MONTGOMERY
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SCHOOLS

Impact of Full-day Prekindergarten Program on Student Academic Performance: Results for Second (2008–2009) Cohort

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Executive Summary

This study is the second in a series of studies on the impact of the Head Start full-day prekindergarten (pre-K) program in Montgomery County Public Schools (MCPS) and the third report on the impact of the pre-K program overall. Prekindergarten and Head Start programs are located in 62 of 130 elementary schools in Montgomery County. These MCPS prekindergarten and Head Start programs offer a high-quality educational experience to income-eligible children in order to provide them with the foundational knowledge and skills necessary for school success in kindergarten and beyond. The pre-K and Head Start programs are integral components of the MCPS *Early Success Performance Plan*, designed to provide necessary supports for all students to achieve at high levels and address the pervasive achievement gap among student groups. Therefore the purpose of this study is twofold: a) to compare the performance of students who attended Head Start full-day classes in 2008–2009 with that of students who attended half-day classes; and b) to replicate the study conducted for the first cohort of Head Start full-day classes in 2007–2008 with a second cohort.

There are three different types of pre-K classes—Head Start full-day, Head Start half-day, and MCPS half-day classes. In this report, Head Start and MCPS half-day classes are referred to as half-day programs. A full-day Head Start program was offered in 10 Title I elementary school locations in the 2007–2008 and 2008–2009 school years. These pre-K classes are modeled after effective and high-quality preschool programs and provide early education services to children who are eligible for Free and Reduced-price Meals System (FARMS) services. All pre-K classes provide scientifically based and literacy-focused instruction five days a week for approximately 180 days per year. Classes are taught by state-certified early childhood education teachers with the support of paraeducators. The class ratio is two adults per class of 20 children. The MCPS pre-K curriculum and instructional program is designed to promote children's cognitive, physical, social, and emotional development. Teaching teams use an interdisciplinary, whole-child approach, with emphasis on language, literacy, and mathematics. The MCPS pre-K and Head Start programs also provide children with lunch at no cost, health care, social services, and transportation.

This study used a rigorous quasi-experimental design to compare the performance of students who attended the Head Start full-day program in 2008–2009 with that of students who attended half-day programs. The analyses tested the statistical as well as practical significance of the difference between reading and mathematics achievement of students in the Head Start full-day program compared with the half-day programs. The following questions were addressed in this study:

1. Did increased instructional time contribute to higher reading and mathematics performance of pre-K students in the second cohort of the Head Start full-day program compared with their peers in the Head Start half-day and MCPS half-day programs in the 2008–2009 school year?
2. Did Head Start full-day effects differ by student subgroups and schools?
3. What is the magnitude of the Head Start full-day program effects? What are the cost-benefit estimates of full-day and half-day programs?

Major Findings

Overall, findings of advanced statistical analyses indicated that the Head Start full-day program containing literacy and mathematics components contributed to significant improvement in literacy and mathematics performance of all students, regardless of family background, as measured by district curriculum-based pre-K measures. A summary of findings are presented below.

Impact of Head Start Full-day Program on Academic Performance

- The increased instructional time contributed to higher reading performance of pre-K students in the Head Start full-day program compared with their peers in the Head Start half-day and MCPS half-day programs. Students in the full-day program significantly outperformed their peers in half-day programs in reading.
- Findings from advanced analyses regarding the impact of increased instructional time on mathematics performance were mixed. Findings from analysis of covariance (ANCOVA) indicated that students in the Head Start full-day program performed at comparable levels to students in the Head Start half-day and MCPS half-day programs on the pre-K mathematics assessments. On the other hand, results from repeated measures showed significant differences between the Head Start full-day and MCPS half-day pre-K programs in favor of the full-day program.

Impact of Head Start Full-day Program Effects on Student Subgroups and Schools

- The fall-to-spring improvements in reading for students in the Head Start full-day program were evident for all students but differed for student subgroups. The largest improvements in reading performance were observed for female students, English for Speakers of Other Languages (ESOL) recipients, and Hispanic students compared to their peers in the Head Start half-day and MCPS half-day programs.
- The performance of students attending the Head Start full-day program on the pre-K mathematics assessments varied by student subgroups with the largest fall-to-spring gains observed for ESOL recipients and Hispanic students.
- The performance of Head Start full-day students on pre-K reading assessments varied by school but the differences among schools were not statistically significant.
- The performance of Head Start full-day students on the pre-K mathematics assessments varied statistically by school. Students in full-day classes in Veirs Mill, Weller Road, and Broad Acres elementary schools made significantly higher gains than their peers in other schools.

Magnitude of the Head Start Full-day Program Effects and the Cost-Benefit Estimates of Full-day and Half-day Programs

- Analyses of effect sizes revealed small to moderate positive program effects for reading favoring all students and every student subgroup in the Head Start full-day program. Similarly, small to moderate effects were seen in most of the comparisons in mathematics. These results signify an educationally meaningful impact of the Head Start

full-day program relative to the half-day programs. The highest effects in literacy were demonstrated for female students, ESOL recipients, and Hispanic students in the Head Start full-day program. Similarly, ESOL recipients and Hispanic students in the full-day program demonstrated the largest and most educationally meaningful progress in mathematics.

- The magnitude of effects associated with the full-day program on reading and mathematics performance were large enough to justify the additional cost of the Head Start full-day program.

Recommendations

- Follow up with students to examine lasting effects of participation in MCPS pre-K programs when students are in Kindergarten through Grade 3.
- Establish a mechanism to ensure that schools enter complete assessment data for all students enrolled.
- Continue to examine, compile, and share best practices in implementing the Head Start full-day program from year to year to increase the fidelity of implementation of the program.
- Reexamine the assessments, particularly the mathematics assessments, to ensure that tests not only emphasize basic concepts in the curriculum but also tap other types of preschool learning.
- Examine factors related to mathematics instruction (such as scheduling, grouping, and instructional resources) in full-day Head Start classes in comparison with those employed for reading instruction.

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Impact of Full-day Prekindergarten Program on Student Performance:
Results for Second (2008–2009) Cohort

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Background

The Early Success Performance Plan focuses on closing the achievement gap and addresses Goal 2 of the MCPS strategic plan, *Our Call to Action: Pursuit of Excellence*—Provide an effective instructional program.

This study investigates the academic outcomes for Montgomery County Public Schools (MCPS) prekindergarten (pre-K) programs in 2008–2009. MCPS prekindergarten programs (MCPS pre-K and Head Start) offer a quality educational experience to mostly 4-year-old low-income children in order to provide them with the foundational knowledge and skills necessary for optimal school learning in kindergarten and beyond. There are three different types of pre-K options—Head Start full-day, Head Start partial-day, and MCPS partial-day classes. The MCPS partial-day pre-K classes are locally funded whereas the Head Start classes are supported by local and federal Title I funds. In this report, both Head Start and MCPS partial-day classes are referred to as half-day programs.

Prekindergarten programs are an integral component of the MCPS *Early Success Performance Plan* and include both full-day and part-day models (MCPS, 2009a). The *Early Success Performance Plan* is a strategy of MCPS Goal 2 of *Our Call to Action: Pursuit of Excellence* which emphasizes the provision of an effective instructional program to promote increased achievement for all students while eliminating the achievement gap. These pre-K classes are modeled after effective and high-quality preschool programs, and provide early education services to children who are eligible for Free and Reduced-price Meals System (FARMS) services in the school district. Prekindergarten and Head Start programs are located in 62 elementary schools in Montgomery County. Once children are registered, they are assigned to a school location in their neighborhood.

Pre-K Program Descriptions

Beginning with the 2007–2008 school year, 10 elementary schools in MCPS expanded their 13 Head Start half-day classes to full-day classes using Title I funding (Zhao, Modarresi, & Liu, 2009).   The same 10 schools also provided Head Start full-day programs in 2008–2009 (Appendix A). The expansion from half day to full day was intended to "meet a well established need in the community and to give students the opportunity to develop essential skills for the most economically disadvantaged young learners to be successful" (MCPS, 2007).   The increased instructional time allows students to experience a more integrated school day with in-depth study of the MCPS pre-K curriculum.   The additional instructional time is expected to promote school readiness and contribute to the narrowing of achievement gaps related to school readiness at the start of kindergarten (Gormley, Gayer, & Phillips, 2005; MCPS, 2009b).

The Head Start full-day and partial-day classes in MCPS provide a high-quality educational experience to eligible pre-K children.   However, full-day classes offer additional instruction in mathematics, literacy, the arts, music, physical education, social interaction, oral language, and vocabulary development. (See Appendix B for a more detailed description.) The Head Start full-day classes last 6 hours 15 minutes each day, while the Head Start partial-day classes last 3 hours 15 minutes each day. The reading instructional time increases from 30 minutes per day in a partial-day class to 60 minutes per day in a full-day class. Mathematics instructional time increases from 20 minutes daily in a partial-day class to 50 minutes daily in a full-day class.

The MCPS partial-day program serves students whose family incomes are slightly above the federal poverty guidelines. Vacancies are filled by students whose family incomes are above the eligibility criteria and who are impacted by at least one or more risk factors, such as having an Individualized Educational Program (IEP) or not speaking English.   MCPS partial-day classes last 2 hours 30 minutes on a regular school day. In this report, both Head Start and MCPS partial-day classes are referred to as half-day programs.

During the 2008–2009 school year, all MCPS pre-K classes were taught by state-certified early childhood education teachers, with the support of paraeducators. The class ratio is expected to be two adults per class of 20 children.   Staff development was provided to all new teachers and refresher sessions were provided to returning teachers.

Components of Daily Pre-K Schedule

All three types of MCPS prekindergarten programs include the following components:

- A cognitively stimulating curriculum based on prekindergarten standards aligned with the K–8 framework;
- A strong emphasis on literacy and mathematics with research-based instructional strategies to support development of foundational concepts and skills;
- Age-appropriate science, social studies, art, music, technology, and physical education experiences;
- Attention to the whole child, including his/her social, emotional, and physical/motor development;

- An assessment system used to individualize instruction for all children, including English language learners and children with developmental delays;
- Family involvement including regular communication as well as opportunities and encouragement for parents to be engaged in their children's education;
- Staff development for teachers and paraeducators that pairs training with classroom practice and emphasizes research-based strategies and a strong knowledge base; and
- Literacy and mathematics learning that takes place throughout the day (MCPS, 2009b).

These pre-K programs are designed to prepare students to be school-ready when they enter kindergarten. As such, the pre-K environment is developed to be age appropriate and literacy rich, with well-defined learning centers. The daily schedule includes a literacy block and a mathematics block as well as time for integrated learning in centers. In addition, the schedule is flexible in response to needs of students and includes: 1) a balance between teacher-directed time (whole and small group) and child-initiated time (centers and outdoor); 2) a brief class meeting prior to whole-group literacy instruction; and 3) outdoor time most days except during inclement weather.

In literacy blocks, activities are focused on the foundational skills of oral language development, phonological/phonemic awareness, concepts about print, and the alphabetic principle. All literacy lessons and experiences are planned to promote children's mastery of the prekindergarten-level indicators of the *English/Language Arts Curriculum Framework* and are differentiated for individual children. The *Reading/Writing/Language Arts Elementary Program Instructional Guide—Prekindergarten Level* provides sample lessons. Instructional guide lessons may be adapted and/or expanded to address the needs, strengths, languages, and interests of children. Additional activities can be found in the *Building Language for Literacy* program and other approved resources. The literacy block comprises whole-group and small-group instruction.

In mathematics, instructional time is set aside every day for instruction in large and/or small groups. Teachers plan activities based on the standards and indicators from the MCPS *Curriculum Framework* and the assessed needs of their children. The *Growing with Mathematics* resource program is the source of mathematics lessons and activities. Teachers sequence the lessons according to the "Year-at-a-Glance" section from the *Prekindergarten Mathematics Curriculum and Instructional Support* document to ensure a logical and coherent order to mathematics instruction.

Center time provides opportunities for children to practice and apply skills, communicate with one another, and extend their understanding of concepts while working and playing independently or in self-selected pairs or groups.

Selected Literature on Academic Impact of Pre-K Programs

Overall, recent studies indicate that high quality pre-K programs benefit students in a variety of ways, particularly increased academic performance of all students especially those from low socioeconomic status, increased levels of school readiness, and decreased need for special

education services (Frede, Jung, Barnnet, Lamy, & Figueras, 2009; Gormley, et al., 2005; Hustedt, Barnett, Jung, & Figueras, 2008; Zhao, et al., 2009).

