

**The Effects of Oklahoma's Early Childhood Four-Year-Old Program on Young Children's School Readiness**

Cynthia Lamy, Ed.D.  
W. Steven Barnett, Ph.D.  
Kwanghee Jung, Ph.D.

National Institute for Early Education Research  
Rutgers University

December 2005

Funding for this project was provided by The Pew Charitable Trusts.

Many thanks are due to our colleagues at The Early Childhood Collaborative at Oklahoma University who partnered with us to accomplish this study, especially Dr. Loraine Dunn, Dr. Stacy Dykstra, Tamra Crabtree, and their field staff. We would like to thank State Superintendent Sandy Garrett, State Department of Education, the Oklahoma Office of Early Childhood Education, especially Dr. Ramona Paul, and the many school administrators and teachers who made this research possible. We are appreciative of the helpful comments made by several fine reviewers. And, we are more than indebted to our sample preschool and kindergarten children who took time out of their busy days to help enlighten us.

## **The Effects of the Oklahoma's Early Childhood Four-Year-Old Program on Young Children's School Readiness**

### **Executive Summary**

This study measures the effects of Oklahoma's universal Early Childhood Four-Year-Old Program on entering kindergartners' academic skills using an innovative research model. Receptive vocabulary, early literacy and early math skills were assessed in a sample of 838 children from across Oklahoma. We find that Oklahoma's Early Childhood Four-Year-Old Program has statistically significant and meaningful impacts on children's early literacy and mathematical development, and find evidence of an enhanced program effect for print awareness skills for children in low-income families.

Specifically:

1. The Early Childhood Four-Year-Old Program produces an increase in children's vocabulary scores of over 3 and a half raw score points, 28 percent more growth over the year due to the program (and a 6% increase in children's average vocabulary scores). This improvement translates into an additional four months of progress in vocabulary growth. This outcome is particularly important because the measure is strongly predictive of general cognitive abilities.
2. Children who attend the Early Childhood Four-Year-Old Program score higher on a test of early math skills. The program increased children's math scores by nearly 1.5 raw score points, 44 percent more growth over the year due to the program (and a 11% increase in children's average math scores). Skills tested include basic number concepts, simple addition and subtraction, telling time and counting money.
3. The Early Childhood Four-Year-Old Program has large effects on children's understanding of print concepts. The program increased all children's print awareness scores by nearly 17 percentage points, 88 percent more growth over the year due to the program (and a 35% increase in children's average vocabulary scores). The program additionally boosts scores for children from low-income families about 8 percentage points higher. Children who attend the program know more letters, more letter-sound associations, and are more familiar with words and books concepts.
4. We found no significant effects on a measure of children's skills in phonological awareness. As this measure is relatively new, it is difficult to determine the extent to which the result is due to a true lack of program effects

Oklahoma's evaluation is part of a larger multi-state study of the effects of state-funded preschool, which includes 5071 preschool and kindergarten children sampled across four additional states – Michigan, New Jersey, South Carolina and West Virginia.

## **Introduction**

State-funded preschool programs have become increasingly common across the country, having been established to some extent in up to 40 states. While myriad services these programs may provide to families are influenced by complex parental needs which may include longer hours, transportation, health services and the like, the main goal of all state-funded preschool programs is the preparation of young children for the increasingly rigorous challenges of kindergarten. Effective preschool programs lay a foundation for children's subsequent school success by imparting the basics – colors, shapes, numbers, letters, how to look at a book, how to get along with classmates, how to live by the rules in school - sending children to kindergarten with solid successes in preschool and the real confidence that success creates. As the number of state funded preschool programs grow, it is important to determine how effective these programs are in improving children's potential for school success.

### **The Early Childhood Four-Year-Old Program Context**

Oklahoma is a national leader as one of the few states to provide universal preschool for all the state's 4-year-olds whose parents wish them to attend. Operated under the auspices of the Oklahoma Department of Education, the state-funded preschool program served 30,180 children in FY '04. Most of the children are served in public schools. However, districts may collaborate with the range of private childcare centers and Head Start programs for services.

