

**Assessing the Impact of  
Tennessee's  
Pre-Kindergarten Program:  
Final Report**

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# Strategic Research Group

**SRG** is a full-service research firm that provides data collection, consultative, and research services. SRG specializes in conducting public opinion surveys, program evaluations, policy assessments, customer satisfaction studies, and community needs assessments on national, state, and local levels.

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## Executive Summary

In 2007, the Tennessee Office of the Comptroller contracted Strategic Research Group (SRG) to conduct a study to investigate the short- and long-term effects of state-funded Pre-Kindergarten (Pre-K)<sup>1</sup> participation on academic outcomes in Kindergarten through Fifth Grade through an examination of existing school records (i.e., secondary data). The evaluation was structured to take place over a multi-year timeframe and in a series of reporting stages. The overarching goal of this effort over the series of reports submitted to date has been to identify Pre-K participants in existing school records and to determine, to the best possible extent given the data available for analysis, whether there is evidence to suggest that Pre-K participation is associated with a positive effect on student performance in Grades K-5 relative to students who did not participate in Pre-K.

On the whole, the results of analyses conducted to date in this series of analyses of outcomes in Grades K-5 point to an initial near-term advantage associated with Pre-K participation in Kindergarten and First Grade—primarily for students who received Free/Reduced Price Lunch (FRPL) or are considered “at-risk” due to socioeconomic status. Longitudinal analyses conducted in two previous reports have found that this initial advantage tends to be followed by a pattern of convergence, although a slight advantage of Pre-K participation appears to be maintained among economically disadvantaged students through the Second Grade. For students in Grades 3-5, analyses have found either no significant effect of Pre-K participation on assessment scores, or, in some cases, have found that students who attended Pre-K, on average, score lower than their non-Pre-K counterparts on some assessments.

The goal of this final report has been to maximize the number of student records that can be included in the analysis, providing opportunities for longitudinal analyses that were not possible for previous reports in this series. This provides valuable perspective considering that each previous report has varied in terms of the program years covered as well as the school years/grade levels incorporated into the analysis. Thus, this final report includes all possible student records from the years specified in the study period.

In order to evaluate the short- and long-term impact of Pre-K on student outcomes, a sample of non-Pre-K students was randomly selected that mirrored the Pre-K group with regard to school or school system, gender, race, and FRPL status. Data were analyzed using random effects analysis of covariance models, also referred to more broadly as hierarchical linear models or multilevel models. Analyses controlled for demographic characteristics such as child race and gender, as well as FRPL status, special education, English as a Second Language (ESL) status, and retention.

Combined results across ten cohorts of students who participated in Pre-K indicate that on standardized assessments in Kindergarten, Pre-K students—particularly those who experience economic disadvantage—perform better than students who did not participate in Pre-K. No overall differences were found between Pre-K and non-Pre-K students in First Grade, although again, Pre-K students who experience economic disadvantage tend to perform better than their non-Pre-K counterparts. However, this same pattern is not consistently observed for students who do not experience economic disadvantage, and the initial advantage attenuates and is largely diminished by the Second Grade. Among students who do not experience economic disadvantage, the initial advantage of Pre-K is less evident, and the models suggest that they may experience slower academic growth over time.

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<sup>1</sup> Throughout this report, the term “Pre-Kindergarten” and its abbreviation “Pre-K” are used to refer specifically to Tennessee’s state-funded Pilot and Voluntary Pre-Kindergarten program and not any other type of early childhood education program. The term “non-Pre-K” is used to refer to students who did not attend Tennessee’s Pre-K program, although they may have participated in other early childhood education programs.

The results of the analyses of long-term effects (i.e., Grades 3-5) find that the differences between Pre-K students and non-Pre-K students are negligible, particularly when examining assessment outcomes for students who experienced economic disadvantage. By the third grade, students who did not experience economic disadvantage performed better on standardized assessments than Pre-K and non-Pre-K students who had received FRPL, although not as well as students who had not experienced any known risk factors.

This study has faced some challenges. One of the greatest is that no assessments were available for students as they began Kindergarten. Instead, assessments conducted end-of-year in Kindergarten are the earliest indicator available that we can use to gauge the most immediate impact of program participation. However, even this indicator is impacted by factors outside of the control of the Pre-K program, including the fact that these data were only available when school systems elected to administer assessments at the Kindergarten level. The majority of Kindergarten students did not complete standardized assessments; more students are assessed in First Grade, but still not the majority.

Arguably, the greatest limitation of this study is that educational records do not indicate whether students participated in any Pre-K program other than Tennessee's Pre-K. Throughout this series of studies, analyses have not been able to determine whether students in the non-Pre-K group attended another type of Pre-K program, nor have the analyses conducted here been able to control for additional interventions students may have received (or have not received) beyond Pre-K. These remain the most significant issues in terms of interpretation of the results because it is quite likely that the benefits of Pre-K are underestimated in the models presented here.

Despite the limitations of this study, however, the overall conclusions to be drawn from this series of reports and the cumulative analyses presented in this final report have been consistent: students who participate in Pre-K reliably show better outcomes on Kindergarten assessments than students who do not participate in the Pre-K program. These results provide evidence that the objective of Tennessee's Pre-K program – school readiness – is being met.

# Assessing the Impact of Tennessee’s Pre-K Program: Project Overview and Summary of Findings

## Project Overview

The State of Tennessee has funded early childhood education since the 1990s. Legislation enacted in 1996 permitted the creation of pilot early childhood and Pre-Kindergarten programs for economically disadvantaged three- and four-year-olds. In the 1998-1999 school year, 30 Pilot Pre-K classrooms were created, serving approximately 600 students. In 2005, the Voluntary Pre-K for Tennessee Act was passed, increasing the state’s investment in Early Childhood Education and access for four-year-olds. Approximately 300 new Pre-Kindergarten classrooms for at-risk four-year-olds were created—effectively tripling the number of students served. In the 2008-2009 school year, the program had grown to over 934 classrooms, serving approximately 18,000 children. Table 1 summarizes the number of students served and the number of classrooms in operation in Tennessee from 1998-1999 through 2008-2009, the years examined in the present study.

**Table 1. Number of Students Enrolled in Tennessee Pre-K, 1998-1999 to 2008-2009**

Program Year	Students Served	Number of Classrooms
1998-1999	600	30
1999-2000	600	30
2000-2001	3,000	150
2001-2002	3,000	90
2002-2003	3,000	150
2003-2004	2,900	150
2004-2005	2,900	147
2005-2006	8,900	446
2006-2007	13,000	677
2007-2008	17,300	934
2008-2009	18,000	934

Source: State of Tennessee, Office of Early Learning

In 2007, the Tennessee Office of the Comptroller contracted Strategic Research Group (SRG) to conduct a study to investigate the short- and long-term effects of state-funded Pre-Kindergarten participation on academic outcomes in Kindergarten through Fifth Grade through an examination of existing school records (i.e., secondary data). SRG was not contracted to collect any new data. SRG was provided two data sources which allowed for the identification of students who had attended Pre-K in the years spanning 1998-1999 through 2008-2009, and standardized assessment data for students in Grades K-5 spanning 1999-2000 through 2008-2009. The evaluation was structured to take place over a multi-year timeframe and in a series of reporting stages. Table 2 summarizes the cohorts and years of data studied in each report.



**Table 2. Cohorts and Program Years Covered in this Evaluation and Corresponding Stages of Reporting**

	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	
Cohort 1	Pre-K	K	1st	2nd	3rd	4th	5th					
Cohort 2		Pre-K	K	1st	2nd	3rd	4th	5th				
Cohort 3			Pre-K	K	1st	2nd	3rd	4th	5th			
Cohort 4				Pre-K	K	1st	2nd	3rd	4th	5th		
Cohort 5					Pre-K	K	1st	2nd	3rd	4th	5th	
Cohort 6						Pre-K	K	1st	2nd	3rd	4th	
Cohort 7							Pre-K	K	1st	2nd	3rd	
Cohort 8								Pre-K	K	1st	2nd	
Cohort 9									Pre-K	K	1st	
Cohort 10										Pre-K	K	
Cohort 11											Pre-K	
	Pilot Pre-K Program Only							Pre-K Expansion and Curriculum Alignment (starting in 2005-2006)				
<b>Reporting Stage</b>	<b>First Interim Report</b>					<b>Second Interim Report</b>			<b>First Annual Report/</b>	<b>Second Annual Report/</b>	<b>Third Interim Report</b>	<b>Final Report</b>

The overarching goal of this effort over the series of reports submitted to date has been to identify Pre-K participants in existing school records and to determine, to the best possible extent given the data available for analysis, whether there is evidence to suggest that Pre-K participation is associated with a positive effect on student performance in Grades K-5 relative to students who did not participate in Pre-K.

## Summary of Reports and Findings

### First Interim Report

The First Interim Report of this evaluation conducted for the State of Tennessee (November, 2007) analyzed student assessment data between 1999-2000 and 2003-2004. This included assessment data for the first five cohorts of Pre-K students who participated in Pre-K between 1998-1999 and 2002-2003. Although this analysis covered a period of five years, it was complicated by the fact that data collection efforts were limited in the early, formative years of the Pre-K program. This resulted in some missing data for key variables (for example, gender, race) and some missing student identifiers, which made it impossible to merge some Pre-K participant data with student records in K-2. An additional issue faced by this evaluation in general, and the First Interim Report specifically, was that administration of assessments in Grades K-2 is not mandatory in Tennessee. Administering K-2 assessments is a decision left up to the discretion of individual Local Education Agencies (LEAs). Thus, even if a Pre-K student could be identified, very few (less than 10%) had valid assessments in Kindergarten—a particularly important time point in assessing the short-term impact of Pre-K participation, and the point in time at which the relative impact of Pre-K participation is most likely to be observed (as discussed in the literature review provided in the First Annual Report, August 2009).

Taken altogether, and given the number of children who participated in the early years of the Pre-K program, the data available for analysis were quite limited.

Yet another issue faced in the First Interim Report is that, because the report included an analysis of assessment data for students who had attended Pre-K in the first five years of the program (and a comparison group of students who did not attend Pre-K), the analysis was limited almost entirely to students in Grades K-2. There was assessment data for only one year of students in Grade 3 and one year of students in Grade 4. There were no Fifth Grade students included in this report. Thus, due to the small number of Pre-K participants for whom data were available across multiple years, and the specific years covered in this report, longitudinal tests (i.e., analyses using data from the same students measured at multiple points in time) were not feasible for the time period between 1999-2004; grade levels were thus analyzed separately. However, rigorous sampling techniques were used to construct comparison groups of at-risk students who did not participate in Tennessee's Pre-K program. Specifically, the non-Pre-K samples were selected such that they mirrored the Pre-K groups with regard to school district, gender, race, and FRPL status. Analyses presented in the first interim report were limited only to students who received FRPL, given the focus of the Pre-K program and priority afforded to students meeting this definition of "risk."<sup>2</sup> This group, those who received FRPL at least once in the time period under study for this report, represented the majority of Pre-K participants.

The findings from this initial exploration of the data were mixed and inconclusive, but did suggest some possible positive correlates of Pre-K participation to be explored further. Across analyses of the first five cohorts of students over five years, there were some positive effects associated with Pre-K participation: Pre-K participants scored slightly higher on some assessments (primarily reading and language arts). However, statistically significant differences between Pre-K participants and students who did not attend Pre-K were relatively small in magnitude. The pattern of results generally seemed to change between cohorts, although it was a recurring pattern that Pre-K students scored slightly higher than the comparison group of at-risk students on a number of different assessments. Given the small number of students for whom data were available and the early, formative stage of the Pre-K program at the time these early cohorts of children participated, these results were encouraging but merited further exploration.

### ***Second Interim Report and First Annual Report***

The Second Interim Report (July 2008) and the First Annual Report (August 2009) analyzed student assessment data from 2004-2007. The analytic approach taken in these reports differed from the approach taken in the First Interim Report, given that a much larger number of students had participated in Pre-K in the timeframe under study and, thus, there was an opportunity for longitudinal analysis. Data were analyzed using random effects models, also referred to as hierarchical linear models or multilevel models. These models included free/reduced price lunch history and participation in Tennessee state-funded Pre-K as predictors of academic achievement. In addition to these two important variables, all analyses in the Second Interim Report controlled for child race and gender, as well as special education, retention, attendance, and English as a Second Language (ESL) status. Growth curve models were used to examine change in assessment scores over three time points (for example, Kindergarten through Second Grade), and difference score models were used to examine change in assessment scores over two time points (for example, First and Second Grades). Single time point models were used to examine differences between the Pre-K and non-Pre-K groups when an assessment was administered in only one grade.

A consistent pattern of results was observed across the assessments administered in Grades K-2 between 2004-2007 reflecting positive short-term effects of Pre-K participation. Pre-K students scored better in the aggregate than a matched sample of non-Pre-K students, but these effects were most

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<sup>2</sup> *Assessing the Effectiveness of Tennessee's Pre-Kindergarten Program: First Interim Report* (November, 2007).

evident for economically disadvantaged students (i.e., students receiving free or reduced price lunch, or “FRPL”). There was some evidence that the effects for these students may persist through the Second Grade, although the magnitude of the effects are objectively small (a relative difference of between 4-7 points, a difference of less than 0.1 standard deviation). Consistent with previous analyses conducted for this annual report, Pre-K participation was not in itself a significant predictor of student performance on assessments in First or Second Grades, and no positive effects attributable to Pre-K participation were identified in the Third Grade or beyond.

### ***Third Interim Report***

The Third Interim Report (February 2010) examined student outcomes in Grades K-5 for a single academic year, 2007-2008. Because only one year of data was analyzed, this report compared outcomes for Pre-K and non-Pre-K students at each grade level; no longitudinal analyses were conducted. Consistent with the results observed in previous reports, student outcomes were positively associated with participation in Pre-K, although for the most part these effects were limited to economically disadvantaged students (i.e., students who received free or reduced-price lunch) and were evident primarily in Kindergarten and First Grade. The magnitude of these effects was found to be small—an estimated relative difference of between 6-7 points on standardized assessments. Effect sizes (Cohen’s *d*) were less than 0.1, or an average change of approximately one-tenth of one standard deviation. No statistically significant effects were found for Pre-K participants in the Second Grade. Pre-K participation was not uniquely associated with significantly higher scores for any other assessment in Third, Fourth, or Fifth Grade.

### ***Second Annual Report***

The Second Annual Report (September 2010) analyzed student outcomes in Kindergarten through Fifth Grade from a single academic year, 2008-2009. Similar to the results found in of previous reports, Pre-K participation continued to be associated with small but reliable effects on student outcomes in Kindergarten and First Grade in 2008-2009, primarily among economically disadvantaged students. Despite the fact that the nature of the assessments had changed substantially from previous years, a small but reliable effect was found that suggests students who participated in Pre-K performed better on these standardized assessments than peers who did not participate in Pre-K in some cases through Second Grade.

### ***Overall Summary of Findings to Date***

On the whole, the results of analyses conducted to date in this series of analyses of outcomes in Grades K-5 point to an initial near-term advantage associated with Pre-K participation in Kindergarten and First Grade—primarily for students who received Free/Reduced Price Lunch (FRPL) or are considered “at-risk” due to socioeconomic status. Longitudinal analyses conducted in two previous reports have found that this initial advantage tends to be followed by a pattern of convergence, although a slight advantage of Pre-K participation appears to be maintained among economically disadvantaged students through the Second Grade. For students in Grades 3-5, analyses have found either no significant effect of Pre-K participation on assessment scores, or, in some cases, have found that students who attended Pre-K, on average, score lower than their non-Pre-K counterparts on some assessments.

## Objectives of the Final Report

The series of reports to date has examined ten years of data which follows ten cohorts of students who participated in Tennessee's Pre-K program. Each successive report has examined a specific group of students, and has included either a subset of years or a single year of data. All the data available for analysis have been examined in the scope of previous reports, although there has not yet been the opportunity to combine all ten years' worth of data into one combined report.

The goal of this final report has been to maximize the number of student records that can be included in the analysis, providing opportunities for longitudinal analyses that were not possible for previous reports in this series. This provides valuable perspective considering that each previous report has varied in terms of the program years covered as well as the school years/grade levels incorporated into the analysis. Thus, this final report includes all possible student records from the years specified in the study period.

## Research Design

The research design utilized for this evaluation, as described in previous reports, utilizes a quasi-experimental research design known as the **nonequivalent groups design**. This methodology, although not without limitations, permits a comparison of Pre-K participants to a comparable group of students who did *not* attend state-funded Pre-K. This particular type of analysis is deemed to involve "nonequivalent groups" to acknowledge the fact that it does not involve random assignment of students to groups at the time of enrollment in Pre-K.<sup>3</sup> However, it is important to note that this design does not preclude the possibility of obtaining comparable groups through random selection. Additionally, it allows for a longitudinal assessment of the progress of both Pre-K and non-Pre-K participants over time. Appendix A provides an overview of the research design.

## Methodology

This report uses the following datasets: student assessment data for 1999-2000 through 2008-2009 and student demographic information from TDOE's Education Information System (EIS) for 2005-2006 through 2008-2009 and a file of Pre-K attendees spanning 1998-1999 through 2005-2006. All datasets had already been previously provided by the Tennessee Department of Education (TDOE) over the course of the study. To conduct the present study, these data sources were merged, and any irregularities or inconsistencies between the sources were addressed and reconciled.