Impact of full-day pre-K on academic performance. While pre-K programs have expanded rapidly in the United States, there is limited literature about the benefit of pre-K programs of different durations and levels of intensity. The results from a study of the 2008–2009 cohort of MCPS pre-K programs were very encouraging (Zhao et al., 2009; Gayl, Young, & Patterson, 2010). The findings revealed that the MCPS Head Start full-day pre-K program contributed to strong gains in academic achievement. These results were manifested in a variety of domains of reading such as vocabulary, concepts about print, and overall literacy, as well as mathematics. Specifically, students in the Head Start full-day program made significantly larger gains in reading skills compared with their peers in the Head Start half-day program. Significantly larger gains were also found in mathematics for some subgroups in the Head Start full-day program compared to their peers in the Head Start half-day program. Likewise, students in the Head Start full-day program made significantly larger gains in reading and mathematics skills when compared with their peers in the MCPS half-day program. These gains were significantly larger for female and Hispanic students, as well as students receiving English for Speakers of Other Languages (ESOL) services. These full-day program effects were sufficient enough to have practical educational significance to justify the higher cost per student (Zhao et al., 2009).

Further, findings from a national representative sample study showed that Head Start had an impact on children's language and literacy development (U.S. Department of Health and Human Services, [DHHS] 2010). Another recent study revealed that the added hours of pre-K education were "substantially effective at closing the achievement gap between urban children and their more advantaged peers" (Robin, Frede & Barnett, 2006). Moreover, an Oklahoma study found that Hispanic students in a full-day program showed dramatic improvement in cognitive and language skills (Gormley et al., 2005).

School readiness. The preparedness of children to learn what schools expect or want them to learn is a cornerstone of today's education reforms. Rigorous studies of a variety of programs showed that children who attend an effective pre-K program score higher on school readiness measures at kindergarten entry. Findings from a nationally representative sample, spread over 23 different states and consisting of 84 randomly selected grantees/delegate agencies, showed that there were statistically significant differences between the Head Start group and the control group on every measure of children's preschool experiences measured in this study (DHHS, 2010). Access to Head Start has a positive impact on several aspects of children's school readiness with benefits being concentrated in language and literacy elements of the cognitive domain, including impacts on vocabulary, letter-word identification, spelling, preacademic skills, color identification, letter naming, and parent-reported emergent literacy.

A pre-K program available to Oklahoma's children, for example, showed significant gains for diverse groups of both half- and full-day students (Gormley et al., 2005). Children evaluated were months ahead in spelling, early mathematics, and letter identification skills compared to those who had not attended preschool.

Evidence also is available indicating that a high quality pre-K program benefits many children, especially those from low socioeconomic status families. Similar academic gains are reported in recent studies in New Jersey and New Mexico. These studies showed that pre-K programs helped improve mathematics literacy and social skills, helped put students on track for kindergarten, and reduced their need for special education services (Frede, et al., 2009; Hustedt, et al., 2009). In these studies, students who attended pre-K were also less likely to be held back a grade because pre-K narrowed the readiness gap before it became the achievement gap (Garcia, Jensen, & Cuellar, 2006; Gormley et al., 2005).

Decreased need for special services. National research also shows that children who attend effective pre-K programs perform better on standardized achievement tests in reading and mathematics and are less likely to be placed in special education (Hustedt, et al., 2009; Isaacs, 2008).

Economic impact. A New Mexico study has shown there are economic benefits to providing pre-K programs. School systems have fewer students being retained, lower numbers of students requiring special education services, and higher graduation rates. In addition students experience educational outcomes that lead to higher earnings in the future which in turn make them less likely to engage in negative behaviors or use welfare services (Hustedt et al., 2009).

In summary, the evidence from these studies suggest that pre-K programs, irrespective of duration, improved academic outcomes and reduced the differential outcomes that are historically moderated and associated with factors of socioeconomic status or belonging to a racial subgroup.

Methodology

Evaluation Design

Because students were not randomly assigned, this evaluation used a nonequivalent control group, pretest-posttest design—a frequently used type of quasi-experimental design. Students were enrolled in the appropriate pre-K program in MCPS based on income eligibility guidelines. As documented by prominent researchers (Shadish, Cook, & Campbell, 2002), the stated design is the most appropriate evaluation design in assessing the effectiveness of any treatment program among the quasi-experimental designs. To reduce the potential selection bias, this design allowed the evaluators to determine the extent to which the full-day pre-K experience (the treatment) contributes to student achievement via statistical controls.

Researchers who conduct field research are urged to include replication as a fundamental feature in their studies (Schafer, 2001). When results are consistent across several years, there is a stronger basis for observed relationship(s) than would be available within each study by itself. Also, results that have been replicated are considered more likely to generalize or continue to be observed. Therefore, the purpose of this study is twofold: a) to compare the performance of students who attended Head Start full-day classes in 2008–2009 with that of students who participated in half-day classes and b) to replicate the study conducted for the first cohort of Head Start full-day classes in 2007–2008 with a second cohort.

Evaluation Questions

The following questions were addressed in this study:

1. Did increased instructional time contribute to higher reading and mathematics performance of pre-K students in the second cohort of the Head Start full-day program compared with their peers in the Head Start half-day and MCPS half-day programs in the 2008–2009 school year?
2. Did Head Start full-day effects differ by student subgroups and schools?
3. What is the magnitude of the Head Start full-day program effects? What are the cost-benefit estimates of full-day and half-day programs?

In this study, the group of students attending the Head Start full-day program was referred to and used as the "treatment group" and the two groups of students participating in half-day pre-K programs were used as the comparison groups.

Study Measures

MCPS pre-K reading and mathematics assessments were used as the outcome measures to address the evaluation questions. Students enrolled in 2008–2009 MCPS pre-K classes were administered MCPS pre-K reading and mathematics assessments three times: in fall, winter, and spring of the school year. The MCPS pre-K reading and mathematics assessments were considered the valid outcome measures because they are research-based, locally developed, and designed to measure important constructs and skills taught in pre-K. Also, due to the young age of pre-K students, test practice effect associated with these assessments would be negligible. The total percent correct scores for reading and mathematics from MCPS pre-K assessments were calculated for the analyses of student achievement. Detailed descriptions of the measures are presented below.

Literacy. The pre-K reading assessment consists of five content clusters, with a total of 94 points. The five clusters are oral language, letter identification, identifying rhyming words, beginning sounds, and concepts about print. The reliability coefficient is a statistic that ranges from zero to one, which quantifies the precision of test scores. The reliability of the reading assessment is 0.85, as measured by Cronbach's alpha which is considered high based on accepted criteria in research (Nunnally, 1978). The correlations among the five reading clusters and the total scores from 2008–2009 ranged from 0.47 to 0.94 (Table C1, Appendix C). The correlations between letter identification and total reading scores are the highest (0.94) followed by oral language (0.63).

Mathematics. The pre-K mathematics unit assessment consists of three content clusters. They are geometry, number representation, and number comparison, with a total of 18 score points.[1] The test reliability in mathematics was 0.83 as measured by Cronbach's alpha.

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[1] Content cluster level information was not included in the 2008–2009 dataset. Therefore, the correlation among the three clusters was not calculated.

Study Samples

In this study, the treatment group consisted of students who attended the Head Start full-day program in 2008–2009. The comparison groups included students attending the Head Start half-day and MCPS half-day programs in the same school year. The analytical sample included only students with complete assessment results for reading and mathematics.

During the 2008–2009 school year, 2,565 students were enrolled in MCPS pre-K programs. As shown in Table 1, 258 of the pre-K students were enrolled in the Head Start full-day classes, 388 in the Head Start half-day classes, and 1,919 in MCPS half-day classes. The majority of the participants (91% Head Start full day; 92% Head Start half day; 93% MCPS half day) were United States citizens, and the remainder were from 58 other countries. English was the first language for only 28% of students in Head Start full day; the remaining 72% spoke a language other than English as their first language. Excluding English, a total of 66 different languages were represented.

Hispanic (57.0 %) and African American (33.7%) students made up the majority of the students in the Head Start full-day classes (Table 1). All students enrolled in Head Start full-day classes were eligible for FARMS services, and 70.1% were receiving ESOL services (Table 1).

Table 1
Demographic Characteristics for 2008–2009 MCPS Students
by Type of Prekindergarten Program ($N = 2,565$)

		Head Start full day ($N = 258$)		Head Start half day ($N = 388$)		MCPS half day ($N = 1,919$)	
		n	*%*	*n*	*%*	*n*	*%*
U.S. Citizen	Yes	234	90.7	357	92.0	1,776	92.5
First language English	Yes	73	28.3	189	48.7	614	32.0
	No	185	71.7	199	51.3	1,305	68.0
Gender	Male	132	51.2	185	47.7	1,003	52.3
	Female	126	48.8	203	52.3	914	47.7
Race and ethnicity	African American	87	33.7	177	45.6	616	32.1
	Asian	13	5.0	30	7.7	193	10.1
	Hispanic	147	57.0	154	39.7	1,003	52.3
	White	11	4.3	27	7.0	106	5.5
Special services	FARMS	251	100.0	322	100.0	1,573	84.2
	No FARMS	0	0	0	0	295	15.8
	Special Education	0	0	0	0	6	0.3
	Current ESOL	176	70.1	171	53.1	1,186	63.5

Note. American Indian students were included in the total but not reported separately. FARMS = Free and Reduced-price Meals System; ESOL = English for Speakers of Other Languages.

Students in the three pre-K programs were very similar with regard to guardian's age, guardian's education, and family size (Table 2). Due to different program income-eligibility criteria, the annual mean, median, and family income, and income per person in a family were higher for students in MCPS half-day classes. As such, students in MCPS half-day classes were less impacted by poverty than their peers in the Head Start classes.

Table 2
Family Background Information for 2008–2009 MCPS Students
by Prekindergarten Program ($N = 2,565$)

Family background	Head Start full day ($N = 258$)			Head Start half day ($N = 388$)			MCPS half day ($N = 1,919$)		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Family income	$17,787	$15,676	$11,024	$16,410	$14,678	$11,369	$26,584	$26,582	$11,631
Income per person in family	$4,580	$4,256	$2,865	$4,343	$4,064	$2,956	$6,783	$7,072	$2,687
Age of female guardian	31	30	7	31	30	7	32	32	6
Years of education of female guardian	11	12	4	12	12	3	12	12	4
Age of male guardian	36	35	8	37	37	8	37	36	13
Years of education of male guardian	11	12	5	12	12	4	12	12	7
Family size	4	4	1	4	4	1	4	4	1

Note. Income per person = family income/family size.

Procedures for Analyses

Two statistical methods were applied to address the evaluation questions: analysis of covariance (ANCOVA) and repeated measure two-way analysis of covariance. Moreover, full-day program effects were estimated with two indicators: 1) treatment effect of participating in Head Start full-day classes (or main effect) and 2) the interaction effect between the type of pre-K program and overall gain from fall to spring (seasonal effect).

Analyses of covariance (ANCOVA). Since students were not randomly assigned to a pre-K class type, ANCOVA was used to statistically control for important background variables and preexisting differences among individual students to observe the full-day pre-K main effects (Campbell & Stanley, 1963; Judd, Smith, & Kidder, 1991; Kirk, 1995). The ANCOVA models tested significant differences between students' adjusted mean scores on the outcome measures (MCPS reading and mathematics assessments) for those who attended the Head Start full-day program and those who had not. For each of the outcome measures, the model included the students' prior performance, demographics, family income per person, special education, and ESOL services. The ANCOVA analyses were conducted by constructing four statistical models.[2] (See Appendix D.) All students in Head Start full-day and Head Start half-day programs who had both fall and spring test results for reading and mathematics were included in the ANCOVA models. To compare students' performances in the Head Start full-day program with their peers in the MCPS half-day program, 500 students in MCPS half-day classes were selected randomly. The purpose was to maintain a more balanced design in ANCOVA analyses since only about 180 Head Start full-day students had complete data for analyses. Among the 500 MCPS half-day students, 328 and 381 students had complete data in reading in mathematics, respectively.

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[2]To test for nonparallelism or interaction (homogeneity of regression slopes), the product term between the pretest scores and the group variable was examined and included in the models.

Repeated measure two-way analyses of covariance. Although posttreatment measures of reading and mathematics outcomes are essential for impact assessment, measures taken before and during intervention can increase precision with which effects are estimated (Rossi, Lipsey, & Freeman, 2004). Therefore the evaluators further included multiple measures of the outcomes to strengthen the evaluation design through the application of the repeated measures analytical procedures for assessing the treatment (full-day pre-K) effects.

The repeated measures[3] analysis of covariance with time as the within-subject factor (fall, winter, spring), and pre-K program type (full-day and half-day variants) as the between-subject factor were conducted on pre-K reading and mathematics scores. Repeated measures were the reading and mathematics test scores for fall, winter, and spring. Included in the analyses were all students in the three types of pre-K programs, with complete assessment data in fall, winter, and spring. In this part of the study, we also examined whether the effect of pre-K on reading and mathematics achievement was the same across racial groups, gender, or among ESOL recipients and non-ESOL recipients.

Effect size estimates. Effect size is a commonly used statistic calculated to measure the standardized difference between two group means and to examine if the effect had any practical importance (American Psychological Association, 2001; Rossi, et al., 2004; Kline, 2004). In this study, two different types of effect sizes were calculated—main effect of participation in the pre-K program and seasonal effects.[4] The sizes associated with the effects of participation in full-day pre-K were calculated based on the adjusted mean score differences between the Head Start full-day program and the two half-day programs obtained by ANCOVA procedures. Seasonal effect sizes were calculated based on the differences between the fall mean scores and the spring mean scores for each pre-K program type as calculated by the repeated measures procedures.

