Full-Day versus Half-Day Kindergarten: In Which Program Do Children Learn More?

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Full-Day versus Half-Day Kindergarten: In Which Program Do Children Learn More?

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Do children learn more in full-day kindergartens than half-day programs? If full-day kindergarten increases learning, are kindergartners in some schools particularly advantaged by their full-day experience? We address these questions with a nationally representative sample of over 8,000 kindergartners and 500 U.S. public schools that participated in the Early Childhood Longitudinal Study—Kindergarten Cohort. More than half of kindergartners experience full-day programs, which are most commonly available to less-advantaged children. Using multilevel (HLM) methods, we show that children who attend schools that offer full-day programs learn more in literacy and mathematics than their half-day counterparts. We also explore differential effectiveness in some school settings.

Introduction

A major national concern is whether all schoolchildren, regardless of their social and educational backgrounds, have equal access to our nation’s most effective educational programs. We know that children do not arrive at the doors of their schoolhouses on an equal footing (Alexander and Entwisle 1988; Comer 1988; Duncan et al. 1998; Entwisle et al. 1997; Lee and Burkam 2002;
National Center for Education Statistics [NCES] 2000; Ramey and Campbell 1991; Zill 1999). Moreover, differences among “arriving” children often determine the educational programs they encounter, how the programs are implemented, and how children’s experiences in these programs influence their learning (Alexander and Entwisle 1996). In this study, we focus on the point at which virtually all children begin their formal educational experience: the kindergarten year.

When young children in the United States should begin their formal schooling and what the nature of that schooling should be have been debated for almost two centuries. Although the availability of publicly funded preschool education (including Head Start) in this country is far from universal and is typically restricted to low-income children, virtually all U.S. children now experience kindergarten (NCES 2000). Despite its almost universal availability, the nature of the optimal kindergarten experience is widely debated among educators, early childhood specialists, parents, and researchers (Balaban 1990; Graue 1999; Karweit 1988, 1992; Spodek 1986; Vecchiotti 2001). Since the 1960s, experts have called for more than “self-directed play.” In the early childhood field, the expression “early intervention” typically refers to introductory activities that focus on both play and academics. Pressure has mounted

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among policy makers, however, to increase the cognitive demands made on kindergarten students (Gullo 1990; Shepard and Smith 1988; Walsh 1989).

One of the goals of those advocating greater academic preparation in kindergarten is to increase the time children spend in these settings. Kindergartens began as play-oriented programs that emphasized exploration and creativity, mostly as full-day experiences (Puelo 1988; Shapiro 1983). As kindergartens became more widespread, however, they began to be offered as half-day programs. The nation’s kindergartners, both in public and private schools, are now about equally divided into half-day and full-day programs (NCES 2000). Our purpose in this study is to evaluate the relative efficacy of full-day and half-day kindergarten over that school year. Our focus is on children’s cognitive development, although we recognize that other outcomes of the kindergarten experience are also important.

Public school districts across the nation are actively debating whether to increase kindergarten from a half-day to a full-day program, whether access to full-day programs should be restricted to low-income children, and how to finance this change. Embedded in this debate are questions about what the nature of the program should be, whether those families who can afford it should be asked to pay for the increased class time, whether there are better ways to use a school’s or district’s scarce educational resources, and the relative emphasis kindergarten should place on children’s cognitive and social development.

Although the relative efficacy of full-day and half-day kindergarten on academic outcomes has been the topic of considerable research, most studies comparing full-day and half-day kindergarten have been conducted in local settings, have modest research designs, are quite dated, and use analysis methods that are inconsistent with the nature of the intervention. For several reasons, we suggest that our study contributes useful information to expand the debate. First, we employ recent, large, and nationally representative samples of children and the public schools they attend. Second, the study focuses on development rather than status, in that we use measures of students’ cognitive status in literacy and mathematics both as they begin kindergarten and at the end of their kindergarten year. Given the nature of the Early Childhood Longitudinal Study—Kindergarten Cohort (ECLS-K) database, we will explore the long-term effects of full-day kindergarten as subsequent waves become available. Third, the study’s use of multilevel research methods reflects the structure of the intervention. Although around 10 percent of U.S. kindergartners experience this program in schools that offer both full- and half-day programs, the large majority of U.S. schools make the decision to offer kindergarten as a half-day or a full-day program as a school (or a district or a state).

Specifically, we make use of the first two waves of the U.S. Department of Education’s newest longitudinal data collection effort, the Early Childhood
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Longitudinal Study—Kindergarten Cohort. Our study includes 504 public schools that offer full-day (50.8 percent) and half-day (49.2 percent) kindergarten as schoolwide programs. Our sample includes the 8,455 ECLS-K children in these schools (55.7 percent in full-day kindergarten). Although the intervention we evaluate is a school-level program, cognitive effects accrue to individual children. Our research questions are thus multilevel, as are the methods we use (hierarchical linear models [HLM]). Our analytic models also take account of the children’s social and academic background as they begin kindergarten, as well as the structural and compositional features of the elementary schools they attend.

Background

A Brief History of Kindergarten in U.S. Schools

The idea.—Kindergarten originated in 1837, when Friedrich Froebel created “a child's garden” for children between the ages of three and seven to develop their mental, social, and emotional faculties through play, music, movement, interaction with the outdoors, and opportunities to engage in independent and creative pursuits (Shapiro 1983). At its inception, kindergarten was viewed as a nurturing, protected place where young children would spend time developing all dimensions of the self before their introduction to the formal academic rigors of the educational system. A cornerstone of early childhood education at this time was the belief that young children think and learn differently from older children (Chung and Walsh 2000). Therefore, the optimum setting for children was a place where they could explore their own interests freely. It was believed that children learned best through self-directed, active exploration with materials and interaction with other children and adults.

Kindergarten “immigrated” to the United States in 1857, when Margarethe Schurz opened the first Froebelian program in Wisconsin. This private, German-speaking, full-day program was followed by the first English-speaking public kindergarten in St. Louis in 1873. The goals and purposes of kindergarten quickly changed from Froebel’s metaphysical goals to the public schools’ goals of inculcating cultural values and norms. However, development of the whole child and self-directed play remained the methods by which these goals were achieved. Between 1890 and 1910, public interest in kindergarten grew substantially. Increasingly, educators became convinced that children would flourish cognitively, emotionally, and socially in environments where they could explore, manipulate, and interact through self-directed play. Reinforcing and perpetuating the idea of development through play were the ideas of such
developmentalists as G. Stanley Hall and Arnold Gesell (Chung and Walsh 2000). Early formal academic instruction was then viewed as detrimental to the development of young children. Dominating the educational landscape at that time was the view that education was a process of development rather than a process of instruction (Bryant and Clifford 1992; Meisels and Shonkoff 2000).

The spirit of Froebel’s philosophy remained intact until the 1970s, when the educational value of early childhood programs began to be recognized. Several factors sparked this shift: Sputnik, rejection of the principles of progressive education, emerging research on cognitive growth in infants and young children, such intervention programs for poor young children as Head Start, and the growing importance of quality early education to the middle class. All of these factors contributed to a greater focus on the academic dimensions of child development (Meisels and Shonkoff 2000). As a result, kindergarten experienced a shift from a play-based curriculum to a curriculum focusing on the formal teaching of discrete skills. The broader standards and assessment movement of the 1990s reinforced the focus on the academic dimension of child development. As a result, more and more school supervisors and teachers succumbed to political and social influences; kindergarten classrooms began to resemble first-grade classrooms in their emphasis on formal reading and math instruction rather than play and socialization (Elkind 1986; Gullo 1990; Hatch and Freeman 1988a, 1988b; Plevyak and Morris 2002; Shepard and Smith 1988; Walsh 1989). The axiom that stressed the broader “continuity of development” shifted to the narrower “continuity of achievement” (Spodek 1986).

Currently, substantial debate exists among early childhood educators, policy makers, and the general public about the purposes and goals of kindergarten and the methods by which these goals should be realized (Brosterman 1997; Graue 1999; Spodek 1986; Vecchiotti 2001). Many researchers, educators, and parents adhere to the “traditional” model of kindergarten as a place where young children learn through play and educating the “whole” child is of primary concern. In contrast, others adhere to the belief that kindergarten should incorporate formal structured lessons. Concern for a child’s overall development is tempered by an emphasis on school readiness and the acquisition of reading and math skills. Under this view, the goal of kindergarten is to prepare children for first-grade academics.

Each position is critical of the other. Those who advocate for the “developmentally appropriate” (Bredekamp and Copple 1997) kindergarten are criticized for underestimating children’s capacity to acquire a wide variety of skills and concepts. Those who advocate for a “formal kindergarten” are criticized for narrowing the curriculum, ignoring children’s social and emotional needs, and dampening young children’s natural curiosity and enthusiasm to learn.
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Although views regarding the goals and methods of instruction differ, both camps see the implementation of full-day kindergarten programs as a way to enrich the kindergarten experience for most children.

Duration.—Over the past 50 years, U.S. kindergarten education has experienced phenomenal growth and transformation. As the result of growing numbers of children attending kindergarten, lack of capacity of public schools to handle the explosion in the population of school-age children, a shortage of teachers, and the belief that five-year-olds were not mature enough to tolerate a full school day being away from their mothers and without napping, virtually all kindergarten programs were half-day by the 1950s (Puelo 1988). In the 1960s and 1970s, many states and communities established publicly funded kindergarten programs for five-year-olds for the first time (Olsen and Zigler 1989). These mostly half-day programs, modeled after traditional private nursery schools, emphasized play and socialization.

In 1965, only about half (47 percent) of five-year-olds were enrolled in kindergarten (Spodek 1986). Twenty years later, kindergarten attendance was nearly universal, enrolling 97 percent of five-year-olds (National Association of Elementary School Principals 1985). Today, half-day programs are steadily giving way to full-day kindergarten programs. The percentage of children attending full-day kindergarten has grown from 10 percent in 1961 to 33 percent in 1987 to 45 percent in 1993 (Bruno and Adams 1994). Moreover, there are increasing demands to expand the academic content and focus of kindergarten (Zernike 2000). Over half of kindergarten children now attend full-day programs (West et al. 2000). Research shows that many parents and teachers have extremely positive views of full-day kindergarten (Elker and Mathur 1997; Evansville-Vanderburgh School Corporation 1988; Graja 1984; Hough and Bryde 1996; Towers 1991).

