



APPLES

BY Norah

**The APPLES Blossom:  
Abbott Preschool Program Longitudinal Effects Study  
(APPLES)  
Preliminary Results through 2<sup>nd</sup> Grade**

**Interim Report  
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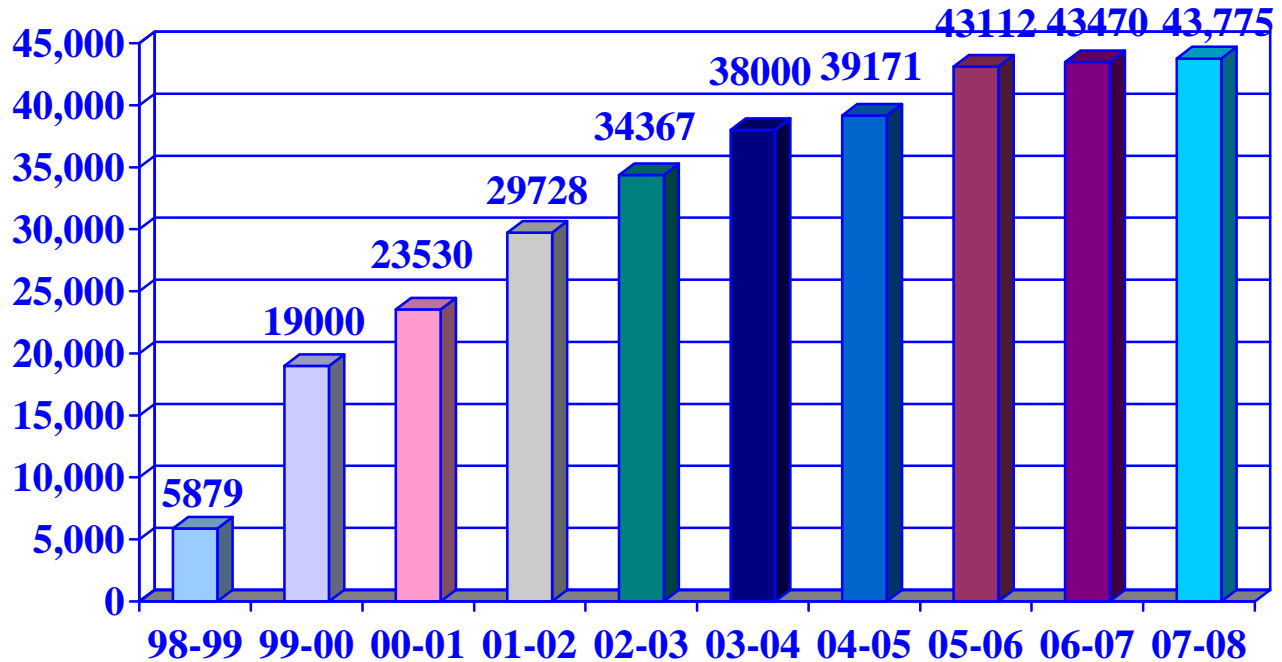
## Introduction

This study investigates the persistence of educational effects of state funded prekindergarten education for children at ages three and four in New Jersey's Abbott districts through second grade. The program providing that education was developed in response to the landmark New Jersey Supreme Court school-funding case, *Abbott v. Burke*. In the 1999-2000 school year, 3- and 4- year old children in the highest poverty districts in the state began to enroll in a new high-quality preschool education program. This program has been designed to prepare them to enter school with the knowledge and skills necessary to meet the New Jersey Preschool Teaching and Learning Expectations: Standards of Quality (NJ Department of Education, 2004b) and the Kindergarten New Jersey Core Curriculum Content Standards (NJDOE, 2004a). Through a Department of Education (DOE) and Department of Human Services (DHS) partnership, Abbott preschool classrooms combine a DOE-funded six-hour, 180-day component with a DHS-funded wrap-around program that provides daily before- and after-care and summer programs. In total, the full-day, full-year program is available up to 10 hours per day, 245 days a year.