Cost-benefit estimates: Combining effect size with costs. In this study, the calculated effect sizes were combined with the cost information to provide a measure of cost-effectiveness of the full-day pre-K program as suggested by other researchers (Harris, 2009; Hill, Bloom, Black, & Lipsey, 2008). Therefore, the design allowed for the calculation of magnitude of effect size associated with the cost of each type of pre-K program.

Ratio of effects (as computed for each type of pre-K class) to costs (annual cost per student) was computed for each pre-K type. This cost-benefit estimation for the full-day program effect was conducted to determine if the Head Start full-day program effect was sufficient to justify its cost. Harris and others present a cost-effectiveness framework for judging program effects and suggest that any intervention that generates increased test scores of 0.025 standard deviations per child per $1,000 spending should be considered "large" (Harris, 2009; Hill, et al., 2008; Ludwig &

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[3]For repeated measures to be meaningful, the assumption of homogeneity of variances must hold. The sphericity assumption is meaningful only if the main effect or interaction effect has more than one degree of freedom. Partial eta squared values were computed to estimate program effect. If significant differences were found, the Bonferroni approach was used to control for Type I error with three groups in the pairwise comparison among the means.

[4]The following formula was used to calculate the effect size in this evaluation: effect size = $(M_t - M_c)/SD$. The M_t and M_c are adjusted group means for students who participated in Head Start full-day classes and those who attended the two half-day classes, respectively, and SD is the standard deviation of the pooled outcome scores.

Philips, 2008).   Research on Head Start cohorts indicates that short-term effects of 0.25 for language arts and 0.1 for mathematics might be large enough to generate long-term benefits in excess of program costs (Ludwig & Phillips, 2008).   Additional evidence indicates that short-term effects of 0.15–0.20 are sufficient for Head Start to pass a benefit-cost test (Harris, 2009; Hill, et al., 2008).

Results

First, descriptive statistics for students with complete results are presented.   Second, the key findings are organized by evaluation questions and presented in several steps.

Descriptive Analyses

Overall, 82% ($N = 2,103$) of the pre-K students enrolled in 2008–2009 had complete reading or mathematics pre-K assessment results.   Among students with complete assessment information, 219 were in the Head Start full-day program (10%), 264 in the Head Start half-day program (13%), and 1,620 in the MCPS half-day program (77%) (Table 3).

Demographic characteristics for the 2,103 students with complete results in mathematics or reading are presented in Table 3. Corresponding to the proportion of students enrolled in pre-K, Hispanic students were over one half of the students in the Head Start full-day program (54.8%) and MCPS half-day program (53.1%) and 40.5% of the Head Start half-day program.   At the same time, approximately one third of the students in the classes were African American (Head Start full day 36.1%, Head Start half day 44.3%, MCPS half day 31.9%).   More than one half of all pre-K students were receiving ESOL services in 2008–2009, and the proportion of ESOL recipients in the Head Start full-day program and half-day programs were similar to those in the pre-K population. All of the students in the Head Start full-day or Head Start half-day programs were eligible for FARMS services.

Table 3
Characteristics for 2008–2009 MCPS Students with Complete Reading or Mathematics
Test Results for Fall, Winter, and Spring Test Administrations
by Prekindergarten Class ($N = 2,103$)

Characteristics		Head Start full-day ($N = 219$)		Head Start half-day ($N = 264$)		MCPS half-day ($N = 1,620$)	
		n	*%*	*n*	*%*	*n*	*%*
Gender	Female	82	44.3	119	52.0	720	46.8
	Male	103	55.7	110	48.0	817	53.2
Race and ethnicity	African American	79	36.1	117	44.3	516	31.9
	Asian	10	4.6	20	7.6	157	9.7
	Hispanic	120	54.8	107	40.5	859	53.1
	White	10	4.6	20	7.6	87	5.4
Special services	FARMS	219	100.0	263	100.0	1,357	83.9
	Special Education	0	0.0	0	.0	3	0.2
	ESOL	153	69.9	142	54.0	1,034	63.9

Note. FARMS = Free and Reduced-price Meals System; ESOL = English for Speakers of Other Languages.

Demographic characteristics of students with incomplete test results are displayed in the appendices (Table C2). Students with complete tests results were similar to students without complete test scores with regard to family background characteristics (Table 4; Table C2).

Table 4
Family Background for 2008–2009 MCPS Students with Complete Reading or Mathematics Test Results for Fall, Winter, and Spring Test Administrations, by Prekindergarten Class ($N = 2,103$)

Family background	Head Start full-day (N = 219)			Head Start half-day (N = 264)			MCPS half-day (N = 1,620)		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Family income	$17,210	$15,600	$10,880	$16,456	$14,642	$11,104	$27,360	$27,492	$11,430
Income per person in family	$4,391	$4,142	$2,701	$4,210	$4,130	$2,602	$6,941	$7,232	$2,572
Age of female guardian	31	30	7	31	30	6	32	32	6
Years of education of female guardian	11	12	4	12	12	3	12	12	4
Age of male guardian	37	36	8	37	37	8	37	36	14
Years of education of male guardian	11	12	5	12	12	4	12	12	5
Family size	4	4	1	4	4	1	4	4	1

Note. Income per person = Family income/family size.

Evaluation Question 1. Did increased instructional time contribute to higher reading and mathematics performance of pre-K students in the Head Start full-day program compared with their peers in the Head Start half-day and MCPS half-day programs in the 2008–2009 school year?

ANCOVA models and repeated measure procedures were used to answer evaluation question 1. Results on impact of instruction time on academic performance at the end of pre-K are displayed for the Head Start full-day program compared with the Head Start and MCPS half-day programs.

Head Start Full-day Pre-K Program vs. Head Start Half-day Pre-K Program

ANCOVA results. Statistical significance tests and effect size analyses were simultaneously used to determine the Head Start full-day instruction effects. Analysis of covariance (ANCOVA) procedures were used to examine the significant differences between full-day and half-day students' mean scores on reading and mathematics after adjusting for their initial abilities and background information. When a statistically significant result is obtained (e.g., $p < .05$), the researcher generally has the confidence to conclude that the treatment effect (full-day instruction) was not due to sampling error. In addition, the authors used the adjusted means calculated through ANCOVA to estimate the practical significance (e.g., the effect size) of the Head Start full-day impacts. The answers to the evaluation question are summarized below.

The adjusted means, mean group difference scores, and effect sizes for both reading and mathematics outcome measures are shown in Table 5. The results showed that the main effect of the Head Start full-day program in reading was statistically significant ($p < 0.001$), after controlling for demographics, income per person in the family, special education services, ESOL services, gender, and prior academic performance. This suggests, on average, students in the Head Start full-day program scored significantly higher than their peers in the Head Start half-day program. This finding is further confirmed by the calculated effect size (0.37) suggesting that students attending the Head Start full-day program outperformed their peers in the Head Start half-day program and the observed higher performance was practically significant. In mathematics, students receiving Head Start full-day instruction did not score significantly higher ($p > 0.05$) than those attending the Head Start half-day program (adjusted mean difference = 1.87). This finding was also confirmed by the effect size measure (ES = 0.10).

Table 5
Adjusted Means, Mean Difference, and Effect Size for the 2008–2009 Spring Reading and Mathematics Scores for Students in the Head Start Full-day and Head Start Half-day Programs

Outcome measure	Adjusted means				Treatment effect		
	Head Start full-day		Head Start half-day		Mean difference	Std. error	Effect size
	Mean	N	Mean	N			
Reading	90.79	182	84.12	205	6.68*	1.43	0.37
Mathematics	89.16	183	87.29	220	1.87	1.47	0.10

Note. Reading: $t = 5.62$; $p = 0.000$; Mathematics: $t = 1.84$; $p = 0.07$.

Head Start Full-day Pre-K Program vs. MCPS Half-day Pre-K Program

This study also sought to determine whether or not there was evidence that students in the Head Start full-day program outperformed their peers attending the MCPS half-day program on reading and mathematics measures.

Findings indicate that students attending the Head Start full-day program significantly outperformed their peers in the MCPS half-day program in reading (Table 6). The calculated effect size (0.32) further indicates the observed higher performance was practically significant. In mathematics, there was no sizeable achievement difference between the two groups of students (Head Start full day vs. MCPS half day) as indicated by the results obtained from ANCOVA (adjusted mean difference = 1.61) and effect size measure (0.09).

Table 6
Adjusted Means, Mean Difference, and Effect Size for the 2008–2009 Spring Reading and Mathematics Scores for Students in the Head Start Full-day and MCPS Half-day Programs

Outcome measure	Adjusted means				Treatment effect		
	Head Start full-day students		MCPS half-day students		Mean difference	Std. error	Effect size
	Mean	N	Mean	N			
Reading	80.92	182	74.69	328	6.24	1.56	0.32
Mathematics	62.13	183	60.52	381	1.61	1.43	0.09

Note. Reading: $t = 5.62$; $p = 0.000$; Mathematics: $t = 1.13$; $p = 0.26$.

Repeated measure results. The repeated measure procedure was used to validate the significant program effects calculated by ANCOVA procedures and to investigate differences among student subgroups and schools. The repeated measure procedure was used because it is more sensitive to detecting program effects over time.

Only students with complete test results in fall, winter, and spring were included in the repeated measure analyses. A two-way within-subjects analysis of variance was conducted to evaluate the main effects for season (fall to spring) and the interaction between season and type of pre-K program. The main effect for season was significant for reading (F, (2, 1,628) = 1,655, p = 0.00) and mathematics (F, (2, 2,015 = 2,027, p = 0.00), with students scoring significantly higher in spring than fall. These findings indicated that students who participated in the Head Start full-day program improved their reading and mathematics performance significantly more than students from either of the half-day programs. The strength of the relationship between attending any of the pre-K programs and the spring reading and mathematics scores was very strong, with the seasonal effect[5] accounting for 56% (reading) and 45% (mathematics) of the variance in academic performance (Table 7).

Table 7
Tests of Within-Subject and Between-Subject Effects for Performance on Reading and Mathematics
From Fall to Spring by Prekindergarten Class, 2008–2009

Source	DF	F	p value	Partial Eta squared	DF	F	p value	Partial Eta squared
			Reading				Mathematics	
Within-Subject								
Season	2	2,027.4	0.000	0.555	2	1,655.007	0.000	0.451
Season x pre-K	4	3.089	0.015	0.004	4	6.095	0.000	0.006
Between-Subject								
Pre-K	2	5.212	0.006	0.006	2	8,295.062	0.003	0.006

Further analyses revealed that reading and mathematics improved significantly from fall to spring for all pre-K students in 2008–2009 regardless of their pre-K program type (Table 8). On average, all students made significant improvements in their reading and mathematics performance from fall to spring ($p < 0.00$).

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[5] Partial eta squared values were computed to estimate seasonal effect.

Table 8
Estimated Marginal Means, Mean Difference, and Effect Sizes for Seasonal
Effect on Reading and Mathematics by Pre-K Program

Outcome/Program	Spring			Fall			Mean difference	*p*-value	Effect size
	Mean	*n*	SD	Mean	*n*	SD			
Reading									
Head Start full day	88.37	180	13.51	47.05	180	25.18	41.32	0.00	2.05
Head Start half day	82.52	203	19.54	46.29	203	25.79	36.23	0.00	1.58
MCPS half day	82.24	1,248	20.57	43.72	1,248	26.52	38.52	0.00	1.62
Mathematics									
Head Start full day	91.38	203	14.97	52.46	203	29.81	38.92	0.00	1.65
Head Start half day	86.27	257	18.91	54.37	257	28.52	31.90	0.00	1.32
MCPS half day	86.44	1,558	18.14	49.29	1,558	29.95	37.15	0.00	1.50

In addition, the seasonal and program interaction effects for reading (F, (2, 1,628) = 3.08, p = 0.01) and mathematics (F, (2, 2,015) = 6.09, p = 0.00) were significant. The significant interaction suggested that students in different pre-K programs performed differently in spring, even when their initial ability during the fall was controlled. Paired sample t-tests were conducted to follow up the significant interactions. The analyses revealed significant differences in reading scores between Head Start full-day and Head Start half-day and MCPS half-day programs in favor of the Head Start full-day program (Table 8). This provides additional evidence that on average, students in full-day classes outperformed their peers in half-day programs in reading. In mathematics, significant differences ($p < 0.05$) in mean spring scores were found only between the Head Start full-day program and the MCPS half-day program in favor of the Head Start full-day program (Table 9).