Factors Influencing the Growth of Full-Day Kindergarten

Several demographic and sociocultural factors explain the growing implementation of full-day kindergarten. First, the number of working mothers with children under six years old is growing; over 60 percent of these mothers are now in the workforce (Children’s Defense Fund 1996). To serve the child-care and scheduling needs of these parents, many schools offer full-day kindergarten programs (although kindergarten must be supplemented with other child-care arrangements for mothers who work full time). At the same time, declining nonkindergarten school enrollments resulting in underutilized physical plants and school staff in some locales may have generated resources that could be devoted to full-day programs.

Second, for growing numbers of children, kindergarten is rarely the first
school experience. Rather, it fits into a continuum that routinely begins with
day care and/or a prekindergarten or preschool experience and moves through
elementary school (Olsen and Zigler 1989). Since the mid-1970s, more and
more children under age five have attended preschool programs: private and
public preschools, Head Start, and child care. Proponents of full-day kinder-
garten believe that children, as a result of their various child-care and preschool
experiences, are ready for more demanding and cognitively oriented educa-
tional programs (Gullo 1990; Helmich 1985; Herman 1984; Humphrey 1980;
Naron 1981). Television, computers, and increased family mobility also enrich
experiences for young children, obligating kindergartens to accommodate to
these changes. Third, recent scientific, technological, and economic develop-
ments have thrust into the forefront of social discourse the critical impor-
tance of academic success, especially literacy and numeracy skills. Public and
political forces collectively impose enormous pressures on schools to focus on
children’s academic achievement, and this focus begins earlier and earlier.

Full-day kindergarten advocates suggest that a longer school day provides
educational support that ensures a productive beginning school experience
and increases the chances of future school success, particularly for poor chil-
dren (Evansville-Vanderburgh School Corporation 1988; Karweit 1989; Ohio
State Legislative Office of Education Oversight 1997; Weast 2001). Research-
ers studying poverty and school achievement universally agree that children
from families living in poverty enter school at high risk for academic under-
achievement (Alexander and Entwisle 1988; Comer 1988; Duncan et al. 1998;
Heath 1983; Ramey and Campbell 1991; Reyes and Stanic 1988) as well as
grade retention and need for special education (Lazar et al. 1982; Sherman
1994). Moreover, the literacy gap between children from low-income families
and their middle and upper-income counterparts increases over time in school
(Puma et al. 1997).

The growing diversity among today’s kindergarten children in terms of their
racial, ethnic, cultural, social, economic, and linguistic backgrounds challenges
educators to serve children well in increasingly complex classrooms. Full-day
advocates suggest several advantages for the longer kindergarten day: (1) it
allows teachers more opportunity to assess children’s educational needs and
individualize instruction, (2) it makes small-group learning experiences more
feasible, (3) it engages children in a broader range of learning experiences, (4)
provides opportunities for in-depth exploration of curriculum, (5) it provides
opportunities for closer teacher-parent relationships, and (6) it benefits working
parents who may need a longer school day.

However, not all educators, researchers, and parents favor full-day kinder-
garten. Detractors argue that young children who attend full-day kindergarten
are at risk of stress and fatigue due to the long day. However, some research
suggests that children attending full-day kindergarten demonstrate less frus-
tration than children in half-day programs and do not show evidence of fatigue (Elicker and Mathur 1997; Snyder and Hoffman 2001). Others argue that full-day kindergarten increases the chance that children will be expected to achieve and perform beyond their developmental capabilities.

Review of Research Comparing Full-Day and Half-Day Kindergarten

There is no absence of research comparing full- and half-day kindergarten. Although the bulk of the studies were conducted in the 1980s, the topic remains of great interest and debate as policy makers, researchers, and educators search for ways to improve the educational experience for young children. Along with mandatory kindergarten, age of entry into kindergarten, alternative program types (i.e., “beginder-garten” and transitional first grade), and curricular reforms, increasing the length of the school day is viewed as a way to positively affect young children’s development. As a result, more and more states and school districts are implementing full-day kindergarten, either instead of or in addition to half-day programs (Anderson 1983; Chmelynski 1998; Helmich 1985; Herman 1984; Humphrey 1990; National Association of State Boards of Education 1999; Ohio State Legislative Office of Education Oversight 1997; Terens 1984; Wisconsin State Department of Public Instruction 1980).

Despite the volume of studies comparing the two programs’ effectiveness, the research typically has several analytic shortcomings: a general weakness in terms of scientific rigor, small samples, unique populations, a limited range of controls, a paucity of longitudinal designs, and inappropriate analysis methods. Most studies focus on academic outcomes; fewer explore children’s behavioral and social outcomes or teachers’ and parents’ attitudes. In the context of this study, we highlight research that explores academic outcomes and briefly summarize the literature on other dimensions of the full-day kindergarten experience. We structure our review to move from studies with weaker designs to those with stronger designs, culminating with a few reviews of this topic. We aim both to give a full picture of available research on this topic and to emphasize stronger studies that allow more confidence in their results.

*Nonmatched/posttest-only studies.*—The methodologically weakest studies that examine differences in achievement between children attending full-day and half-day kindergarten use nonrandom and/or posttest-only designs. Some studies concluded that, by the end of kindergarten, children who attended full-day (or extended) programs outscored those who attended half-day programs on standardized tests of achievement (Alber-Kelsay 1998; Harman 1982). Even when the socioeconomic (SES) conditions of schools were matched, differences in achievement (including higher test scores and grades and fewer retentions) favored full-day programs (Humphrey 1980). These
advantages were sustained in grades 3 and 4 (Humphrey 1983). A study by Koopman (1991) supported these results. In contrast, two other nonmatched, posttest-only studies revealed no achievement differences between children attending full-day and half-day kindergarten (McClinton and Topping 1981; Savitz and Draker 1984). Thus, there is no consensus among studies with these weak designs.

In a retrospective analysis of 8,290 children in 27 school districts and a prospective analysis of two cohorts of children in 252 kindergarten classrooms, researchers found that both preschool and full-day kindergarten experience had positive effects on children’s school success through first grade (Cryan et al. 1992). Success in school (or lack of it) was measured by grade retention, whether or not children received special education or remedial services, scores on standardized tests, and teachers’ rankings of behavior. A more recent retrospective analysis of 17,363 urban children in Philadelphia by Weiss and Offenberg (2002) concluded that when third graders’ promotion rates, achievement test scores, report card marks, and school attendance were examined, students who attended full-day kindergarten were considerably more likely to be on grade level than students who attended half-day kindergarten. Moreover, these effects were sustained. By third grade, students who had attended full-day kindergarten showed higher achievement in reading, math, and science, earned higher grades, and had better attendance records than students who had attended half-day programs. When the students reached fourth grade, however, the full-day advantage accrued only in school attendance and science achievement.

Nonmatched/pretest and posttest studies.—Most research comparing achievement between children who attend full-day and those who attend half-day kindergarten is somewhat stronger in design. Although many studies were localized examinations of nonmatched half-day and full-day groups, these studies had pretest/posttest designs. Several such studies were sponsored by school districts aiming to evaluate the efficacy of newly implemented full-day programs. Many studies in the category also compared the effectiveness of the two options for specific groups of children.

Studies of this type focusing exclusively on at-risk children reported positive effects for extended and full-day kindergarten on standardized test scores (Carapella and Loveridge 1978; daCosta and Bell 2001; Hausner 2000; Johnson 1992; Nieman and Gastright 1981; Slaughter and Powers 1983; Warjanka 1982). Similarly, full-day kindergarten showed positive effects on minority children’s academic achievement (Entwisle et al. 1987; Morrow et al. 1998). White, middle-class children in one study exhibited no achievement differences between full-day and half-day kindergartners (Evans and Marken 1983). Hildebrand (2001) found that children attending full-day kindergarten scored higher than children attending half-day or alternate-day kindergarten in read-
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ing. However, there were no learning differences between full-day and half-day children in mathematics and writing. Research comparing the academic development of a socially diverse sample of full-day and half-day kindergartners found that children attending full-day kindergarten experienced greater gains than their half-day counterparts (Adock 1980; Anderson 1983; Entwisle et al. 1987; Lysiak and Evans 1976). In contrast, Hatcher et al. (1979) found no achievement differences between full- and half-day programs.

Although most of these studies’ results favor full-day over half-day kindergarten, two factors suggest a cautious interpretation. First, self-selection may have elevated unduly the benefits of full-day kindergarten. Second, the class sizes of extended-day programs were often smaller than those of half-day classes. In other words, studies with this design included few or no statistical controls for potentially confounding factors, other than the admittedly important pretest score. As a result, it is unclear whether selection effects, smaller class sizes, or other unmeasured factors may explain the greater academic gains for children in full-day kindergarten. Moreover, not all studies with this design reported an advantage for full-day programs.

Random assignment/matched control group studies.—Although the results are somewhat dated, we provide more detail about three studies that employed rigorous designs that included both random assignment and statistical controls for potentially confounding variables. One is Johnson’s (1974) three-year study comparing the academic achievement of children attending full-day and half-day kindergarten. Three cohorts of 40 children each were assigned randomly to full-day or half-day kindergarten classes with similar curricula. Even with random assignment, groups were also adjusted so that they matched on SES, ethnicity, and gender. On two achievement tests administered at the beginning and end of kindergarten, there were no differences between the two groups. Moreover, the two groups did not differ in first-grade reading level. However, when Karweit (1987) reanalyzed Johnson’s data by combining cohorts (to increase statistical power), she reported marginally positive effects for children attending full-day kindergarten. Effect sizes across the three cohorts were .38 SD at the end of kindergarten and .21 SD at the end of grade 1.

Although conducted over three decades ago, Winter and Klein’s (1970) two pilot studies also had strong designs. In four elementary schools in one large suburban district, they estimated the effect of attending extended-day kindergarten programs on children’s achievement. Two schools served predominantly poor children, and two served mostly middle-class children. In the first study, children identified by achievement scores and teacher ratings as educationally disadvantaged were randomly assigned to traditional half-day or extended-day kindergarten classes. The second pilot study assigned children who were educationally advantaged but whom teachers judged to be “least ready” for school to traditional half-day or extended-day kindergarten classes.
At the end of grade 1, extended-day kindergartners obtained higher achievement scores than half-day kindergartners. Effects were stronger, moreover, for children identified as educationally disadvantaged.