Enrollment in the Abbott preschool program has increased dramatically since its inception in 1999. During the 2008-2009 school year, the tenth year of Abbott preschool implementation, the 31 Abbott districts served over 43,000 3- and 4-year-old children in preschool – about 80 percent of the population. The preschool program is delivered by a mixed public-private delivery system overseen by the public schools. Private child care providers and Head Start agencies contract with local boards of education to serve about

two-thirds of the children. The rest are served in public school classrooms. The increase in enrollment over time is shown in Figure 1 below.

**Figure 1: Abbott Preschool Enrollment 98-99 to 07-08**



The Court established basic program standards for preschool education in the Abbott districts that included a maximum class size of 15, certified teachers with early childhood expertise, assistant teachers in every classroom, comprehensive services and a developmentally appropriate curriculum designed to meet learning standards. Some of these standards could be implemented quite quickly. Others like the requirement for teacher certification took time. Over the first five years, everyone from the classroom level on up worked hard to fully implement these standards and to bring classroom practices up to the level of effectiveness that these standards are designed to support. Such standards facilitate highly effective preschool education, but do not by themselves guarantee it. To ensure high quality and consistency for children across auspice and

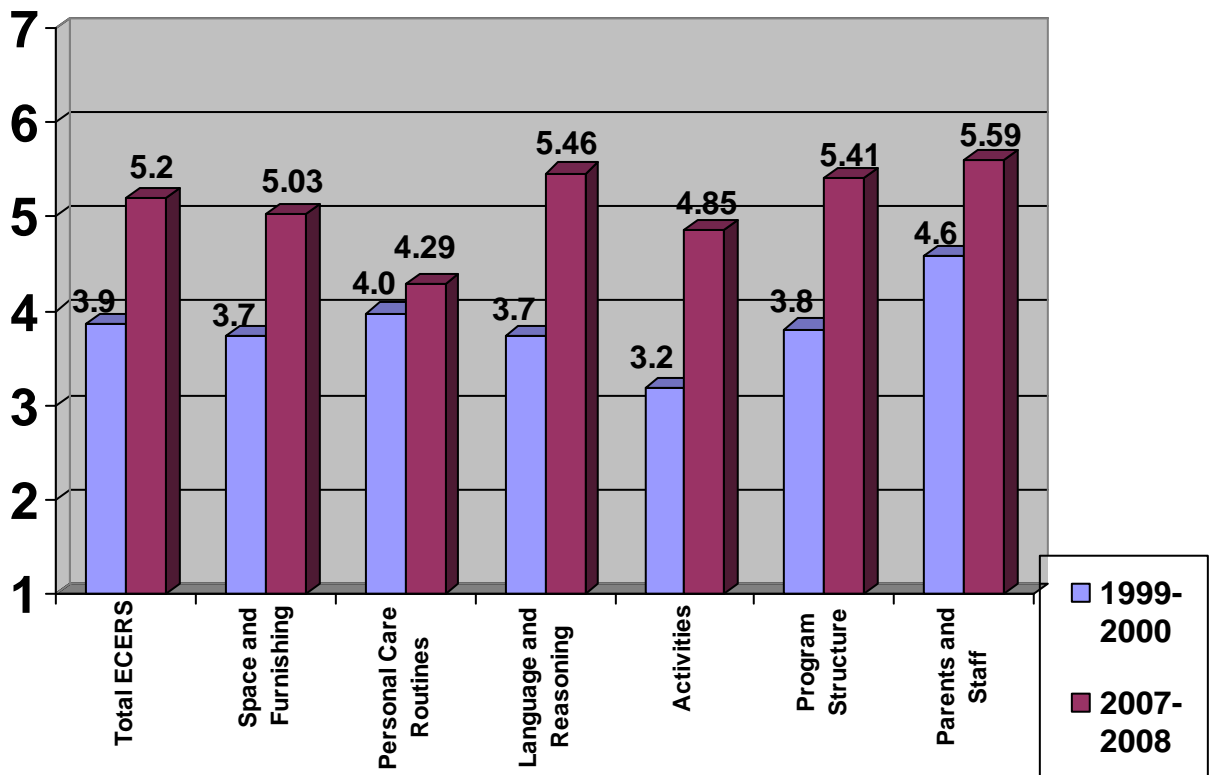
district and to assist administrators and staff who may have been inadequately prepared in early childhood education, more detailed operational standards were developed (Abbott Preschool Program Implementation Guidelines; Office of Early Childhood Education, NJDOE, 2002, revised 2005). These standards were also designed to ensure that the particular needs of children in each community were addressed. The Abbott preschool program is not designed to be simply a “cookie cutter” approach that is identical in every community.