The NIEER *2004 State of Preschool: State Preschool Yearbook* analyzed state funded preschool initiatives in '02-'03 based on access, resources and quality. Each state was ranked on access to and resources for preschool education. Oklahoma ranked first in the nation in providing access for 4-year-olds. In addition, Oklahoma's policies rated relatively highly, earning eight points on a 10 point quality standard checklist. Importantly, Oklahoma's ECFP requires that teachers hold a bachelor's degree and specialized training in early childhood education as well as comprehensive curriculum standards.

## **Methods**

### **Study Design**

The Preschool Four-Year-Old Program evaluation is based on regression-discontinuity (RD) design, a statistical model with several strengths. The design addresses one of the most vexing problems in educational research, that of selection bias. Typically, program effects are estimated by comparing the test scores of children who attended a program with the scores of similar children who did not go. Where programs are universal, the problem of finding a "comparable" group of children who did not go to preschool is obvious. Yet, even where programs target only some children, a problem remains: those who go to preschool are *not* the same those who do not. Preschool

programs that target specific types of children create these differences, but differences also come about because some parents choose to enroll their children and others do not. In sum, children who go to preschool differ from those who do not because programs select children and families select programs.

Our approach is to compare two groups of children who select (and are selected by) the state program, using a fairly stringent age cutoff for enrollment eligibility to define groups. This concept is easier to understand when considered in the extreme case: consider two children who differ only in that one was born the day before the age cutoff and the other the day after. When both are about to turn 5 years old the slightly younger child will enter the preschool program and the slightly older child will enter kindergarten having already attended the preschool program. If both are tested at that time, the difference in their scores can provide an unbiased estimate of the state preschool program's effect. Obviously, if only children with birthdays one day on either side of the age cutoff were included in a study, the sample size would be unreasonably small. However, the approach can be applied to wider age ranges around the cutoff. In fact, all children entering kindergarten from the state preschool program, and all children beginning preschool in the same year can be included using regression-discontinuity statistical techniques that adjust for the effects of age. This RD approach reduces the likelihood that selection bias has an appreciable impact on our results.

The research question of interest is whether attendance in the state-funded preschool program at age 4 has an impact on children's academic skills at kindergarten entry. This question is addressed with identical methods and measures across the five study states. The programs in Michigan, New Jersey and South Carolina are targeted to at-risk children while the programs in Oklahoma and West Virginia are universal. Each state program is unique, but all required licensed teachers with four-year college degrees and certification in early childhood (with minor exceptions in Michigan).

### **Sampling Strategy**

To choose a sample of children we first randomly selected state-funded preschool classrooms from a list of the total number of state-funded preschool classrooms across the state. We then sampled the same number of kindergarten classrooms as preschool classrooms within the districts from which the preschool classrooms were selected. From each of these classrooms we then randomly selected approximately four children.

Trained research staff from the Early Childhood Collaborative visited each sampled program site, selected children into the sample using a procedure to ensure randomness, and conducted the child assessment as early as possible in the school year. A liaison at each site gathered information on the children's preschool status, usually from existing school records but occasionally from parent report, and was reimbursed \$5 per selected child.

### **Sample**

As mentioned above, the evaluation requires two groups of children. One group, currently attending kindergarten who attended the state-funded preschool program the previous year, is called the "Preschool" group or the experiment group. The second group, currently attending the state-funded preschool program is called the "No Preschool" group, or the control group. This group is called the "No Preschool" group despite the fact that they are currently enrolled in the state-funded preschool program, because they are only at the very beginning of their preschool year and have not had the preschool "treatment" yet.

In Oklahoma, an initial random sample of 143 preschool classrooms across the entire state was drawn, and a matching number of kindergarten classrooms were then randomly selected by district. As a result of district, school or classroom refusals, data was gathered from 201 classrooms, with an average of four children per class. The total Oklahoma sample size is 838 children, 425 in the No Preschool group and 413 in the Preschool group. The sample is 49 percent male, and includes children of different ethnicities in numbers that closely represent the overall state percentages, as follows: White, 69 percent of the sample; American Indian, 13 percent; Hispanic, 7.5 percent; African-American, 8 percent; and Asian, 1 percent.

Findings for the Oklahoma sample are not directly comparable to the sample of 5071 children from the four additional states (Michigan, New Jersey, South Carolina and West Virginia) because of differences across programs. For instance, children in other states may begin state-funded preschool at age 3, and other circumstances that affect the experiences of children who do not attend state-funded preschool programs. The larger sample is 48 percent male with ethnicities as follows: White, 47 percent, African-American, 25 percent, Hispanic, 21 percent, Native American, 2.5 percent, Asian, 2 percent; and all other ethnicities, 2 percent.