Taking advantage of a school district’s decision to move from half-day kindergarten to full-day kindergarten over a two-year period, Holmes and McConnell (1990) studied the effects of full-day kindergarten on academic achievement. Half of the 20 schools in the district were randomly chosen to provide full-day kindergarten. Half of the schools in both groups consisted of lower-income schools that were receiving federal funds from Title 1. Researchers found that the children who attended full-day kindergarten scored higher on reading comprehension and mathematics concepts and applications. Two later reanalyses (by Hough and Bryde [1996] and Wang and Johnstone [1999]) supported these results.

In a two-year mixed-method study, Eliker and Mathur (1997) compared 69 children in four full-day kindergarten classrooms to 110 children in eight half-day classrooms, using random assignment. All kindergarten programs were activity based and child centered. The researchers matched teachers in full-day and half-day kindergartens on education, experience, and teaching philosophy. Beyond the randomized design and demographic matching, the study included statistical controls for family income and prekindergarten developmental screening, although parents of full-day and half-day students did not differ in educational level and ethnicity in this relatively small study. Comparing them to children in half-day classes, it is not surprising that researchers reported that full-day kindergartners spent more time in both child-initiated activities and teacher-directed individual work and were rated higher on grades and readiness for first grade. Parents and teachers in the full-day programs were also more satisfied along several dimensions. Thus, these studies with stronger designs favored full-day kindergarten, particularly for disadvantaged populations.

Research reviews.—Four literature syntheses, most conducted in the 1980s, compared many studies of full-day and half-day kindergarten. The authors differed in the numbers of studies they included, their standards for including studies, and their conceptual organizations. Stinard (1982) included eight studies comparing the effects of different kindergarten schedules on children’s development. As all the reviewed studies were generalizable to the population of kindergarten children and all measured student outcomes, the review excluded studies that focused exclusively on disadvantaged populations. Seven studies reported positive effects for full-day kindergarten on achievement, with the eighth reporting no differences.

Karweit (1987), who categorized 18 existing studies according to methodology and design, concluded that full-day kindergarten has positive short-term effects on children’s achievement and that those effects are stronger for
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children from low-SES families. Speculating that the nature of instructional programs may have important consequences for children’s development, Karweit recommended additional research to examine the effect of different types of kindergarten programs on children’s development.

Puleo (1988), who reviewed 20 studies that compared treatment and control groups in multiple regression models, identified eight types of studies: those that examine short-term and long-term academic development; the interaction between SES and full-day and half-day kindergarten; instructional time; social, emotional, and developmental effects; teachers’ reactions to full-day kindergarten; parents’ reactions to full-day kindergarten; attendance; and financial considerations. Despite Puleo’s observation that much of the research “suffers from serious problems in internal and external validity” (1988, 428), he concluded that full-day kindergarten has many positive effects. Furthermore, he also recommended additional research to evaluate the nature of time engaged in educational activities for both half-day and full-day kindergarten.

Olsen and Zigler (1989), who examined approximately 30 studies, concurred with the findings of the others; children in full-day programs demonstrate greater short-term gains on standardized tests, especially for disadvantaged and bilingual children. They suggested, however, that a full-day kindergarten curriculum is not necessarily more individually oriented or innovative than a half-day kindergarten curriculum. The authors cautioned against embracing full-day kindergarten, as children may not be ready developmentally to cope with longer periods of academic instruction. The most recent review, by Fusaro (1997), is a meta-analysis of 23 studies examining the efficacy of full-day kindergarten. Fusaro concluded that children who attend full-day kindergarten academically outperform children who attend half-day kindergarten. His analysis reveals that full-day kindergarten accounts for a substantial proportion of the variance in outcome measures.¹ These reviews are not orthogonal; a number of studies were included in more than one review. Thus, it is not surprising that the reviews drew similar conclusions.

Social and behavioral effects.—We have concentrated our review on research focusing on academic differences between full-day and half-day kindergarten as this is the focus of our research. However, some studies have explored social and behavioral effects. Cryan et al. (1992) concluded that teachers rated full-day children higher than half-day children on dimensions of classroom behavior. Similarly, children who attend full-day kindergarten were found to engage in more child-to-child interactions (Hough and Bryde 1996), experience greater improvement in social skills (da Costa and Bell 2000; Elicker and Mathur 1997), and have better self-concepts (Anderson 1983; Humphrey 1983) than children who attend half-day kindergarten. In contrast, other studies showed no behavioral or social differences between children in full-day and half-day kindergarten (Cleminshaw and Guidulbaldi 1979; Hatcher and
Lee et al.

Schmidt 1980). Several studies demonstrated positive parent and teacher attitudes toward full-day kindergarten (Anderson 1985; Eicker and Mathur 1997; Evansville-Vanderburgh School Corporation 1988; Graja 1984; Hough and Bryde 1996; Housden and Kam 1992; Humphrey 1983; Johnson 1993; Terens 1984). Thus, the findings from this area are more mixed.

Summary of research on full-day and half-day kindergarten.—This topic has been subjected to considerable empirical scrutiny, with the majority of studies having been conducted at least two decades ago. Many appeared as reports, although those with stronger designs were peer-reviewed articles in academic journals. Studies from the 1990s reveal that the topic continues to be an important focus of early childhood education. Many of the more recent studies include a focus on children’s social and behavioral outcomes, as well as teachers’ and parents’ perceptions of full-day kindergarten. In general, research findings favor full-day (or extended-day) kindergarten over half-day programs. Furthermore, some of this research suggests that full-day kindergarten is especially effective for socially and educationally disadvantaged children. Some studies document long-term benefits from full-day kindergarten, whereas others report no long-term positive effects. A handful of studies report that children who attend full-day kindergarten are less likely to be retained and to be enrolled in special education classes. There are, however, several studies that report no differences between full-day and half-day kindergarten. However, no study demonstrates academic advantages for children in half-day kindergarten. Although many studies had weak designs, some were stronger; several incorporated matched samples, pre/post designs, statistical controls, randomized designs, and longitudinal follow-ups. The majority of studies on this topic were conducted in local settings, either in single schools or single school districts. Virtually all the studies focused exclusively on public schools. Generalizing the results of localized studies to a larger population is inappropriate. Virtually all studies, including the research syntheses, used single-level research methodologies, even though the phenomenon is inherently multilevel. That is, half-day or full-day kindergarten is a group-level experience (in classrooms, schools, or districts), although effects are expected to accrue to individual children.

Research Focus

Research Questions

The study described here resembles much of the research we have reviewed on full-day and half-day kindergarten in that we use a comparative evaluation approach to explore how the type of kindergarten program children experience influences their academic achievement. The outcomes on which we focus mea-
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sure children’s cognitive outcomes at the end of the kindergarten year in the
domains of literacy and mathematics. Despite that similarity, our study improves
on much of the existing research in at least four ways. First, it is current, using
data collected in school year 1998–99. Second, it is national rather than local;
we use a large and nationally representative sample of public schools and kin-
dergarten children. Third, it is longitudinal, in that the data we use were collected
at both the beginning and end of the kindergarten year. Fourth, we employ
multilevel methods to explore what is, in essence, a multilevel question: how
one school structural characteristic influences the children whose educational
experiences are in that school.

We construct our evaluation in a two-level hierarchical format (children
nested within schools). Our models include within-school (level-1) statistical
controls for children’s social and academic backgrounds. As we control for
children’s academic achievement as they enter kindergarten, we interpret our
findings as estimating learning in these two cognitive domains over the kin-
dergarten year. We also include school-level controls (at level 2) for structure,
social, and academic composition. Beside the major evaluation question, com-
paring the impact of the full-day and half-day kindergarten experience on
learning, we also explore whether participating in full-day or half-day kin-
dergarten has differential effects on children’s learning, based on the types of
schools they attend. Our analyses are designed to address two questions:

Research question 1. Do young children who attend public schools that
offer full-day kindergarten programs learn more over the school year, in
terms of achievement in the domains of literacy and mathematics, than
their counterparts who attend schools with half-day programs?

Research question 2. Are the learning benefits associated with enrollment
in public schools offering full-day or half-day kindergarten different for
schools of varying academic composition or in schools with different social
compositions?

The first question focuses on program effectiveness (measured in terms of
learning). The second question has implications for equity (measured in terms
of differential learning for children who attend certain types of schools). Both
effectiveness and equity are important, particularly for policy makers and
practitioners who make decisions about whether to implement full-day and
half-day programs in public schools and for parents who may have some
latitude in selecting which schools their kindergarten children may attend.

Conceptual Model

A school effects study.—The conceptual model displayed in figure 1 guides our
inquiry. Both the model and the research questions fall within the purview of
FIG. 1.—Multilevel heuristic model for evaluating the effects of full-day versus half-day kindergarten on children’s learning in literacy and mathematics.
Learning in Full- and Half-Day Kindergarten

“school effects research.” Studies of this sort investigate how characteristics of schools (here, the type of kindergarten program offered) influence children’s school progress (in this case, learning in literacy and mathematics over the kindergarten year). As we investigate school effects on children, we formulate a multilevel model that recognizes that students are “nested” in schools. Kindergarten structure, the central construct in this study, is located directly beneath the outcomes in our model. The outcomes, achievement in literacy and mathematics at the end of kindergarten, are at the right. We underscore the centrality of these two constructs to our research by the heavy lines outlining the boxes that represent them.

Characteristics of children.—Within the box at the left in figure 1 are two types of important background characteristics related to children’s school achievement: social background (gender, race/ethnicity, socioeconomic status or SES, non–English language status, and age) and academic background (whether the child was repeating kindergarten and his or her cognitive status in either literacy or mathematics at the beginning of kindergarten). We expect that academic and social background characteristics are related to one another. Our multilevel analyses investigate the direct relationship of social and academic background on end-of-year achievement, captured by arrow A.