Observation data on preschool classroom quality have been systematically collected in the Abbott districts since the 1999-2000 school year. Results have been reported periodically since (Barnett, Tarr, Lamy, & Frede, 2002; Frede et al, 2004; Lamy et al, 2005). Classroom quality rose steadily each year and, by the 2004-2005 school year, classroom quality scores had reached acceptable levels, and children were entering kindergarten with language and literacy skills closer to the national average than in prior years (Frede, et al, 2004; Lamy, et al, 2005). Therefore, this evaluation was launched to more precisely estimate the learning gains from the Abbott prekindergarten program including the extent to which gains persist into elementary school.

Classroom quality has continued to improve in the Abbott districts since 2004-05 due to local and state efforts. Figure 2 reports quality scores from the first year together with scores from 2007-08 on one indicator, the ECERS-R. The ECERS-R is the most widely used observational measure of preschool program practice and it correlates highly with other measures that are commonly used (for more information on the ECERS-R and other measures used to assess quality of the Abbott preschools see Frede et al., 2007). In 2007-08, the average Abbott classroom scored better than “good” (a score of 5) and most

programs were in the good to excellent range (5 to 7). This is a dramatic change from 1999-2000, when few classrooms reached “good.” Increases have been particularly large for the two parts of the scale most closely related to children’s learning and development—Language and Reasoning, and Activities. One implication of the continuing change is that Abbott preschool programs are likely to have stronger impacts on learning and school success for children attending today than they did for the children in this study.

**Figure 2: Classroom Quality Scores 1999-2000 vs. 2007-2008**



This is the second report on this study of the 2004-05 cohort of Abbott preschool attendees. A previous report discussed the effects of the Abbott pre-K program at the beginning and end of kindergarten (Frede, et. al., 2007). These results are only briefly

reviewed here to provide context for findings of the present report. For detailed information on the methodology and findings the reader should consult the earlier report.

### **Previous Results**

In the fall of 2005, we implemented a two-step research process to estimate the long-term effects of attendance in an Abbott preschool classroom. The first step was to implement a Regression Discontinuity Design (RDD) to estimate the effects of the program on children's abilities at kindergarten entry (Trochim, 1984). This approach relies on the fact that eligibility for Abbott pre-K within a designated school district is determined by date of birth alone. This assignment rule allows us to construct two groups, one entering kindergarten that has already attended the program at age 4 and one entering preschool that has not yet attended at age 4. These groups are unlikely to differ with respect to measured or unmeasured child and family characteristics so that the RDD minimizes the potential effects of selection bias which occurs when the effects of differences between the two groups of children are confounded with program effects (Cook, 2008).

The RDD approach can be viewed as similar to a randomized trial for children near the age cutoff. The RDD creates groups that *at the margin* differ only in that some were born a few days before the age cutoff and others a few days after the cutoff. When these children are about to turn 5 years old the slightly younger children will enter the preschool program and the slightly older children will enter kindergarten having already attended the preschool program. By testing all of the children at that time, we obtain an unbiased estimate of the preschool program's effect under reasonable assumptions. Of course, it is quite limiting to analyze data only for children with birthdays only a few

days on either side of the age cutoff. Alternatively, the RDD can be viewed as modeling the relationship between an assignment variable (age) and measures of children's learning and development. The pre-cutoff sample is used to model the relationship prior to treatment. The post-cutoff sample is used to model the relationship after the treatment. This approach can be applied to wider age ranges around the cutoff. However, its validity depends on correctly modeling the relationship.

Unfortunately, the RDD approach cannot provide an estimate of effects beyond kindergarten entry. We employed a second design to obtain estimates beyond kindergarten entry—comparing children who attended pre-K to a conventional no-treatment comparison group identified at kindergarten entry. We then assessed the accuracy of estimates obtained from this second approach at kindergarten entry by comparing them to the RDD estimates. If the initial estimates from both analyses are similar, then we can have confidence in the longitudinal results. To the extent that they differ, we have an indication of the likely direction and magnitude of bias in the longitudinal estimates.