## **Measures of School Readiness**

### **Receptive Vocabulary**

Children's receptive vocabulary was measured using the Peabody Picture Vocabulary Test, 3<sup>rd</sup> Edition (PPVT-3) (Dunn & Dunn, 1997) and for Spanish-speakers the Test de Vocabulario en Imagenes Peabody (TVIP) (Dunn, Padilla, Lugo & Dunn, 1986). The PPVT is commonly used as quick test of IQ and can be used as a rough assessment of general cognitive abilities. The PPVT is a direct measure of vocabulary size and 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. Raw scores are reported.

### **Mathematical Skills**

Children's early mathematical skills were measured 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 will be used. Subtests of the Woodcock-Johnson are reported to have good reliability. Raw scores are reported.

### **Phonological Skills and Print Awareness**

Phonological skills development was measured using the Blending subtest of the Preschool Comprehensive Test of Phonological & Print Processing (Pre-CTOPPP; Lonigan, Wagner, Torgeson & Rashotte, n.p.) The Pre-CTOPPP was designed as a downward extension of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgeson & Rashotte, 1999), which measures phonological sensitivity in elementary school-aged children. Although not yet published, the Pre-CTOPPP has been used with middle-class and low-income samples and includes a Spanish version. Since the Pre-CTOPP has only been very recently developed, very little technical information is available about its performance and psychometric properties.

The Blending subtest includes items that measure whether children can blend initial phonemes onto one-syllable words, initial syllables onto two-syllable words, and ending phonemes onto one-syllable words. The percentage of items the child answered correctly out of the 21 total subtest items is reported.

Print Awareness was measured using the Print Awareness subtest of the Pre-CTOPPP. Items measure whether children recognize individual letters and letter-sound correspondences, and whether they differentiate words in print from pictures and other symbols. The percentage of items answered correctly out of the 36 total subtest items is reported.

## **Results**

The main results for the effects of Oklahoma's program are displayed in individual figures for each outcome measure. Each figure displays a regression line of the children's predicted test scores by the distance away in days their birthdate is from the program enrollment cut-off date. The discontinuity in the regression line at the cut-off date is the estimated effect of the preschool program.

### **Receptive Vocabulary**

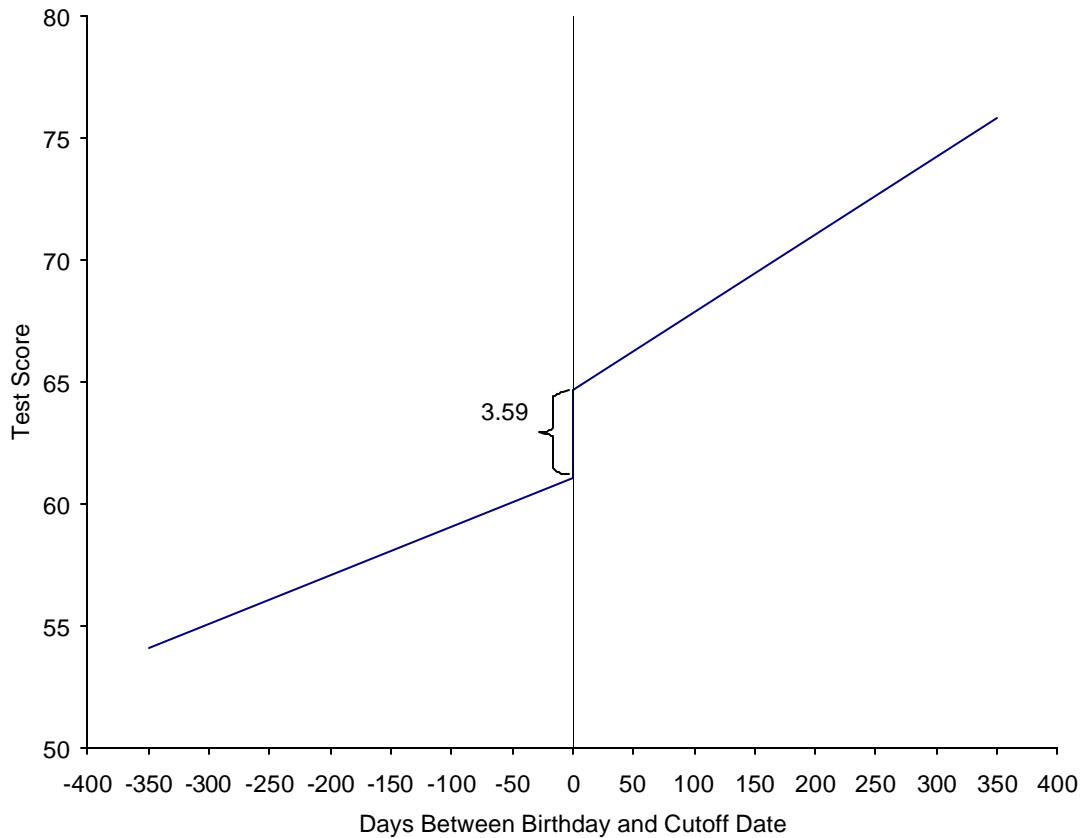
The estimated effect of state-funded preschool on children's receptive vocabulary as measured by the PPVT (or TVIP for Spanish-speaking children) is statistically significant for Oklahoma. Attending Oklahoma's program is estimated to increase PPVT