Table 9
Pairwise Comparisons for Perceived Differences in Reading and Mathematics Scores

Classes compared		Reading			Mathematics		
		Mean difference	Std. error	Sig.(a)	Mean difference	Std. error	Sig.(a)
Head Start full day	Head Start half day	5.920(*)	2.176	**.020**	2.423	2.014	0.229
	MCPS half day	6.589(*)	1.695	**.000**	5.055(*)	1.601	**0.002**

Note. Based on estimated marginal means.
* The mean difference is significant at the .05 level; adjustment for multiple comparisons: Bonferroni.

Table 10 displays the estimated marginal means and standard deviations for reading and mathematics by pre-K program. In fall, the mean reading scores for students in the Head Start full-day program (47.1) were similar to those of students in Head Start and MCPS half-day programs (46.3 and 43.7 respectively). The standard deviation, one of the statistics that measures the spread or variation was fairly large in fall, indicating a wide range in the initial performance of students entering the pre-K program. By spring, the adjusted mean scores in reading improved significantly in the Head Start full-day program, from 47.1 to 88.4, with a 41.3-point increase.

Table 10
Estimated Marginal Mean Score and Standard Deviation of Reading and Mathematics for
Students with Complete Test Results for 2008–2009 Fall, Winter, and Spring Test
Administrations, by Prekindergarten Program

	Head Start full day			Head Start half day			MCPS half day		
	N	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*
Reading ($N = 1,631$)									
Fall	180	47.1	25.2	203	46.3	25.8	1,248	43.7	26.5
Winter	180	74.0	19.9	203	68.0	24.0	1,248	66.9	25.4
Spring	180	88.4	13.5	203	82.5	19.5	1,248	82.2	20.6
Seasonal gain		**41.3**			**36.2**			**38.5**	
Mathematics ($N = 2,018$)									
Fall	203	52.5	28.8	257	54.4	28.5	1,558	49.3	29.0
Winter	203	79.3	21.5	257	75.3	24.7	1,558	72.3	24.8
Spring	203	91.4	15.0	257	86.3	18.9	1,558	86.4	18.3
Seasonal gain		**38.9**			**31.9**			**37.1**	

Note. SD = standard deviation.

The fall-to-spring point increases for the Head Start half-day and the MCPS half-day programs were 36.2 and 38.5, respectively. The mean scores for students in the Head Start full-day program also had a much smaller standard deviation (13.5 in spring) compared with their peers in Head Start half-day (19.5 in spring) and MCPS half-day programs (20.6 in spring). Not only did the students in the full-day program make significantly higher fall-to-spring improvements in reading, their mastery of skills assessed on the pre-K assessments became more homogenous, indicating minimal gaps in the performance on pre-K reading assessments among students compared with their peers in the half-day pre-K programs.

In fall, the mean scores in mathematics were similar among Head Start full-day (52.5), Head Start half-day (54.4%), and MCPS half-day (49.3) pre-K groups. In winter, the mean mathematics scores for Head Start full-day students were higher than for the half-day pre-K students. By spring, the mean scores for Head Start full-day increased by 39 points from fall to spring compared with 32 and 37 for Head Start and MCPS half-day students, respectively. The differences in mean mathematics scores for the Head Start full-day program and MCPS half-day program were statistically significant in favor of the Head Start full-day program. Also, the standard deviation of scores measuring the mastery of skills assessed by pre-K mathematics unit assessments for students in the full-day group was lower than the half-day group. These findings support the hypothesis that extended time for mathematics instruction would result in greater academic gains in mathematics for pre-K students.

Evaluation Question 2. Did Head Start full-day effects differ by student subgroups and schools?

Repeated measure procedures were used to answer evaluation question 2. Results are displayed for the Head Start full-day and Head Start and MCPS half-day programs by student subgroups followed by school-level results.

Differences Across Student Groups

Tables C4–C5 (Appendix C) present results from repeated measures for the student subgroups. The tests of within-subject effect revealed that the season main effect was significant as well as the interactions between season and gender, race and ethnicity, and ESOL receipt (Table C4). These findings signified that some student subgroups in the Head Start full-day program made greater improvements in reading and mathematics performance from fall to spring than their counterparts in the half-day programs. Follow-up tests were conducted to evaluate pairwise differences among the means for each student subgroup. Estimated marginal means and standard deviations in reading and mathematics, by subgroup are shown in Tables C6–C7 (Appendix C).

      Estimated marginal means for reading and mathematics scores by gender. Figure 1 shows estimated marginal means in reading and mathematics for students by gender. While the scores for male students show growth from fall to spring, there was minimal variation in reading scores for male students among the groups in fall, winter, or spring. In reading, the score increase for male students was 42.6 points for the Head Start full-day program, 37.8 points for the Head Start half-day program, and 37.1 points for the MCPS half-day program. While the fall scores for female students in the Head Start full-day program were similar to scores for students in the half-day programs, the female students in the full-day program surpassed their half-day counterparts in winter and spring. However, the average fall-to-spring increase in reading scores for female students in the Head Start full-day program (39.8) was similar to female peers in the MCPS half-day program (40.1) but higher than peers in the Head Start half-day program (34.7).
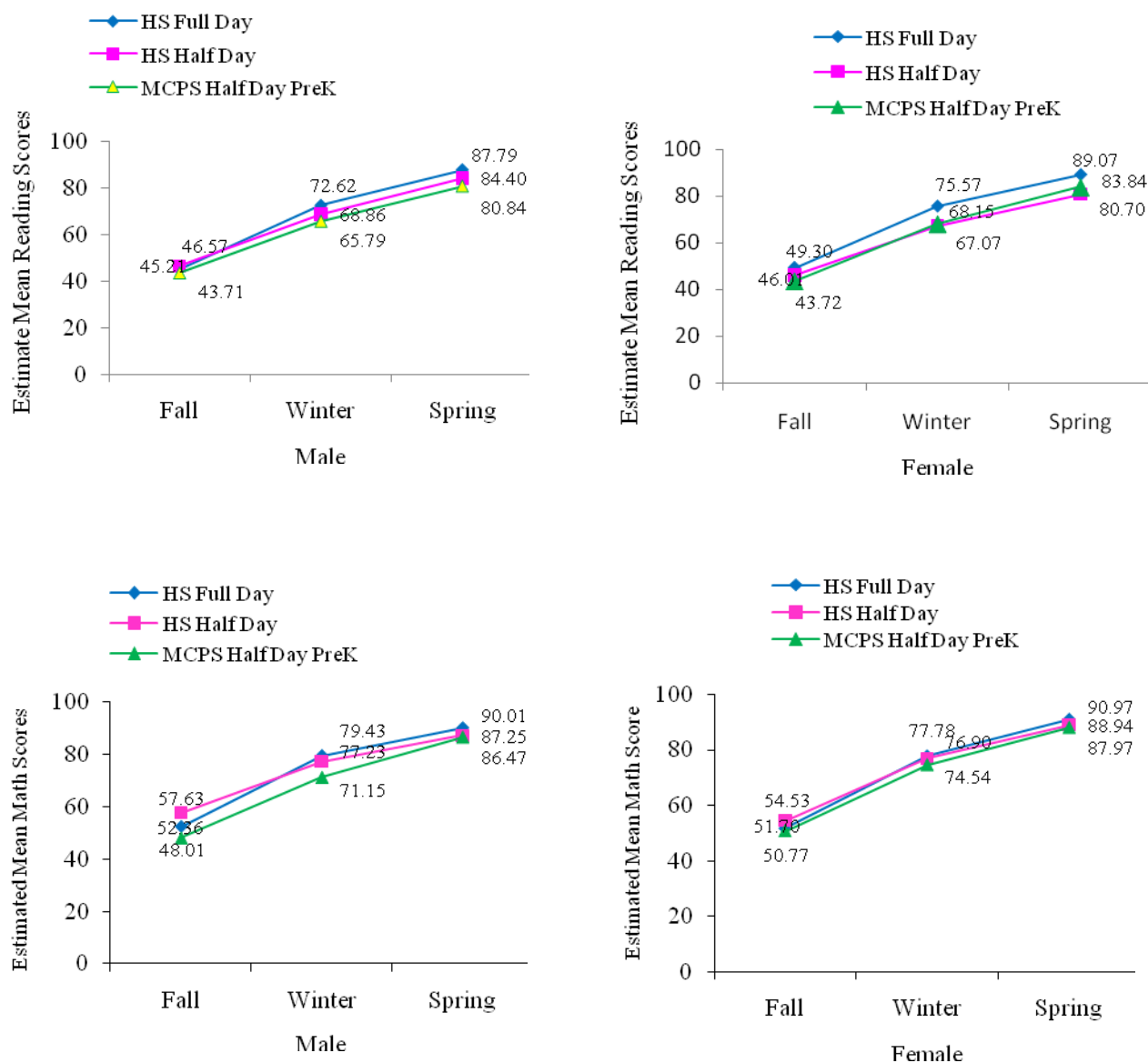
Figure 1. Estimated marginal means in reading and mathematics by gender and prekindergarten program in 2008–2009.

In mathematics, fall-to-spring scores for female and male students were very similar indicating the performance of male and female students was comparable across the pre-K programs.

Estimated marginal means for reading and mathematics scores by race and ethnicity. Overall, Head Start full-day students from every racial subgroup[6] made greater fall-to-spring gains in reading than their counterparts in half-day programs (Table C6; Figure 2). The

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[6]Due to the smaller number of Asian American and White students, results should be interpreted with caution.

largest fall-to-spring gain in reading scores was obtained by Hispanic students in the Head Start full-day program (45.5 points) compared with their counterparts in Head Start half-day (37.2 points) and MCPS half-day (43.4 points) programs.
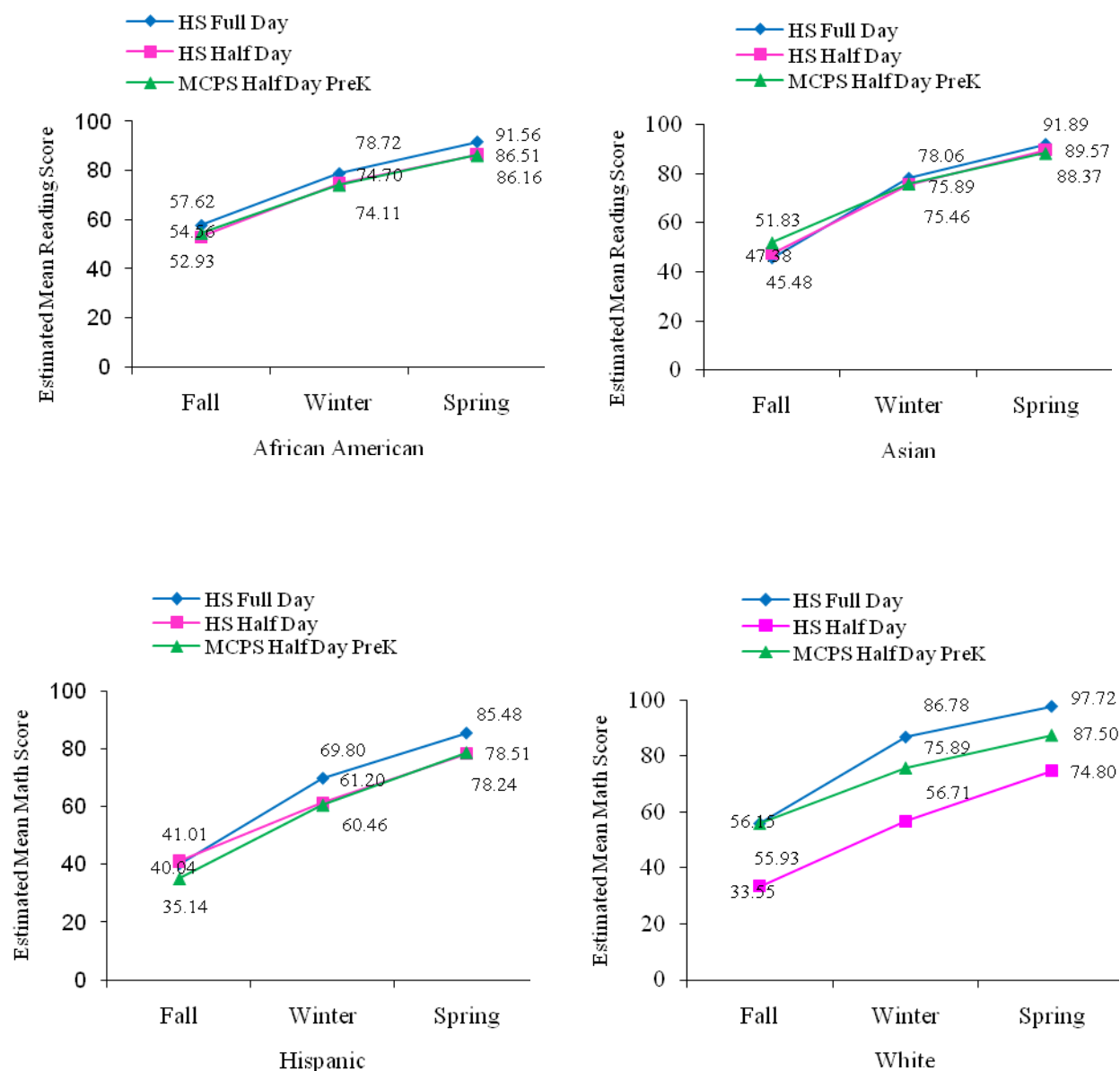
Figure 2. Estimated marginal means in reading by race and ethnicity and prekindergarten program in 2008–2009.