For the second design we drew an additional comparison sample of kindergarten children who did not attend the Abbott preschool program. We obtained a sample at kindergarten entry of 1,038 children in 15 districts. Of these, 284 did not attend the Abbott pre-K program, 451 attended for 1 year, and 303 attended for two years. As some children attended Abbott preschool for one year at age 4 and others attended preschool for two years at ages 3 and 4, we are able to separately estimate the effects of one year and two years of preschool attendance using this second design. The study has limited ability to adjust for any incidental differences between the groups or to assess their



comparability (except by way of the RDD). However, this is less of a problem than it might be because the communities in our study are fairly homogeneous; all are larger, low-income urban school districts in a single state. In addition, we have ensured that the treatment and comparison samples are balanced with respect to district, and we control for district in the analyses.

As reported previously we find positive effects on children's learning in the areas of oral language, early literacy, and mathematics at kindergarten entry. The standardized effects (i.e., converted to standard deviation units) of one year at age four using the RDD were 0.28 for the language, 0.56 for print awareness, and 0.36 for math. The estimated effects for one year of preschool based on the conventional comparison group in the longitudinal study were 0.21 for language, 0.29 for print awareness, and 0.20 for math. A reasonable conclusion is that with the design used for the longitudinal study results in a significant underestimation of the program effects because the longitudinal study design does not fully control for differences between those who do and do not attend pre-K. Therefore, we expect that the longitudinal study also will underestimate the true effects going forward through kindergarten, first, and second grade, as well.

We find that effects are larger for two years of participation than for one, and that effects persisted through the end of kindergarten. The standardized effect sizes for two years of participation were 0.42 for language, 0.31 for print awareness, and 0.34 for math. That is, two years had larger effects for language and math, but not for print awareness. When estimates were repeated for children at the end of kindergarten, the effect sizes were virtually the same as at the beginning of kindergarten for language, suggesting that advantage was fully maintained. Math effects appeared to be slightly smaller than earlier.

The print awareness measure was no longer useful at the end of kindergarten as most children have mastered the relevant knowledge and skills. It appears that these are readily taught and mastered, which explains why two years seems to give little additional benefit, as well.

### Sample for Follow-up through Second Grade

Subsequent follow-ups of the sample have been conducted in the Spring of 2007 and 2008. Children would have been in first and second grade, respectively, if they were had not been retained in grade at any point. Children were followed up and assessed regardless of their actual grade level, and the 2007 data are referred to as “first grade” and the 2008 data as “second grade” even though some of the children in each year’s data are actually behind a grade level. In addition, we have collected demographic data on the sample that was not previously available so that we now have information on age, gender, ethnicity, and lunch status. Sample characteristics at second grade are reported in Table 1.

Table 1  
*Second Grade Sample Demographics*

	N	Girl %	Age <i>M</i> ( <i>Std</i> )	Black %	Hispanic %	White/ Asian %	Free Lunch %	Reduced- Priced Lunch %	Full- Priced Lunch %	Missing Lunch Info %	Spanish Home Language %
No Pre-K	150	44	8.12 (0.34)	36	56.7	6.7	67.3	9.3	6.7	16.7	19.6
1 Year of Pre-K	306	52.3	8.07 (0.32)	38.2	53.6	7.2	69.3	8.8	9.8	12.1	21.5
2 Year of Pre-K	207	51.2	8.06 (0.33)	34.8	61.8	2.9	64.7	12.1	5.3	17.9	19.6

One of the challenges in every longitudinal study is locating the children who originally entered the study. This becomes more difficult the longer the study continues.

Children move outside their original districts or even out of the state, change their names or how they report their names to the schools, and may decline to participate at a later time. Loss of participants over time, or attrition, has two negative consequences. One is a decrease in sample size, which reduces statistical power. The other is that attrition may be nonrandom affecting the generalizability of the findings and potentially decreasing the comparability of the treatment (Abbott Preschool) and comparison groups.