As we have discussed in previous reports, great care is taken by TDOE and SRG to ensure student anonymity. No identifying information was provided along with student outcome data. To protect student confidentiality and to comply with federal regulations regarding student FRPL status, SRG does not obtain student names or Social Security Numbers. Social Security Numbers, however, are encrypted by TDOE so that the various data sources could be combined for the data analysis. This permits SRG to link student assessment results with student demographic information and Pre-K participation data in a way that maintains student confidentiality.

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<sup>3</sup> Cook, T.D. & Campbell, D.T. (1979). Quasi-Experimentation: Design and Analysis for Field Settings. Rand McNally, Chicago, Illinois.

## **Data Sources**

For this Final Report, SRG drew from three data sources: 1) Pre-Kindergarten demographic data, 2) K-5 student assessment data, and 3) EIS student data from the 2005-2006 through 2008-2009 school years.

It is important to note here that data management has been an ongoing process throughout the evaluation. Although the present report does not include any data not already analyzed in previous reports, combining all available years of data has allowed us to cross-check records of Pre-K students who had questionable records in earlier files and attempt to resolve inconsistencies. This requires us to exclude some students over the course of the evaluation but enables us to include others who had to be excluded from previous analyses. This will be discussed further in the Data Management section (see Appendix B).

### **1. Pre-Kindergarten Demographic File**

The Pre-Kindergarten (Pre-K) demographic file is a database maintained by the TDOE's Office of Early Learning. The database spans eight academic years from 1998-1999 to 2005-2006. Starting with the 2006-2007 school year, demographic information about Pre-K students is included in the Education Information System (for more information about the EIS, see the following section).

The Pre-K demographic database contains information on the school (including county, system/local education agency (LEA), and school/provider name), program information (e.g., Pre-K funding source), and student demographic information (date of birth, gender, race, FRPL status, special education status, whether English is the student's native language, and whether the school provided transportation). Although information is not available for all variables for all years in the Pre-K demographic file, the most important function of this data source is to identify students who participated in Tennessee's Pre-K Program beginning in 1998-1999 through 2005-2006.

### **2. Education Information System Data**

The Education Information System (EIS) is a web-based data repository containing detailed student, teacher, school, and district level information. All schools input information in a standardized format, and the EIS system is designed to catch data entry errors. EIS data are available beginning with the 2005-2006 school year. Although EIS includes data for prior school years, SRG was informed that these data are not complete.

The data provided to SRG by TDOE are in the form of spreadsheets that include demographic information, attendance records, disciplinary records, and special education records. EIS contains data for students in Kindergarten through Twelfth Grade, and for Pre-K students beginning in 2006-2007.<sup>4</sup>

### **3. Student Assessment Data**

The third data source available for this evaluation contains standardized assessment scores for students. These files were provided to us previously by the TDOE Assessment, Evaluation, and Research Division. The files contain: 1) demographic characteristics of students (e.g., date of birth, gender, race, FRPL status, receipt of special education services) and 2) test scores in the

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<sup>4</sup> SRG did not obtain data for students in Grades 6-12 as they are not needed for the present evaluation.

following general content areas: reading and language arts, mathematics, science, and social studies, along with composite scores by content area.<sup>5</sup>

The Tennessee Comprehensive Assessment Program (TCAP) is the principal tool for assessing the performance of public school students in the State of Tennessee. The TCAP includes Tennessee-specific assessments which allow students, parents, and educators to interpret test scores as they relate to Tennessee's state curriculum standards.

For students in Grades K-2, TCAP currently consists of Norm-Referenced Tests (NRT). Students in Grades 3-8 currently take Criterion Referenced Tests (CRT). NRTs measure student performance relative to other test takers. Comparatively, CRTs measure performance according to specific standards, and test items are directly linked to specific performance indicators in the state curriculum. The TCAP Achievement test is mandated for all students in Grades 3-8. The test is not mandated for Grades K-2; however, school systems may elect to test students in Grades K, 1 and/or 2, and their decision to test may vary from year to year. LEAs may administer tests for one, two, or three of these grade levels in a given year, and they may change their decision to administer assessments each year. Thus, there is a great deal of variability in the number of schools administering assessments for students in Grades K-2 across this time period.

The test for Kindergarteners includes reading, language arts, and mathematics. At Grade 1, the test includes reading, language arts, mathematics, science, social studies, word analysis, vocabulary, and math computation. The Grade 2 test includes all these subjects and also incorporates spelling. The CRT assessments for Grades 3-8 include four subject areas: reading/language arts, mathematics, science, and social studies.<sup>6</sup> Tennessee students are assessed each spring.

#### Comparability of NRTs and CRTs

Although both NRTs and CRTs are important and valuable in their use and application, there are some issues in terms of their comparability. For example, when CRTs are employed, each individual student's results are compared with a predetermined standard. The performance of other students who also took the test at the same time is not taken into consideration in evaluating the results. Student scores are typically reported in terms of the number of items correct, or the percentage correct. In contrast, for NRTs, each individual student is compared with other students who took the test, and the score reflects that student's performance relative to other students (not a predetermined criterion). Scores are typically reported in terms of a percentile or stanine, which indicates the student's position relative to a national sample of other test-takers in the same cohort. Because there are significant conceptual and practical differences in the nature of the CRT and NRT assessments, longitudinal analyses across these measures are not feasible. Thus, separate analyses must be conducted for K-2 assessments and assessments given in Grades 3-5.

#### Changes in Assessments and Implications for Analysis

The present report includes an analysis of student outcomes from 1999-2000 through 2008-2009, ten academic years. During this timeframe, some changes took place in Tennessee with respect to student assessment, and these changes have important implications for the types of analyses that can be conducted to assess student outcomes.

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<sup>5</sup> See Table 10 on page 20 for a list of all specific assessments administered in Grades K-5.

<sup>6</sup> Note: The scope of the present analysis is focused on student performance in grades K-5.

The first change of significance is the adoption of CRTs in Grades Three through Eight. From 1999-2000 through 2002-2003, student assessments were NRT tests created by CTB Terra Nova. The data for these years are all norm-referenced and have used the same scale (i.e., same minimum and maximum scores) since 1998. There were no cut points for NRT data to indicate proficiency levels during this time; proficiency levels (advanced, proficient, below proficient) were introduced with criterion-referenced tests.

Beginning in the 2003-2004 school year, however, Tennessee used a norm-referenced test for students in Grades Three through Eight for reading, language arts, mathematics, science and social studies. The implication for the present report is that assessment scores for students in Grade Three in 2003-2004 are not comparable to scores for that grade level in other years and thus, they were not included in the analysis.

Additionally, a change in K-2 assessments occurred in 2008-2009 when TN switched from assessments developed by Terra Nova to the Stanford 10 Achievement Test developed by Pearson Education, Inc. As a result of this change, assessments for students in Grades K-2 in 2008-2009 are not comparable to those administered in previous years, and thus, this Final Report does not include scores for students in Grades K-2 for 2008-2009. However, data for these students were analyzed in the Second Annual Report (September 2010).

SRG next proceeded with the process of identifying Pre-K students, locating their assessment results, resolving any data discrepancies or inconsistencies in the data sources, and drawing a comparable sample of students who did not attend Pre-K. The procedures used were the same as those discussed in recent reports. A detailed discussion of the data management steps is in Appendix B.

### ***Sampling Strategy***

In order to evaluate the short- and long-term impact of Pre-K on student outcomes, Pre-K students must be compared to a similar group of students that did not attend Tennessee's Pre-K program.

Just as with previous reports, we selected the matched non-Pre-K samples such that they mirror the Pre-K groups with regard to gender, race, and FRPL status. For the First Interim Report (which covered the 1998-1999 through 2003-2004 school years) we also matched the two groups on school district. Because the numbers of Pre-K students in each grade level were significantly larger in the years covered in the Second Interim Report (2004-2005 through 2006-2007), as well as subsequent reports, it was possible to match the non-Pre-K and Pre-K students first at the school level and then at the district level in instances where a match was not possible at the school level but was possible at the district level. This modification to the sampling strategy offers a greater degree of assurance that the Pre-K and non-Pre-K students are similar in key ways aside from individual characteristics (e.g., gender, race, and FRPL status).

The sampling strategy for the non-Pre-K samples first involved identifying the grade and year in which students were first assessed. The goal was to match students as early as possible in the years covered in this report (again, 1999-2000 through 2008-2009) and follow the matched groups when possible (e.g., Grades K-2 and 3-5). For example, students who were assessed in Kindergarten in 1999-2000 and had attended Pre-K were matched with a sample of non-Pre-K Kindergarten students who were also assessed in 1999-2000. Pre-K students who were assessed in Grade 1 in 2000-2001 but who did not have assessment scores for the previous year were matched with a group of non-Pre-K students who also did not have assessment scores the previous year. To follow this example out to conclusion, Pre-K students who were assessed in Grade 2 in 2001-2002 but who did not have assessment scores for the previous two years were matched to a group of non-Pre-K Grade 2 students who also did not have assessment scores the previous two years.

This strategy allows us to track matched students over multiple assessment points (again, when available). Following the same matched students for multiple assessments (i.e., over multiple years) will reduce the problems associated with unobserved heterogeneity, or how individuals may differ in

some way that we cannot determine or predict. By following the same students over time there is less concern that differences in performance from one year to the next are due to the group of students in one year being somehow different from the students in the following years. This strategy also increases the comparability of the Pre-K and non-Pre-K groups. For one thing, Pre-K and non-Pre-K students will be comparable with regard to exposure to assessment tests, at least for the time period under study.

The next step was to create a distribution of the Pre-K group for each grade and year by district, then by school within district, then by FRPL status within each school, then by race and gender within each school. The goal was to create a sample of non-Pre-K students that resembled the Pre-K students as closely as possible in terms of their school district, school, FRPL status, race, and gender by finding an appropriate number of non-Pre-K students with the same demographic characteristics as each individual Pre-K student (i.e., precision matching). It is important to note here that the majority of non-Pre-K matches were identified at the school level.

We attempted to identify one non-Pre-K student for every Pre-K student. The goal here was to maintain a comparison group that was relatively comparable in size to the Pre-K group, an important consideration given that the overall population of students who did not attend Pre-K is much larger than the population of students who did attend Pre-K. This ensured that the results were not dominated by the comparison group.

Table 3 provides the Pre-K group sizes and corresponding non-Pre-K sample sizes for each grade as well as the percentage of Pre-K students for whom a non-Pre-K match existed in each grade level. (Appendix C provides the Pre-K group sizes and non-Pre-K sample sizes broken out by all 42 possible grade/year combinations). The group sizes (both Pre-K and non-Pre-K) do *not* represent the number of students in each grade level that are available for analysis. The actual numbers of students in each grade level is much larger. Instead, Table 3 provides the number of students who were *assessed for the first time* at each grade level. For example, across all years there are 2,400 students who were assessed for the first time in Kindergarten who attended Pre-K, so we attempted to match each Pre-K student with a non-Pre-K student. As Table 3 indicates, 90.9% of the Pre-K students were matched. Although the vast majority of students first assessed in Kindergarten were matched, the percentage is still lower than the other grade levels (with the exception of Grade 4) because few LEAs administer assessments in Kindergarten, thus resulting in a lower success rate for finding non-Pre-K matches. The reason for the small group sizes in Grades 4 and 5 (and percentage of matched students, especially in Grade 4) is due to the fact that by Grade 4, nearly all students have been assessed in a lower grade level.

**Table 3. Pre-K Group Sizes, Non-Pre-K Sample Sizes, and the Percentage of Pre-K Students Matched for Each Grade**

Grade	Pre-K Group Size	Non-Pre-K Sample Size	Percentage Matched
Kindergarten	2,400	2,181	90.9%
First	5,216	5,114	98.0%
Second	2,884	2,846	98.7%
Third	2,678	2,633	98.3%
Fourth	106	91	85.8%
Fifth	34	32	94.1%



To review, for each Pre-K student, we attempted to identify at random a non-Pre-K student of the same race, gender, and FRPL status within the same school, or else at least within the same district. Also, when it was necessary to choose a non-Pre-K match from an alternate school within the same district, preference was given to selecting students from schools where there were other students who had attended Pre-K. Although it was not always possible to match Pre-K students to non-Pre-K students in their *own* school, matching Pre-K students with non-Pre-K students from schools where there were other Pre-K students helped maintain the comparability of the Pre-K and non-Pre-K groups. Further, students were never matched across district, only within district.

It should be noted that non-Pre-K samples were drawn from a three-category classification of race (White, Black, and Other Race) rather than the five category classification available in the assessment data (White, Black, Hispanic, American Indian/Native American, and Asian/Pacific Islander). The very low numbers of students in the latter three categories (combined, these three categories comprised only 4.2% of the Pre-K students) meant that it was very often not possible to match students on their specific racial category. Yet, it is important to maintain the minority status of these students through the creation of the “Other Race” category. Even after collapsing the three categories to create an “Other Race” category for purposes of matching, however, there were still too few cases to allow them to be analyzed with a reasonable degree of confidence. For purposes of analysis, then, we created two categories for race—white and non-white.

At this point, as many Pre-K students as possible had been identified in the assessment data, any inaccuracies or irregularities were resolved, and a comparable sample of non-Pre-K students was selected for each grade/year in the timeframe under investigation. The next step was to conduct the appropriate statistical analysis to determine whether there were meaningful differences, in aggregate, between the Pre-K and non-Pre-K groups.

This sampling strategy required that we select a limited number of key characteristics on which to match Pre-K students to non-Pre-K comparison students—specifically, race, gender, and FRPL status. In the subsequent analyses, we also controlled for additional student characteristics that were relevant to the outcomes under investigation, but students were not matched on every variable; the greater the number of matching variables, the more difficult it is to identify exact matches, especially for characteristics for which the percentages are skewed. The following section details the additional variables included (and controlled for) in the models.

### ***Analytic Approach***

Once the Pre-K students had been identified in the assessment data and a comparable sample of non-Pre-K students had been selected, the next step was to move to the analysis of the assessment results. All data reported in subsequent tables include only valid student records for Pre-K students and the sample of non-Pre-K students.

### **Variables Included in the Models and Characteristics of Students**

The following section provides the distribution of students for all of the key predictor variables in the analysis, for all students overall and also for the Pre-K group (13,318 students) and non-Pre-K group (12,897 students). Again, because students were matched based on three key variables—race, gender, and FRPL status (in addition to school/school system), the distributions of these variables are extremely similar for the Pre-K and non-Pre-K students.

- 1. FRPL status** (FRPL or no FRPL). Students’ FRPL status was coded into one of two categories. A student was identified as receiving FRPL if he or she received FRPL in any year in which the student was assessed (as indicted in the assessment data), and/or while attending Pre-K (according to the EIS or Pre-K Demographic File). Table 4 summarizes students’ FRPL status overall and in the Pre-K and non-Pre-K groups.

**Table 4. Free/Reduced Price Lunch (FRPL) Status for Pre-K and Non-Pre-K Students**

	Overall	Pre-K	Non-Pre-K
FRPL	85.5%	85.2%	85.7%
No FRPL	14.5%	14.8%	14.3%
Total	100.0% (26,215)	100.0% (13,318)	100.0% (12,897)

2. **Race** (white/non-white). See pages 15-16 for a discussion of this variable. Table 5 summarizes the proportion of white and non-white students in the Pre-K and non-Pre-K groups.

**Table 5. Race of Pre-K and Non-Pre-K Students**

	Overall	Pre-K	Non-Pre-K
White	64.8%	64.6%	65.0%
Non-white	35.2%	35.4%	35.0%
Total	100.0% (26,215)	100.0% (13,318)	100.0% (12,897)

3. **Gender** (male or female). Table 6 summarizes the proportion of male and female students overall and in the Pre-K and non-Pre-K groups.

**Table 6. Gender of Pre-K and Non-Pre-K Students**

	Overall	Pre-K	Non-Pre-K
Male	51.4%	51.4%	51.5%
Female	48.6%	48.6%	48.5%
Total	100.0% (26,215)	100.0% (13,318)	100.0% (12,897)

4. **Special education status** (yes/received special education or no/did not receive special education). Similar to the FRPL measure, special education students were identified as those who had received special education services in any year in which they were assessed and/or while in Pre-K according to the assessment dataset, the EIS data, and/or the Pre-K Demographic File. Table 9 summarizes the proportion of students receiving special education services overall and in the Pre-K and non-Pre-K groups. A chi-square test indicated that the Pre-K group has a statistically significantly higher proportion of Special Education students

than the non-Pre-K group. However, Special Education status will be controlled for in the analysis of assessment scores and, thus, this difference will be accounted for.

**Table 7. Special Education Services Received by Pre-K and Non-Pre-K Students**

	Overall	Pre-K	Non-Pre-K
Yes	23.7%	25.0%	22.4%
No	76.3%	75.0%	77.6%
Total	100.0% (26,215)	100.0% (13,318)	100.0% (12,897)

5. **Native English speaker** (yes/native English speaker or no/non-native English speaker). Native English speakers are defined as students whose primary or native language is English. This information was obtained from the EIS. A chi-square test indicated that the Pre-K group has a statistically significantly lower proportion of native English speaking students than the non-Pre-K group. However, native English speaker will be controlled for in the analysis of assessment scores and thus this difference will be accounted for.