Figure 3 displays mathematics performance by race and ethnicity. In mathematics, the mean spring scores for every racial and ethnic subgroup in the Head Start full-day program were consistently higher than scores for their counterparts in half-day programs. Again, Hispanic students in the full-day program had a significantly larger score increase (43.5 points) compared with their Hispanic peers in the half-day programs (35.6 for Head Start half-day and 41.8 points for MCPS half-day, respectively).
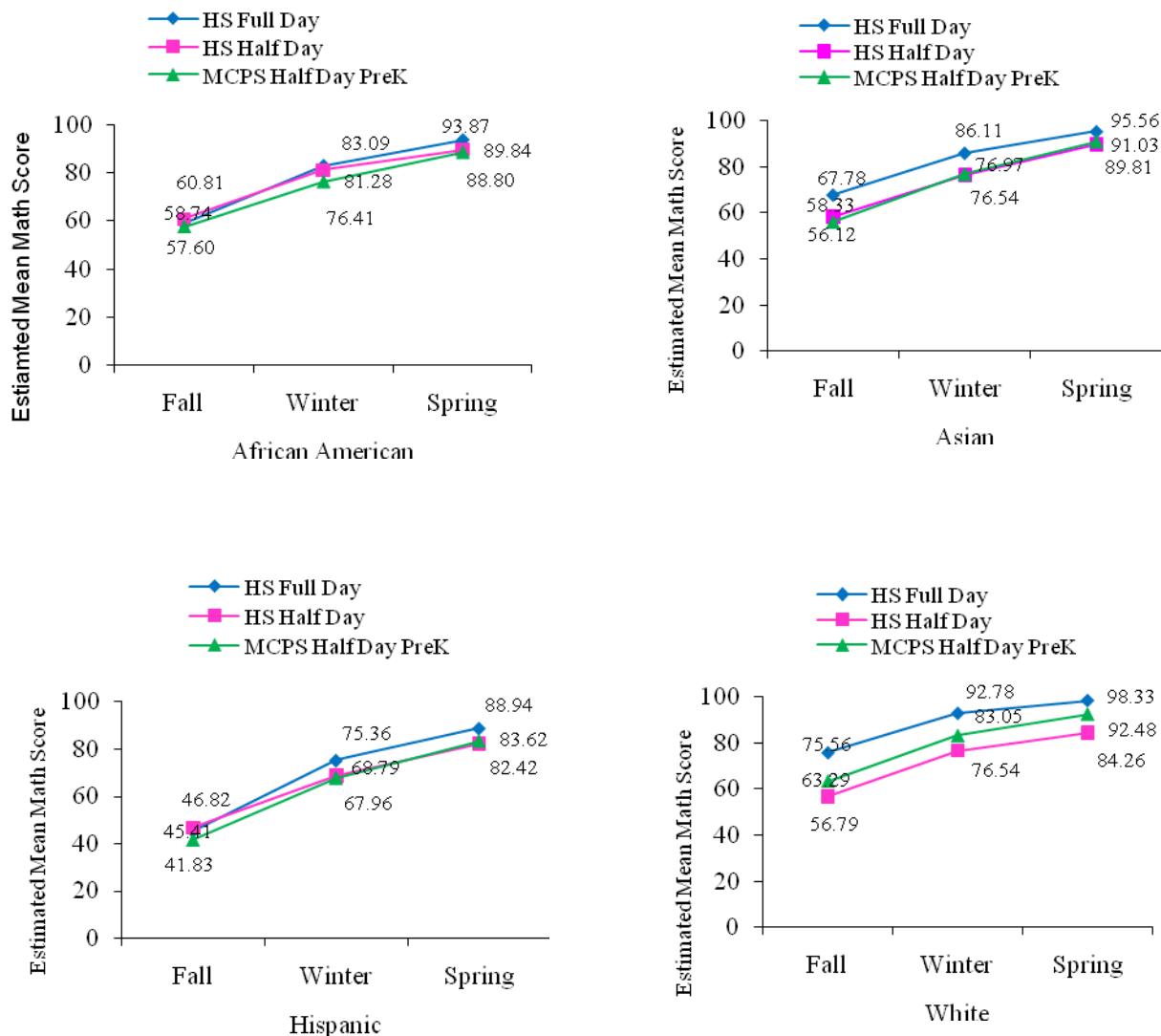
Figure 3. Estimated marginal means in mathematics by race and ethnicity and prekindergarten program in 2008–2009.

ESOL service receipt. Figures 4 and 5 show the mean reading and mathematics scores for students receiving ESOL services. ESOL recipients in the Head Start full-day program had higher performance increases (41.6 points in reading and 40.6 points in mathematics) compared with non-ESOL recipients (40.5 points in reading and 35.0 points in mathematics). Considering the lower starting point in fall, by spring ESOL recipients had accelerated their performance to levels comparable with their non-ESOL peers. This attainment narrowed the achievement gap between ESOL and non-ESOL recipients on skills assessed by the pre-K assessments.
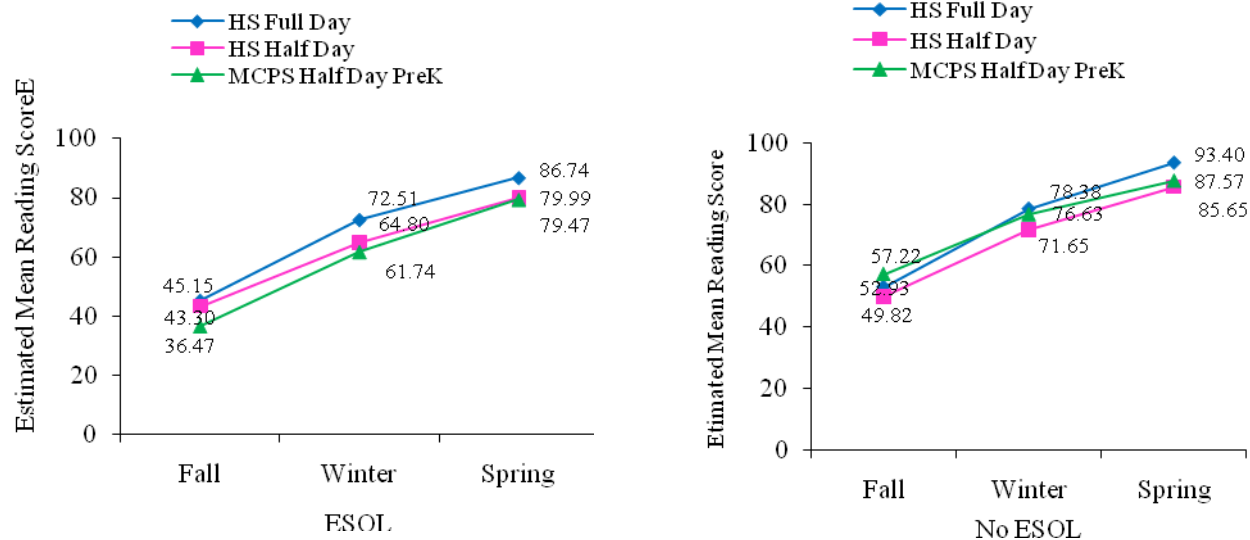
Figure 4. Estimated marginal means in reading by ESOL receipt and prekindergarten classes in 2008–2009.
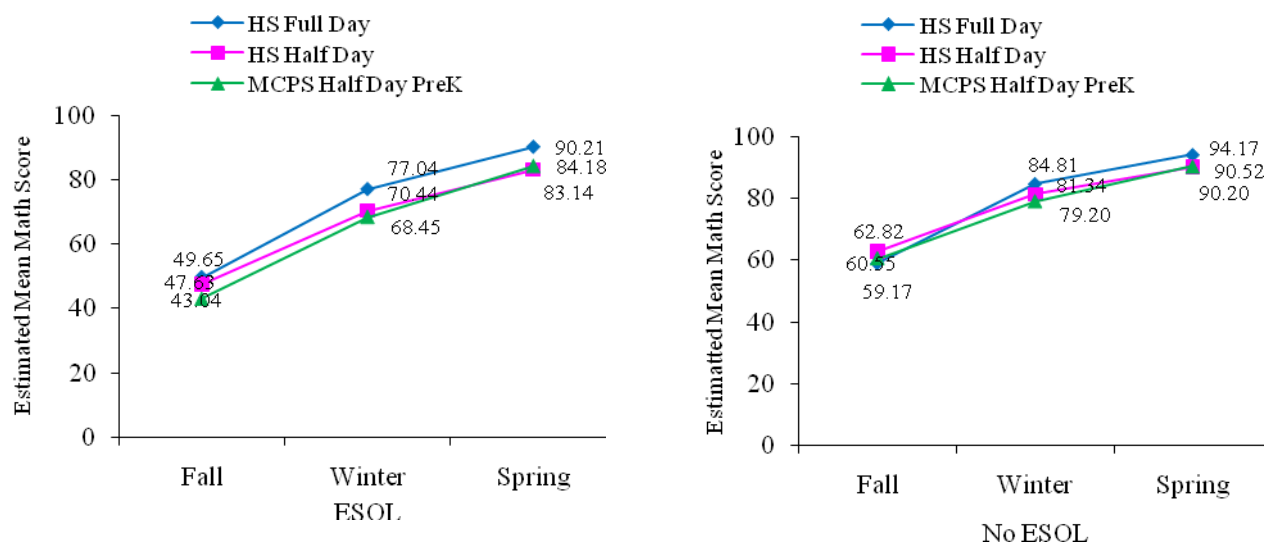
Figure 5. Estimated marginal means in mathematics by ESOL receipt and prekindergarten program in 2008–2009.

These findings suggest that longer pre-K classes contributed to significantly higher improvements in reading outcomes for all students, particularly female, ESOL recipients, and Hispanic and White students. For every student subgroup, students in the full-day program outperformed their peers in the half-day programs.

Differences Among Schools With Head Start Full-day Program

Table 11 presents the mean scores and standard deviations in reading and mathematics for students in the Head Start full-day program by school. The average pre-K spring reading scores ranged from 84% (New Hampshire Estates and Broad Acres) to 94% (Weller Road). The spring mathematics scores ranged from 75% (Broad Acres) to 98% (Weller Road). Head Start full-day effects on reading performance did not differ by school. Further, analyses at the school level revealed that the Head Start full-day effect on mathematics scores varied significantly by school (F $(7,195)$ = 5.2, p = 0.000). The school effect explained 14.7% of the variation in the mathematics scores.

The highest average spring scores in reading were recorded for Weller Road (94.4%), Viers Mill (92.7%), and Montgomery Knolls (92.4%) elementary schools. The largest gains in mean fall-to-spring reading scores were observed for Veirs Mill (55.8), followed by Weller Road (54.1), and Broad Acres (49.3) elementary schools. Standard deviation, the statistic that measures the spread or variation in the data decreased from fall to spring for all schools particularly for Montgomery Knolls (from 27.3 in fall to 6.2 in spring) and Weller Road (from 19.1 in fall to 6.9 in spring) elementary schools (Table 11).

Table 11
Estimated Marginal Mean, Standard Deviation, and Fall-to-Spring Change of Reading and
Mathematics Scores for Students in the Head Start Full-day Program, With Test Results in 2008–2009
Fall, Winter, and Spring, by School

| Outcome/School		Fall			Winter		Spring		Fall–spring change
	N	Mean	*SD*	Mean	*SD*	Mean	*SD*	
Reading									
Arcola	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Broad Acres	20	34.99	19.23	62.87	20.76	84.31	12.06	49.31
East Silver Spring	20	48.23	27.00	71.84	23.36	86.01	16.98	37.78
Georgian Forest	20	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Highland	19	46.10	25.02	n/a	n/a	n/a	n/a	n/a
Montgomery Knolls	20	48.80	27.34	76.06	17.43	92.37	6.21	43.56
New Hampshire Estates	60	53.30	26.59	71.90	21.63	83.97	14.84	30.67
Twinbrook	39	50.80	25.80	74.96	22.46	90.96	15.31	40.16
Viers Mill	20	36.90	21.42	76.70	16.47	92.66	10.93	55.76
Weller Road	20	40.37	19.07	79.23	17.72	94.41	6.88	54.05
Mathematics									
Arcola	20	46.11	36.99	77.78	21.78	95.28	8.51	49.17
Broad Acres	20	33.04	20.58	58.89	23.67	74.72	14.58	41.68
East Silver Spring	20	51.23	29.98	68.21	18.26	n/a	n/a	n/a
Georgian Forest	20	63.73	33.34	87.35	14.98	96.08	10.89	32.35
Highland	19	67.04	25.59	n/a	n/a	n/a	n/a	n/a
Montgomery Knolls	20	60.13	23.01	86.42	13.77	91.67	15.13	31.54
New Hampshire Estates	60	56.13	26.73	78.81	19.06	87.10	15.32	30.97
Twinbrook	39	62.19	30.31	83.04	30.67	95.87	18.94	33.68
Viers Mill	20	33.63	26.09	69.17	18.25	94.17	6.62	60.54
Weller Road	20	50.29	27.56	86.11	12.16	98.25	4.16	47.95

Note. Fall-to-spring change information was computed only for schools with students who had complete test results for three test administrations; n/a = incomplete or missing information.