Characteristics of schools.—Four major constructs characterize elementary schools in our conceptual model: setting, social composition, academic composition, and kindergarten program type. We capture school setting with four measures: (1) location (large city, medium city, suburb/large town, or small town/rural), (2) school region (Northeast, Midwest, South, or West), (3) the total number of kindergarten children in the school, and (4) the grade levels the school serves (primary schools [through grade 3], elementary schools [through grade 5 or grade 6], and combined schools [through grade 8 or grade 12]). We capture school social composition with two measures: (1) minority enrollment and (2) average SES. We capture school academic composition with one measure: the average ability of entering kindergartners. The school characteristic of special interest, in the separate darkly outlined box, is full-day versus half-day kindergarten. We would expect children to learn more in full-day kindergarten programs because of the increased time they are exposed to school. The main effects of school controls on children’s learning are indicated in figure 1 by arrow B. The direct effect of kindergarten program type on the outcomes is indicated by arrow C. The analytic results that are captured by arrow C address research question 1.

Reflecting the multilevel nature of our questions, the constructs illustrated in figure 1 are measured at two levels. Children’s social and academic backgrounds and academic outcomes are measured on individual children, which are represented in our conceptual model in white circles. School characteristics are illustrated in figure 1 in gray boxes. Arrow D represents the equity concerns.

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in this multilevel model. We investigate equity in this model through a series of school-level interactions (i.e., school characteristics by kindergarten program type). Results associated with arrow D address research question 2.

Method

Data and Sample

The ECLS-K data.—The data we use were drawn from the Early Childhood Longitudinal Study—Kindergarten Class of 1998–99 (ECLS-K), sponsored by the National Center for Education Statistics (NCES) (U.S. Department of Education 2000).3 The purpose of ECLS-K is to document the educational status and progress of a nationally representative cohort of U.S. children from kindergarten through fifth grade. The ECLS-K base-year (1998) data collection had a stratified design structure. The primary sampling units were geographic areas consisting of counties or groups of counties from which 1,277 public and private schools offering kindergarten programs were selected. Finally, a random sample of approximately 24 children per school was drawn, regardless of school or kindergarten size. The ECLS-K plan calls for collecting data on the same children as they enter kindergarten, at the end of their kindergarten year, in the fall and spring of first grade (with a random subsample in the fall), and in the spring of third and fifth grades. In this study, we use data from the first two waves of ECLS-K, in the fall and spring of kindergarten. Sampled children were tested at each wave. Information at both waves was also collected from parents, through structured interviews administered by telephone, and from each child’s kindergarten teacher, through written surveys. A school administrator was also surveyed in the first wave.

Weights.—Certain types of schools (particularly private schools) were oversampled in ECLS-K, as were certain types of children (Asian/Pacific Islanders). The ECLS-K data include school-level and child-level weights used to generalize results to the population from which they were drawn. Analyses using the ECLS-K data require the use of these design weights to compensate for the stratified sampling strategy, unequal probabilities of selection (specifically, here we must compensate for the intentional oversampling of Asian/Pacific Islander children and fixed numbers of children selected in schools regardless of their size), and to adjust for the effects of nonresponse.4 Using these design weights allows us to generalize the results of analyses of the ECLS-K data to the U.S. population of kindergarten children and schools offering kindergarten programs in the 1998–99 school year. Thus, this study has very strong external validity.

We used three different weights in our analyses. First, we weighted our
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descriptive analyses on kindergarten children, using an adjusted version of the child weight BYCW0 (normalized to preserve the sample size of children for statistical testing). Second, we weighted descriptive analyses on schools, using an adjusted version of school weight S2SAQW0 (again, normalized to preserve the actual school sample size). Third, for our two-level hierarchical linear models, we used both the adjusted school weight and a within-school weight that we constructed.5

Analytic sample.—We selected our analytic sample in three stages. At stage 1, we focused on children with data on the measures important to our study. We selected children who (1) remained in the same public school over the year of kindergarten, (2) had complete cognitive test scores (fall and spring), and (3) had a nonmissing weight value. This initial student sample was nested in an initial sample of public schools. At stage 2, we refined our school sample, selecting only those schools that (1) were included in the ECLS-K school file, (2) offered either full-day or half-day kindergarten (but not both), and (3) included at least five children from our initial student sample (to facilitate multilevel analysis).6 At stage 3 we eliminated schools that included only prekindergarten and kindergarten.7 These three school restrictions, of course, eliminated additional children from the initial student sample.

The full ECLS-K sample is smaller than that called for in the original sampling plan: approximately 870 schools and over 18,200 children participated in the kindergarten year data collection. Our final analytic sample included 8,455 kindergarten students in 504 public schools (with an average within-school sample of 17 children). Missing data analyses suggested a slightly more affluent and less racially diverse group of kindergarten students than the students in the full ECLS-K sample. Of the 8,455 sampled kindergartners, 55.7 percent (weighted percent) were in full-day programs and 44.3 percent attended half-day kindergartens (see [online] app. B, tables B1 and B2, for descriptive information on the samples). Of the 504 public schools, 50.8 percent (weighted percent) offered kindergarten as a full-day program. The majority of the sampled schools (roughly 78 percent) were elementary schools (up to grade 5 or grade 6), although some (about 7 percent) were primary schools (grade 3 and below) and 15 percent were combined schools (including up through grade 12).

Measures

Outcomes.—At the beginning and end of kindergarten, children were individually administered adaptive and untimed cognitive assessments of skills in literacy, mathematics, and general knowledge. Our dependent measures are a subset of these scores, in literacy and mathematics at the end of the kin-
dergarten year. The literacy assessment included items “designed to measure basic skills (print familiarity, letter recognition, beginning and ending sounds, rhyming sounds, word recognition), vocabulary (receptive vocabulary), and comprehension (listening comprehension, words in context). Comprehension items were targeted to measure skills in initial understanding, developing interpretation, personal reflection, and demonstrating critical stance” (NCES 2000, chap. 2, 6). The mathematics assessment measured conceptual knowledge, procedural knowledge, and problem solving. The items were equally divided between number sense and measurement. We used the scale score versions of these tests that had been equated with the Item Response Theory (IRT). In our analyses, we converted the IRT scores to z-scores (mean \(M = 0\), standard deviation \(SD = 1\)), in order to present our results in effect size units.

Child characteristics.—As independent variables, we used several measures of children’s social background: gender (female = 1, male = 0); race/ethnicity (a series of dummy variables that captured whether the student was Asian, Hispanic, or black, with whites as the uncoded comparison category); SES (a z-score, \(M = 0\), \(SD = 1\)); non-English-speaking household (coded 1; English-speaking household coded 0); and age (a z-score \(M = 0\), \(SD = 1\), recoded from children’s age in months). Our descriptive tables also provide information about children’s poverty status (1 = below the poverty line, 0 = at or above the poverty line). We captured academic background by whether children were repeating kindergarten during 1998–99 (repeaters = 1, first timers = 0) and their IRT test scores at kindergarten entry in literacy and mathematics, also as z-scores. By including controls for entry-level test scores, we interpret the outcomes as measures of learning in each domain. As the time between fall and spring testing varied substantially (from four to eight months), we also included an indicator of the testing time gap (in days, converted to a z-score). As young children learn fast, larger time gaps likely result in more learning, and we felt that it was important to adjust for time between assessments.

School characteristics.—Our central school-level independent variable is a dummy-coded indicator of whether the school offered kindergarten as a full-day or a half-day program (full-day = 1, half-day = 0). We provide information about how we constructed the full-day/half-day indicator variable, as well as details of the construction of all the child-level and school-level measures used in the study, in appendix A (online). Other measures of school setting include urbanicity (dummy-coded indicators for large city, medium city, and small town or rural setting, each compared to suburbs and large towns); region (dummy-coded indicators for Midwest, South, and West, each compared to the Northeast); kindergarten size (as a z-score); and the grades the school served (dummy-coded indicators for primary and combined schools, each
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compared to elementary schools. We tapped school social composition as follows: minority enrollment (several dummy-coded indicators: 26–50 percent, 51–75 percent, and 76–100 percent, each compared to 0–25 percent); and school average SES (a z-score \( M = 0, SD = 1 \)). School academic composition was the average ability of entering kindergartners (a z-score aggregate).

Analytic Approach

Multilevel questions and methods.—Both research questions guiding this study are multilevel, consistent with our school effects approach. Addressing these questions involves estimating the difference between kindergarten children’s learning in literacy and mathematics in full-day or half-day public schools (research question 1) and whether this effect differs for public schools of varying academic compositions, structures, or social compositions (research question 2). Given the multilevel nature of both our questions and our data, we use a multilevel analysis strategy, hierarchical linear modeling or HLM (Raudenbush and Bryk 2002; Raudenbush et al. 2000). Although the statistical details of HLM are complex, the concept is not.

In an HLM model such as we use here (with children nested in schools), analyses are at two levels. Level 1 focuses on individuals within each school, where children’s achievement scores are adjusted for the academic and social background characteristics of their kindergarten peers in that school. Although HLM uses maximum likelihood statistical estimation, this procedure can be conceptualized as analogous to a series of small within-school regressions—one in each school—with regression coefficients (mostly intercepts, but possibly also other regression slopes) becoming outcomes at the next level. Adjusted outcomes (one for each school) become the dependent variables in a school-level analysis. Our research questions are addressed at level 2; the decision to offer kindergarten as a full-day or half-day program is made by schools. The full-day/half-day effect is adjusted for other structural and compositional characteristics of schools. More detail about the HLM procedures as they apply in this study is provided as we describe our results.

Presentation of results.—Results are both descriptive and analytic. Descriptive results present information about both children and schools. Information on children is presented as subgroup means on the background and outcome measures for children who experienced kindergarten in either full-day or half-day programs. Group mean differences were tested for statistical significance with \( t \)-tests (for continuous variables) and cross tabulation for categorical variables. We also present zero-order correlations between child-level variables. Information about schools is presented as group means on each school char-

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acteristic included in our study, again by whether the school offered full-day or half-day kindergarten.