**Table 8. Native English Speaker Status for Pre-K and Non-Pre-K Students**

	Overall	Pre-K	Non-Pre-K
Native English Speaker	86.6%	86.5%	86.7%
Non-Native English Speaker	13.4%	13.5%	13.3%
Total	100.0% (26,215)	100.0% (13,318)	100.0% (12,897)

6. **Retention** (retained/not retained). Students were deemed to have been retained if they had more than one year of assessment scores in the same grade level. It is important to keep in mind that because these students were identified from their assessment data and not all students are assessed (particularly in Grades K-2), the percentage of students retained will be lower than if we had data for all students. Table 9 summarizes the proportion of students retained overall in the Pre-K and non-Pre-K groups.

**Table 9. Retention for Pre-K and Non-Pre-K Students**

	Overall	Pre-K	Non-Pre-K
Yes	7.1%	6.9%	7.4%
No	92.9%	93.1%	92.6%
Total	100.0% (26,215)	100.0% (13,318)	100.0% (12,897)

## Characteristics of the Assessments

As indicated previously, there are some differences in the number and type of assessments administered each year in Grades K-2 and 3-5. Table 10 summarizes the assessments and the grade levels in which they are administered. It is important to note that the norm-referenced assessments conducted in Kindergarten, First, and Second Grades were markedly different in the 2008-2009 academic year than in any previous year under study in the current series of reports (beginning with assessment data for the 1999-2000 academic year). Because NRT scores from 2008-2009 are not comparable to those from previous years, they could not be included in the present analysis. However, a discussion of the results from the analysis of these scores can be found in the Second Annual Report (September 2010). Additionally, until 2003-2004, students in *all* grades were administered Norm Referenced Tests (NRTs). Starting in 2003-2004, students in Grades 3-5 were administered Criterion Referenced Tests (CRTs). This change in assessments means that scores for students in Grade 3 in 2002-2003 are not comparable with assessment scores for students in Grades 3-5 in subsequent years, and, for this reason, scores for students in Grade 3 in 2002-2003 are not included in the analysis for this Final Report.

**Table 10. Summary of Assessments Administered in Grades K-5**

	Kindergarten	First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade
	Norm-Referenced Assessments			Criterion-Referenced Assessments		
Language Arts	X	X	X			
Math Computation		X	X			
Mathematics	X	X	X	X	X	X
Reading	X	X	X	X	X	X
Science		X	X	X	X	X
Social Studies		X	X	X	X	X
Spelling			X			
Vocabulary		X	X			
Word Analysis		X	X			

To have a better understanding of the number of students assessed at multiple time periods (and thus able to be included in longitudinal analyses), Table 11 presents the number of students in the Pre-K and non-Pre-K samples who were assessed at one, two, or three time points in Grades K-2. Table 12 presents the number of Pre-K and non-Pre-K students assessed at one, two, or three time points in Grades 3-5.

**Table 11. Number of Pre-K and Non-Pre-K Students Assessed One, Two, or Three Years in Grades K-2**

	Overall	Pre-K	Non-Pre-K
One year	59.4% (12,269)	58.4% (6,129)	60.5% (6,140)
Two years	33.8% (6,980)	34.7% (3,643)	32.9% (3,337)
Three years	6.7% (1,392)	6.9% (728)	6.5% (664)
Total*	100% (20,641)	100% (10,500)	100% (10,141)

\* Total number of cases will not add up to 26,215, because not all students have assessments in Grades K-2 in the years covered in this report.

**Table 12. Number of Pre-K and Non-Pre-K Students Assessed One, Two, or Three Years in Grades 3-5**

	Overall	Pre-K	Non-Pre-K
One year	45.5% (8,733)	46.0% (4,544)	45.0% (4,189)
Two years	28.8% (5,520)	29.2% (2,886)	28.3% (2,634)
Three years	25.7% (4,935)	24.8% (2,444)	26.7% (2,491)
Total*	100% (19,188)	100% (9,874)	100% (9,314)

\* Total number of cases will not add up to 26,215, because not all students have assessments in Grades 3-5 in the years covered in this report.

### **Modeling Strategy**

The data were analyzed using *random effects models*, also referred to as *hierarchical linear models* or *multilevel models*. These models allow for “nesting” in the data. Simply put, “nesting” occurs when data are organized in multiple units or levels. This is commonly seen in educational data, such that students are “nested” in schools and schools are “nested” in districts. Students in one aggregate unit are often more alike than students across different units. Consequently, student assessment scores from a particular school will likely be more similar to one another (i.e., correlated with one another) than scores from different schools. This can occur because, all else being equal, children “nested” within the same school have a more similar learning environment than children from different schools. The same is true at the district level, as well.

Another form of nesting occurs with data from multiple time points; in this case, assessment scores in multiple school years. Here it is likely that assessment scores from two different years from a single child will be more alike and thus more highly correlated than two scores from two different children. This similarity arises from a common source or individual history that likely influences the scores in a

similar fashion over repeated measures. That is, repeated observations are nested within a child's record.

In essence, the models used here cluster related observations into unique groups, thereby controlling for these intergroup relationships--for example, multiple observations from a single child are treated as a single group, or children who attended the same school may be treated as a unique group. Given this, the variability in scores can be decomposed into within-group and between-group variability. By doing so, the models provide a more accurate representation of the data. Indeed, failing to account for "nesting" can lead to biased findings and thus a misunderstanding of the processes giving rise to the observed scores.

The mean (i.e., average score) and variability of an outcome (i.e., how scores vary around the mean) are of interest in the models presented here. The models in the current report examined the relationship between each outcome and the predictors outlined above. In order to obtain accurate estimates of the relationship between each of these predictors and each outcome, the models tested and accounted for multiple sources of score variability. These sources of variability included individual variability, school variability, and school district variability.

### **The General Model**

All models evaluated for this report include the child's FRPL and Pre-K histories as predictors of academic achievement. As will be seen in the discussion of the results, the results focus on these two child-level characteristics as well as their interaction. The models were structured in this way for theoretical and practical reasons.

The effect of Pre-K participation is of primary interest in this evaluation, and thus that is the central focus of all the analyses. Also, because the program specifically targets children deemed "at-risk" and FRPL status is the only consistent variable available for analysis that serves as a proxy for "risk," FRPL status was also considered a variable of interest.

Further, as with previous reports, all models examined here also controlled for a child's race and gender. The models employed in this report also include additional control variables: whether or not a child received special education within the observed grades, whether or not a child was retained within the observed grades, the average number of days a child was absent from class during the observed timeframe, and whether or not the child's primary or native language is English. These control variables (and their theoretically or statistically relevant interactions) were included to ensure an accurate representation of the population under study and to ensure potentially mitigating effects were accounted for in the model to control for any potential bias.

Depending on the number of grades a particular outcome was assessed, one of three models was used. These models include a *single time point model*, a *difference model*, and a *growth model*. Each of these models is described briefly below.

#### Single Time Point Models

When an outcome (i.e., assessment score) was observed in only one grade (for example, Spelling in Grade 2), the relationships between an outcome and predictors were examined using all children with a viable score on the outcome of interest who had no missing values for the predictors of interest and did not have multiple observations within a given grade. The models also controlled for possible nesting within school and school district. The single time point models used in the present analyses are often referred to as random effects analyses of covariance, or ANCOVAs.

#### Difference Models (Two Time Points)

When an outcome was observed in two grades (for example, norm-referenced scores in Social Studies in Grades 1 and 2), the relationships between an outcome and predictors were examined

over the two grades using all children with a viable score on the outcome of interest in at least one grade who had no missing values for the predictors of interest, and did not have multiple observations within a given grade. These models, also called ANCOVAs, controlled for possible nesting within individual. Nesting within school and school district was also examined.

### Growth Models (Three Time Points)

When an outcome was observed over three grades (for example, norm-referenced scores in Reading or criterion-referenced scores in Mathematics), the relationships between an outcome and predictors were examined over all three grades using all children with a viable score on the outcome of interest in at least one grade who had no missing values for the predictors of interest and did not have multiple observations within a given grade. These models controlled for possible nesting within individual within and over grade level as well as within school and school district. This type of model is often called a “growth model.”

## **Results**

### **Organization of the Results**

The results for this report are organized by the type of assessment (norm-referenced and criterion-referenced) for each grade level, and within each type of assessment by the number of time points studied (three, two, or one). For purposes of the present report, and as defined by the State of Tennessee, Office of the Comptroller, the results of Norm-Referenced Assessments administered in Grades K-2 reflect the short-term effects of Pre-K participation, and the results of Criterion-Referenced Assessments administered in Grades 3-5 reflect the long-term effects of Pre-K participation. For each assessment, model-implied adjusted mean scores are presented for Pre-K and non-Pre-K students. These mean scores are adjusted for the variables included in the model, meaning that these scores control for race, gender, special education, Native English speaker status, and retention.

Within the analysis of Norm-Referenced Tests (Grades K-2), the results are organized such that the results of growth curve models (spanning three time points) are discussed first, followed by difference score models (spanning two time points), and concluding with tests administered at only one point in time. The analyses conducted for Criterion-Referenced Assessments all include three time points (Grades 3-5), as assessments in Mathematics, Reading, Science, and Social Studies are administered to students in all three grades.

### **Organization of the Tables**

Tables are organized such that overall differences between the Pre-K and non-Pre-K group are presented first (leftmost columns). Differences between Pre-K and non-Pre-K students who were eligible for FRPL are presented in the next two columns, and differences between Pre-K and non-Pre-K students who were not eligible for FRPL are presented last (rightmost columns). It is important for the reader to note that the primary comparisons of interest in this report are comparisons of the Pre-K and non-Pre-K groups, and so only statistically significant differences between the Pre-K and non-Pre-K groups are denoted in the tables and discussed in the results. Further, the reader should take caution that unless a difference between the Pre-K and non-Pre-K group is identified as “statistically significant,” any differences between the Pre-K and non-Pre-K groups are likely (and expected to be) due to measurement error (e.g., inaccuracies in the data) and to natural group variation.

Although FRPL was included in these models to explore whether there were effects associated with Pre-K participation among FRPL and non-FRPL students and whether the results show similar patterns, we would like to reiterate that exploring outcomes associated with students’ FRPL status is not a primary objective of this report. That is, our discussion of the results focuses on effects associated with Pre-K *within* categories of students’ FRPL status. For example, any differences

between the Pre-K and non-Pre-K groups are discussed and interpreted separately for students who received FRPL and for students who did not receive FRPL. This decision was made due to the important conceptual differences between the FRPL and non-FRPL groups. However, we acknowledge the importance of addressing FRPL status for practical and theoretical reasons, and so the effects of all other relevant control variables including students' FRPL status (i.e., whether a student did or did not receive FRPL in the time period under study) were included in order to help interpret the effects of Pre-K participation within the groups.

### **Results for Norm-Referenced Assessments (Grades K-2)**

Three assessments were administered to students in Grades K-2 at all three grade levels: Reading, Language Arts, and Mathematics. Scores were analyzed for students who completed these assessments in Kindergarten, First Grade, and Second Grade.

For Kindergarteners, the results show that for Reading and Mathematics, students' scores reflected a significant difference such that students who attended Pre-K (both those who were eligible for FRPL and those who were not) tended to score higher than students who did not attend Pre-K. There was also a significant difference associated with students FRPL status. More specifically, among students who were eligible for FRPL, Pre-K participants scored higher than their non-Pre-K peers for all three of the assessments that are administered in Kindergarten (Table 13).

In First Grade, there are no overall differences in scores for Reading, Language Arts, and Mathematics assessments for Pre-K and non-Pre-K students. However, similar to the results for Kindergarteners, there is an advantage among those who attended Pre-K such that students who attended Pre-K and were eligible for FRPL scored, on average, higher on Language Arts and Mathematics than students who were eligible for FRPL but did not attend Pre-K.

In Second Grade, although Pre-K participation appears to be associated with lower scores than non-Pre-K students for Reading, the pattern of results for students who were eligible for FRPL is again similar to Grades and 2 in that students who attended Pre-K and were eligible for FRPL scored, on average, higher on Language Arts and Mathematics than students who were eligible for FRPL but did not attend Pre-K.



**Table 13. Adjusted Mean Scores for Pre-K and Non-Pre-K Students—Kindergarten**

Assessment	Group					
	Pre-K	Non-Pre-K	Pre-K FRPL	Non-Pre-K FRPL	Pre-K No FRPL	Non-Pre-K No FRPL
Kindergarten Reading	<b>543.16*</b>	<b>540.29*</b>	<b>536.14**</b>	<b>533.48**</b>	550.17	547.09
Kindergarten Language Arts	540.49	538.12	<b>533.13**</b>	<b>530.14**</b>	547.86	546.10
Kindergarten Mathematics	<b>504.35*</b>	<b>501.12*</b>	<b>495.95**</b>	<b>491.01**</b>	512.76	511.23

\* Denotes a statistically significant difference between Pre-K and non-Pre-K students, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who received FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold)..

\*\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who did not receive FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

**Table 14. Adjusted Mean Scores for Pre-K and Non-Pre-K Students—First Grade**

Assessment	Group					
	Pre-K	Non-Pre-K	Pre-K FRPL	Non-Pre-K FRPL	Pre-K No FRPL	Non-Pre-K No FRPL
First Grade Reading	587.72	587.49	582.03	581.08	593.42	593.89
First Grade Language Arts	591.22	590.48	<b>582.72**</b>	<b>580.96**</b>	599.73	600.00
First Grade Mathematics	538.47	537.69	<b>530.90**</b>	<b>527.45**</b>	546.04	547.93

\* Denotes a statistically significant difference between Pre-K and non-Pre-K students, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who received FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold)..

\*\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who did not receive FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

**Table 15. Adjusted Mean Scores for Pre-K and Non-Pre-K Students—Second Grade**

Assessment	Group					
	Pre-K	Non-Pre-K	Pre-K FRPL	Non-Pre-K FRPL	Pre-K No FRPL	Non-Pre-K No FRPL
Second Grade Reading	<b>611.63*</b>	<b>613.62*</b>	605.78	605.33	<b>617.49***</b>	<b>621.90***</b>
Second Grade Language Arts	618.06	618.87	<b>611.50**</b>	<b>609.48**</b>	624.61	628.26
Second Grade Mathematics	565.30	566.89	<b>559.81**</b>	<b>557.72**</b>	<b>570.80***</b>	<b>576.06***</b>

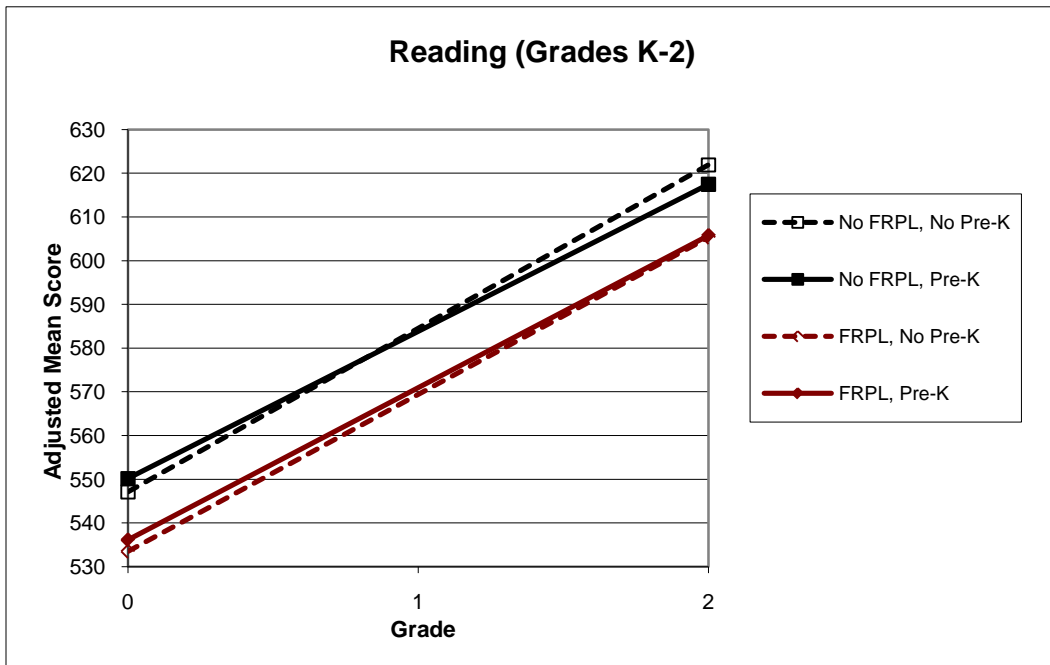
\* Denotes a statistically significant difference between Pre-K and non-Pre-K students, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who received FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

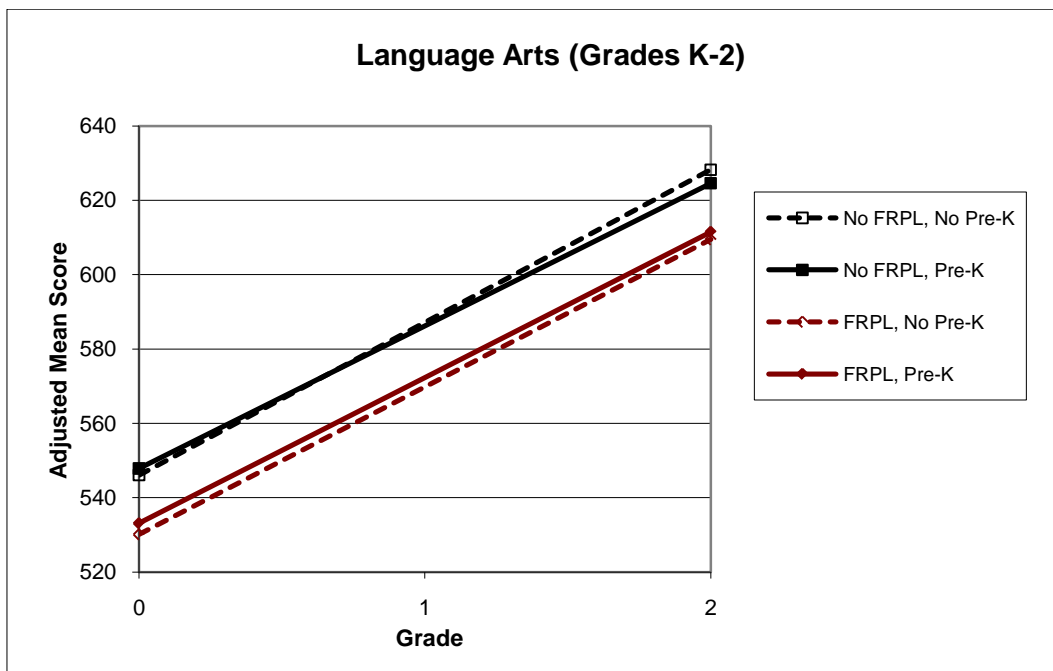
\*\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who did not receive FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

Change over time in students' average performance in Reading, Language Arts, and Mathematics in Grades K-2 is summarized in Figures 1-3. In these figures, the solid lines show the trend of students who did attend Pre-K (broken down by FRPL status). The dashed lines show the trend for students who did not go to Pre K (also broken down by FRPL status). The figures show that the scores for all students are increasing over grade level. However, students who attended Pre-K are increasing at a slightly slower rate than those who did not go to Pre-K. Thus, while Pre-K appears to give children within each FRPL status group an initial bump in assessment scores during Kindergarten, this bump appears to deteriorate by Second Grade.