The diminishing standard deviation indicated that students entered pre-K with large variations in initial literacy skills and became more homogeneous in their performance on the skills assessed by spring pre-K assessments (Table 11).

Similar to reading, the highest fall-to-spring gain in mathematics scores were observed for Viers Mill (60.5), followed by Arcola (49.2) and Weller Road (48.0) elementary schools. The standard deviation in the mathematics scores decreased from fall to spring for all schools particularly for Weller Road (27.6 to 4.2), Veirs Mill (26.1 to 6.6), and Arcola (37.0 to 8.5) elementary schools, indicating a reduction in the achievement gap among Head Start full-day students on skills assessed in pre-*K.*

Evaluation Q3. What is the magnitude of the Head Start full-day program effects? What are the cost-benefit estimates of full-day and half-day programs?

Repeated measure procedures were used to answer evaluation question 3. Results are displayed for the Head Start full-day program compared with the Head Start and MCPS half-day programs in reading and mathematics. Lastly, cost-benefit analyses for full-day and half-day pre-K programs are presented.

Magnitude of Head Start Full-day Program Effects

Effect sizes. The tests of statistical significance were not used as a stand-alone measure of how much the intervention "matters" because it does not address the practical significance or relative impact of the effect size (APA, 2001). For education interventions, empirical benchmarks on impact findings from previous research provides a context for viewing the effect sizes found by research studies and interpreting the practical significance of educational effects. Such a comparison takes into account the objectives of the intervention that produces the effect and the context within which that effect is estimated. Because performance on pre-K assessments is taken as proxy for mastery of early skills that promote long-term outcomes, research on Head Start cohorts indicates that short-term effects of 0.25 for language arts and 0.1 for mathematics might be large enough to generate long-term benefits in excess of program costs (Ludwig & Phillips, 2008).

In this part, the statistics for computing the effects sizes for the student subgroups were derived from the repeated measures.

Reading. Figures 6 and 7 compare the magnitude of program-level effect sizes associated with differences in reading mean scores between the Head Start full-day program and the Head Start half-day program. In every case, the effect of the Head Start full-day program relative to the Head Start half-day program was moderate (d = 0.34) and meaningful in an educational setting. Further, the added impact of the Head Start full-day program relative to the Head Start half-day program on literacy was evident for all subgroups, particularly female students (d = 0.48), Hispanic students (d = 0.40), and ESOL recipients (d = 0.39). These findings indicated that all students who attended the Head Start full-day program made larger gains in literacy than their peers in any of the half-day programs and the gains were practically significant.
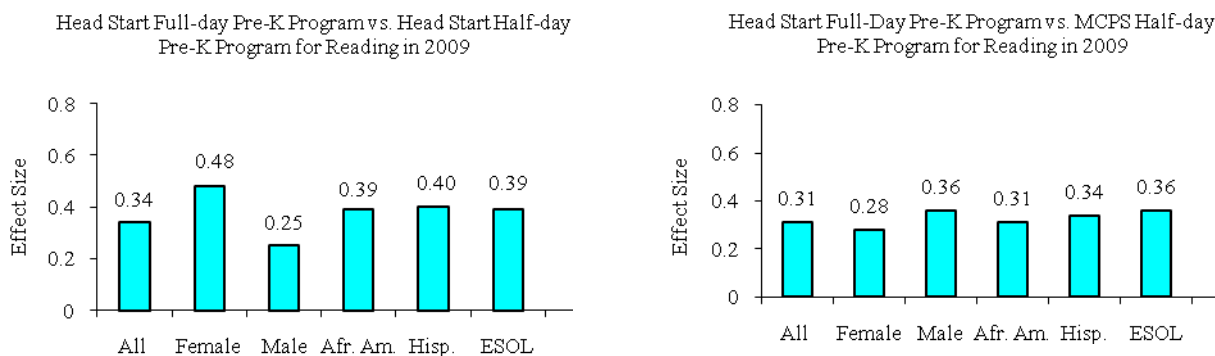
Figure 6. Effect sizes for Head Start full-day program vs. Head Start half-day program in reading.

Mathematics.   Overall, the effect size for mathematics achievement associated with participation in the Head Start full-day program was 0.30 between the Head Start full-day program and the Head Start half-day program, and 0.27 between the Head Start full-day program and the MCPS half-day program (Figure 7).   The largest effect of the Head Start full-day program on mathematics achievement was observed for Hispanic students ($d = 0.34$ Head Start half-day; $d = 0.24$ MCPS half-day) and ESOL recipients ($d = 0.32$ Head Start; $d = 0.24$ MCPS half-day) subgroups.   That is, Hispanic students and ESOL recipients in the Head Start full-day program outperformed their peers in the half-day programs in mathematics.   The magnitude of the differences in the performance of the groups was educationally meaningful.   These effects surpassed the benchmark of program effects of 0.1 for mathematics which are considered large enough to generate long-term benefits in excess of program costs (Ludwig & Phillips, 2008). Positive program effects associated with the Head Start full-day program were observed for male (0.09–0.1) and African American (0.07–0.09) students whereas the negligible effect sizes for female students signify that the performance of female students in the full-day program was comparable to their counterparts in the half-day programs.
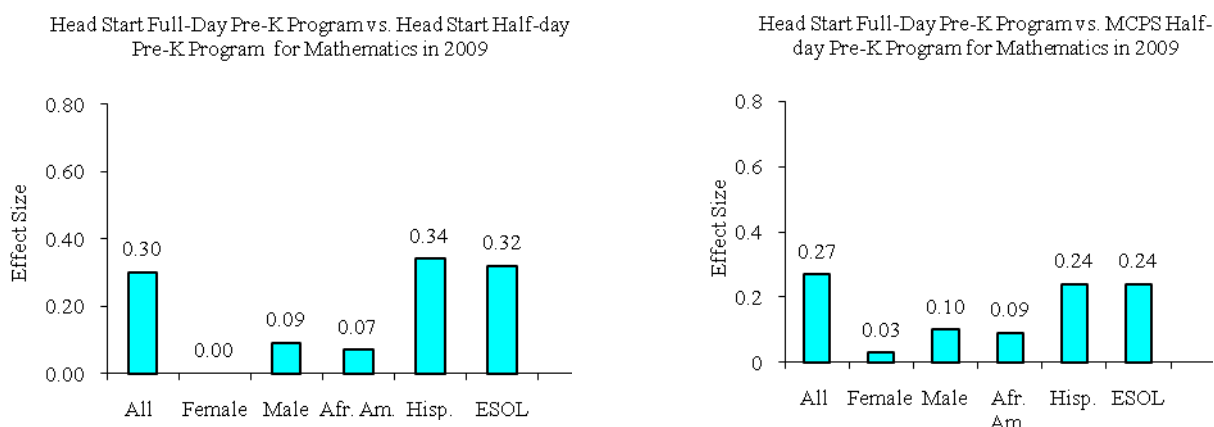
Figure 7. Effect sizes for Head Start full-day program vs. Head Start half-day program in mathematics.

Cost-Benefit Analyses

Table 12 provides information on seasonal effect size for the pre-K programs and cost for each program The Head Start full-day program had the largest seasonal effect on both reading ($d = 2.06$) and mathematics ($d = 1.61$). This suggests that students in the full-day program had larger score increases from fall to spring in 2008–2009 compared with the half-day programs. On the other hand, due to longer instruction and staff time, the cost is also highest for the Head Start full-day program, followed by the Head Start half-day program and the MCPS half-day program. With program effect sizes for the full-day program being 0.34 and 0.31 in reading and 0.30 and 0.27 in mathematics compared with the Head Start and MCPS half-day programs, the cost-benefit estimates[7] for the full-day program ranged from 0.029 to 0.032 per child per $1,000 in reading, and 0.026 to 0.029 per child per $1,000 in mathematics. These effects surpassed the benchmark of program effects of 0.025 and are considered large enough to be sufficient to justify the full-day program cost and generate long-term benefits in excess of program costs (Hill et al., 2008; Harrison, 2007; Ludwig & Philips, 2008).

Table 12
Cost-Benefit Estimates Based on Seasonal Effects for MCPS Prekindergarten Classes, 2008–2009

		Reading	Mathematics
Program	Cost per child ($)	Seasonal effect size	Seasonal effect size
Head Start full-day	$10,509	2.06	1.61
Head Start half-day	$7,856	1.61	1.34
MCPS half-day	$4,673	1.60	1.53

The evidence indicates that the effects associated with the Head Start full-day program were sufficiently large to justify its higher cost. In addition, with longer instruction time, the moderate program effects for economically disadvantaged and limited English proficient students indicate that these students were able to perform on par with or outperform their peers.

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[7] Effect size/cost per program*1000.

Discussion

MCPS pre-K and Head Start programs offer a high-quality educational experience to income-eligible children in order to prepare them with the foundational knowledge and skills necessary for school success in kindergarten and beyond. Therefore, the purpose of this impact study was to determine the extent to which 2008–2009 MCPS pre-K classes supported that goal.

Specifically, this report discusses the effects of Head Start full-day pre-K on reading and mathematics performance. The study compared the performance of a group of students who attended Head Start full-day classes during 2008–2009 with the performance of students who attended pre-K on a half-day basis. The findings demonstrated significant progress in mastery of literacy and mathematics skills for all pre-K participants as measured by MCPS pre-K assessments. The scores on the pre-K assessments used to evaluate literacy and mathematics also revealed that students who attended full-day classes demonstrated significantly higher performance on reading than students in half-day classes. The results also demonstrated that Head Start full-day classes also yielded positive and educationally meaningful effects on reading and mathematics performance of students from most student subgroups.

These results for the second MCPS Head Start full-day cohort were consistent with results for the first cohort of 2007–2008 MCPS Head Start full-day pre-K (Zhao, et al., 2009). These results also support the hypothesis that full-day pre-K contributes to significant academic gains for students who are highly diverse, impacted by poverty, and who start pre-K with low baseline scores (DHHS, 2010). As such, students who arguably need pre-K most benefit from full-day classes more. The observed positive effects on performance for ESOL recipients and Hispanic students provide evidence similar to other studies which indicated that Head Start full-day classes promote school readiness and contribute to narrowing the achievement gap between students at risk and their more advantaged peers (Gormely & Phillips, 2005).

When effect sizes were combined with costs of the pre-K classes, the program effect met the 0.15–0.20 mark. These effects are considered sufficient for Head Start to pass the benefit-cost test, making a strong case for the additional resources associated with providing full-day pre-K classes.

While significant improvement in attainment of mathematics skills was observed in full-day classes, analyses of the pre-K assessment mathematics tool show that it contains 18 items. These items were designed to adequately measure the pre-K mathematics curriculum for half-day classes and may not reflect overall academic growth in the students who attend full-day classes. Hence, the mathematics scores were prone to a ceiling effect whereby a measurement cannot take on a value higher than some limit or "ceiling." This ceiling is imposed not by the phenomenon being measured (current performance), but rather by the finite nature of the pre-K measuring instrument—the mathematics assessment (Linn & Gronlund, 1999). As such, assessment of the real effects of the Head Start full-day program on mathematics achievement may have been limited to the skills assessed by the instrument available.

Recommendations

- Follow up with students to examine lasting effects of participation in MCPS pre-K classes when students are in Grades K–3.
- Establish a mechanism to ensure that schools enter complete assessment data for all students enrolled.
- Continue to examine, compile, and share best practices in implementing Head Start full-day classes from year to year to increase the fidelity of implementation of the program.
- Reexamine the assessments, particularly the mathematics assessments, to ensure that the tests not only emphasize basic concepts in the curriculum but also tap other types of preschool learning. The locally prepared tests such as the pre-K assessments are useful for classroom testing because they are designed to yield measurements of specific knowledge and skills covered in the instructional program in half-day classes. However, it is important to select objectives carefully and to include enough items for each instructional cluster to provide for reliable interpretation. It is now necessary to reexamine the assessments for full-day classes to better accurately reflect program impact.
- Examine factors related to mathematics instruction (such as scheduling, grouping, and instructional resources) in full-day Head Start classes in comparison with those employed for reading instruction.

References

.

American Psychological Association. (2001). *Publication manual of the American Psychological Association*. Washington, DC: Author.

Campbell, D. & Stanley, J. (1963). *Experimental and quasi-experimental designs for research*. Chicago: Rand McNally College Publishing.