So far attrition has been moderate. In the original analyses at kindergarten entry the number of children with valid test scores varied between 1,038 and 1,054 depending on the measure. In 2009, we will follow-up by using data from the statewide assessment in Grade 3, which may allow us to identify more children than in the previous year. However, the Grade 3 assessment does not include children who were retained in grade, which creates its own problem of non-random attrition. To address the problem we plan to identify children who were behind in grade level (many have already been identified) and we hope to administer the third grade test to them individually.

In order to assess the extent to which attrition is or is not random we have conducted analyses on the initial test scores of the children at kindergarten entry. These analyses investigate whether test scores differ between the initial sample and follow-up sample and whether differences from the initial to follow-up sample vary by the number of years of Abbott Pre-K. The results show no significant differences between the initial sample and the existing sample at 1<sup>st</sup> or 2<sup>nd</sup> grade.

### **Measures Collected at First and Second Grade**

Data collectors trained by NIEER assessed each child individually in the Spring of 2007 and 2008. Measures administered at this time provide continuity with earlier

measures but accommodate the children's developing abilities. The battery of child assessments took an average of approximately 25 minutes per child and was administered in the child's school, in a room or quiet area appropriate for assessment.

*Receptive Vocabulary.* Children's receptive vocabulary has been measured every year since kindergarten entry using the Peabody Picture Vocabulary Test, 3<sup>rd</sup> Edition (PPVT-III; Dunn & Dunn, 1997) and, for Spanish-speakers, the *Test de Vocabulario en Imagenes Peabody* (TVIP; Dunn, Padilla, Lugo, & Dunn, 1986). The PPVT is predictive of general cognitive abilities and is a direct measure of vocabulary size. The rank order of item difficulties is highly correlated with the frequency with which words are used in spoken and written language. The test is adaptive (to avoid floor and ceiling problems), establishing a floor below which the child is assumed to know all the answers and a ceiling above which the child is assumed to know none of the answers. Reliability is good as judged by either split-half reliabilities or test-retest reliabilities. The TVIP is appropriate for measuring growth in Spanish vocabulary for bilingual students and for monolingual Spanish speakers.

All children in our sample were administered the PPVT, regardless of home language, to get some sense of their receptive vocabulary ability in English. In kindergarten all children who spoke some Spanish were also subsequently administered the TVIP. The testing session was then continued, with the additional measures administered in either English or Spanish, depending upon what the child's teacher designated as his or her best testing language. In this follow-up, we have discontinued Spanish-language testing as English is the language of instruction for all children and by

the end of kindergarten we found few children for whom Spanish was a stronger language than English.

*Mathematical Skills.* Children's early mathematical skills have been measured each year with the Woodcock-Johnson Tests of Achievement, 3<sup>rd</sup> Edition (Woodcock, McGrew, & Mather, 2001) Subtest 10 Applied Problems. For Spanish-speakers the *Bateria Woodcock-Munoz Pruebas de Aprovechamiento – Revisado* (Woodcock & Munoz, 1990) *Prueba 25 Problemas Aplicados* was used in kindergarten. Subtests of the Woodcock-Johnson are reported to have good reliability. In this follow-up, we added two more Woodcock-Johnson subtests to the assessment battery for first and second grade: Subtest 5 Calculation and Subtest 6 Math Fluency. Subtests 5, 6, and 10 together comprise the Broad Math Battery of the Woodcock-Johnson.

*Literacy Skills.* The literacy measures used in this study have been changed the most over time. Initially, we measured print awareness in kindergarten using a subtest of the Preschool Comprehensive Test of Phonological and Print Processing (Pre-CTOPPP; Lonigan, Wagner, Torgeson, & Rashotte, 2002). However, the Pre-CTOPPP is not appropriate for older children. Instead, in the first and second grade follow-up we used subtests from the WJ-III (Woodcock et al., 2001) to measure early literacy skills. In the first grade, Woodcock-Johnson Subtests for Letter-Word Identification, Word Attack, and Sound Awareness (Rhyming, Deletion, and Substitution) were used. Subtests Letter-Word Identification and Word Attack subtests comprise the Basic Reading Battery of the Woodcock-Johnson. In the second grade, Woodcock-Johnson Subtests for Letter-Word Identification, Reading Fluency and Passage Comprehension were used. Together these provide a measure of Broad Reading. These literacy sections of the WJ-III are widely

used in research and are reported to have good psychometric properties. As with the other measures, all children were assessed in English for this follow-up.