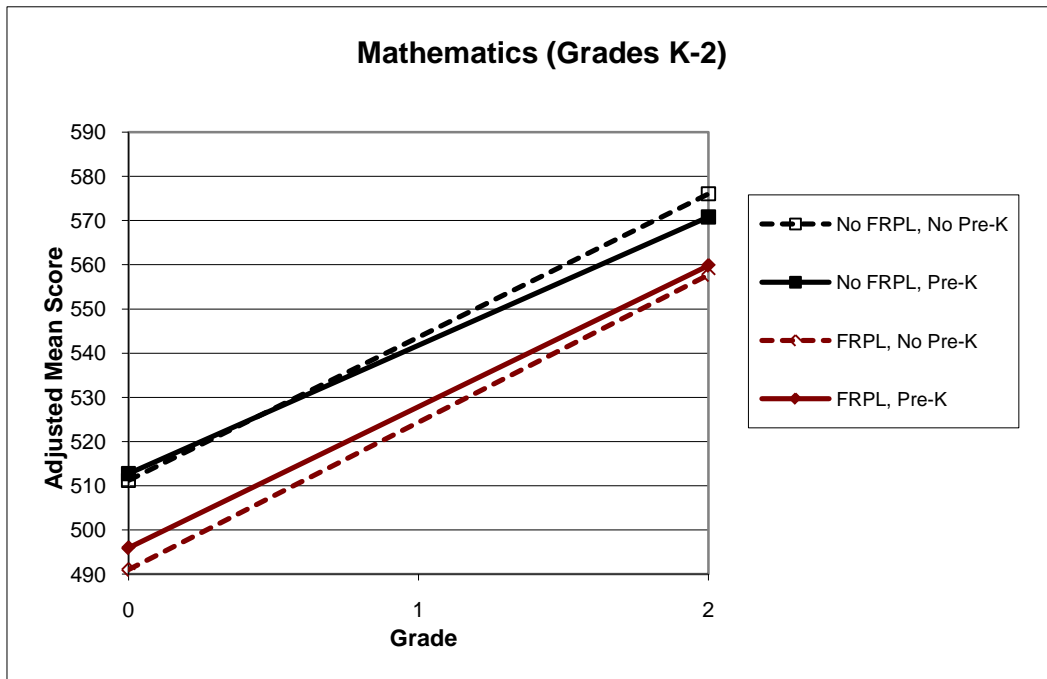
**Figure 1. Model-Implied Adjusted Mean Scores for Reading in Grades K-2 for Pre-K and Non-Pre-K Students by Student FRPL Status**



**Figure 2. Model-Implied Adjusted Mean Scores for Language Arts in Grades K-2 for Pre-K and Non-Pre-K Students by Student FRPL Status**



**Figure 3. Model-Implied Adjusted Mean Scores for Mathematics in Grades K-2 for Pre-K and Non-Pre-K Students by Student FRPL Status**



In addition to Reading, Language Arts, and Mathematics, students in the First Grade also complete Norm-Referenced Assessments in Vocabulary, Word Analysis, Math Computation, Social Studies, and Science. Because assessments are administered in both the First Grade and the Second Grade, it is possible to examine student performance over two years in these areas using difference score modeling.

The same pattern emerged across all assessments in both First Grade and Second Grade. In no case was Pre-K participation a significant predictor of student performance. Among students who were eligible for FRPL, however, First Grade students who attended Pre-K had higher scores, on average, than their non-Pre-K counterparts on the Social Studies and Science assessments. Conversely, among students who were not eligible for FRPL, Second Grade students who did not attend Pre-K had higher scores on the Vocabulary and Social Studies assessments.

These results are summarized in Table 16. Figures 4-8 show the results for the Pre-K and non-Pre-K Groups by FRPL status in Vocabulary, Word Analysis, Math Computation, Social Studies, and Science assessments in First and Second Grade.

**Table 16. Adjusted Mean Scores for Pre-K and Non-Pre-K Students—  
First and Second Grades**

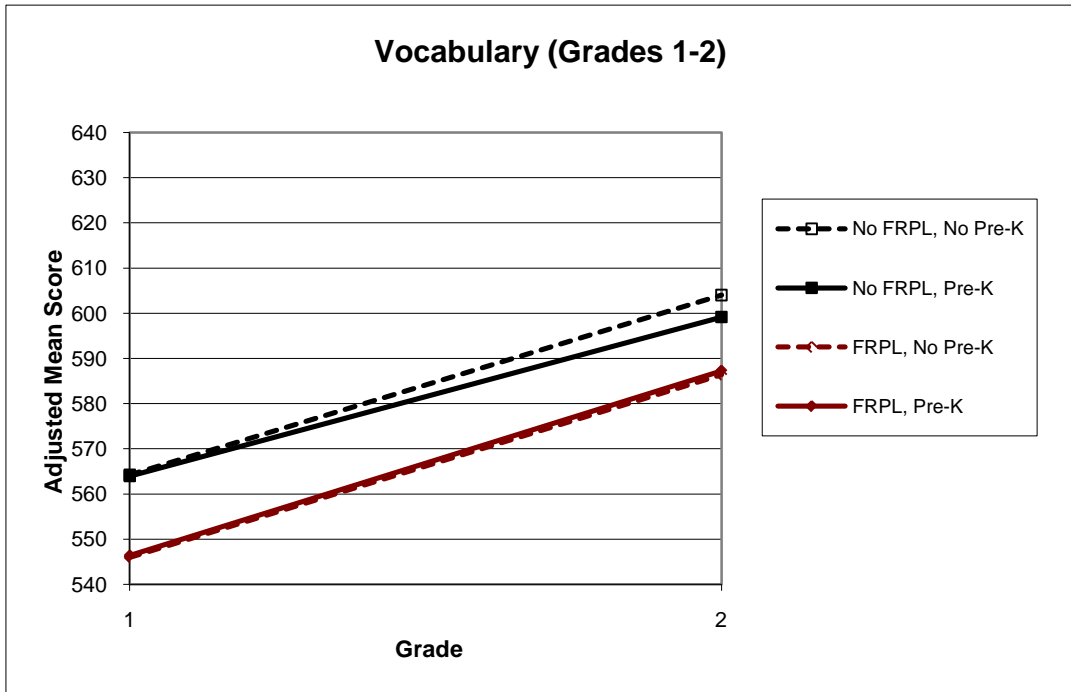
Assessment	Group					
	Pre-K	Non-Pre-K	Pre-K FRPL	Non-Pre-K FRPL	Pre-K No FRPL	Non-Pre-K No FRPL
First Grade Vocabulary	555.16	555.10	546.35	545.97	563.97	564.22
First Grade Word Analysis	583.94	583.15	577.81	576.35	590.08	589.95
First Grade Math Computation	496.28	496.24	491.11	489.62	501.45	502.86
First Grade Social Studies	587.57	587.26	<b>581.77**</b>	<b>579.48**</b>	593.37	595.04
First Grade Science	566.53	566.45	<b>560.99**</b>	<b>558.74**</b>	572.07	574.16
Second Grade Vocabulary	593.21	595.21	587.27	586.41	<b>599.15***</b>	<b>604.02***</b>
Second Grade Word Analysis	616.42	617.44	610.92	610.14	621.93	624.74
Second Grade Math Computation	542.75	543.01	537.10	535.49	548.40	550.53
Second Grade Social Studies	607.28	608.68	600.09	598.63	<b>614.46***</b>	<b>618.73***</b>
Second Grade Science	585.87	585.94	579.22	577.35	592.51	594.52

\* Denotes a statistically significant difference between Pre-K and non-Pre-K students, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

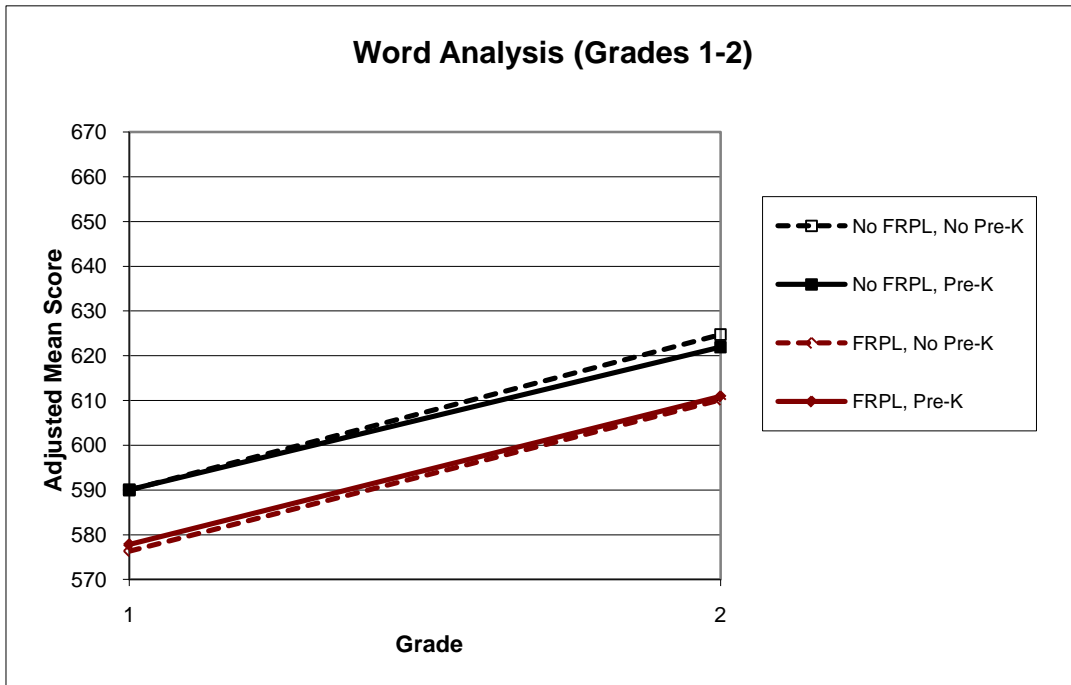
\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who received FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

\*\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who did not receive FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

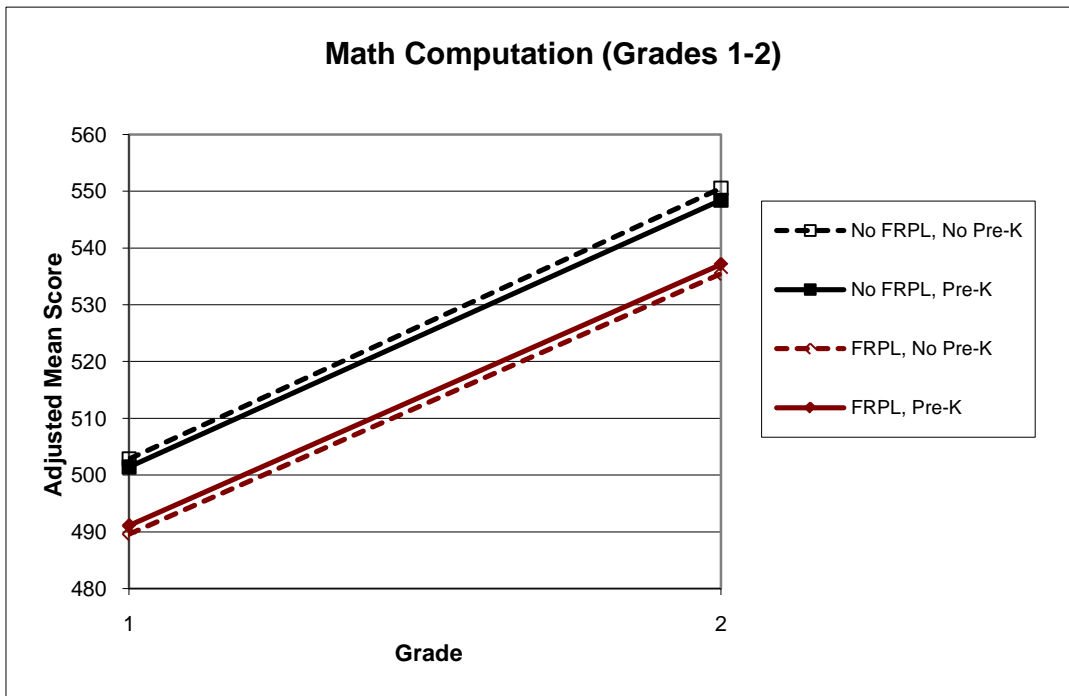
**Figure 4. Adjusted Mean Scores for Vocabulary in Grades 1-2 For Pre-K and Non-Pre-K Students by FRPL Status**



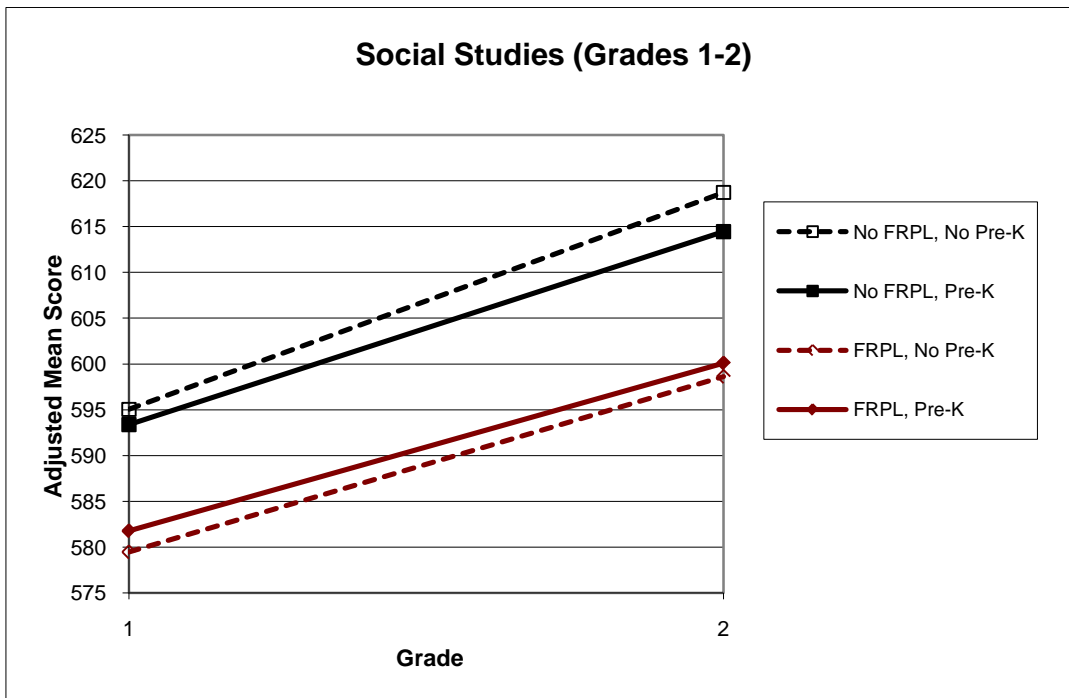
**Figure 5. Adjusted Mean Scores for Word Analysis in Grades 1-2 for Pre-K and Non-Pre-K Students by FRPL Status**