scores by about 3.6 raw score points. For children of preschool and kindergarten age on this measure raw score points translate into about the same number of standard score points, so the improvement is about 24 percent of a normed standard deviation. The effect of the program can also be understood as 28 percent more growth over the year or a 6 percent increase in children’s average vocabulary scores.

Age equivalence scores provide a measure of children’s vocabulary knowledge using a normed estimate of the average age of children who score the same. Results indicate that the average improvement due to Oklahoma’s program is approximately an additional four months of vocabulary development.

Figure 1 below portrays a regression line of the children’s predicted PPVT scores by the distance in days their birth-date is from the program enrollment cut-off date. The discontinuity in the regression line at the cut-off date represents the estimated effect of the preschool program, or 3.59 raw score points.

**Figure 1. The Effect of Oklahoma’s Early Childhood Program on Children’s Receptive Vocabulary Scores**



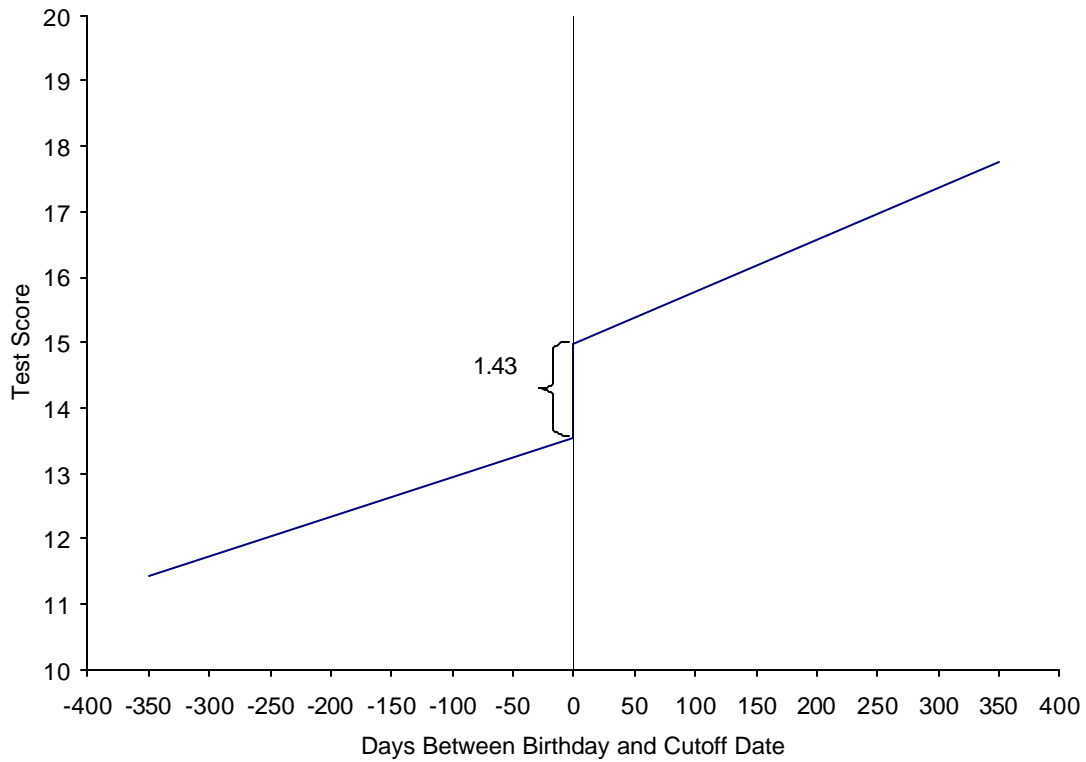


**Math Skills**

The estimated effect of state-funded preschool on children’s early math skills as measured by the Woodcock-Johnson-III Applied Problems subtest scores is statistically significant for Oklahoma’s program. The improvement in children’s scores due to Oklahoma’s