### **Follow-Up Analyses and Initial Findings: First and Second Grade**

The effects of Abbott preschool program participation on children's test scores at the end of first and second grade were estimated using regression analysis. Effects on grade repetition by entry to second grade were estimated using logit and probit analyses as appropriate for a binary dependent variable. These analyses were conducted on the longitudinal sample with independent variables for student ethnicity, free or reduced lunch status, gender, age, and school district, as well as dummy variables indicating one or two years attendance in an Abbott preschool program. Analyses were conducted on raw scores. The Stata program was employed, and intra-cluster correlation is taken into account through the estimation of cluster-robust standard errors. All of the first and second grade analyses were conducted with no replacement of missing data, as all procedures for replacing missing data create problems of their own. However, in a future report we will present the results of analyses using multiple imputation procedures to replace data. The estimated effect sizes (i.e., standardized in standard deviation units for comparison purposes) at kindergarten entry and the end of kindergarten are reported below in the text and in tables that report scores for each group: no preschool, one year of preschool at age 4, and two years of preschool at ages 3 and 4.

**Receptive Vocabulary.** Oral language (as measured by the PPVT) forms not only the basis of social communication, but reveals conceptual knowledge and is essential for both reading and writing acquisition. At the end of kindergarten, one year of the Abbott preschool program had an effect size of 0.18 ( $p < .05$ ) and the two year effect size was

0.38 ( $p < .01$ ). At the end of second grade the benefits of Abbott participation continued to be significant with results of 0.22 ( $p < .05$ ) for one year of attendance and 0.40 ( $p < .01$ ) for two years. Keeping in mind that comparison with the regression discontinuity results at kindergarten entry indicated that the longitudinal study underestimates program effects, these results are quite strong. As was true earlier, the estimated effects of two years of participation are twice the size of those for one year of Abbott Pre-K. Table 2 displays these results together with earlier results for comparison. These results suggest that there has been no decline in the program's effects in this domain since kindergarten entry. Standard scores indicate that children are still somewhat below the national average in this domain, despite the substantial gain from two years of Abbott pre-K.

**Mathematics.** All of the estimated effects in mathematics favored the Abbott preschool attendees with two years having more impact than one. Math measures included Applied Problems, Calculation, Math Fluency and Broad Math. The most consistently observed difference was that Applied Problems scores were higher in first grade—effect sizes of 0.18 ( $p < .05$ ) for one year and 0.26 ( $p < .05$ ) for two years—and in second grade—effect sizes of 0.24 ( $p < .05$ ) for one year and 0.44 ( $p < .01$ ) for two years. Estimated effects on Calculation at the end of second grade were small, but were statistically significant ( $p < .05$ ) in a one-tailed test for two years of Pre-K. Estimated effects were small for Broad Math, but effects on standard scores were statistically significant in one-tailed tests for one year and two years of Pre-K.

Estimated effects on Applied Problems from kindergarten entry through 2<sup>nd</sup> grade are reported in Table 2. Although there is some variation in these over time, they suggest little or no reduction in effects from kindergarten entry through the end of second grade,

and the effects are large enough to be meaningful. Two years of very consistently has a much larger effect than one year of Abbott Pre-K participation, though not always double. Comparison to the RDD results indicates that we substantially underestimate effects on mathematics achievement, perhaps by so much that the true effects at the end of second grade were about .40 for one year and .80 for two years. Standard scores indicate that even children in the follow-up sample who did not attend Pre-K score at about the national average in mathematics, even though behind those who attended the program.