To facilitate comparison of effects across outcomes in different metrics, we present multivariate results from the between-school HLM models in a between-school effect-size (SD) metric (Rosenthal and Rosnow 1984). Research question 1 is addressed with the effect of full-day versus half-day kindergarten on adjusted school average achievement in literacy and mathematics in the level-2 HLM models. We addressed research question 2 (equity) with a series of school-level interactions between the full-day/half-day kindergarten indicator and school structure and composition measures in our level-2 HLM models.10

Results

Descriptive Results

Which children have access to full-day kindergarten?—Table 1 presents enrollment patterns for U.S. public school children who attended full-day kindergarten in 1998–99. Slightly over half of these children (55.7 percent) are in full-day programs. Boys and girls are equally likely to enroll in full-day kindergarten. White, Hispanic, and Asian children enroll in full-day kindergarten at comparable rates (around 48–51 percent), but black children are more likely to enroll in full-day kindergarten (83 percent). Kindergarten repeaters are more likely to attend full-day programs than are first-time kindergartners (67 percent vs. 55 percent). Moreover, children from English-speaking households are more likely to attend full-day kindergarten than are children in non-English-speaking households (56 percent vs. 51 percent). Children from families living under the poverty line are much more likely to enroll in full-day kindergarten than children whose families are at or above the poverty line (70 percent vs. 52 percent).

Table 2 presents additional subgroup means for children in full-day and half-day kindergarten. In general, full-day kindergartners are less advantaged in socioeconomic terms. In addition to the increased full-day enrollments of children living in poverty, there are mean differences in SES between the two groups of 0.27 SD, with more advantaged children in half-day programs. Age differences are very small, with the full-day group only 0.6 months older than the half-day group (which may be due to the somewhat higher percentage of kindergarten repeaters attending full-day programs). Differences in academic background are considerably smaller than differences in social background. Half-day kindergartners enter school with slightly higher math and literacy scores, but the differences are small. By the end of kindergarten, half-day
TABLE 1

Who Enrolls in Full-Day Kindergarten?

<table>
<thead>
<tr>
<th></th>
<th>Percent Enrolled in Full-Day Kindergarten</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>55.7</td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>55.4</td>
</tr>
<tr>
<td>Male</td>
<td>56.0</td>
</tr>
<tr>
<td>Race/ethnicity:</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>50.5</td>
</tr>
<tr>
<td>Black</td>
<td>82.4***,a</td>
</tr>
<tr>
<td>Hispanic</td>
<td>51.1</td>
</tr>
<tr>
<td>Asian</td>
<td>48.1</td>
</tr>
<tr>
<td>Non-English-speaking household</td>
<td>51.0***,b</td>
</tr>
<tr>
<td>English-speaking household</td>
<td>55.9</td>
</tr>
<tr>
<td>Kindergarten repeater</td>
<td>67.0***,c</td>
</tr>
<tr>
<td>First-time kindergartner</td>
<td>55.2</td>
</tr>
<tr>
<td>Below poverty line</td>
<td>70.4***,d</td>
</tr>
<tr>
<td>At or above poverty line</td>
<td>52.2</td>
</tr>
</tbody>
</table>

NOTE.—Unweighted n = 8,455 public school children.

*a Compared to whites (tested with χ² statistic).

*b Compared to kindergartners from English-speaking homes (tested with χ² statistic).

*c Compared to first-time kindergartners (tested with χ² statistic).

*d Compared to children living in households at or above the poverty level (tested with χ² statistic).

*** p < .001.

kindergartners’ math advantage has shrunk considerably, and there are no significant differences in literacy scores. All children were tested, on average, just over six months apart, but those in full-day schools experienced a very slightly longer testing time gap (by two days).

Which public schools offer full-day kindergarten programs?—Patterns of the access to full-day kindergarten, presented in table 3, indicate that roughly half the public schools in this sample offer full-day programs (50.8 percent). Full-day kindergarten programs are more common in large cities and small town/rural areas than in medium-sized cities and suburbs (62 percent and 60 percent vs. 43 percent and 40 percent). School grade span is marginally related to the availability of full-day kindergarten, with combined schools (e.g., including grades K–12) more likely to offer full-day kindergarten. The access to full-day kindergarten is comparably low in the Northeast and the West (where 25–29 percent of kindergartens are full day), but full-day programs are more common in the Midwest (where 46 percent are full day) and very common in the South (where 84 percent are full day). Full-day programs are also more
Table 2 presents additional subgroup means for public schools that offer full-day or half-day kindergarten. Full-day kindergarten enrollments tend to be somewhat larger than half-day enrollments (74 children per school vs. 66 students per school). Consistent with the academic and social background patterns in table 2, schools with half-day programs enroll higher SES students (difference of 0.29 SD) and children with higher entering ability (difference of .12 SD).

Summary of descriptive results.—These results suggest some trends among children and schools in terms of their access to full-day or half-day kindergarten programs. Black children, kindergarten repeaters, and children from less affluent families are more likely to attend full-day kindergarten. Attendees enter
full-day kindergarten with somewhat lower achievement scores in literacy and mathematics, but by the end of the year they are on equal status with half-day kindergartners in literacy and only slightly behind in mathematics. Full-day kindergarten is much more common in schools located in large cities or small town/rural areas, in the South and Midwest, and in schools with higher proportions of minority students. These descriptive differences suggest that full-day kindergarten may be intended as a compensatory program for at-risk children in public schools, reflecting what was described in the literature. The complex interrelationships among these school and child characteristics, as
well as their association with children’s full-day or half-day experiences in kindergarten, suggest the need to evaluate the relative efficacy of kindergarten programs in a multivariate and multilevel format.

**Multivariate and Multilevel HLM Results**

*Within-school HLM models exploring learning.*—An HLM analysis that explores these research questions with the ECLS-K data typically begins by partitioning the total variance in spring literacy and mathematics achievement into its within- and between-school components. Informative here is the proportion of total variance in each outcome that lies systematically between schools (the intraclass correlation or ICC; see app. B [online], table B3). Slightly more than one-fifth of the variance in spring achievement lies between schools: 23.3 percent for literacy and 21.4 percent for math (adjusted ICCs). Only this proportion of the variance in outcomes, which in this instance is substantial, can potentially be explained by school-by-school differences such as whether the school offers full- or half-day kindergarten. These proportions suggest substantial academic stratification among U.S. schools. They also provide empirical support for the need to use multilevel methods beyond the theoretical rationale we offered earlier.

Within-school (level-1) HLM models explore how child-level characteristics are associated with the outcomes (see table 5). Our focus in these models is on two random effects, namely, the two intercepts, or average achievement adjusted for gender, race, and social and academic background. These two

<table>
<thead>
<tr>
<th></th>
<th>Half Day</th>
<th>Full Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unweighted sample size</td>
<td>236</td>
<td>268</td>
</tr>
<tr>
<td>Weighted percentages</td>
<td>49.2</td>
<td>50.8</td>
</tr>
<tr>
<td>Kindergarten size</td>
<td>65.8</td>
<td>73.9*</td>
</tr>
<tr>
<td>Average entering SES</td>
<td>.01***</td>
<td>−.28</td>
</tr>
<tr>
<td>Average entering ability</td>
<td>−.02****</td>
<td>−.14</td>
</tr>
</tbody>
</table>

**Table 4**

*Characteristics of Schools with Half-Day and Full-Day Kindergarten Programs*

NOTE.—Unweighted public schools.

Np 504

a Differences in means tested for significance (using a t-test). Significance levels are indicated on the larger of the two numbers.

b Entering ability is the within-school mean of the fall standardized literacy and mathematics scores.

* p < .05.

*** p < .001.
### Learning in Full- and Half-Day Kindergarten

#### TABLE 5

<table>
<thead>
<tr>
<th>Within-School Models of Kindergarten Achievement</th>
<th>Spring Literacy Achievement</th>
<th>Spring Math Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random effect (intercept)</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Fixed effect:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>.08***</td>
<td>.00</td>
</tr>
<tr>
<td>Black</td>
<td>-.14***</td>
<td>-.17***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>.00</td>
<td>-.05*</td>
</tr>
<tr>
<td>Asian</td>
<td>.18**</td>
<td>.11*</td>
</tr>
<tr>
<td>Non-English-speaking household</td>
<td>-.03</td>
<td>-.01</td>
</tr>
<tr>
<td>Age</td>
<td>.01*</td>
<td>.09***</td>
</tr>
<tr>
<td>Kindergarten repeater</td>
<td>-.20***</td>
<td>-.12***</td>
</tr>
<tr>
<td>SES</td>
<td>.05***</td>
<td>.05***</td>
</tr>
<tr>
<td>Fall achievement</td>
<td>.75***</td>
<td>.77***</td>
</tr>
<tr>
<td>Testing time gap</td>
<td>.12***</td>
<td>.10***</td>
</tr>
</tbody>
</table>

Variance components for random effects:

- Between-school SD: .214*** for Literacy, .172*** for Math
- Between-school variance ($\tau_{00}$): .046*** for Literacy, .030*** for Math
- Degrees of freedom: 503 for both Literacy and Math
- Chi-square: 1,957.8*** for Literacy, 1,468.6*** for Math

**Note.**—Unweighted $n = 8,455$ public school children; unweighted $N = 504$ public schools.

* $p < .10$,
** $p < .05$,
*** $p < .001$.

The parameters are “random” effects, because we have allowed them to vary between schools (their between-school variance is “free” and not “fixed”). We explore these two parameters as functions of school characteristics.

Children’s test scores in each subject at kindergarten entry are very strongly associated with their scores on the same tests at the end of kindergarten (effect sizes [ES] of 0.75 and 0.77 SD for literacy and mathematics). Beyond the large coefficients for prior ability, several other residual fixed effects of children’s background characteristics are associated with learning. Fixed effect patterns differ between the two outcomes. For example, over the kindergarten year, girls learn slightly more than boys in literacy (ES of 0.08 SD) but not math; the same pattern occurs for Asians compared to whites (ES of 0.18). Black children learn less than their white counterparts on both tests (ES = -0.14 SD in literacy and -0.17 SD in math). Age is significantly related to learning in math but not literacy (ES = 0.03). Children who repeat kindergarten learn less than their first-time counterparts in both subjects (ES = -0.20 SD in literacy and -0.12 SD in math). SES is positively but modestly associated with learning in both subjects (ES of 0.05 SD). Children learn...
more in both subjects if the time between assessments is greater (ESs of 0.12 SD and 0.10 SD). Residual variances, shown at the bottom of table 6, suggest that even with these child-level statistical controls in the model, significant between-school variability remains in the two adjusted intercepts. This suggests that modeling them as functions of school characteristics will be fruitful.13

Between-school HLM models: Testing the effectiveness of full-day and half-day kindergarten.—The major findings for this study are displayed in table 6. Because the fixed effects changed very little from the within-school models, they are not reported in the between-school models. Rather, we concentrate our discussion on school-level effects on the intercepts (average learning in literacy and mathematics). In school effect studies and other studies using multilevel methods, it is customary to report effect sizes relative to the between-school variation only (Raudenbush and Bryk 2002). In other words, such an effect size reflects a standardized difference relative to the variation in the outcome that is attributable to schools. These results were calculated by dividing the results from our HLM analysis by the between-school SD of each outcome estimated from the within-school model (0.214 for literacy and 0.172 for mathematics, from table 6).