program is about 1.43 raw score points. One raw score point roughly translates into 3 standard score points for samples of preschool and kindergarten age, so Oklahoma’s program effect is equivalent to about 4.2 standard score points or 29 percent of a normed standard deviation. The effect of the program can also be understood as 44 percent more growth over the year or an 11 percent increase in children’s average math scores.

Figure 2 below portrays a regression line of the children’s predicted Applied Problems scores by the distance in days their birth-date is from the program enrollment cut-off date. The discontinuity in the regression line at the cut-off date represents the estimated effect of the preschool program, or 1.43 raw score points.

**Figure 2. The Effect of Oklahoma’s Early Childhood Program on Children’s Early Math Scores**

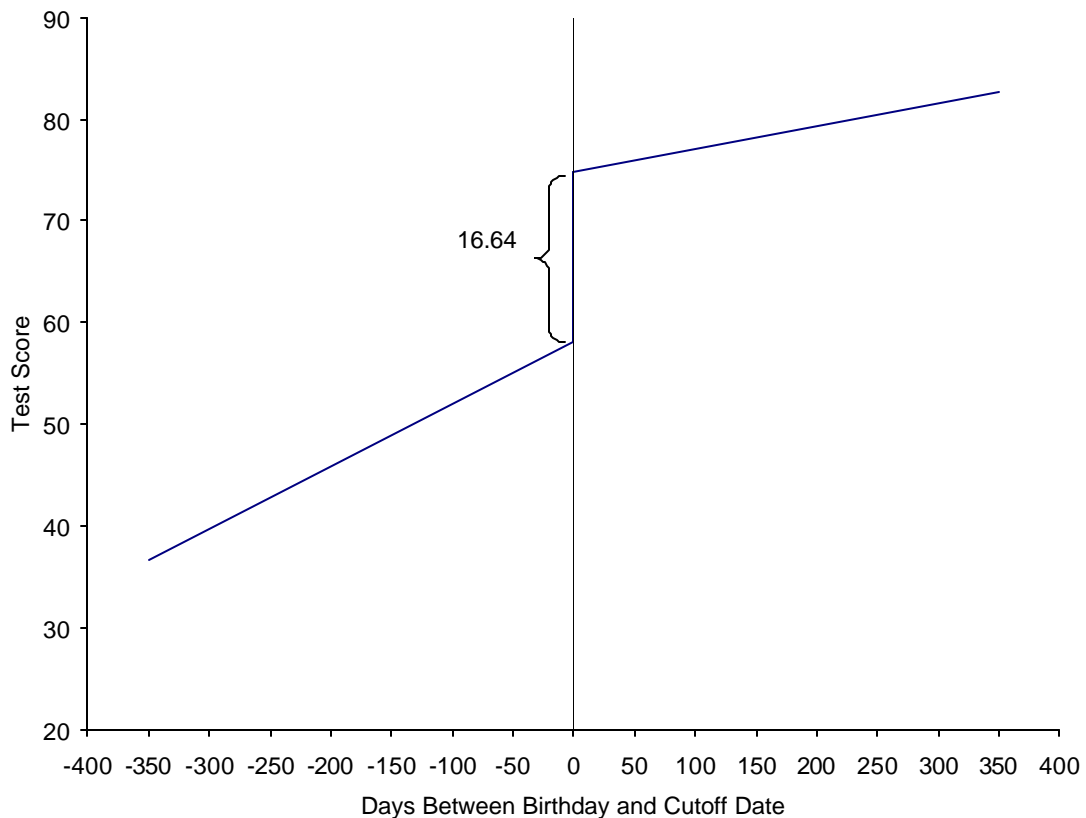


**Print Awareness**

The estimated effect of state-funded preschool on children's Print Awareness scores is statistically significant for Oklahoma's program. The effect of Oklahoma's program on children's gains in Print Awareness scores is 16.64 percent more items answered correctly. This improvement represents approximately 62 percent of a standard deviation on the Print Awareness subtest. The effect of the program can also be understood as 88 percent more growth over the year or a 35 percent increase in children's average print awareness scores.