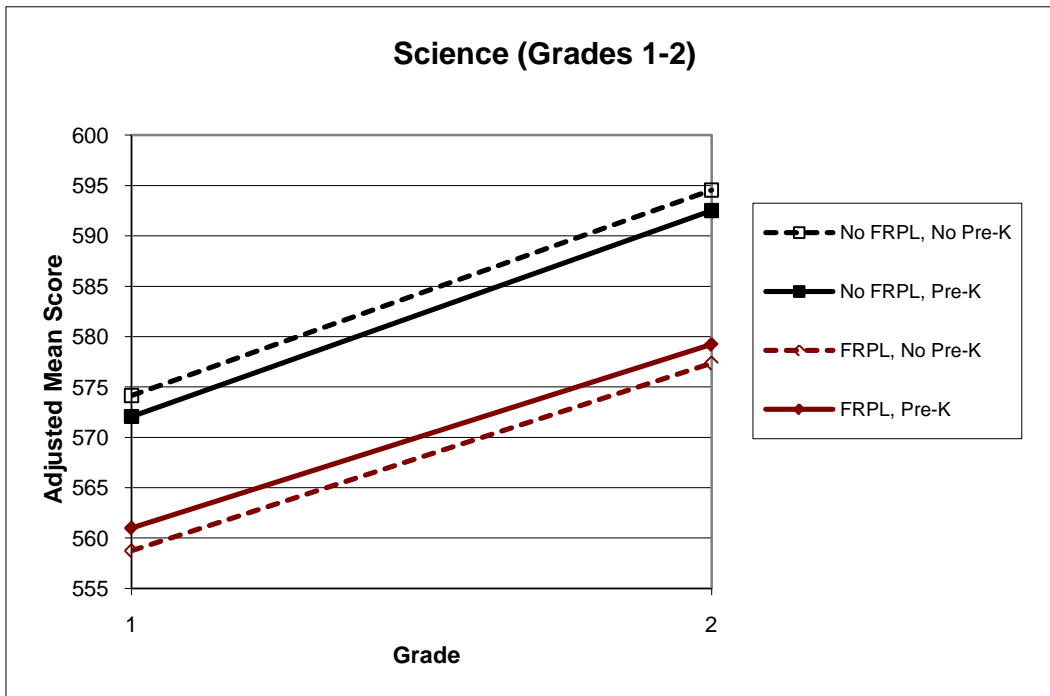
**Figure 6. Adjusted Mean Scores for Math Computation in Grades 1-2 for Pre-K and Non-Pre-K Students by FRPL Status**



**Figure 7. Adjusted Mean Scores for Social Studies in Grades 1-2 for Pre-K and Non-Pre-K Students by FRPL Status**



**Figure 8. Adjusted Mean Scores for Science in Grades 1-2 for Pre-K and Non-Pre-K Students by FRPL Status**



The Spelling assessment is only administered in the Second Grade; thus, results for Spelling were not examined longitudinally. There was no statistically significant difference in student scores attributable to Pre-K participation for this assessment.

Table 17 summarizes the adjusted mean scores for each group, and Figure 9 illustrates the pattern of results for Second Grade spelling for Pre-K and non-Pre-K students, by FRPL status.

**Table 17. Adjusted Mean Scores for Pre-K and Non-Pre-K Students—Second Grade**

Assessment	Group					
	Pre-K	Non-Pre-K	Pre-K FRPL	Non-Pre-K FRPL	Pre-K No FRPL	Non-Pre-K No FRPL
Second Grade Spelling	575.77	576.06	568.63	566.74	582.90	585.39

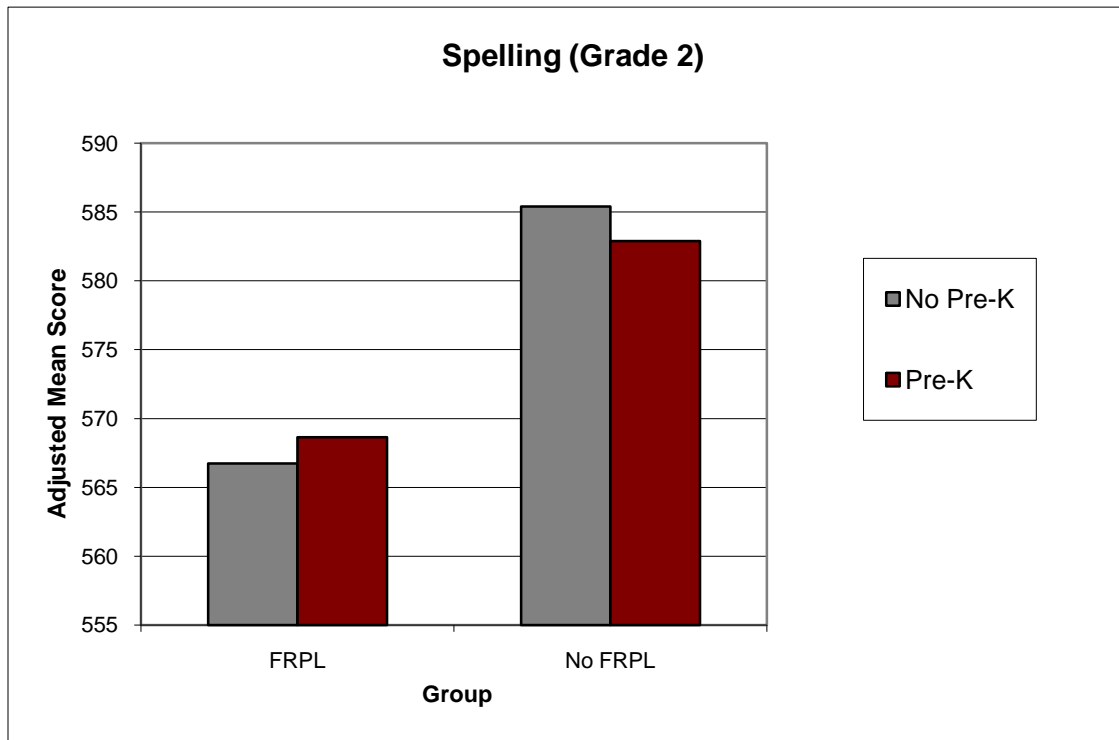
\* Denotes a statistically significant difference between Pre-K and non-Pre-K students, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who received FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

\*\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who did not receive FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).



**Figure 9. Adjusted Mean Scores for Spelling in Grade 2 for Pre-K and Non-Pre-K Students by FRPL Status**



**Summary of Findings: Short-Term Effects**

Combined results across ten cohorts of students who participated in Pre-K indicate that, on standardized assessments in Kindergarten, Pre-K students—particularly those who experience economic disadvantage—perform better than students who did not participate in Pre-K. No overall differences were found between Pre-K and non-Pre-K students in First Grade, although again, Pre-K students who experience economic disadvantage tend to perform better than their non-Pre-K counterparts. However, this same pattern is not consistently observed for students who do not experience economic disadvantage, and the initial advantage attenuates and is largely diminished by the Second Grade. Among students who do not experience economic disadvantage, the initial advantage of Pre-K is less evident, and the models suggest that they may experience slower academic growth over time.

**Results for Criterion-Referenced Assessments (Grades 3-5)**

In Grades 3-5, Criterion-Referenced Assessments are administered in Reading, Mathematics, Social Studies, and Science. Student performance on these assessments is compared to a predetermined standard (i.e., “cut point”) to determine proficiency. The cut points established by TDOE for each of these subjects in each grade are presented in Table 16.

**Table 18. TCAP Cut Scores for Reading, Mathematics, Social Studies, and Science in Grades 3-5**

<b>Final Cut Scores Established in 2004</b>			
<b>Content Area</b>	<b>Grade</b>	<b>Proficient</b>	<b>Advanced</b>
Reading	3	455	496
	4	461	510
	5	467	522
Mathematics	3	448	484
	4	457	507
	5	463	517
Social Studies	3	188	212
	4	190	216
	5	194	217
Science	3	188	213
	4	189	215
	5	191	218

Source: Tennessee Department of Education

Analyses across assessments administered in Grades 3 through 5 sought to determine whether there were systematic significant differences to indicate a long-term advantage associated with Pre-K participation (see Table 19 and Figures 10-13). Pre-K participation did not predict significantly higher scores for any assessment in Third, Fourth, or Fifth Grade. Whether or not students received FRPL was consistently a significant predictor for student outcomes across assessments in Grades 3-5.

**Table 19. Adjusted Mean Scores for Pre-K and Non-Pre-K Students—  
Grades Three-Five**

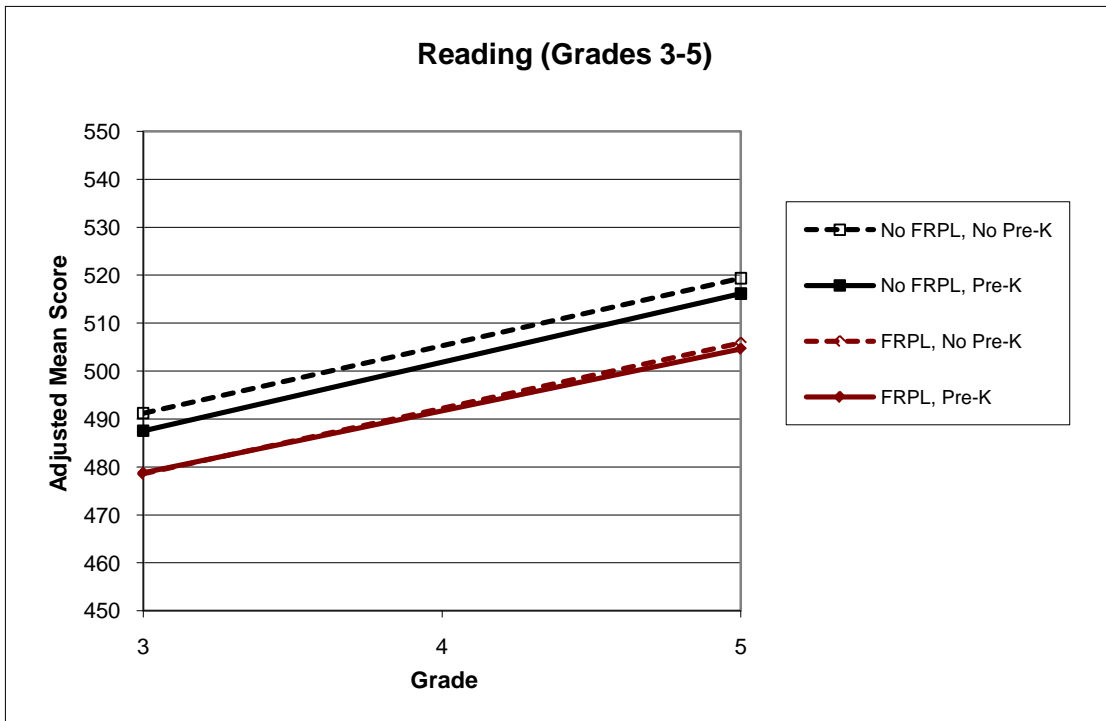
Assessment	Group					
	Pre-K	Non-Pre-K	Pre-K FRPL	Non-Pre-K FRPL	Pre-K No FRPL	Non-Pre-K No FRPL
Third Grade Reading	<b>483.16*</b>	<b>484.88*</b>	478.77	478.55	<b>487.55***</b>	<b>491.21***</b>
Third Grade Mathematics	<b>472.71*</b>	<b>474.32*</b>	468.39	467.79	<b>477.03***</b>	<b>480.85***</b>
Third Grade Social Studies	<b>199.62*</b>	<b>200.58*</b>	196.06	196.00	<b>203.19***</b>	<b>205.16***</b>
Third Grade Science	<b>200.67*</b>	<b>201.74*</b>	197.82	197.85	<b>203.53***</b>	<b>205.63***</b>
Fourth Grade Reading	<b>492.97*</b>	<b>495.39*</b>	487.08	487.64	<b>498.86***</b>	<b>503.13***</b>
Fourth Grade Mathematics	<b>490.25*</b>	<b>492.19*</b>	485.50	484.98	<b>495.00***</b>	<b>499.41***</b>
Fourth Grade Social Studies	<b>203.85*</b>	<b>205.00*</b>	200.40	200.90	<b>207.30***</b>	<b>209.10***</b>
Fourth Grade Science	202.75	203.54	199.24	199.38	206.25	207.71
Fifth Grade Reading	<b>510.38*</b>	<b>512.62*</b>	504.61	505.88	<b>516.16***</b>	<b>519.35***</b>
Fifth Grade Mathematics	<b>506.63*</b>	<b>510.20*</b>	501.29	502.52	<b>511.97***</b>	<b>517.89***</b>
Fifth Grade Social Studies	<b>204.91*</b>	<b>205.95*</b>	201.61	202.18	208.21	209.73
Fifth Grade Science	<b>203.31*</b>	<b>205.02*</b>	<b>199.91**</b>	<b>200.79**</b>	<b>206.71***</b>	<b>209.25***</b>

\* Denotes a statistically significant difference between Pre-K and non-Pre-K students, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

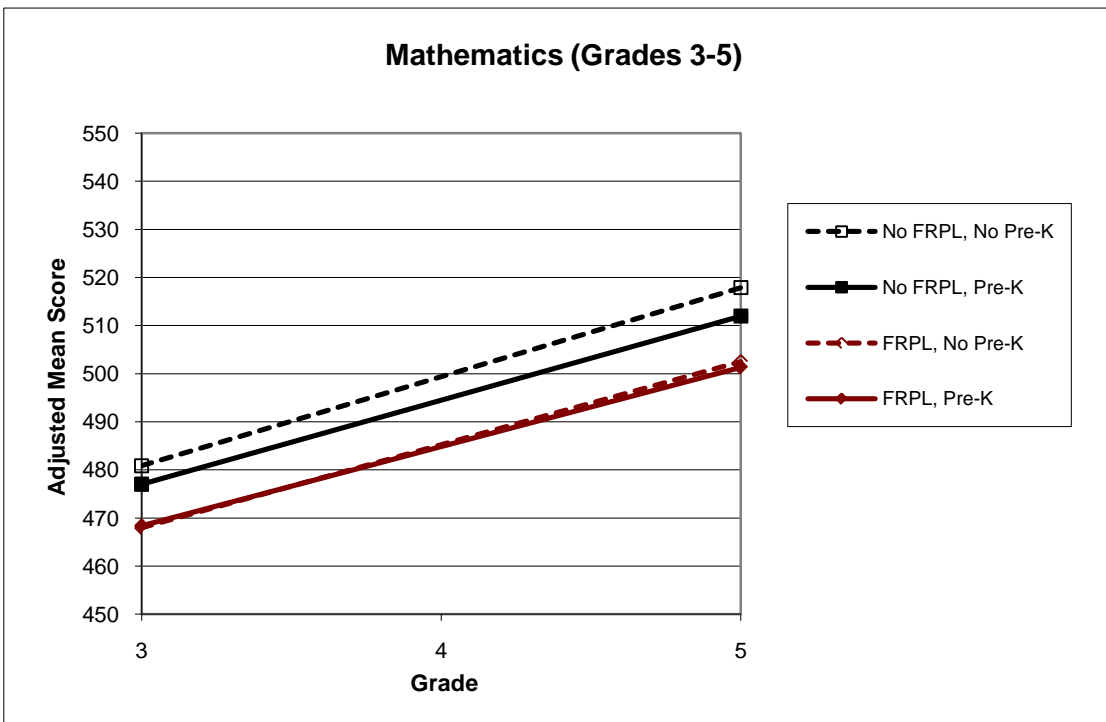
\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who received FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

\*\*\* Denotes a statistically significant difference between Pre-K and non-Pre-K students who did not receive FRPL, at the  $p < .05$  level after adjusting for multiple comparisons (means appear in bold).