Results that address research question 1 are at the top of table 6. Children who attend schools that offer full-day kindergarten learn more in both literacy (ES = 0.93 between-school SD, p < .001) and math (ES = 0.75 between-school SD, p < .001), net of children’s social and academic backgrounds and of characteristics of their schools.14 Although not directly related to our research questions, we note that children learn more in both subjects in schools enrolling more able children (average entering ability ES = 0.27 between-school SD in literacy, 0.42 between-school SD in math, both p < .001). This finding is similar to that found in Australian kindergartens reported by Share et al. (1984). School social composition is also related to mathematics learning (but not literacy learning), with less affluent children learning more (ES = −0.34 between-school SD in math, p < .01). School urbanicity and grade levels are unrelated to learning. The change in the between-school variance components (from the bottom of tables 5 and 6) indicates the extent to which our models explain the between-school variation in literacy and mathematics learning in kindergarten. Our models explain nearly 25 percent of the between-school variance in literacy and mathematics achievement.15

Differential effectiveness of full-day kindergarten in some settings.—Several results from table 6 address research question 2. The findings concerning equity are associated with interaction effects between the full-day/half-day indicator and other school features. Significant interaction terms indicate that the effect on learning of attending a school offering full-day kindergarten differs according to (1) region of the country and (2) the racial composition of the school. To facilitate the substantive interpretation of numerical interaction terms from
<table>
<thead>
<tr>
<th>Random Effects</th>
<th>Spring Literacy Achievement</th>
<th>Spring Math Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept:</td>
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<td></td>
</tr>
<tr>
<td>Base</td>
<td>-.83***</td>
<td>-.70**</td>
</tr>
<tr>
<td>Full-day kindergarten</td>
<td>.93***</td>
<td>.75***</td>
</tr>
<tr>
<td>School demographics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average entering ability</td>
<td>.27***</td>
<td>.42***</td>
</tr>
<tr>
<td>Average SES</td>
<td>-.12</td>
<td>-.34**</td>
</tr>
<tr>
<td>Kindergarten size</td>
<td>-.02</td>
<td>-.03</td>
</tr>
<tr>
<td>School urbanicity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large city</td>
<td>.20</td>
<td>.16</td>
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<tr>
<td>Medium city</td>
<td>.12</td>
<td>-.09</td>
</tr>
<tr>
<td>Rural/small town</td>
<td>-.03</td>
<td>.20</td>
</tr>
<tr>
<td>School type:</td>
<td></td>
<td></td>
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<tr>
<td>Primary (e.g., K–3)</td>
<td>.10</td>
<td>.03</td>
</tr>
<tr>
<td>Combined (e.g., K–12)</td>
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<td>-.03</td>
</tr>
<tr>
<td>Unknown</td>
<td>.37</td>
<td>.47</td>
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<tr>
<td>Region:</td>
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<tr>
<td>Midwest</td>
<td>.15</td>
<td>.33*</td>
</tr>
<tr>
<td>South</td>
<td>.32</td>
<td>.24</td>
</tr>
<tr>
<td>West</td>
<td>.93***</td>
<td>1.02***</td>
</tr>
<tr>
<td>Full-day × West</td>
<td>-.96**</td>
<td>-1.13**</td>
</tr>
<tr>
<td>Black/Hispanic enrollment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26%–50%</td>
<td>.09</td>
<td>-.56*</td>
</tr>
<tr>
<td>51%–75%</td>
<td>.86**</td>
<td>-.10</td>
</tr>
<tr>
<td>76%–100%</td>
<td>-.14</td>
<td>-.24</td>
</tr>
<tr>
<td>Full-day × 51%–75%</td>
<td>-.89***</td>
<td></td>
</tr>
<tr>
<td>Full-day × 25%–50%</td>
<td></td>
<td>.72*</td>
</tr>
<tr>
<td>Variance components for random effects:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between-school SD</td>
<td>.189***</td>
<td>.151***</td>
</tr>
<tr>
<td>Between-school variance ((\tau_0))</td>
<td>.035***</td>
<td>.023***</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>485</td>
<td>485</td>
</tr>
<tr>
<td>Chi-square</td>
<td>1,607.8***</td>
<td>1,215.4***</td>
</tr>
</tbody>
</table>

**NOTE.**—Unweighted \(n = 8,455\) public children; unweighted \(N = 504\) public schools.

\(^a\) All effects expressed in between-school SD units (literacy between-school SD = .214); from table 5.

\(^b\) All effects expressed in between-school SD units (math between-school SD = .172); from table 5.

\(^*\) \(p < .10\).

\(*^*\) \(p < .05\).

\(*^**\) \(p < .01\).

\(*^***\) \(p < .001\).
Fig. 2.—Differential full-day and half-day kindergarten effects on learning by region of the country.

table 6, we present them as graphs in figures 2 and 3. Results are sums of the main effects for full-day kindergarten for each subject and any relevant interaction terms (see Aiken and West 1991; Cohen et al. 2003).

The scores in figure 2 reflect learning differences between full-day and half-day kindergarten by region of the country. Literacy is in panel A; mathematics is in panel B. In both subjects, consistent benefits accrue for full-day kindergarten for schools in the Northeast, the Midwest, and the South. For schools in the West, however, where full-day kindergarten is not as common and where it is available in less than 30 percent of the public schools (table 3), the learning pattern is quite different. Full- and half-day programs exhibit near-identical literacy learning, suggesting a higher than usual performance among half-day kindergartners and a lower than usual performance of full-day kindergartners. Despite the fact that the full-day/half-day lines cross in panel B, suggesting that average mathematics achievement is higher for kindergartners in half-day programs in the West than for full-day programs, additional statistical testing indicates no significant difference between full-day and half-day programs for schools located in the western states.
The full-day advantage also varies depending upon the racial composition of the school (shown in fig. 3). There is a consistent full-day kindergarten advantage in literacy learning for children in schools that enroll 50 percent or fewer minority students or in schools with minority enrollments over 75 percent. However, in schools enrolling 51–75 percent minority students, children learn the same amount whether in half-day or full-day kindergarten schools (due to the unusually high literacy performance of children in half-day programs in such schools). In contrast, the full-day kindergarten in mathematics learning is nearly double in schools that enroll 26–50 percent minority students, due to the unusually low mathematics performance of children in half-day schools with those racial compositions.

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Fig. 3.—Differential full-day and half-day kindergarten effects on learning by school racial/ethnic composition. \(a\), literacy; \(b\), mathematics.
Reconsidering the Full-Day Learning Advantage

Time between assessments is less than a school year.—We suggest that the full-day learning advantage is underestimated for the same reason that our models certainly underestimate the total amount of learning that takes place during the kindergarten year. Instead of spanning the full academic year (ECLS-K children are in school, on average, for 9.5 months), the fall tests were administered after the beginning of kindergarten (some as late as December), and the spring tests were administered before the end of the kindergarten school year. The time between test administrations averaged 185–87 days, or 6.2 months (from table 2). Consequently, analyses with ECLS-K data estimate kindergarten learning over only 65 percent of the kindergarten year. Thus, the actual learning may be up to 50 percent more than estimated here. Of course, such an adjustment may lead to an overestimate of the effect if learning is substantially reduced during the initial and final months of the school year. Hence, we might more appropriately think of these estimates and adjusted estimates as possible lower and upper bounds for the full-day advantage in the months-of-learning metric.

Is full-day kindergarten a double dose of half-day kindergarten?—If full-day kindergartners experience twice as much schooling as their half-day counterparts, are nine months of full-day kindergarten equivalent to 18 months of half-day kindergarten (i.e., nine extra months of learning)? Full-day kindergarten might amount to a “double dose” of half-day kindergarten, which might double the learning from half-day kindergarten, assuming no diminishing returns. Our results here, however, suggest a more modest learning advantage. In what sense, if any, is full-day kindergarten a double dose of half-day kindergarten? We explored this question empirically with ECLS-K teachers’ reports of the frequency and duration of their kindergarten class and the time they devoted to instruction in various subjects. The results in table 7 summarize kindergarten teachers’ reports of time spent on instruction.\footnote{16}

In terms of hours children spend in school, full-day kindergarten is on average a double dose of half-day kindergarten; half-day children are in school just under 16 hours per week, whereas full-day children are in school nearly 32 hours per week. Although full-day kindergartners also receive more time on instruction in nearly all areas (most notably in reading and mathematics), it is not a double dose. Full-day kindergarten classes spend 30 percent more time on instruction in reading and language arts than half-day classes (5.7 hours per week vs. 4.4 hours per week) and 46 percent more time on mathematics (3.3 hours per week vs. 2.6 hours per week). In either case, the full-day kindergartners experience only 1.3 more hours of instruction per week in reading and only 1.2 more hours per week of mathematics instruction. This
Learning in Full- and Half-Day Kindergarten

TABLE 7

Kindergarten Teacher Reports of Instructional Time per Week

<table>
<thead>
<tr>
<th></th>
<th>Half-Day Kindergarten</th>
<th>Full-Day Kindergarten</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unweighted sample size</td>
<td>1,370</td>
<td>951</td>
</tr>
<tr>
<td>Weighted percentages</td>
<td>39.7</td>
<td>60.3</td>
</tr>
<tr>
<td>Total hours children in school</td>
<td>15.8</td>
<td>31.5</td>
</tr>
<tr>
<td>Hours per week spent on instruction in:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading and language arts</td>
<td>4.4</td>
<td>5.7***</td>
</tr>
<tr>
<td>Mathematics</td>
<td>2.6</td>
<td>3.8***</td>
</tr>
<tr>
<td>Social studies</td>
<td>.9</td>
<td>1.6***</td>
</tr>
<tr>
<td>Science</td>
<td>.8</td>
<td>1.4***</td>
</tr>
<tr>
<td>Music</td>
<td>.9</td>
<td>1.1***</td>
</tr>
<tr>
<td>Art</td>
<td>1.1</td>
<td>1.5***</td>
</tr>
<tr>
<td>Dance</td>
<td>.4</td>
<td>.5***</td>
</tr>
<tr>
<td>Theater</td>
<td>.3</td>
<td>.4***</td>
</tr>
<tr>
<td>Foreign language</td>
<td>.2</td>
<td>.3**</td>
</tr>
<tr>
<td>English as a second language</td>
<td>.8</td>
<td>.7</td>
</tr>
</tbody>
</table>

NOTE.—Unweighted n = 2,325 public school teachers.