**Reading.** The instruments used to assess first grade literacy skills were letter-word identification, word attack, sound awareness, and basic reading. Second grade literacy skills were measured by letter-word identification, reading fluency, passage comprehension and broad reading. Although differences in these literacy outcomes tended to favor children who had attended Abbott prekindergarten programs, they generally were small and statistically significant. Program effects are most apparent on Passage Comprehension on which the former pre-K attendees scored higher with effect sizes equal to 0.16 for one year and 0.20 for two years—both effects are statistically significant at the .05 level using a one-tailed test. These can be seen in Table 2. Standard scores indicate that children in the follow-up sample scored near the national average on Broad Reading by the end of second grade regardless of pre-K attendance.

We note that literacy is the domain where the initial comparison of results from the RDD and longitudinal designs indicated the most serious problem. The RDD result for one year of Abbott Pre-K at kindergarten entry was nearly double (90 percent larger) the result produced using the conventional comparison group. Therefore, literacy is the



domain in which the study faces the greatest challenge detecting long-term effects and for which the results must be interpreted most cautiously. This may explain the lack of significant effects on Broad Reading at the end of second grade.

Table 2

*Effect Sizes*

	RDD	Longitudinal		1 <sup>st</sup>	2 <sup>nd</sup>
		K Entry	K End		
PPVT					
Year 1	.28	.21	.22	.18	.22
Year 2		.42	.41	.38	.40
WJ Applied Problems					
Year 1	.36	.20	.13	.18	.24
Year 2		.34	.29	.26	.44
Literacy					
Year 1	.56 <sup>a</sup>	.29 <sup>a</sup>	0 <sup>a</sup>		.16 <sup>b</sup>
Year 2		.31 <sup>a</sup>	.14 <sup>a</sup>		.20 <sup>b</sup>

Note. <sup>a</sup> Kindergarten literacy was measured using the Pre-CTOPP.

<sup>b</sup> Second grade literacy was measured by WJ subtest Passage Comprehension

**Grade Retention.** Now that the study children have reached second grade we are able to investigate the effects of preschool attendance on grade retention in kindergarten and first grade. Our measure should be considered an assessment of retention by entry to second grade, as it is possible that a few children were retained shortly after entering second grade. Nevertheless, it is a measure of children who repeated either kindergarten or first grade. We find that the Abbott Pre-K program

significantly reduced retention in first grade and kindergarten. Grade retention was 10.7% (16) for children who did not attend pre-K, 7.2% (22) for those who attended for one year, and 5.3% (11) for those who attended two years. The effect on grade retention of two years of Abbott pre-K is statistically significant ( $p < .05$ ) and twice as large as the effect of one year of Abbott pre-K.

### **Discussion**

Considerable resources have been invested in the Abbott Preschool Program. It has high program standards compared to many other state-funded pre-K programs and the federal Head Start program (Barnett, Epstein, Friedman, Boyd, & Hustedt, 2008). It also has a relatively high per pupil cost, which reflects those high standards as well as New Jersey's high cost of living. The program operates for a full school day, employs licensed teachers paid on the same scale as public school teachers, has a maximum class size of 15 with an assistant teacher assigned to each classroom, provides in-class supports to classroom staff on curriculum and differentiating instruction and has dedicated staff to work with parents and the community (Frede, 2005).

The effectiveness of any preschool program depends on how well it is implemented, but quality of implementation is not always measured in program evaluations. It is noteworthy that the Abbott pre-K program has been a work in progress. At the time the children in this follow-up study attended the program, quality was better than that in many other programs but not what it is today. The program has improved a half point over all on the 7 point scale, from fair to good on average to good to excellent on average since the children in this study attended Abbott Pre-K. When interpreting the results of this report it should be acknowledged that, even if perfectly estimated, the

program's effects reported here are smaller than we would expect for subsequent cohorts of children in the Abbott districts.

Earlier studies found that the Abbott Preschool Program has beneficial effects on children's learning in the domains of language, literacy and math abilities skills at kindergarten entry and exit (Frede et al., 2004; Lamy et al., 2005; Wong, Cook, Barnett, & Jung, 2008). We find positive effects on children's learning in those same domains through the end of second grade. This studies' effect sizes are reasonably large compared to the estimated effects in other studies and are about the same size as reported by the Chicago Child Parent Center study at the end of second grade (Reynolds et al.; 2007). The estimated effects on grade retention are consistent the results other studies, taking into consideration that only kindergarten and first grade are involved so far. However, there are two discrepancies with other studies in the details.