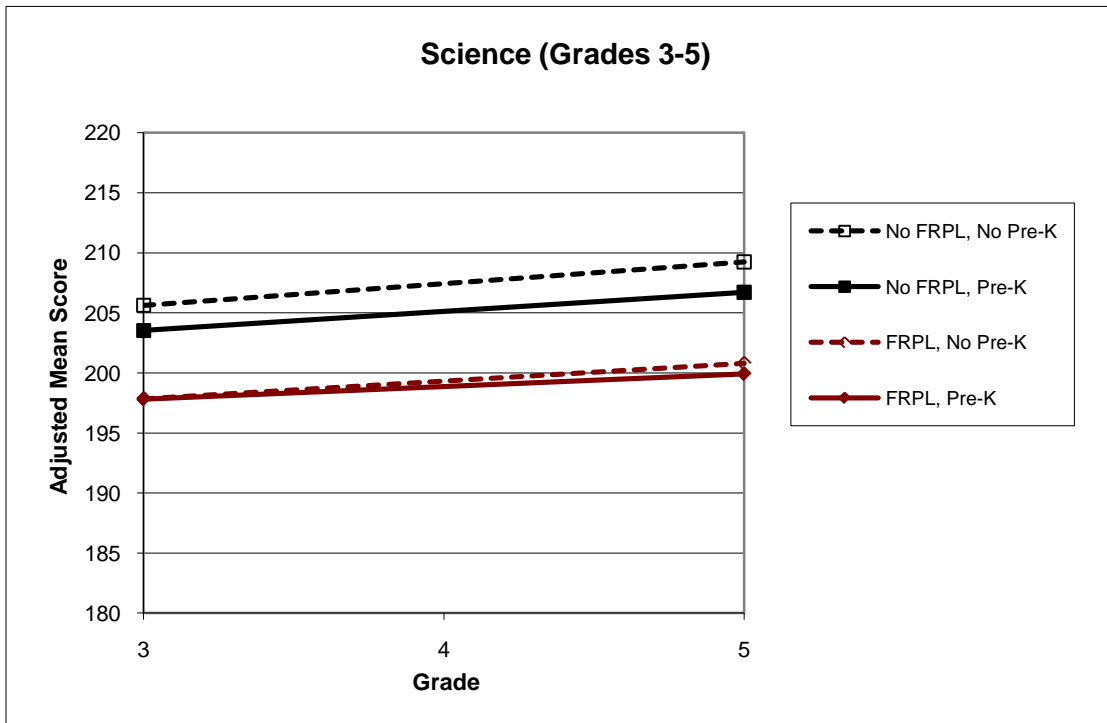
**Figure 10. Adjusted Mean Scores for Reading in Grades 3-5 for Pre-K and Non-Pre-K Students by FRPL Status**



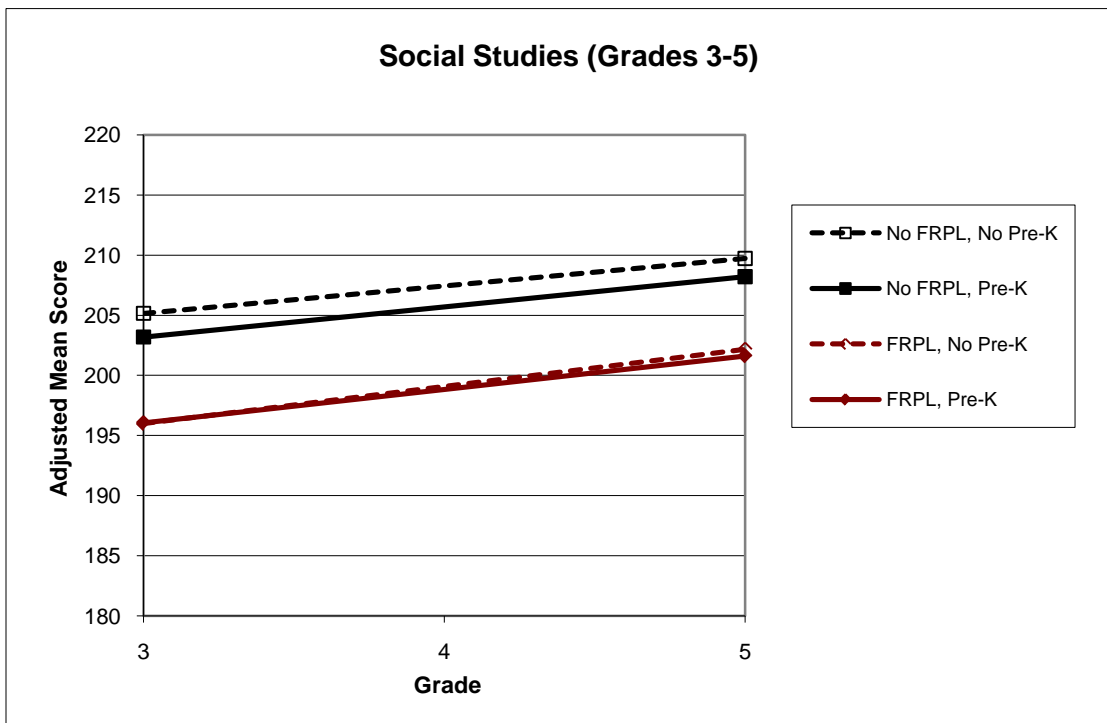
**Figure 11. Adjusted Mean Scores for Mathematics in Grades 3-5 for Pre-K and Non-Pre-K Students by FRPL Status**



**Figure 12. Adjusted Mean Scores for Science in Grades 3-5 for Pre-K and Non-Pre-K Students by FRPL Status**



**Figure 13. Adjusted Mean Scores for Social Studies in Grades 3-5 for Pre-K and Non-Pre-K Students by Student FRPL Status**



### ***Summary of Findings: Long-Term Effects***

Four to six years after participating in Pre-K, the differences between Pre-K students and non-Pre-K students are negligible, particularly when examining assessment outcomes for students who experienced economic disadvantage. By the third grade, students who did not experience economic disadvantage performed better on standardized assessments than Pre-K and non-Pre-K students who had received FRPL, although not as well as students who had not experienced any known risk factors.

These long-term differences suggest a need for ongoing intervention for these former Pre-K participants, and indicate that the risk factors which made them eligible for participation in the Pre-K program likely require more than one year of intervention.

## General Summary and Conclusions

Over the past four years, this project has compiled and analyzed data from students who participated in Tennessee's Pre-K program from its inception in 1998 through the 2008-2009 academic year. The goal has been to assess the progress of students who participated in the program, and to attempt to determine, to the best extent possible given the data collected and maintained by the state of Tennessee, how students who participated in Pre-K performed on standardized assessments over time as they progressed through school. Further, the performance of Pre-K students on these assessments has been compared with a sample of demographically similar children who did not participate in the program.

This exploration has faced some challenges. Assessment data for students from the earliest years of program implementation was sparse in the K-5 school records. The availability of assessment data for students at different grade levels was likewise limited and varied from year to year, depending on whether individual school systems administered assessments. Assessments changed during the time period under investigation, complicating longitudinal analyses. Most significantly, no assessments were available for students as they began Kindergarten; the earliest assessments of student performance for Pre-K participants were administered almost one full year after Pre-K participation and after their participation in Kindergarten—and these data were only available when school systems elected to administer assessments at the Kindergarten level. The majority of Kindergarten students did not complete standardized assessments; more students are assessed in First Grade, but still not the majority.

Arguably, the greatest limitation of this study is that educational records do not indicate whether students participated in any Pre-K program other than Tennessee's Pre-K. Throughout this series of studies, analyses have not been able to determine whether students in the non-Pre-K group attended another type of Pre-K program such as Head Start or a private preschool, nor have the analyses conducted here been able to control for additional interventions students may have received (or have not received) beyond Pre-K. These remain the most significant issues in terms of interpretation of the results because it is quite likely that the benefits of Pre-K are underestimated in the models presented here.

Still, with this final report, combining data from all possible Pre-K students across 10 years, we have maximized the availability of all valid student records available for analysis, and maximized the opportunity for longitudinal analysis of the data available. This series of reports began in 2007 with an analysis of Pre-K students from 1998-99 through 2003-2004. Although this was the longest time period analyzed in the series of reports commissioned by the state of Tennessee, there was no opportunity for longitudinal analysis for student outcomes in Grades K-2; data were available for too few students for longitudinal models to be constructed. Likewise, there was no opportunity for longitudinal analysis in Grades 3-5 as only two cohorts of Pre-K students had begun to progress into these grade levels. More recent reports have covered only a single year of data. Thus, the final report presents the most comprehensive analyses possible to date.

The overall conclusions to be drawn from this series of reports and the cumulative analyses presented in this final report have been consistent: students who participate in Pre-K reliably show better outcomes on Kindergarten assessments than students who do not participate in the Pre-K program. As students progress through higher grades, however, the initial advantage attenuates over time. For students who experience economic disadvantage, Pre-K and non-Pre-K student outcomes converge. Former Pre-K students who do not experience economic disadvantage, however, show slower rates of academic growth compared to peers who experience no known risk factors. However, it is important to acknowledge that Pre-K students in the years under investigation in this report likely experienced some form of risk in order to be eligible for participation in Pre-K, and these risk factors

have likely impacted their academic outcomes over time—yet they cannot be controlled for in the analyses conducted here.

It is a reasonable and valuable endeavor to investigate the academic outcomes of Pre-K participants as they progress through elementary school, and we hope that the results of these analyses will inform legislators, educators, and other stakeholders in the state of Tennessee. This study provides stakeholders one piece of evidence in a large and complex system that may inform decisions and practices. However, to consider this study a summative evaluation of the effectiveness of the Pre-K program would be unfounded and unfair. The Pre-K program has experienced significant changes in the past 10 years, not the least of which was a substantive curricular revision and alignment. The most recent cohort of Pre-K students included in the present study participated in Pre-K three years ago. To evaluate the program as it exists today on the basis of outcomes experienced by students who participated in the Pre-K program 5 or 10 years ago would be an unsound approach. Long-term outcomes and even short-term outcomes two or three years post-participation in Pre-K reflect not only participation in this early intervention but also a tremendous number of other variables in the schools as well as variables in lives of the children and families who participated in the program. The fact that the initial positive effects observed in Kindergarten for Pre-K participants do not appear to be sustained or impact students' rates of academic growth over time speaks more to the need for additional support and intervention in these grades, not factors that are within the scope or capacity of a limited intervention like the Pre-K program to address.

As we have addressed many times over the sequence of reports in this series, this study only examines one particular type of outcome that is likely to be impacted by Pre-K participation: academic performance. Further, this study defines academic performance in a very specific way, as measured by standardized assessment tests. In previous reports, we have discussed that the early intervention afforded by Pre-K programs similar to Tennessee's program has been associated with many benefits to student participants—among these are communication and social skills, physical health and well-being, social behaviors, and motivation to learn. None of these outcomes were able to be addressed in this study, as these outcomes were not systematically studied in the formative years of the program. Certainly, it is possible that Pre-K students have benefited from their participation in the program in all of these domains as well as others, and seeking evidence for these potential benefits is a valuable area of potential future investigation.

The singular goal of the Pre-K program is to improve children's readiness for school—and that should be the standard by which this program is measured and evaluated. Unfortunately, that critical piece of information was not systematically collected in the first ten years, and thus we have had to rely on other pieces of information, such as they are, to serve as proxies. Specifically, assessments conducted end-of-year in Kindergarten are the earliest indicator available that we can use to gauge the most immediate impact of program participation, and even this indicator is impacted by factors outside of the control of the Pre-K program. Still, scores for former Pre-K participants in Kindergarten show the most clear and consistent pattern of results in this series of reports: students who participated in the program performed better on these assessments than students who did not participate. It is our hope that over time, evaluation of this program will be focused on more immediate outcomes associated with Pre-K performance, those which have the greatest potential to inform all program stakeholders. As the program moves forward, systematically collecting data for all students entering Kindergarten would only improve the program's ability to evaluate its effectiveness and would provide a much-needed baseline against which to measure all children's future academic growth.

In sum, despite the limitations of this study, the results provide evidence that the objective of Tennessee's Pre-K program – school readiness – is being met. Students who participated in the program do show evidence of better performance in Kindergarten when compared to students who did not participate in the program. It is understandably desirable for program stakeholders to hope to see a long-lasting and robust effect resulting from this participation that is sustained over time as children grow and progress through school. Perhaps future investigations may be able to provide



some evidence to speak to this issue. The results of the present study, such as it has been designed and implemented, cannot provide such evidence. However, the results should clearly inform stakeholders that not only should the Pre-K program continue to serve at-risk students in Tennessee, it should be complemented with additional support and intervention for students over time to help sustain the early academic growth observed among Pre-K students in Kindergarten.

## Appendix A. Research Design

For the purpose of this project, and as specified by RFP 308.14-004, “Pre-Kindergarten students” refers to students who attend state-funded Pre-Kindergarten programs; specifically, either the pilot Pre-Kindergarten programs or lottery/general fund-funded Pre-Kindergarten programs. Also for the purpose of this project, as defined by the RFP, the non-Pre-K comparison groups consist of students who do/did not attend Pre-Kindergarten but whose characteristics otherwise match as nearly as practicable those of “Pre-Kindergarten students.”

This evaluation, again as specified by the State of Tennessee, Office of the Comptroller, utilizes a quasi-experimental research design known as the **nonequivalent groups design**. This methodology, although not without limitations, permits a comparison of Pre-K participants to a comparable group of students who did *not* attend state-funded Pre-K. This particular type of analysis involves “nonequivalent groups” to acknowledge the fact that it does not involve random assignment of students to groups at the time of enrollment in Pre-K.<sup>7</sup> However, it is important to note that this design does not preclude the possibility of obtaining comparable groups through random selection. Additionally, it allows for a longitudinal assessment of the progress of both Pre-K and non-Pre-K participants over time.

Parents elect for their children to participate in the Pre-K program in Tennessee, and program eligibility is determined by state policy such that all children meeting the state-determined eligibility requirements may be served.<sup>8</sup> Thus, randomization was not utilized in the present study in terms of assigning students to the Pre-K group. This is an important consideration in understanding and interpreting the results of the present study, and in distinguishing the present research methodology from experimental research methods.<sup>9</sup> Random assignment to a treatment or control group effectively equates the groups *before* an intervention is administered (for example, participation in a Pre-K program) and helps ensure that any resulting differences between the groups in later measurements are due to the intervention under study and not some other systematic difference between the treatment and control group. Experimental research methodology uses random assignment to create treatment and comparison groups—that is, the researchers conducting the study determine on a randomized basis which participants receive the treatment (the experimental group) and which do not (the control group). The experimental method is considered the most rigorous of research designs and enables researchers to address cause-and-effect relationships with the greatest degree of certainty.<sup>10</sup>

However, when implementing and evaluating complex educational programs, experimental methods are not always the most practical choice. First, fledgling programs often devote their resources to program implementation first and incorporate evaluation later. Thus, new programs are rarely designed with a rigorous experimental evaluation in place at the beginning. Further, researchers simply cannot control all the important variables which are likely to influence program outcomes, even with the best experimental design. Educational programs do not operate in a vacuum; even with a rigorous experimental design, researchers cannot be completely confident that any individual program

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<sup>7</sup> Cook, T.D. & Campbell, D.T. (1979). Quasi-Experimentation: Design and Analysis for Field Settings. Rand McNally, Chicago, Illinois.

<sup>8</sup> Eligibility requirements can be found at [http://www.state.tn.us/education/earlylearning/doc/OEL\\_FAQs.pdf](http://www.state.tn.us/education/earlylearning/doc/OEL_FAQs.pdf)

<sup>9</sup> Campbell, D. T., & Stanley, J. C. (1966). Experimental and quasi-experimental designs for research. Chicago: Rand McNally.

<sup>10</sup> Trochim, William M. The Research Methods Knowledge Base, 2nd Edition. Internet WWW page, at URL: <<http://www.socialresearchmethods.net/kb/>> (version current as of October, 2006).

independently produces specific results in terms of student achievement.<sup>11</sup> Thus, although utilizing random assignment is advantageous it does not in itself guarantee high internal validity—and may actually create a “false sense of security” in the research findings.<sup>12</sup> Experimental designs tend to be rare given the complexity and expense required to implement them effectively and because of logistical and ethical concerns.

Because of such limitations, other designs like the quasi-experimental design utilized in the present evaluation are often reasonable alternatives to address research questions of interest. Further, they are necessary alternatives when more rigorous approaches are not possible, as in the case of the present study. Although quasi-experimental designs do not possess the same degree of scientific rigor as the experimental design, they are a practical and frequently utilized technique in applied social science.

The present study was commissioned as a review of existing data collected by the state of Tennessee, and did not permit for collection of any new data to supplement existing educational records. Because random assignment to Pre-K/non-Pre-K groups was not possible, rigorous sampling techniques were used to select a comparison group from the many Tennessee schoolchildren who completed assessments in Grades K-5 but did not attend Pre-K, with the aim of constructing a valid comparison group that is matched as practicably as possible with the Pre-K group. Still, by the very nature of this research design, there is no way to ensure that the groups are, indeed, equivalent in all respects (thus the use of the term “nonequivalent groups”). There may be important differences between the Pre-K group and the non-Pre-K participants that simply cannot be captured retrospectively and accounted for in the data available for analysis in this report. Further, we can safely assume that there are important ways the non-Pre-K students may differ from the Pre-K participants. For example, a student may not have participated in Pre-K but may have participated in some other form of early childhood educational intervention. Unfortunately, the data available for analysis at present do not address participation in other early childhood programs and thus we cannot statistically control for the possibility that non-Pre-K participants did not receive *any* other form of intervention—we can only say for certain that they did not participate in Tennessee’s Pre-K program. Random sampling, however, is the best technique to minimize the effects of such extraneous variables.

It is important to note that even if groups were constructed based on random assignment to the Pre-K and non-Pre-K groups, it would still be important to address whether non-Pre-K children participated in another, different early childhood education program. Ideally, at the time the groups were formed, information would be collected from both groups about their experiences. Because the present study is retrospective as opposed to prospective, there is a great deal of information about the comparison group that remains unknown. However, the goal of the present study was to describe the performance of Pre-K students on TCAP assessments relative to students who did not participate in Pre-K using data collected and maintained by TDOE—not to collect such additional data—although future prospective studies may be able to include such additional controls.

Finally, we acknowledge that this study also faces the limitation of utilizing a “post-test only” approach. That is, no baseline or pre-test data are available for either the Pre-K group or the non-Pre-K matched sample over the time period studied in this report. Given that randomization in selecting children to participate in the program is not feasible, there is clearly no possibility of statistically controlling for baseline differences for the non-Pre-K comparison group. Thus, we must make the assumption that the Pre-K and non-Pre-K groups “started out” at a similar point prior to the opportunity to participate in

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<sup>11</sup> Gribbons, B., & Herman, J. (1997). True and quasi-experimental designs. Washington, DC: ERIC Clearinghouse on Assessment and Evaluation. [ED421483]

<sup>12</sup> Gribbons & Herman (1997).