** p < .01.

*** p < .001.

amounts to about 15 extra minutes per day of additional instruction in each subject. Consequently, although in terms of time spent in school, full-day kindergarten is a double dose of half-day kindergarten, in terms of instruction it is not. Increased instructional time in the two subject areas we explored in ECLS-K amounts to around 30 minutes a day.

Discussion

What Do These Findings Mean?

Access to full-day kindergarten.—Although full-day kindergarten occurs in over half the nation’s public schools that offer kindergarten as school-wide programs, access to the program is clearly nonrandom. There are two clear trends regarding access. The first trend concerns the types of children served. Full-day programs are more likely to enroll less advantaged children (children from families of lower SES, black children, and children who enter kindergarten less proficient in math and literacy). Moreover, full-day programs are more commonly found in schools located in large cities, which enroll less affluent and more minority children. The second trend concerns national distribution.
Full-day kindergarten is much more common than half-day kindergarten in the South, whereas half-day programs are more common than full-day programs in the Northeast and West. In the Midwest, public schools reflect a fairly even mix of full- and half-day programs.

Why might these trends occur? A logical explanation for the first trend focuses on public efforts to induce social equity. Despite the higher cost of operating full-day kindergarten programs, they may be implemented to achieve a compensatory aim, in that they serve a generally less advantaged population. Schools with disadvantaged populations may be able to offer such programs because their Title 1 funds could cover the added costs. We explore the issue of costs and benefits later in our discussion. Regional differences may also reflect long-standing traditions and state preferences.

Although our analyses here are restricted to public schools, there are important sector differences in the availability of full-day kindergarten programs. Public schools are evenly split between full-day and half-day kindergarten programs, but full-day kindergarten is the norm in many private schools. Nearly 75 percent of Catholic schools in ECLS-K offer full-day kindergarten and nearly 90 percent of nonreligious private schools offer full-day kindergarten.

Effectiveness of full-day and half-day programs.—We evaluated program effectiveness by how much children learned in mathematics and literacy over the kindergarten year. We measured learning as end-of-the-year achievement, adjusted for initial achievement, on standardized tests that were untimed, adaptive, and individually administered. Results are clear: when children’s social and academic backgrounds are taken into account, as well as structural, social, and academic features of their schools, children who experience full-day kindergarten as a whole-school program are advantaged in terms of their cognitive learning (effects of 0.93 between-school SD in literacy and 0.75 between-school SD in mathematics).

Where does this advantage come from? Although full-day kindergartners spend twice as much time in school as their half-day counterparts, and these children experience more time devoted to instruction in full-day classes, clearly all the additional time is not spent on instruction. Teachers of full-day kindergarten classes report spending only about one-third more time on instruction than those who teach half-day classes. The additional learning is certainly associated with this added time on instruction; however, we acknowledge that there are many worthwhile activities in kindergarten classes beyond formal instruction in academic subjects. Teachers of full-day kindergarten use the additional time with their students to broaden their social as well as their academic experiences. Considering the full specification of our analytic models (i.e., a wide range of controls for characteristics of both children and schools, as well as the multilevel analysis methods we used), we argue that our findings of a substantial learning boost for kindergarten children in full-time compared
Learning in Full- and Half-Day Kindergarten

to half-time classes and schools are important in their own right and have important implications for early education policy.

*Differential effectiveness of full-day programs in some settings.*—Given the reports in the literature about the differential effectiveness of full-day kindergarten programs for disadvantaged children, we expected that social differentiation in learning over the kindergarten year by children’s social background (i.e., the within-school SES/achievement slope) would be influenced by enrollment in full-day kindergarten; it was not. Thus, although full-day kindergarten is more prevalent in schools serving more disadvantaged clienteles, we cannot conclude that full-day kindergarten is more effective for children of different social backgrounds. However, the full-day kindergarten advantage differs by two school characteristics: region of the country and school racial composition.

Full-day kindergarten demonstrates consistent learning benefits in all regions except the West, where children in half-day kindergarten programs learn at comparable levels to children in full-day programs. We suggest that the lack of differential effectiveness for full-day kindergarten in schools in western states is due to the fact that half-day kindergarten is the norm in that region. Teachers of full-day public kindergarten in the West may not have the experience in using the extra time effectively.

Our finding about relative effectiveness and equity in schools with different racial composition is both provocative and difficult to explain with ECLS-K data. More complex than the consistent pattern for region, racial composition differences reflect unusual learning patterns for certain half-day kindergarten programs (in one setting, unusually high, in another unusually low). A more targeted exploration of the source of these differential effects seems warranted. Whereas the patterns by region suggested that, in the West, the very common full-day kindergartens are especially effective in both literacy and mathematics, the differential patterns by racial composition (fig. 3) are consistent neither by subject nor by racial concentration. Although we are able to offer suggestions to explain these unusual patterns, such striking differences may explain some of the inconsistent findings in the research literature (usually based on local samples) for the full-day kindergarten advantage. In all instances, the differential effects of full-day programs that we report seem to stem more from unusual results in half-day programs in some types of schools (e.g., those in the West, those enrolling 51–75 percent minorities). A fuller understanding of these findings—assuming they are not statistical anomalies in ECLS-K—would require more information about such school contexts and resources, probably collected with field methods.
Policy Implications

Many of the findings we report confirm existing research comparing full-day and half-day kindergarten, which has documented favorable effects for full-day programs. By comparison, however, our findings emerge from a strong research design, they are drawn from analyses intended to reflect the structure of the intervention, and they include the most current information available on large and nationally representative samples of children in the nation’s public schools. Thus, our results do more than simply confirm existing research. Their considerably stronger internal and external validity (compared to extant research) highlights the learning advantages that accrue to children who attend kindergarten in schools that offer it on a full-day basis. Moreover, our favorable findings for kindergarten are not confined to disadvantaged children or to low-income or urban schools—all children benefit, in terms of learning more, when they attend kindergarten as a full-day program.

Are the benefits worth the cost?—Although our analyses demonstrate consistent, positive, and substantial effects of full-day kindergarten on children’s cognitive growth, one pragmatic question remains: Are the cognitive benefits of full-day kindergarten worth the fiscal costs? The extra funds required to operate full-day kindergartens pertain mostly to the costs of additional personnel and facilities, with only modest cost saving from reduced transportation demands. Because kindergarten teachers in schools with half-day programs can instruct two classes per day, full-day programs generally double the number of kindergarten teachers required.\(^1\) Considering the large proportion of school district budgets consumed by teacher salaries, this is not a trivial issue. Moreover, in states where classroom space is already at a premium, as it is in California and Florida, the extra classrooms required to implement full-day kindergartens (or the funds to build new classrooms) may be unavailable.\(^2\) Although private schools can potentially pass these associated costs on to their “customers,” public school districts (and their states) must absorb such expenditures.

In addition to the objections common to calls for increased education spending, particular political hurdles stand in the way of funding for full-day kindergarten. Conservative legislators in some states have argued that full-day kindergarten is tantamount to taxpayer-supported child care (Smith 1998) or is simply a jobs creation program for teachers (Johnston 1996). Even during the late 1990s, when many states enjoyed budget surpluses, several state legislatures defeated proposals to fund universal full-day kindergarten, including those in the states of Washington, Indiana, and South Carolina (Denn 2000; Johnston 1996; Smith 1999). Compared to other popular education reforms, such as class size reduction, political support for full-day kindergarten is more subdued.

In light of the financial and political stakes involved with expanding kin-
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dergarten instruction, a careful cost-benefit analysis of full-day kindergarten seems warranted. However, as Levin (2002) notes, an assumption inherent in any cost-benefit analysis is that the policy alternatives in question share common objectives. For several reasons, this assumption makes such an analysis challenging in the context of full-day or half-day kindergarten. First, theorists and practitioners disagree greatly about the basic objectives of kindergarten. Although most would welcome the cognitive benefits we describe here, many early childhood specialists place more value on the socioemotional rather than the strictly academic benefits of kindergarten. Second, districts implement full-day kindergarten for a variety of reasons. Although some may simply construe it as an extension of half-day kindergarten, others may conceive full-day kindergarten as an opportunity to place more emphasis on developing children’s academic skills and conceptual knowledge. Where full-day kindergarten is viewed simply as “more” kindergarten, simple cost-benefit analyses may be quite appropriate. However, evaluations in contexts where different expectations are placed on full-day kindergarten must take these differing objectives into account.

It is perhaps more appropriate to conceptualize the “alternative” to full-day kindergarten as the programs and materials that could have been realized if not for full-day kindergarten. Before such analyses could begin, however, researchers must identify the alternatives: full-day kindergarten compared to what? For example, districts and states must balance the value of full-day kindergarten with adding compensatory programs for disadvantaged children in higher grades, reducing elementary class sizes, or improving facilities. Using existing funds for full-day kindergarten, such as Chapter I money, does not make the program “cost free”; other beneficial activities offered in the school, such as health screenings, remedial reading instructors, or after-school programs, will likely suffer (Levin 2002). However, not all schools would prioritize their needs in the same manner. In this sense, the “alternatives” to full-day kindergarten likely vary from school to school, district to district, state to state, and even family to family.

Although many districts assert that they cannot afford to offer full-day programs, others contend that they cannot afford not to offer full-day kindergarten, due to competition from other schools and districts. In districts where parents can choose any public school, schools sometimes feel that if they do not offer full-day kindergarten, parents will select other public (or private) schools with full-day programs. Elementary school principals in states with charter school programs have similarly expressed fears that local charter schools offering full-day programs will draw students away from local public schools that do not (Turner 2002). Here, the appropriate analytic model approaches may be those used in business, in that students and their families are literally “customers.”