Other studies of preschool programs for three- and four-year-olds have not tended to find the same degree of persistence in PPVT scores. Our results, particularly those for two years of Abbott Pre-K, are more similar to the results of the Abecedarian (Campbell et al., 2002) and IHDP (McCarten, et al., 1997) studies where intervention began earlier and was provided in full-day, year-round programs. Perhaps the intensity of the Abbott program, which is offered for a full school day, and the provision of wrap-around child care full-day, year-round contribute to the larger and more persistent effect on the PPVT which measures language and conceptual knowledge (see also, Robin, Frede, & Barnett, 2006). The Abbott program also differs from many others in that it provides services to all children in a community, raising the possibility of peer effects and that large scale

changes in the overall performance of classrooms in years after preschool may affect the long-term results.

Other studies have found larger effects on literacy skills, though not always in the first several years of primary school. For example, the effects of the Perry Preschool program on reading achievement were not fully evident until middle school (though keep in mind that study had a small sample; Schweinhart and Weikart, 1980). One complicating factor is the intensive focus of Abbott schools on literacy in the early grades (MacInnes, 2009). Possibly this focus has enabled the children who did not attend preschool to catch up to their peers who did attend pre-K in basic literacy skills. We do not know how much extra attention children who were falling behind may have received as a result of these efforts. It remains to be seen whether the persistent language advantage from preschool participation will become more evident in reading comprehension in Grade Three where it is more thoroughly assessed than in second grade. Children's early print awareness and receptive vocabulary skills have been found to predict later reading abilities in the early elementary grades (Snow, Burns, & Griffin, 1998). However, it should be noted that relative to national norms children in the study are performing better on the reading measures than on the oral language (and conceptual knowledge) measure at second grade.

Relatively little research compares the effects of one year versus two years of preschool attendance. Some studies find little difference, while others have found substantial gains from starting earlier (Barnett, 2008). From kindergarten through second grade, children who attended the Abbott Preschool Program for two years at ages 3 and 4 out-performed children who attended for only one year at age 4. Two years of program

participation roughly doubles gains at second grade on most measures. The sole exception is literacy and reading for which two years has appeared to be at best slightly better. These results must be interpreted cautiously, as selection bias could also affect the differences between estimated effects for one and two years of program participation. Parents who know about and choose to send their children to preschool at age 3 may be different in immeasurable ways from those who only send them at 4. For this comparison we do not have the estimates from the more rigorous RDD to verify our results.

The evidence of downward bias in the longitudinal study estimates should be taken into consideration when interpreting our results. The RDD study indicated that there was substantial downward bias in estimates from our longitudinal study design and that this was most severe for literacy and least severe for language. This bias may explain why effects do not appear as sustained for literacy as for language through the end of second grade. The downward bias in the estimated initial effects on literacy is more than enough to have resulted in the lack of statistical significance even if true long-term effects were in the neighborhood of 0.25 or 0.30. Such effects would be large enough to be educationally meaningful. The estimated effects on passage comprehension in second grade are suggestive that we may be missing literacy effects because of the research design doesn't correct well enough for initial differences between the Pre-K and No-Pre-K groups that affect literacy development. An additional factor is that loss of some of the sample over time reduces our ability to detect effects.

The effects found in this study are the first links in a chain of results that have been found to produce long-term gains in school success and economic benefits in other preschool education studies that have followed children into adulthood (Campbell et al.,

2002; Reynolds, Temple, Robertson, & Mann, 2002; Schweinhart et al., 2005). There is a consistent picture in the study reported of gains in knowledge and skills accompanied by increased school success as measured by grade retention. These gains in learning and ability are large enough to be practically meaningful and are already beginning to result in savings for taxpayers who do not have to pay for extra years of schooling. The results of this study add to the considerable body of evidence indicating that quality preschool education can make significant contributions to efforts to improve children's learning and development (Frede, 1998). This study extends the evidence that such effects can be produced for today's children on a large scale by public programs administered through the public schools by demonstrating persistent and not just initial effects on children's cognitive abilities (Gormley, Gayer, Phillips, & Dawson, 2005).

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