Pre-K. However, it is entirely possible given the nonrandom formation of the Pre-K group that the two groups may have initially differed had a pre-test been administered. From an evaluation standpoint, this makes any differences observed in later assessments difficult to interpret, and any such differences must be interpreted with caution.

Despite the limitations of the present design, this design offers some distinct advantages. First, because multiple measurements are available for the Pre-K and non-Pre-K groups, the resulting analyses afford a better sense of the patterns of variability *within* each group over time as well as *between* each group over time. Second, this design permits an exploration of ten years of existing data without the need to collect additional data on past program participants, a time-consuming and costly process. **The present study is not a means of conclusively determining whether participation in the Pre-K program causes an improvement in students' later performance on standardized assessments, and to construe it as such would be to misinterpret the goals and methodology applied here.** A prospective, experimental study would be better suited to permit such conclusions about the program. However, using existing data collected and maintained by TDOE, this study uses the data at hand to provide the most accurate description possible of how Pre-K participants are doing in the short- and long-term based on the information available at the present time. Thus, the overarching goal of the present evaluation is to identify dominant trends in the overall pattern of results for Pre-K and non-Pre-K students and to determine if, overall, Pre-K students demonstrate any clear differences over time in their performance on these assessments relative to the non-Pre-K comparison group.

## Appendix B. Data Management

As was mentioned in the Methodology section, over this course of this project the Tennessee Department of Education (TDOE) has provided the following data to SRG: 1) student assessment data for 1999-2000 through 2008-2009, 2) student demographic information from TDOE's Education Information System (EIS) for 2005-2006 through 2008-2009, and, 3) a file of Pre-K attendees spanning 1998-1999 through 2005-2006. The following narrative describes the procedures used to merge, check, and clean the data sources and prepare the data for analysis.

### 1. Identify Pre-K Students in the Assessment Data

The first step in the data management process was to identify which students in the assessment datasets attended Pre-K. To do so, the assessment datasets were merged together with the Pre-K demographic file and the EIS data and a variable was created that indicated whether or not the student had attended Tennessee-funded Pre-K. This allowed us to individually examine questionable records of Pre-K students throughout the data management phase. The subsequent steps detail the effort taken to prepare Pre-K and non-Pre-K students' assessment records for analysis.

### 2. Identify and examine assessment records with duplicate encrypted Social Security Numbers (ESSNs).

The next step in preparing the data for analysis was to identify and examine records with duplicate encrypted Social Security Numbers (ESSNs). Each year the assessment data contained a small number of cases with duplicate ESSNs, meaning that there were two (and in a very small number of instances, three) sets of scores for the same grade level and school year linked to the same ESSN. An examination of duplicate records found that in most cases, although the ESSN was the same, the demographic information (i.e., date of birth, gender, and/or race) was not, indicating that the assessment scores were for different students. For students with duplicate records who had attended Pre-K, each record was individually cross-checked with the demographic information linked to the ESSN with the Pre-K demographic file (when available) and EIS data (again, when available) to determine which record was correct. For Pre-K students whose demographic information was not reported in the Pre-K demographic file and did not have a record in the EIS, both records had to be excluded from analysis. It should be noted, however, that cases with duplicate ESSNs represented a very small proportion of all cases. Additionally, because so few students are assessed in Grades K-2 (and especially in Kindergarten), duplicate records were examined for all students in these grades regardless of whether the records were for students who had attended Pre-K or not. This effort allowed us to retain as many valid assessment records in Grades K-2 as possible.

### 3. Identify and examine records for students with assessments scores for more than one grade level in a given school year.

The third step was to identify and examine records for students that had assessment scores for more than one grade level in the same school year. Although it is reasonable for a student to have scores at the same grade level for consecutive years (e.g., scores as a First Grader in both 2004-2005 and 2005-2006) as a result of retention, multiple sets of scores in the same school year at different grade levels is indicative of an error.<sup>13</sup> An examination of a number of these instances found that in each instance, the two sets of scores, although linked to the same ESSN, differed on demographic information. Again, efforts were made to retain as many valid Pre-K student records

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<sup>13</sup> This was verified by the Senior Executive Director for the TDOE Office of Assessment, Evaluation and Research.

and for students in K-2 by individually cross-checking these students' records with the Pre-K demographic file and EIS data when available.

**4. Examine the consistency of demographic information between the assessment data and EIS data.**

An additional means of checking the validity of student records was to compare demographic information for students who had both assessment scores and a record in the Pre-K demographic file and/or the EIS.

Following the same approach outlined in steps two and three above, all records for Pre-K students with discrepant values for date of birth, gender and/or race in the assessment and EIS data were examined individually. Their demographic information was also cross-checked against the Pre-K demographic file, when available. The small number of non-Pre-K students with discrepant demographic information between assessment and EIS data were excluded from the analysis. As before there was one exception: students who had different values for race were retained, provided their values for gender and date of birth were consistent.

Table B1 displays the final number of Pre-K students who had assessment scores for each grade covered in this report once the data management phase was complete. The reader should keep in mind that Table B1 reflects the number of *valid records* in the Pre-K demographic file, EIS, and assessment records available for analysis at the conclusion of the data management phase of this analysis.

**Table B1. Number of Pre-K Students with Valid Records Available for Analysis in Each Grade and Year**

Year	Grade K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
1999-2000	16	--	--	--	--	--
2000-2001	59	61	--	--	--	--
2001-2002	74	165	132	--	--	--
2002-2003	217	419	262	-- <sup>a</sup>	--	--
2003-2004	301	950	528	284	151	
2004-2005	204	990	1,368	623	287	153
2005-2006	159	1,022	1,701	1,720	631	281
2006-2007	617	864	1,478	2,318	1,738	630
2007-2008	830	2,213	1,298	2,355	2,294	1,716
2008-2009 <sup>b</sup>	--	--	--	2,143	2,368	2,291
Total	2,477	6,684	6,767	9,443	7,469	5,071

<sup>a</sup> Starting in 2003-2004, students in Grades 3-5 were administered Criterion Referenced Tests (CRTs). This change in assessments means that scores for students in Grade 3 in 2002-2003 are not comparable with assessment scores for students in Grades 3-5 in subsequent years, and, for this reason, scores for students in Grade 3 in 2002-2003 are not included in the analysis for this Final Report.

<sup>b</sup> Starting in 2008-2009, TN changed the type of NRT assessments administered in Grades K-2. As a result of this change, assessments for students in Grades K-2 in 2008-2009 are not comparable to those administered in previous years, and thus, this Final Report does not include scores for students in Grades K-2 for 2008-2009. However, data for these students were analyzed in the Second Annual Report (September 2010).

The number of Pre-K students with valid records who were assessed in a given grade varies widely. There are three main reasons for the range of group sizes beyond naturally occurring differences in the number of students who completed Pre-K each year. First, as was mentioned previously, assessments in Grades K-2 are not mandated. Second, it is clear that some number of students changed LEAs, and some number of students may have entered Kindergarten late or repeated a grade, placing them in a different cohort from which they started. A third factor impacting the number of Pre-K students in each grade/year, as was discussed previously, is that some students whose records indicated demographic discrepancies were excluded from analyses. Students were also excluded if they were found to have more than one set of scores in a particular school year at different grade levels. However, this resulted in the exclusion of a small number of cases.

## **Appendix C. Group Sizes for Pre-K Students and Non-Pre-K Matches by Grade and Year**

Table C1 below provides the number of Pre-K students who were first assessed in a particular grade and year, the corresponding number of non-Pre-K students who were sampled for inclusion in the analysis, and the percentage of Pre-K students for whom a non-Pre-K student match was identified for each grade/year. As discussed in the Sampling Strategy section of the report, the goal was to match students as early as possible in the years covered in this report (again, 1999-2000 through 2007-2008 for students in Grades K-2 and 1999-2000 through 2008-2009 for students in Grades 3-5) and follow the matched groups when possible (e.g., Grades K-2 and 3-5). For example, students who were assessed in Kindergarten in 1999-2000 and had attended Pre-K were matched with a sample of non-Pre-K Kindergarten students who were also assessed in 1999-2000. Pre-K students who were assessed in Grade 1 in 2000-2001 but who did not have assessment scores for the previous year were matched with a group of non-Pre-K students who also did not have assessment scores the previous year, and so on.

The reader will notice that the size of the Pre-K groups varies greatly across grade and year. Of particular note, the number of students with assessment scores in Kindergarten ranges from 16 in 1999-2000 to 806 in 2007-2008. This is largely because the Pre-K program expanded greatly over the years, especially between 2004-2005 and 2005-2006; however, the majority of students are not assessed in Kindergarten and so the Pre-K group sizes for students in Kindergarten across the years will be relatively small in comparison to the number of students who attended Pre-K the previous year. Second, the group sizes in Grades 4 and 5 tend to be very small. This is due largely to the fact that, starting in Grade 3, assessments are mandatory. As a result, the vast majority of students will have been assessed by Grade 3 or earlier, and, thus, a non-Pre-K match will have been identified prior to Grade 4 (exceptions would include students who moved to TN after Grade 3 or were deemed to have invalid assessment records for some reason).



**Table C1. Number Pre-K Students Assessed for the First Time by Grade and Year, the Number of Non-Pre-K Matches Identified, and the Percentage of Pre-K Students Matched**

<b>Grade/Year</b>	<b>Pre-K Students</b>	<b>Non-Pre-K Matches</b>	<b>Percentage of Pre-K Students Matched</b>
Kindergarten 2000	16	16	100.0%
Kindergarten 2001	57	57	100.0%
Grade 1 2001	48	48	100.0%
Kindergarten 2002	73	72	98.6%
Grade 1 2002	126	125	99.2%
Grade 2 2002	85	85	100.0%
Kindergarten 2003	213	212	99.5%
Grade 1 2003	356	351	98.6%
Grade 2 2003	89	86	96.6%
Grade 3 2003	26	26	100.0%
Kindergarten 2004	283	271	95.8%
Grade 1 2004	747	738	98.8%
Grade 2 2004	183	182	99.5%
Grade 3 2004	38	38	100.0%
Grade 4 2004	0	n/a	n/a
Kindergarten 2005	190	177	93.2%
Grade 1 2005	715	696	97.3%
Grade 2 2005	676	668	98.8%
Grade 3 2005	70	69	98.6%
Grade 4 2005	4	4	100.0%
Grade 5 2005	1	1	100.0%
Kindergarten 2006	150	148	98.7%
Grade 1 2006	792	774	97.7%
Grade 2 2006	804	792	98.5%
Grade 3 2006	279	274	98.2%
Grade 4 2006	15	13	86.7%
Grade 5 2006	2	2	100.0%
Kindergarten 2007	612	566	92.5%
Grade 1 2007	707	695	98.3%
Grade 2 2007	543	535	98.5%
Grade 3 2007	577	569	98.6%
Grade 4 2007	19	17	89.5%
Grade 5 2007	4	4	100.0%
Kindergarten 2008	806	662	82.1%
Grade 1 2008	1,725	1,687	97.8%
Grade 2 2008	504	498	98.8%
Grade 3 2008	856	849	99.2%
Grade 4 2008	36	34	94.4%
Grade 5 2008	13	12	92.3%
Grade 3 2009	832	808	97.1%
Grade 4 2009	32	23	71.9%
Grade 5 2009	14	13	92.9%
<b>Total</b>	<b>13,318</b>	<b>12,897</b>	<b>96.8%</b>

## Appendix D. Technical Specification of Models

The models presented in this report can be understood through a general 3-level hierarchical linear model that accounts for child-level outcomes nested within school and school nested within school district. The general model is presented relying heavily on the Raudenbush and Bryk (2002) terminology. The general model is presented in “levels” and is discussed in terms of multiple observations within schools and multiple schools within school district.

### Level 1

Level 1 defines the relationship between child-level outcomes and child-level predictors:

$$y_{isd} = \pi_{0sd} + \sum_{j=1}^J (\pi_{jsd} * x_{ij}) + e_{isd} \quad (1)$$

and

$$e_{isd} = \sim N(0, \sigma^2). \quad (2)$$

In Equation 1,  $y_{isd}$  denotes outcome  $y$  for individual  $i$  in school  $s$  within school district  $d$ . The score is defined by an intercept,  $\pi_{0sd}$ , and  $J$  child-level predictors ( $x_{ij}$ ) including interactions of interest (e.g. Pre-K status by free/reduced-lunch status). The intercept denotes the mean level of  $y$  when  $\sum_{j=1}^J x_{ji} = 0$ .

The residual,  $e_{isd}$ , captures the individual-specific deviation from the mean score for school  $s$  within school district  $d$ . This deviation is the “error” in prediction not otherwise account for by unique school or school district variability. As described in Equation 2,  $e_{isd}$  is assumed to be normally distributed with a mean of 0 and a standard deviation of  $\sigma$ .

$e_{isd}$  is not the only variance component in the general model. Indeed, the intercept is a “random” coefficient allowed to vary over school. This unique school variability is parameterized in Level 2 of the general model.

### Level 2

Level 1 parameters  $\pi_{0sd}$  and  $\pi_{jsd}$  are the outcomes of interest in Level 2 of the general model:

$$\begin{aligned} \pi_{0sd} &= \beta_{00d} + r_{0sd} \\ \pi_{jsd} &= \beta_{j0d} \end{aligned} \quad (3)$$

and

$$r_{0sd} \sim N(0, \tau_{00}^2). \quad (4)$$

Equation 3 states that the mean score for school  $s$  in school district  $d$  (i.e.,  $\pi_{0sd}$ ) is a linear combination of the overall mean score within school district  $d$ ,  $\beta_{00d}$ , and a school-specific deviation ( $r_{0sd}$ ). The school-specific residuals are assumed to be normally distributed with a mean 0 and a standard deviation of  $\tau_{00}$  (see Equation 4). As can be seen in Equation 3, the effect of the  $j^{\text{th}}$  child-level predictor ( $\pi_{jsd}$ ) is assumed to be a function of school district  $d$ 's effect for the  $j^{\text{th}}$  predictor ( $\beta_{j0d}$ ).

### Level 3

Level 3 defines the Level 2 parameters ( $\beta_{00d}$  and  $\beta_{j0d}$ ) as outcomes of interest such that

$$\begin{aligned}\beta_{00d} &= \gamma_{000} + \sum_{q=1}^Q (\gamma_{00q} * w_{dq}) + u_{00d} \\ \beta_{j0d} &= \gamma_{j00} + \sum_{q=1}^Q (\gamma_{j0q} * w_{dq})\end{aligned}, \quad (5)$$

and

$$u_{00d} \sim N(0, \tau_{000}^2). \quad (6)$$

Equation 5 states that the effect of being in district  $d$  ( $\beta_{00d}$ ) is a linear combination of the overall mean score ( $\gamma_{000}$ ) conditioned on  $Q$  district level predictors ( $w_{dq}$ ), and a district-specific deviation ( $u_{00d}$ ) from the overall mean score. Equation 5 also states that the effect of the  $j^{\text{th}}$  child-level predictor ( $\beta_{j0d}$ ) is a linear combination of the overall effect of the  $j^{\text{th}}$  predictor ( $\gamma_{j00}$ ) conditioned on  $Q$  district-level predictors.

### General Model

Given the parameterizations for each level outlined above the general model in its reduced form (i.e., substituting and combining terms) is:

$$\begin{aligned}y_{isd} &= \gamma_{000} + \sum_{j=1}^J (\gamma_{j00} * x_{ij}) + \sum_{q=1}^Q (\gamma_{00q} * w_{dq}) \\ &+ \sum_{j=1}^J \sum_{q=1}^Q (\gamma_{j0q} * w_{dq} * x_{ij}) + [e_{isd} + r_{osd} + u_{00d}]\end{aligned}, \quad (7)$$

where all deviations are distributed as described in Equations 2, 4, and 6. Cross-level interactions ( $w_{dq} * x_{ij}$ ) were only included for two child-level predictors (Pre-K status and free/reduced-lunch status). For the “child-level” models discussed in this paper, all  $q$ -predictors are absent from the model reducing Equation 7 to:

$$y_{isd} = \gamma_{000} + \sum_{j=1}^J (\gamma_{j00} * x_{ij}) + [e_{isd} + r_{osd} + u_{00d}]. \quad (8)$$

The interpretation of the parameters in Equation 7 (the “district-level” model) remain unchanged for the “child-level” model described in Equation 8.

## Appendix E. Means, *p*-values, and Effect Sizes for Analyses Reported

Note that *p*-values are marked with an asterisk (\*) to denote values deemed statistically significant at  $p > 0.05$  after controlling for the False Discovery Rate, a statistical adjustment necessary given the number of multiple comparisons being made in the present analysis. In other words, only scores in boldface type with *p*-values marked with an asterisk remain statistically significant after controlling for the number of comparisons involved in the analysis.