Figure 3 below portrays a regression line of the children's predicted Print Awareness scores by the distance in days their birth-date is from the program enrollment cut-off date. The discontinuity in the regression line at the cut-off date represents the estimated effect of the preschool program, or 16.64 raw score points.

**Figure 3. The Effect of Oklahoma's Early Childhood Program on Children's Print Awareness Scores**



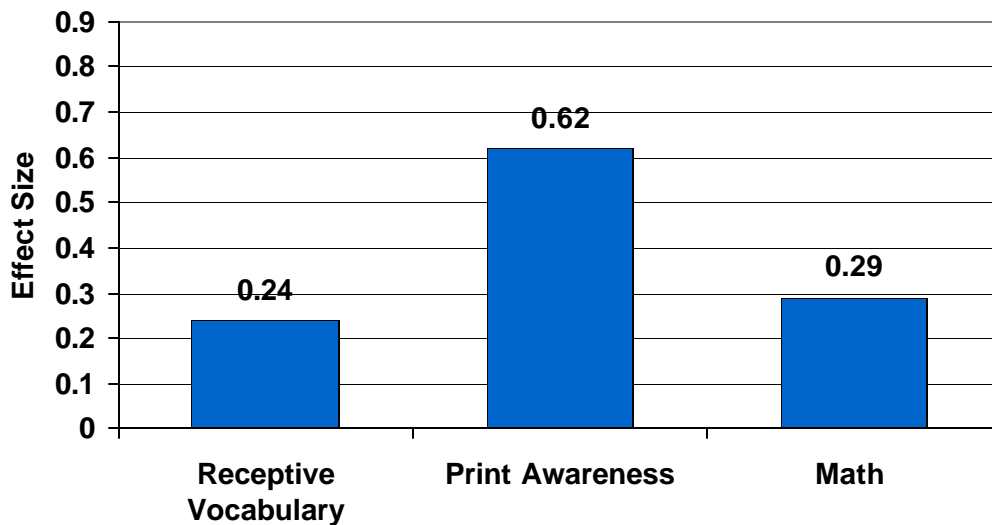
**Phonological Skills**

Results indicate that the estimated effect of state-funded preschool overall and of Oklahoma’s preschool program on children’s phonological development scores is minimal and not statistically significant. While the difference in Blending subtest scores between the groups may seem large (77.43 percent of items correct for the No Preschool group versus 88.94 percent for the Preschool group), the difference due to the program is not statistically different from zero. The remainder of the difference is mostly likely accounted for by the fact that the Preschool group children are older than the No Preschool group children, and they have developed the skills to score higher outside of the preschool program.

**Summary**

By way of summary, Figure 4 below, portrays the effect sizes of the impact of state-funded preschool programs on children’s receptive vocabulary, print awareness and math scores. These effect sizes are another way of standardizing the estimated effects so that they may be compared to estimated effects in other studies.

**Figure 4. The Effect of Oklahoma’s Early Childhood Program on Children’s Scores across Measures**



### **Preschool Effects and Family Income**

Family income, measured by whether children qualify for free or reduced price lunch status as reported by the school, was not included in the primary analyses presented here because missing data on this measure reduced sample size by nearly 20 percent overall and by more than 50 percent in one state. However, separate analyses were conducted to test whether there were larger effects for children from lower income families. In Oklahoma, we found that the effect of the preschool program on children's print awareness skills is stronger for children from lower income families. Children who qualify for free or reduced price lunch had a gain from the preschool program that was 8 percentage points larger on the print awareness test than did children from higher income families who attended the program. This finding was replicated in one of the other four states. No other differences in program effects were found. Otherwise, results are virtually identical to those presented here when free lunch status is included in the statistical analyses. Of the 82% of sample children for whom we have data in Oklahoma, 50% receive free or reduced price lunch.