Frede, E., Jung, K., Barnett, S., Lamy, C., & Figueras, M. (2009). The APPLES blossom: Abbot preschool program longitudinal effects study. Preliminary results through 2nd Grade. *Interim Report*. National Institute for Early Education Research. NJ: Rutgers State University.

García, E. E., Jensen, B. T., and Cuéllar, D. (2006). Early academic achievement of advancing school readiness for young Hispanic children. *Developmental Educator, 2*, 123–147.

Gayl, C. V. Young, M., & Patterson, K. (2010). *Tapping Title I: What every school administrator should know about Title I, pre-K and school reform*. Washington, DC: Pew Center on the States.

Gormley, W. T., Gayer, T., & Phillips, D. (2005). The effects of universal pre-K in Oklahoma: Research highlights and policy implications. *The Policy Studies Journal*, *33*(1), 65–81.

Harris, D. (2009). Toward policy-relevant benchmarks for interpreting effect sizes: Combining effects with costs. *Educational Evaluation and Policy Analysis*, *31*(1) 3–29.

Harrison, D. N. (2007). *New benchmarks for interpreting effect sizes: Combining effects with cost*. Working paper at University of Wisconsin at Madison.

Hill, C. J., Bloom, H. S., Black, A. R., & Lipsey, M. W. (2008). Empirical benchmarks for interpreting effect sizes in research. *Child Development Perspectives*, *2*(3), 172–177.

Hustedt, J. T., Barnett, W. S., Jung, K., Figueras, A. (2008). Impacts of New Mexico pre-K on children's school readiness at kindergarten entry: Results from the second year of a growing initiative. National Institute for Early Education Research, Rutgers State University of New Jersey.

Isaacs, J. (2008). Impacts of Early Childhood Programs. Washington, DC: The Brookings Institution.

Judd, C. M., Smith, E. R. & Kidder, L. H. (1991). *Research methods in social relations* (6th ed.) London: Holt, Rinehart and Winston, Inc.

Kirk, R. E. (1995). *Experimental design: Procedures for the behavioral sciences*. New York, NY: Brooks/Cole Publishing Company.

Kline, R. (2004). *Beyond significance testing: Reforming data analysis methods in behavioral research.* Washington, DC: American Psychological Association.

Linn, R. W. & Grondlund, N. C. (1999). *Measurement and assessment in teaching.* Upper Saddle River, NJ: Prentice Hall.

Ludwig, J., & Philips, D. A. (2008). *Long-term effects of Head Start on low-income children.* Presented at 2008 Annual New York Academy of Science.

MCPS (2007). *Use of Title I funds in fiscal year 2008.* Memo to Board of Education. Rockville MD: Montgomery County Public Schools.

MCPS (2009a). *Our call to action: Pursuit of excellence. The strategic plan for Montgomery County Schools 2008-2011.* Rockville MD: Montgomery County Public Schools.

MCPS (2009b). *Division of Early Childhood Programs and Services prekindergarten fact sheet.* Rockville MD: Montgomery County Public Schools.

Nunnally, J.C. (1978). *Psychometric theory.* New York, NY: McGraw Hill Publishing Company.

Robin, K. B., Frede, E. C., & Barnett, W. S. (2006). *Is it better? The effects of full-day vs. half-day preschool on early school achievement.* New Brunswick, NJ: National Institute of Early Education Research.

Rossi, P., Lipsey, M., & Freeman, H. (2004). *Evaluation: A systematic approach.* Thousand Oaks, CA: Sage.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* Boston, MA: Houghton Mifflin Company.

Schafer, William D. (2001). Replication: a design principle for field research. *Practical Assessment, Research & Evaluation*, 7(15).

Zhao, H. Modaressi, S. & Liu, S. (2009). *Impact of full day pre-kindergarten program on student academic performance.* Rockville MD: Montgomery County Public Schools.

U.S. Department of Health and Human Services. (January 2010). *Head Start impact study: Final report.* Washington, D.C.: Administration for Children and Families, DHHS.

Appendices

Appendix A

Table A1
Title I Elementary Schools With Head Start Full-day Program

Elementary school	*N*
Arcola	20
Broad Acres	20
East Silver Spring	20
Georgian Forest	20
Highland	19
Montgomery Knolls	20
New Hampshire Estates	60
Twinbrook	39
Viers Mill	20
Weller Road	20
Total	258

Appendix B

Sample Pre-K Schedules for Head Start Full-day, Head Start Half-day,
and MCPS Half-day Pre-K Programs

Table B1
Sample Daily Schedules (Part-day)
Prekindergarten AM (2 ½ hour day)

Time	Instruction/Activity
8:50–8:55 (5 minutes)	Arrival Greetings. Conversation. Sign-in or check-in system (e.g., move name card/photo). May include question of the day or table activities.
8:55–9:00 (5 minutes)	Class Meeting Welcome. Daily schedule. Highlights of day or week. May include selection of student jobs, daily message, and/or question of the day.
9:00–9:30 (30 minutes)	Literacy Block – Large Group Literacy Lesson 5 minutes: oral language/vocabulary, phonological/phonemic awareness, letter identification 15 minutes: Read Aloud or shared reading (focusing on skill/concept development such as concepts about print, oral language, vocabulary, phonemic awareness, letter identification, fluency, and comprehension) - Literacy Block – Small Group Literacy Lessons 10 minutes: differentiated activities focusing on prekindergarten-level indicators from the MCPS *English Language Arts Curriculum Framework*
9:30–9:55 (25 minutes) Includes clean-up time	Center Time Centers include dramatic play, literacy, blocks, art, math/manipulatives, and science
9:55–10:10 (15 minutes)	Outdoor Time Includes physical development, natural science, and socialization activities
10:10–10:30 (20 minutes)	Small Group Math Instruction or Special Subject (Art, Music, or PE) Note: Art, Music, and PE may occur at other times during the day.
10:50–11:15 (25 minutes)	Lunch Hand washing before and after lunch. Conversation during lunch.
11:15–11:20 (5 minutes)	Prepare for dismissal
11:20	Dismissal

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Table B2
Sample Daily Schedules (Part-day)
Prekindergarten PM (2 ½ hour day)

Time	Instruction/Activity
12:35–12:40 (5 minutes)	Arrival Greetings. Conversation. Sign-in or check-in system (e.g., move name card/photo). May include question of the day or table activities.
12:40–1:05 (25 minutes)	Lunch Hand washing before and after lunch. Conversation during lunch.
1:05–1:10 (5 minutes)	Class Meeting Welcome. Daily schedule. Highlights of day or week. May include selection of student jobs, daily message, and/or question of the day.
1:10–1:40 (30 minutes)	Literacy Block – Large Group Literacy Lesson 5 minutes: oral language/vocabulary, phonological/phonemic awareness, letter identification 15 minutes: Read Aloud or shared reading (focusing on skill/concept development such as concepts about print, oral language, vocabulary, phonemic awareness, letter identification, fluency, and comprehension) - Literacy Block – Small Group Literacy Lessons 10 minutes: differentiated activities focusing on prekindergarten-level indicators from the MCPS *English Language Arts Curriculum Framework*
1:40–2:05 (25 minutes) Includes clean-up time	Center Time Centers include dramatic play, literacy, blocks, art, math/manipulatives, and science
2:05–2:20 (15 minutes)	Outdoor Time Includes physical development, natural science, and socialization activities
2:20–2:40 (20 minutes)	Small Group Math Instruction or Special Subject (Art, Music, or PE) Note: Art, Music, and PE may occur at other times during the day.
3:00–3:05 (5 minutes)	Prepare for dismissal
3:05	Dismissal

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Table B3
Sample Daily Schedule (Part-day)
Head Start (3 ¼ hour day)

Time	Instruction/Activity
8:50 – 8:55 (5 minutes)	Arrival Greetings. Conversation. Sign-in or check-in system (e.g., move name card/photo). May include question of the day or table activities.
8:55 – 9:00 (5 minutes)	Class Meeting Welcome. Daily schedule. Highlights of day or week. May include selection of student jobs, daily message, and/or question of the day.
9:00 – 9:30 (30 minutes)	Literacy Block – Large Group Literacy Lesson 5 minutes: oral language/vocabulary, phonological/phonemic awareness, letter identification 15 minutes: Read Aloud or shared reading (focusing on skill/concept development such as concepts about print, oral language, vocabulary, phonemic awareness, letter identification, fluency, and comprehension) - Literacy Block – Small Group Literacy Lessons 10 minutes: differentiated activities focusing on prekindergarten-level indicators from the MCPS *English Language Arts Curriculum Framework*
9:30 – 10:05 (35 minutes)	Center Time Centers include dramatic play, literacy, blocks, art, math/manipulatives, and science
10:05 – 10:15 (10 minutes)	Clean-up Time
10:15 – 10:35 (20 minutes)	Outdoor Time Includes physical development, natural science, and socialization activities
10:35 – 10:55 (20 minutes)	Mathematics Instruction May include calendar activities and mathematics-related read aloud
10:55 – 11:20 (25 minutes)	Small Group Math Instruction or Special Subject (Art, Music, or PE) Note: Art, Music, and PE may occur at other times during the day.
11:20 – 11:25 (5 minutes)	Table setting and hand washing
11:25 – 11:50 (25 minutes)	Family style lunch Conversation during lunch.
11:50 – 12:00 (10 minutes)	Prepare for dismissal
12:05	Dismissal

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Table B4
Full-Day Head Start Sample Schedule

Time	Instruction
5 minutes	Arrival Sign in or check in (attendance), Venn diagram or question of the week
5 minutes	Class Meeting Morning message or question of the week, reading daily schedule, calendar activities, and job chart
3 minutes	Movement/Music
20 minutes	Whole Group Literacy Lesson 5 minutes: oral language/vocabulary focus 15 minutes: Read-Aloud/Shared Reading, *Building Language for Literacy* (BLL) lesson and/or Reading, Writing, Language Arts Guide lesson
2 minutes	Movement Transition
10 minutes	Shared Writing (e.g., taking dictation about a shared experience or children's plans for center time.)
30 minutes	Child- Selected Centers (Free Choice) - Interaction with peers and adults in learning activities Centers include: Dramatic Play—BLL and other dramatic play settings… Literacy—books/print materials, comfortable reading space, writing/drawing materials, blank books, mailboxes, computer, listening station, alphabet games, and puzzles, magnetic letters, puppets and puppet stage, etc. Blocks—enhanced with props, theme-related books (e.g. construction), and writing materials (for making signs) Art—paint, glue, clay, and/or playdough; a variety of drawing, writing, and printing tools; collage materials; and paper Math—magnetic numerals, writing/drawing materials, puzzles, math literature books, real-world photographs, pattern blocks, attribute blocks, connecting links, connecting cubes, pegs and pegboards, shapes to trace around, etc. Manipulatives—puzzles, counting sets, attribute blocks, geometric solids, etc. Science—sand and water table, objects to sort and classify, pan balance scale, magnifying glasses and other materials from science kits
3 min	Movement Transition
35 minutes	Differentiated Small Group Literacy Lesson Rotation/ Indicator-Focused Literacy Centers Each student participates in a teacher-directed, small group literacy lesson daily. Differentiated lessons focus on foundational skills: Oral Language, Concepts about Print, Phonemic Awareness, or Letter Knowledge and lasts for 5-7 minutes. As one group meets with the teacher, the remaining students work in indicator-driven literacy centers, such as book center, listening station, letter puzzles, writing center, computer, puppets, flannel board etc. Paraeducator facilitates student learning in literacy centers.

Continued

Table B4
Full-Day Head Start Sample Schedule, continued

5 minutes	Clean-up Time
30 minutes	Outside Time Physical motor, science, and social activities (includes transition time)
20 minutes	Whole Group Math Lesson Teacher-directed whole group mathematics lesson (daily)
35 minutes	Table setting and hand washing Family-Style Lunch (conversation and sharing among children and adults) Brushing teeth-Children look at books on rug after eating
30 minutes	Special: Art, Music, P.E. (includes transition time)
40 minutes	Rest Break: Students rest or participate in quiet time activity: look at books/ play with manipulatives (includes transition time)
35 minutes	Differentiated Small Group Math Lesson Rotation/ Indicator-Focused Math Centers: The teacher and paraeducator each meet with math small groups of students for 15-minute, differentiated lessons focusing on math indicators. Remaining students work in structured indicator-driven math centers. Students rotate so that everyone participates in adult-directed small group and math centers daily.
2 minutes	Movement Transition
20 minutes	Integrated Whole Group Lesson: Teacher-directed whole group lessons focusing on social skills, science, social studies, health, etc. Include lessons from *Talking About Touching*, *Second Step*, *Color Me Healthy* and science curriculum
30 minutes	E.L.M., Pre-K Level: Time for in-depth investigation of BLL and other curriculum topics. Teachers support and extend children's learning by providing experiences to develop and reinforce literacy, mathematics, and problem-solving skills. Time to promote oral language, vocabulary, science, social studies, and social-emotional skills through teacher-student and student-student interactions in social settings. (includes transition time)
15 minutes	Prepare to Dismiss: Review Day, Pack Belongings, Dismissal

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Appendix C

Table C1
Pearson Correlation Coefficients Among Cluster Scores and Total Scores for MCPS
Prekindergarten Reading Assessments

	Reading total	Oral language	Letter identification	Rhyming words	Beginning sounds
Reading total					
Oral language	0.63*				
Letter identification	0.94*	0.38*			
Rhyming word	0.47*	0.36*	0.30*		
Beginning sounds	0.59*	0.39*	0.44*	0.51*	
Concepts about print	0.53*	0.46*	0.36*	0.36*	0.39*

*Correlation is significant at the 0.01 level (2-tailed).