**Table E1. Mean Scores, *p*-values, and Effect Sizes for Analyses Reported**

Grade Level	Assessment	Comparison	Model-Implied Adjusted Mean Scores		<i>p</i> -value	Effect Size (d)
			Pre-K	Non-Pre-K		
Kindergarten	Reading	Overall	<b>543.16</b>	<b>540.29</b>	<b>.033*</b>	<b>.01</b>
		FRPL Only	<b>536.14</b>	<b>533.48</b>	<b>.013*</b>	<b>.01</b>
		Non-FRPL Only	550.17	547.09	.212	.01
	Language Arts	Overall	540.49	538.12	.147	.01
		FRPL Only	<b>533.13</b>	<b>530.14</b>	<b>.022*</b>	<b>.01</b>
		Non-FRPL Only	547.86	546.10	.557	<.01
	Mathematics	Overall	<b>504.35</b>	<b>501.12</b>	<b>.033*</b>	<b>.01</b>
		FRPL Only	<b>495.95</b>	<b>491.01</b>	<b>&lt;.001*</b>	<b>.02</b>
		Non-FRPL Only	512.76	511.23	.582	<.01

Grade Level	Assessment	Comparison	Model-Implied Adjusted Mean Scores		p-value	Effect Size (d)
			Pre-K	Non-Pre-K		
First Grade	Reading	Overall	587.72	587.49	.802	<.01
		FRPL Only	582.03	581.08	.135	.01
		Non-FRPL Only	593.42	593.89	.787	<.01
	Language Arts	Overall	591.22	590.48	.511	<.01
		FRPL Only	<b>582.72</b>	<b>580.96</b>	<b>.021*</b>	<b>.01</b>
		Non-FRPL Only	599.73	600.00	.896	<.01
	Mathematics	Overall	538.47	537.69	.453	<.01
		FRPL Only	<b>530.90</b>	<b>527.45</b>	<b>&lt;.001*</b>	<b>.03</b>
		Non-FRPL Only	546.04	547.93	.337	.01
	Vocabulary	Overall	555.16	555.10	.955	<.01
		FRPL Only	546.35	545.97	.635	<.01
		Non-FRPL Only	563.97	564.22	.911	<.01
	Word Analysis	Overall	583.94	583.15	.443	<.01
		FRPL Only	577.81	576.35	.038	.01
		Non-FRPL Only	590.08	589.95	.947	<.01
	Math Computation	Overall	496.28	496.24	.972	<.01
		FRPL Only	491.11	489.62	.068	.01
		Non-FRPL Only	501.45	502.86	.535	<.01
	Social Studies	Overall	587.57	587.26	.786	<.01
		FRPL Only	<b>581.77</b>	<b>579.48</b>	<b>.003*</b>	<b>.02</b>
		Non-FRPL Only	593.37	595.04	.429	.01
Science	Overall	566.53	566.45	.951	<.01	
	FRPL Only	<b>560.99</b>	<b>558.74</b>	<b>.018*</b>	<b>.02</b>	
	Non-FRPL Only	572.07	574.16	.420	.01	

Grade Level	Assessment	Comparison	Model-Implied Adjusted Mean Scores		p-value	Effect Size (d)
			Pre-K	Non-Pre-K		
Second Grade	Reading	Overall	<b>611.63</b>	<b>613.62</b>	<b>.025*</b>	<b>.01</b>
		FRPL Only	605.78	605.33	.484	<.01
		Non-FRPL Only	<b>617.49</b>	<b>621.90</b>	<b>.008*</b>	<b>.02</b>
	Language Arts	Overall	618.06	618.87	.449	<.01
		FRPL Only	<b>611.50</b>	<b>609.48</b>	<b>.008*</b>	<b>.02</b>
		Non-FRPL Only	624.61	628.26	.069	.01
	Mathematics	Overall	565.30	566.89	.111	.01
		FRPL Only	<b>559.81</b>	<b>557.72</b>	<b>.003*</b>	<b>.02</b>
		Non-FRPL Only	<b>570.80</b>	<b>576.06</b>	<b>.005*</b>	<b>.02</b>
	Vocabulary	Overall	593.21	595.21	.069	.01
		FRPL Only	587.27	586.41	.284	.01
		Non-FRPL Only	<b>599.15</b>	<b>604.02</b>	<b>.018*</b>	<b>.02</b>
	Word Analysis	Overall	616.42	617.44	.296	.01
		FRPL Only	610.92	610.14	.266	.01
		Non-FRPL Only	621.93	624.74	.121	.01
	Math Computation	Overall	542.75	543.01	.821	<.01
		FRPL Only	537.10	535.49	.048	.01
		Non-FRPL Only	548.40	550.53	.314	.01
	Social Studies	Overall	607.28	608.68	.196	.01
		FRPL Only	600.09	598.63	.065	.01
		Non-FRPL Only	<b>614.46</b>	<b>618.73</b>	<b>.035*</b>	<b>.01</b>
	Science	Overall	585.87	585.94	.957	<.01
		FRPL Only	579.22	577.35	.051	.01
		Non-FRPL Only	592.51	594.52	.414	.01
	Spelling	Overall	575.77	576.06	.839	<.01
		FRPL Only	568.63	566.74	.073	.02
		Non-FRPL Only	582.90	585.39	.361	.01

Grade Level	Assessment	Comparison	Model-Implied Adjusted Mean Scores		<i>p</i> -value	Effect Size (d)
			Pre-K	Non Pre-K		
Third Grade	Reading	Overall	<b>483.16</b>	<b>484.88</b>	<b>.008*</b>	<b>.01</b>
		FRPL Only	478.77	478.55	.636	<.01
		Non-FRPL Only	<b>487.55</b>	<b>491.21</b>	<b>.002*</b>	<b>.01</b>
	Mathematics	Overall	<b>472.71</b>	<b>474.32</b>	<b>.008*</b>	<b>.01</b>
		FRPL Only	468.39	467.79	.183	.01
		Non-FRPL Only	<b>477.03</b>	<b>480.85</b>	<b>&lt;.001*</b>	<b>.02</b>
	Science	Overall	<b>199.62</b>	<b>200.58</b>	<b>.011*</b>	<b>.01</b>
		FRPL Only	196.06	196.00	.844	<.01
		Non-FRPL Only	<b>203.19</b>	<b>205.16</b>	<b>.005*</b>	<b>.01</b>
	Social Studies	Overall	<b>200.67</b>	<b>201.74</b>	<b>.006*</b>	<b>.01</b>
		FRPL Only	197.82	197.85	.918	<.01
		Non-FRPL Only	<b>203.53</b>	<b>205.63</b>	<b>.003*</b>	<b>.01</b>

Grade Level	Assessment	Comparison	Model-Implied Adjusted Mean Scores		p-value	Effect Size (d)
			Pre-K	Non Pre-K		
Fourth Grade	Reading	Overall	<b>492.97</b>	<b>495.39</b>	<b>.001*</b>	<b>.02</b>
		FRPL Only	487.08	487.64	.304	.01
		Non-FRPL Only	<b>498.86</b>	<b>503.13</b>	<b>.001*</b>	<b>.02</b>
	Mathematics	Overall	<b>490.25</b>	<b>492.19</b>	<b>.004*</b>	<b>.01</b>
		FRPL Only	485.50	484.98	.314	<.01
		Non-FRPL Only	<b>495.00</b>	<b>499.86</b>	<b>&lt;.001*</b>	<b>.02</b>
	Science	Overall	<b>203.85</b>	<b>205.00</b>	<b>.006*</b>	<b>.01</b>
		FRPL Only	200.40	200.90	.118	.01
		Non-FRPL Only	<b>207.30</b>	<b>209.10</b>	<b>.021*</b>	<b>.01</b>
	Social Studies	Overall	202.75	203.54	.062	.01
		FRPL Only	199.24	199.38	.677	<.01
		Non-FRPL Only	206.25	207.71	.065	.01

Grade Level	Assessment	Comparison	Model-Implied Adjusted Mean Scores		p-value	Effect Size (d)
			Pre-K	Non Pre-K		
Fifth Grade	Reading	Overall	<b>510.38</b>	<b>512.62</b>	<b>.008*</b>	<b>.01</b>
		FRPL Only	504.61	505.88	.057	.01
		Non-FRPL Only	<b>516.16</b>	<b>519.35</b>	<b>.039*</b>	<b>.01</b>
	Mathematics	Overall	<b>506.63</b>	<b>510.20</b>	<b>&lt;.001*</b>	<b>.02</b>
		FRPL Only	501.29	502.52	.050	.01
		Non-FRPL Only	<b>511.97</b>	<b>517.89</b>	<b>&lt;.001*</b>	<b>.02</b>
	Science	Overall	<b>204.91</b>	<b>205.95</b>	<b>.036*</b>	<b>.01</b>
		FRPL Only	201.61	202.18	.149	.01
		Non-FRPL Only	208.21	209.73	.096	.01
	Social Studies	Overall	<b>203.31</b>	<b>205.02</b>	<b>.001*</b>	<b>.02</b>
		FRPL Only	<b>199.91</b>	<b>200.79</b>	<b>.029*</b>	<b>.01</b>
		Non-FRPL Only	<b>206.71</b>	<b>209.25</b>	<b>.006*</b>	<b>.01</b>



## Appendix F. Pre-K Participation by LEA, 1998-2009

Table F1 summarizes the number of students participating in the Pre-K program each academic year by LEA. These students would have been eligible to attend Kindergarten the following year. It is important to note that the figures in Table F1 represent *valid cases only*, or student records that did not contain any unresolvable anomalies and included a valid student identifier, as some records were incomplete and could not be used for analysis. As such, the actual numbers of Pre-K students who attended the program in a given year are larger than those reported in Table F1.

Cells with a “\*” denote instances in which the Pre-K demographic data file did include records for that particular school system and school year, but because the records did not include a student identifier, the exact number of Pre-K students could not be determined.

As Table F1 indicates, the Pre-K program has experienced enormous growth statewide since 1998-1999, with the largest increases occurring in the 2000-2001 and 2001-2002 school years, and especially in the 2005-2006 school year (as would be expected). There are 13 school systems with valid Pre-K records in every school year from 1998-1999 to 2008-2009.

**Table F1. Number of Students Participating in Pre-K by School System, 1998-1999 to 2008-2009 (Valid Records Only)**

School System	Number of Pre-K Students by School System and Year (Valid Records Only)											
	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	TOTAL 1998- 2009
Alamo								42	62	69	58	231
Alcoa								19	32	46	39	136
Anderson County	17	19	18	29	35	33	38	105	128	131	144	697
Athens								59	95	124	140	418
Bedford County										60	63	123
Bells								33	34	44	39	150
Benton County									26	43	43	112
Bledsoe County				17	14	11	17	38	67	67	72	303
Blount County	17	7	78	72	110	47	65	81	112	142	149	880
Bradford			1	14	16	14	14	35	19	32	19	164
Bradley County				36				62	181	270	278	827
Bristol			9	18		18	22	26	69	82	83	327
Campbell County				19	23	16	15	62	93	157	139	524
Cannon County								27	44	41	83	195
Carroll County											1	1
Carter County					33	*			46	45	56	180
Cheatham County								38	59	104	109	310
Chester County									20	43	42	105
Claiborne County	16	10	10	21	26	24	26	83	138	230	195	779
Clay County								34	40	38	51	163
Cleveland			33		34	53	44	119	120	103	168	674
Clinton								18	21	21	25	85
Cocke County									63	60	61	184
Coffee County	13	14	25	27	32	36	35	54	99	108	120	563

School System	Number of Pre-K Students by School System and Year (Valid Records Only)											TOTAL 1998- 2009
	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	
Crockett County									16	27	25	68
Cumberland County								105	146	221	205	677
Davidson County	9	4	59	218	243	183	175	383	690	929	1,041	3,934
Dayton								12	18	19	18	67
Decatur County									40	61	56	157
DeKalb County			6	25	34	34	30	59	66	76	96	426
Dickson County			11	10	22	15	19	40	72	93	104	386
Dyer County	15	17	34	47	57	56	56	134	123	126	136	801
Dyersburg				10	19	20	20	44	94	100	124	431
Elizabethton			42	36		42	42	57	63	78	81	441
Etowah									22	34	31	87
Fayette County				22	49	63	62	110	149	158	147	760
Fayetteville								19	37	60	61	177
Fentress County								46	92	112	104	354
Franklin								15	42	48	80	185
Franklin County	15	19	36	62	84	70	63	136	172	229	236	1,122
Gibson County SSD			5	37	32	35	36	55	63	108	76	447
Giles County										91	89	180
Grainger County								36	68	80	78	262
Greene County			16					99	249	296	303	963
Greeneville	3	2	20	63	76	83	87	109	57	92	97	689
Grundy County								14	33	62	69	178
Hamblen County								55	68	138	142	403
Hamilton County			48	92	99	97	107	320	474	723	720	2,680
Hancock County			14	12	23	17	24	60	57	34	58	299
Hardeman County								24	122	179	186	511
Hardin County								27	68	105	117	317
Hawkins County			5	12	16	9	17	35	71	77	66	308
Haywood County	28	21		27	27	30	30	32	78	120	2	395
Henderson County									1	92	107	200
Henry County	17		19	28	28	31	26	56	46	45	53	349
Hickman County								32	69	78	81	260
Hollow Rock Bruceton								20	18	19	22	79
Houston County								40	54	52	48	194
Humboldt			38	36	25	40	41	58	74	66	62	440
Humphreys County			5	3	17	19	16	77	113	144	157	551
Huntingdon								46	63	67	64	240
Jackson County			3	7	13	9	10	22	14	41	48	167
Jefferson County	12	10	12	6	30	67	23	100	116	149	156	681
Johnson City	12	11	13		40	25	27	36	41	71	72	348
Johnson County				27				29	51	48	58	213
Kingsport	16	16	28	31		21	30	65	88	111	116	522
Knox County	13	34	48	60	20	58	47	169	164	389	367	1,369
Lake County			*	15	38	20	20	34	34	42	44	247

School System	Number of Pre-K Students by School System and Year (Valid Records Only)											
	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	TOTAL 1998- 2009
Lauderdale County			19	*	11	22	18	86	137	179	181	653
Lawrence County	9	17	55	90	114	107	110	158	181	245	207	1,293
Lebanon								53	138	167	143	501
Lenoir City	17	30	15	35	51	36	33	36	38	43	39	373
Lewis County								41	61	54	83	239
Lexington								16	17	37	34	104
Lincoln County			19	26	25	20	20	36	139	137	141	563
Loudon County			15	19	35	22	20	92	118	153	186	660
Macon County									42	54	65	161
Madison County			20	53	65	91	94	152	252	307	308	1,342
Manchester								38	38	60	71	207
Marion County								57	79	85	77	298
Marshall County										42	33	75
Maryville								18	39	41	44	142
Mauzy County			6	78	87	59	64	65	156	189	227	931
McKenzie								19	21	21	21	82
McMinn County				14	13	15	9	50	93	177	198	569
McNairy County			15	20	21	15	21	81	107	136	122	538
Meigs County								43	78	69	67	257
Memphis	53	17	98	234	53	218	198	675	1,241	2,094	2,254	7,135
Milan	4	17		35	41	40	49	60	36	101	81	464
Monroe County								22	38	65	65	190
Montgomery County								41	260	431	427	1,159
Moore County										20	13	33
Morgan County								70	111	112	121	414
Murfreesboro				49		64	80	151	211	225	258	1,038
Newport									19	38	42	99
Oak Ridge								38	51	104	91	284
Obion County								20	39	103	102	264
Oneida								34	36	49	45	164
Overton County								60	109	96	97	362
Paris									59	63	62	184
Perry County			10	6	17	12	10	34	48	40	41	218
Pickett County								14	19	20	18	71
Polk County								34	61	79	75	249
Putnam County			16	45	90	89	66	247	313	340	355	1,561
Rhea County			11	23	20	22	19	54	83	91	87	410
Richard City										7	12	19
Roane County									106	126	132	364
Robertson County								38	110	191	192	531
Rogersville								14	13	14	22	63
Rutherford County			29		61	*		72	125	230	231	748
Scott County				42	49	43	52	123	125	155	181	770
Sequatchie County			13	14	16	10				20	19	92

School System	Number of Pre-K Students by School System and Year (Valid Records Only)											TOTAL 1998- 2009
	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	
Sevier County	14	8	14	3	20	*	20	94	80	107	109	469
Shelby County			2	72	272	21	18	95	158	259	270	1,167
Smith County								30	63	88	94	275
South Carroll			14	21	20	17	19	23	13	20	22	169
Stewart County			4	7	16	20	6	49	79	88	99	368
Sullivan County			10	28	95	38	21	63	80	125	115	575
Sumner County									1	2		3
Sweetwater								23	45	65	64	197
Tipton County								159	167	210	208	744
Trenton				9	20	20	15	35	62	62	80	303
Trousdale County										15	21	36
Tullahoma										80	86	166
Unicoi County			13	28	30	33	30	80	89	96	98	497
Union City								21	41	44	42	148
Union County								20	65	69	62	216
Van Buren County			22	16	15	22	21	22	21	28	30	197
Warren County								37	103	129	141	410
Washington County									1			1
Wayne County			18	41	44	47	46	84	101	113	118	612
Weakley County	18		18	48	15	5	2	32	57	117	112	424
West Carroll SSD								20	41	39	35	135
White County								21	74	79	82	256
Williamson County								104	103	119	139	465
Wilson County									79	167	189	435
<b>TOTAL</b>	<b>318</b>	<b>273</b>	<b>1,092</b>	<b>2,195</b>	<b>2,631</b>	<b>2,404</b>	<b>2,345</b>	<b>7,599</b>	<b>12,234</b>	<b>17,081</b>	<b>17,668<sup>a</sup></b>	<b>65,840</b>

<sup>a</sup> The total for 2008-2009 also includes two students from the Tennessee School for the Deaf.