispanic | Intercept | 0.404 | 0.407 | -0.306 | 0.216 |
| | ALLDAY | -0.661 | 0.857 | 0.096 | 0.439 |
| Asian | Intercept | 1.272** | 0.485 | 0.258 | 0.347 |
| | ALLDAY | -0.500 | 0.919 | 0.747 | 0.713 |

Note: * p<0.05,** p<0.01

Table 3. Estimates of Reading and Math IRT Scores from HLM Analyses

attend all-day kindergarten, raised reading scores significantly in all-day kindergarten. In other racial groups, however, the study did not note the significant effect of all-day kindergarten although there were significant differences among the performances of the Caucasian group and minority racial groups.

Another significant result of the all-day kindergarten effect was associated with students' age. At the beginning of the kindergarten, no significant effect of all-day kindergarten associated with students' age was observed. The growth rate, however, turned out to be significant, indicating the younger students in all-day kindergarten tended to raise reading scores faster as compared in half-day kindergarten ($\gamma_{010} = -0.114, p < 0.05$).

*Math Scores*

This study did not find a significant effect of all-day kindergarten on the math scores of students, although a slightly higher math performance of all-day kindergarten students was noticed as compared to that of half-day students at the fall semester of kindergarten.

The researchers found a similar pattern in the interaction coefficient of all-day kindergarten and SES, but it was not significant. In other words, the all-day kindergarten students from low SES families tend to show high initial math performance, but the effect was not significant. The study further noted a minor non-significant positive effect of all-day program for African-American students.

**Effects of SES, Racial Groups, Gender, and Age on Academic Scores of Students**

This section discusses the main effects of independent variables without considering the kindergarten effects. These results were presented in Table 3. The effects of SES on reading and math scores were significant in both the initial scores and growth rates indicating that students with higher SES backgrounds tend to have higher initial scores and raised their scores faster than those with lower SES backgrounds. There was also a significant main effect of racial background. The study found significant differences among the performances of racial groups. The initial scores and the growth rates of scores in both reading and math were lower for African-American students compared to those of Caucasian students, indicating African-American students started off with substantially lower reading scores and were not able to catch up with Caucasian students. Asian students, however, made a significant progress from kindergarten to first grade showing a significant growth rate, although they had a significantly lower performance than Caucasian students at the beginning of kindergarten.

In this study, the two variables of student's age and gender were examined as covariates. The age effects on reading and math scores indicated that older students showed higher scores in reading and math than the younger ones at school entry, but there was no significant difference in growth rates of younger and older children. The gender difference in reading scores was found in this study. Girls' performance was significantly higher in both initial scores and growth rates. In math scores, significant gender differences were not noted.

**Discussion and Conclusion**

This study examined the long-term effect of all-day kindergarten on students' academic performance in reading and mathematics. All-day kindergarten students began with significantly higher scores in reading compared to their half-day counterparts, but did not show significant higher growth rate of the reading scores. In math, a significant effect of all-day kindergarten was not observed, only a slightly higher math performance of all-day kindergarten students was noticed as compared to that of half-day students at the fall semester of kindergarten. The findings of the study are consistent with the results of previous studies that attending an all-day kindergarten facilitates the language development and literacy skills of children who are preparing to transition to formal schooling (Chmelynski, 1998; da Costa & Bell, 2000; Fusaro, 1997). The present study does not, however, substantiate previous findings of higher achievement of all-day kindergarten students in mathematical reasoning and concepts (Elicker & Mathur, 1997; West, Denton, & Reaney, 2000).

The findings of the study about the differential effects of all-day kindergarten for students of various SES and racial

backgrounds have important implications. All-day students from low SES families tended to show high reading performance in the fall semester of kindergarten. The academic performance of Hispanic students in all-day kindergarten was also higher. Both of these findings make important contribution to the current debate about the benefits of all-day kindergarten. The results indicated that Hispanic students in all-day kindergarten demonstrated high reading performance at the beginning of formal schooling and maintained their high performance level until the end of first grade. Importantly, the Hispanic group demonstrated substantially low scores when the study did not consider the all-day kindergarten effects. In other words, Hispanic students in all-day kindergarten showed enhanced reading performance, who might lag behind if they did not attend all-day kindergarten. In this sense, the results for low SES and Hispanic students confirmed prior findings of literature, in which extended all-day programs were found to enhance the academic achievement of students from low SES and educationally deprived familial backgrounds (Fusaro, 1997; Ohio State Legislative Office of Education Oversight, 1997).

Although this study found that kindergarten program type was associated with the achievement levels of students, the study is based on survey data. Because this study is not an experimental study in which random assignment makes it possible to estimate causal-effect relationships, the direct causal-effect link between the kindergarten program and student achievement levels should not be inferred. The study provides a better understanding of the all-day kindergarten program for diverse racial and social groups. Furthermore, it is important to note that there may be many other social and non-academic advantages of all-day kindergarten that this study did not consider. The over-all effectiveness of an all-day kindergarten is certainly a promising subject for future research. The present study mainly focused on the effect of kindergarten program type on children's academic achievement, controlling for gender and age at school entry. More studies are needed that focus on racial, cultural and home backgrounds of children, when considering the effect of kindergarten program type. Future studies would provide more comprehensive results if such school factors as location (urban versus rural), average income level, and minority ratio, are also taken into account. More importantly, the quality of all-day kindergarten programs should be considered in the future studies. For example, the quality of the extended hours, the use of developmentally appropriate curriculum, the interaction between teachers and students should be investigated when comparing half-day and all-day programs.

This study contributes to a better understanding of all-day kindergarten using a large-scale data by providing a broad picture of outcomes of all-day kindergarten. The practical implications include a clarification of prior research results and the establishment of a firmer foundation on which educational policymakers can base their decisions about all-day kindergarten programs.

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