Table C2
Characteristics for 2008–2009 MCPS Prekindergarten Students Without Complete
Reading or Mathematics Test Results for Fall, Winter, and Spring
Test Administrations, by Prekindergarten Program ($N = 462$)

		Head Start full-day ($N = 39$)		Head Start half-day ($N = 124$)		MCPS half-day ($N = 299$)	
		N	%	N	%	N	%
Gender	Female	15	57.7	26	57.8	114	56.7
	Male	11	42.3	19	42.2	87	43.3
Race/ethnicity	African American	8	20.5	60	48.4	100	33.4
	Asian	3	7.7	10	8.1	36	12.0
	Hispanic	27	69.2	47	37.9	144	48.2
	White	1	2.6	7	5.6	19	6.4
Special Education	Yes	0	0.0	0	0.0	3	1.5
	No	26	100.0	45	100.0	198	98.5
Current ESOL	ESOL	23	71.9	29	49.2	152	60.6
	No ESOL	9	28.1	30	50.8	99	39.4

Note. ESOL = English for Speakers of Other Languages.

Table C3
Family Background Information For Students Without Complete Reading or Mathematics Scores For
2008–2009 Fall, Winter, And Spring Test Administration By Pre-K Program

Family background	Head Start full-day		Head Start half-day		MCPS half-day	
	Mean	Median	Mean	Median	Mean	Median
Family income	$21,030	$18,540	$16,312	$15,015	$22,380	$23,400
Income per person in family	$5,638	$4,635	$4,627	$3,929	$5,922	$6,000
Age of female guardian	31	30	31	30	31	31
Years of education of female guardian	10	12	12	12	11	12
Age of male guardian	34	34	36	35	36	36
Years of education of male guardian	10	12	11	12	13	12
Family size	4	4	4	4	4	4

Note. American Indian students were included in the total but not reported separately.

Table C4
Tests of Within-Subject Effect for 2008–2009 MCPS Prekindergarten Students'
Performance on Reading and Mathematics from Fall to Spring, by Subgroup

Source	Reading				Mathematics			
	DF	*F*	*p* value	Partial Eta Squared	*DF*	*F*	*p* value	Partial Eta Squared
Gender								
Season	2	2,020.5	**.000**	.554	2	1,404.4	**.000**	.432
Season x pre-K	4	2.940	**.019**	.004	4	1.567	.180	.002
Season x pre-K x gender	6	2.197	**.041**	.004	2	.767	.464	.000
Race/Ethnicity								
Season	2	791.3	**.000**	.328	2	5,61.5	**.000**	.219
Season x pre-K	4	2.724	**.028**	.003	4	1.154	.329	.001
Season x pre-K x race	18	9.141	**.000**	.048	12	.795	.656	.002
ESOL								
Season	2	1,724.6	**.000**	.515	2	1,444.8	**.000**	.418
Season x pre-K	4	2.674	**.030**	.003	4	4.836	**.001**	.005
Season x pre-K x ESOL	6	26.4	**.000**	.047	4	1.212	.303	.001

Note. Bolded *p* values are statistically significant; ESOL = English for Speakers of Other Languages.

Table C5
Tests of Between-Subject Effects for 2008–2009 MCPS Prekindergarten Students'
Performance on Reading and Mathematics From Fall to Spring, by Subgroup

		Reading				Mathematics		
Source	DF	F	p value	Partial Eta Squared	DF	F	p value	Partial Eta Squared
Gender								
Pre-K	2	5.306	**.005**	.006	2	5.093	**.006**	.005
Gender	1	.308	.579	.000	1	.111	.739	.000
Gender x pre-K	2	.781	.458	.001	2	.789	.455	.001
Race/Ethnicity								
Pre-K	2	3.469	**.031**	.004	2	3.719	**.024**	.004
Race	3	20.250	**.000**	.036	3	20.05	**.000**	.029
Race x pre-K	6	1.786	.098	.007	6	.695	.654	.002
ESOL								
Pre-K	2	3.792	**.023**	.005	2	4.419	**.012**	.004
ESOL	1	33.785	**.000**	.020	1	48.21	**.000**	.023
ESOL x pre-K	2	4.953	**.000**	.006	2	.865	.421	.001

Note. Bolded *p* values are statistically significant; ESOL = English for Speakers of Other Languages.

Table C6
Means and Standard Deviation of Reading for Students in MCPS
Prekindergarten Classes, by Season and Subgroup

Student subgroup	Fall		Winter		Spring		Fall-to-spring change
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	
Gender							
Male							
Head Start full day	45.64	24.045	72.66	21.042	88.03	14.152	42.39
Head Start half day	45.09	25.707	66.75	23.927	82.75	19.762	37.66
MCPS half day	43.49	26.03	64.56	26.026	79.79	22.046	36.30
Female							
Head Start full day	48.45	26.398	73.75	20.654	88.57	13.414	40.12
Head Start half day	44.78	26.026	64.68	25.003	79.89	20.849	35.11
MCPS half day	44.37	26.592	67.12	25.166	83.26	19.898	38.89
Race/Ethnicity							
African American							
Head Start full day	57.61	25.054	78.72	18.490	91.55	10.119	33.94
Head Start half day	52.93	25.468	74.70	20.360	86.51	15.266	33.58
MCPS half day	54.55	26.379	74.11	23.867	86.15	18.353	31.60
Asian American							
Head Start full day	45.47	37.386	78.05	16.915	91.88	9.185	46.41
Head Start half day	47.37	29.376	75.46	20.500	89.57	8.983	42.20
MCPS half day	51.83	26.377	75.88	21.780	88.36	17.504	36.53
Hispanic							0
Head Start full day	40.03	22.332	69.79	20.643	85.48	15.243	45.45
Head Start half day	41.01	24.967	61.20	26.157	78.23	23.077	37.22
MCPS half day	35.13	23.496	60.46	25.198	78.50	21.840	43.37
White							
Head Start full day	55.92	17.253	86.77	9.086	97.72	3.551	41.80
Head Start half day	33.55	17.478	56.71	22.443	74.79	22.375	41.24
MCPS half day	56.15	25.648	75.88	22.649	87.49	16.052	31.34
ESOL							
Head Start full day	45.32	25.365	71.03	21.267	86.25	14.956	40.93
Head Start half day	40.51	26.375	61.98	25.966	78.8	21.852	38.29
MCPS half day	36.94	24.059	60.37	25.636	78.73	21.807	41.79

Note. ESOL = English for Speakers of Other Languages.

Table C7
Means and Standard Deviation of Mathematics for Students in MCPS
Prekindergarten Classes, by Season and Subgroup

Student subgroup	Fall		Winter		Spring		Fall-to-spring change
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	
Gender							
Male							
Head Start full day	51.82	28.854	78.84	23.633	88.62	18.704	36.81
Head Start half day	58.85	28.947	76.77	24.206	86.46	19.586	27.61
MCPS half day	48.22	29.275	70.70	26.637	86.87	20.652	38.64
Female							
Head Start full day	54.58	27.994	77.85	20.289	87.99	14.866	33.42
Head Start half day	56.14	27.227	76.08	23.066	88.28	16.787	32.13
MCPS half day	51.09	28.437	73.95	23.763	88.10	17.521	37.01
Race/Ethnicity							
African American							
Head Start full day	58.74	30.190	83.08	23.204	93.87	17.387	35.13
Head Start half day	60.81	25.045	81.28	20.947	89.83	16.478	29.02
MCPS half day	57.59	27.921	76.41	22.640	88.79	16.641	31.20
Asian American							
Head Start full day	67.77	30.293	86.11	19.466	95.55	5.737	27.78
Head Start half day	58.33	34.942	76.54	22.021	89.81	16.308	31.48
MCPS half day	56.11	28.626	76.96	23.652	91.03	13.733	34.92
Hispanic							
Head Start full day	45.41	28.234	75.36	20.566	88.93	14.144	43.52
Head Start half day	46.81	29.179	68.78	26.775	82.42	20.520	35.61
MCPS half day	41.83	27.859	67.96	25.853	83.61	20.060	41.78
White							
Head Start full day	75.55	18.921	92.77	9.460	98.33	3.749	22.78
Head Start half day	56.79	29.121	76.54	27.120	84.25	21.579	27.46
MCPS half day	63.29	24.851	83.05	17.224	92.47	10.105	29.18
ESOL							
Head Start full day	50.83	29.869	76.58	23.522	88.27	17.699	37.44
Head Start half day	48.86	29.436	69.82	26.211	83.02	19.600	34.16
MCPS half day	43.43	28.262	67.55	25.976	83.96	20.696	40.53

Note. ESOL = English for Speakers of Other Languages

Table C8
Comparison of Magnitude of Effects

	Head Start half-day	MCPS half-day
Reading		
All Students [a]	0.34	0.31
Female	0.48	0.28
Male	0.25	0.36
African American	0.39	0.31
Asian	0.26	0.21
Hispanic	0.40	0.34
White	1.30	0.69
ESOL	0.39	0.36
No ESOL	0.57	0.36
Mathematics		
All Students [a]	0.30	0.27
Female	0.00	0.03
Male	0.09	0.10
African American	0.07	0.09
Asian	0.18	0.01
Hispanic	0.34	0.24
White	0.80	0.61
ESOL	0.32	0.24
No ESOL	0.12	0.05

Note. Due to their small numbers, results for Asian American and White students were not shown here, despite significant improvement for those in the full-day program. ESOL = English for Speakers of Other Languages.
[a] Effect size was calculated by ANCOVA. All other effect sizes were computed with repeated measure results.

Appendix D

ANCOVA Model Description

Model 1 (Head Start full-day program vs. Head Start half-day program in reading)

The dependent variable or outcome measure for this model was the spring 2009 MCPS pre-K reading test scores. The independent variable was a dummy variable created to represent the status of the students' experiences. The control variables or covariates included race and ethnicity, income per person in the family, special education status, ESOL services, and gender. The pretests for this cohort were the fall 2008 MCPS pre-K reading test scores. The correlation coefficient of the fall pre-K reading scores with spring pre-K reading scores was significant ($r = 0.496$; $p < 0.05$). The sample for the analysis included 313 students who had both fall and spring MCPS pre-K reading scores during the 2008–2009 school year.

Model 2 (Head Start full-day program vs. Head Start half-day program in mathematics)

The dependent variable for this model was the spring 2009 MCPS pre-K mathematics scores. The independent variable was a dummy variable created to represent the status of the students' experiences. The control variables or covariates included race and ethnicity, income per person in the family, special education, ESOL services, and gender. The pretests for this cohort were the fall 2008 MCPS pre-K mathematics scores. The correlation coefficient of the fall 2008 MCPS pre-K mathematics scores with the spring scores was significant ($r = 0.493$; $p < 0.05$). The sample for the mathematic analyses included 358 students who had both fall and spring MCPS pre-K mathematics scores during the 2008–2009 school year.

Model 3 (Head Start full-day program vs. MCPS half-day program in reading)

The dependent variable for this model was the spring 2009 MCPS pre-K reading test scores. The independent variable was a dummy variable created to represent the status of the students' experiences (Head Start full day vs. MCPS half day). The control variables or covariates included race and ethnicity, income per person in the family, special education, ESOL services, and gender. The pretests for this cohort were the fall 2008 MCPS pre-K reading test scores. The correlation coefficient of the fall 2008 pre-K reading scores with spring 2009 pre-K reading scores was significant ($r = 0.57$; $p < 0.05$). The sample for the analysis included 490 students who had both fall and spring MCPS pre-K reading scores during the 2008–2009 school year.

Model 4 (Head Start full-day program vs. MCPS half-day program in mathematics)

The dependent variable for this model was the spring 2009 MCPS pre-K mathematics scores. The independent variable was a dummy variable created to represent the status of

the students' experiences (Head Start full day vs. MCPS half day). The control variables or covariates included race and ethnicity, income per person in the family, special education status, ESOL services, and gender. The pretests for this cohort were the fall 2008 MCPS mathematics scores. The correlation coefficient of the fall 2008 pre-K pretest mathematics scores with the spring 2009 mathematics pre-K scores was significant ($r = 0.53$; $p < 0.05$). The sample for the mathematic analyses included 487 students who had both fall and spring MCPS pre-K mathematics scores during the 2008–2009 school year.