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What other funding options are available?—With the increasing popularity of full-day kindergarten, school districts and states have financed the additional costs through a variety of means. Half of all states plus the District of Columbia offer at least minimal assistance to local school districts that wish to offer full-day kindergartens (Galley 2002). However, rarely do such funds cover the full costs for all schools. School districts in the states of Arizona, Colorado, Indiana, Massachusetts, Michigan, Oregon, and Washington have implemented “pay for K” programs in which full-day kindergarten is offered to parents willing to pay tuition for it (Denn 2000; Gewertz 2002). In Seattle, several public schools began charging parents $2,000 per year for full-day kindergarten (Gewertz 2002). In several districts, schools enrolling high proportions of low-income students offer full-day kindergarten to all children free of charge, while more affluent schools do not charge tuition to students eligible for meal subsidies.22 Districts may also recover some costs by eliminating bus routes that transport kindergartners between home and school in the middle of the school day. The cost of full-day kindergarten may also be offset by a reduction in other social programs. For example, Lemke et al. (2000) found evidence that “current and former welfare recipients living in areas with full-day kindergarten are more likely to work than recipients living in areas with part-time or no kindergarten” (24).

Finally, we would hope that the efficacy of full-day kindergarten would not be evaluated based solely on the analyses we present here, which are restricted to academic achievement outcomes. We agree with Levin (2002) that policy interventions should not be judged on the basis of a single outcome. We would further this notion by adding that full-day kindergarten should not be evaluated using even a single domain, such as cognitive growth; kindergarten clearly benefits children’s development in many domains. However, we do hope that policy makers would include our results in considerations about whether to implement full-day kindergarten programs. Children attending schools that offer full-day kindergarten evidence considerably greater academic learning compared to their academically and socially similar counterparts in half-day schools. Expanding half-day kindergarten programs to full-day programs seems a straightforward reform to not only make schools more effective for young children but also to give them a good start on the long academic trajectory that constitutes their schooling experience.

Notes

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was presented at the annual meeting of the American Sociological Association, Anaheim, CA, August 2002. For more information about the study, contact Valerie E. Lee at velee@umich.edu.

1. Fusaro reported an average effect size difference between full-day and half-day kindergarten in terms of the product-moment correlation coefficient, with an r between .77 and .79 (a very large effect). Consequently, on average, 59–62 percent of the variance in outcomes was explained by enrollment in a full-day kindergarten program. This result seems to us to be almost too good to be true, especially given that a relationship of this magnitude is comparable to pretest/posttest correlations.

2. Most school effects studies that investigate the influence of school characteristics and organizational structure on student learning include enrollment size as an important feature of school structure. In this case, school size is strongly related to the grade levels in the school. Thus, we use the number of kindergarten students in the school as a proxy measure of this construct.

3. At the time that we undertook this study, the first two waves of the ECLS-K data were available on a public use CD-ROM available from the National Center for Education Statistics at no cost. More recently, two more waves of data on the same children at the beginning and end of first grade have become available. Detailed information about ECLS-K is located in codebooks and CDs available from the National Center for Education Statistics in the U.S. Department of Education or on their website. We have chosen to focus on short-term effects here; however, in the future we will investigate sustained effects.

4. The weights provided by ECLS-K are constructed to reproduce the actual number of children and schools in the U.S. population. Consequently, the use of these weights would lead to inflated statistical power. In order to accurately estimate statistical significance, we have normalized these weights. This simple procedure involves dividing each weight by its average in our samples of children and schools. Thus the average weight in each case will be 1, and the weighted analyses preserve the unweighted sample size.

5. No within-school HLM weight was available from the ECLS data, although within-school samples are not simple random samples due to the intentional oversampling of Asian/Pacific Islander children. To compensate for oversampling of some children and nonresponse for others, we constructed within-school weights from the student-level weight, BYCW0.

6. Close to 10 percent of the sample of ECLS-K schools offer both full-day and half-day kindergarten within the same school. Because in that case the full-day/half-day “treatment” is not a school-level phenomenon, we did not include such schools and ECLS-sampled children.

7. This group also comprised about 10 percent of the original ECLS-K school sample. These schools are overwhelmingly nonpublic (about 34 percent of them are non-Catholic/other religious schools and 48 percent are other nonreligious private schools), and so most of them had already been removed by the initial restriction to public schools. Because of the unusual nature of kindergarten in these schools and the fact that no ECLS-K children will remain in them at grade 1, we eliminated these schools and the ECLS children in them from our analytic sample.

8. A major purpose of Item Response Theory (IRT) scale scores is to allow comparison of scores over time, in order to estimate cognitive growth (as we do here). “IRT uses the pattern of right, wrong, and omitted responses to the items actually administered in a test and the difficulty, discriminating ability, and ‘guess-ability’ of each item to place each child on a continuous ability scale” (NCES 2000, chap. 3, 2).

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adaptive tests. Children were also administered a short language-screening assessment if their school records showed a language-minority background. Children who did not achieve criterion on this screening test were excluded from the testing (NCES 2000, chap. 2, 4). These tests, created by leading experts in the field of early childhood, demonstrated strong psychometric properties, with the reliabilities of the ability estimates ranging from .92 to .95 (the reliability of the fall mathematics test was .92, that of the spring mathematics test was .94, that of the fall reading test was .93, and that of the spring reading test was .95). The report cited here provides more detail about the cognitive tests, IRT equating procedures, the language screening, method of administration, and psychometric properties.

9. Mixed-race and Native American Indian children are also included in the uncoded comparison category.

10. In order to investigate whether the effect of full-day kindergarten was different in different school settings, we computed all possible interaction terms between the full/half indicator and other measures of school structure and composition. The effects varied in schools with different racial compositions and by region. For all other school characteristics, the full-day kindergarten effect was constant (i.e., interactions were nonsignificant). In accord with standard methodological practice (Aiken and West 1991) and to produce a more parsimonious interaction model, we dropped nonsignificant interaction terms.

11. The fixed effects in our level-1 HLM models shown in table 5 were all grand-mean centered. This allows us to interpret the intercept as average school achievement, adjusted for the academic and social background of the children in the school.

12. One initial exploration of equity here was on the SES/learning slope, and we found that the modest SES/learning slope did vary between schools at \( p < .05 \). However, the full-day/half-day kindergarten indicator was statistically unrelated to the SES/learning slopes in the two subjects. Moreover, neither were any of the other school factors in our model statistically related. Therefore, we converted SES to a fixed effect in the within-school portion of our analyses.

13. Before turning to HLM models, we investigated the effectiveness of full-day kindergarten using OLS regression and ANCOVA methods. In particular, we investigated whether the impact of full-day kindergarten on learning was associated with children’s social background. We computed interaction terms between measures of the child’s social and academic background and the program indicator. Using regression techniques (a common approach for program evaluations and ubiquitous in the studies we reviewed), we found no evidence that the effect of full-day kindergarten on learning was associated with the gender or SES of the child. Nor did the effect of full-day kindergarten depend upon whether a child was repeating kindergarten or from a non-English-speaking household. Our regression results did suggest that full-day programs might be especially beneficial for mathematics achievement in two instances: (1) younger children exhibited enhanced benefits from full-day kindergarten \( (p < .01) \) and (2) children with higher initial skills exhibited enhanced benefits from full-day kindergarten \( (p < .01) \). Our regression results also suggested that full-day programs might be less beneficial for literacy achievement in two instances: (1) black children exhibited substantially reduced benefits from full-day kindergarten \( (p < .01) \) and (2) benefits from full-day kindergarten declined somewhat as the length of time between assessments increased \( (p < .01) \). However, because of the nature of the intervention (at the school level) and the multilevel structure of the data, we maintain that our multilevel approach is the appropriate one for this evaluation.

14. The main effect of full-day kindergarten in these analyses is, of course, the effect in schools coded 0 on all other variables. Thus, this effect applies to suburban, ele-
mentary public schools that enroll 25 percent or fewer minority students, with average entering ability, average school SES, and average kindergarten size.

15. To determine the percent of explained variance, subtract the between-school variance ($\tau_0$) estimate in table 6 from the between-school variance in table 5, and divide by the between-school variance in table 5. Hence, for literacy learning, the percent of variance explained by our model is equal to $0.239 \cdot (0.01 / 0.046)$. For math, the percent of explained variance is $0.233 \cdot (0.007 / 0.030)$.

16. These reports are for classes meeting five days a week, which typifies almost all of the ECLS-K kindergarten classes.

17. It is difficult to declare a nonfinding as substantively important, mainly because a possible alternative explanation for nonfindings relates to low statistical power and high Type-II error rates. Using HLM, within-school ECLS-K sample sizes are small (they average 17 children per school). Because the extant research we reviewed did not employ any multilevel methods, the statistical significance of the findings about differential effectiveness for less advantaged children in those studies may have been inflated by conducting the analyses at the child level (where sample sizes are typically large). Virtually no existing studies have examined the question of differential effectiveness of full-day and half-day kindergarten in a multilevel format.

18. The differential effects based on the racial composition of the school may also be related to the result from the exploratory regression models that indicated that black children exhibited substantially reduced benefits from full-day kindergarten in terms of literacy learning (n. 12). Certainly there appear to be complex learning patterns involving full-day kindergarten, the black-white performance gap, and school racial composition.

19. In exploratory analyses, we examined learning for children in half-day kindergarten who attended morning vs. afternoon classes. As we found no differences, we did not pursue the issue further.

20. A few schools and public school districts offer both full-day and half-day kindergarten programs. In such districts in our state, the full-day program is typically available free of charge only to children from low-income families. Sometimes, such schools offer the full-day option to other children if their parents are willing to pay an added tuition, as noted in our discussion. As we explain in note 5, we dropped such schools from our sample.

21. Puelo (1988) presented results from the most detailed cost analysis he could identify, namely, a 1980 study conducted by the Wisconsin State Department of Public Instruction. After factoring in total costs for full-day and half-day programs (including number of teachers, salary and fringe benefits, transportation, cost for instructional materials, library materials, and cost of teacher aides), the Wisconsin report estimated that full-day programs during the 1981–82 and 1983–84 school years would incur 20–24 percent additional costs over half-day programs. We were unable to locate a more recent study of comparable scope.

22. However, equity questions remain regarding lower-middle-class families who do not qualify for free or reduced lunch programs or who do not attend schools where full-day kindergarten is free but who cannot afford to pay the full-day tuition.
References


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