## **Discussion**

These study findings provide strong evidence of the positive impact of the Oklahoma Early Education program on children's language (vocabulary), literacy (print awareness) and math skills development. There is some evidence that, while all children gained, the benefits are greater for children from lower income families. This evidence indicates that Oklahoma's program produces the kinds of effects that lead to increased school success and later improvements in children's reading and math skills. For example, 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). The effects found in this study are the first link in a chain that produces the long-term school success and economic benefits documented by preschool studies that have followed children into adulthood (Schweinhart, Montie, Ziang, Barnett, Belfield, & Nores, 2005; Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Reynolds, Temple, Robertson, & Mann, 2002).

Important positive effects were found for children's receptive vocabulary, math and print awareness skills, with Oklahoma's program effects on receptive vocabulary scores very similar to the findings of the overall study. Overall, findings suggest that state-funded preschool programs, including Oklahoma's program, may produce particularly large effects on children's early print awareness skills. Oklahoma's preschool programs also provide an extra boost in print awareness skills for children from lower income families, evidence that, while everyone gains, disadvantaged students gain most from the preschool programs.

We did not find that state-funded preschool programs significantly improved children's blending skills, our sole measure of phonological awareness. Perhaps these preschool classrooms did not provide as much support for these skills as they did for language development and print awareness (Lamy & Frede, 2005). In that case, activities and interactions to support children's phonological sensitivity – hearing smaller sounds within the spoken word that may be parsed out and switched for others to create rhymes and alternate endings – may need to be increased. However, additional construct measurement issues may influence this finding. The No Preschool sample children produced higher average scores on this measure than the average scores reported by the instrument authors. Higher scores at preschool entry would mitigate the impact of preschool on those scores at kindergarten entry; however, the fact that even highly disadvantaged children had higher average scores while scoring relatively lower on other measures may indicate that this instrument is not measuring those skills well for children of this age. Our results suggest that more research is needed on the measure itself.

Results indicate that estimated program effects varied among the study states on print awareness and math skills, but not on vocabulary. We do not discuss these variations in detail here because their interpretation is not straightforward. It is possible that some of the variation is due to differences among the programs. However, the broader context of available preschool experiences is not the same across states, nor is population served. The samples varied across states, from highly disadvantaged to a cross-section of the general population, as programs vary from highly targeted to universal. For example, in New Jersey's Abbott program the majority of the sample children attended the same program at age 3. In the other states, many fewer children (in some cases none) attended the state-funded program at age 3, but they could have attended Head Start or a private preschool program or child care center and it is likely that many did (Yarosz & Barnett, 2001).

This study's results are consistent with findings from other rigorous studies of state preschool education programs (Gormley et al., 2004; Barnett et al., 2004; Frede & Barnett, 1992; Irvine, Horan, Flint, Kukuk, & Hick, 1982). Where direct comparisons can be made, the size of the impacts is quite similar to those found in the recent study of Oklahoma's program in Tulsa. These estimated effects for state-funded prekindergarten programs are smaller than those found for highly intensive model programs that had much better student-teacher ratios and provided more than one-year of education at age 4 (Barnett, 1998).

The states studied almost universally require prekindergarten teachers to be licensed teachers with BA degrees and certification in early childhood education. Head Start requires that 50 percent of teachers have two-year Associates' degrees and the others must have a Child Development Associate (CDA) credential or its equivalent. A CDA represents 120 clock hours of training. Public preschool programs with weak standards for teacher qualifications (and low teacher pay) might increase their effectiveness by raising their teacher qualifications standards and compensating teachers accordingly.

In sum, this study finds that Oklahoma's Early Education program produces significant, meaningful improvements in children's early language, literacy and math skills development at entry into kindergarten, similar to the results of other relatively high-quality programs across the country.

References

- Barnett, W.S. (1998). Long-term effects on cognitive development and school success. In W.S. Barnett & S.S. Boocock (Eds.) *Early care and education for children in poverty*, (pp. 11-44). Albany: SUNY Press.
- Barnett, W.S. (2002) Early childhood education. In A. Molnar (Ed.) *School Reform Proposals: The Research Evidence (pp.1-26)*. Greenwich, CT: Information Age Publishing.
- Barnett, W.S., Robin, K.B., Hustedt, J.T., & Schulman, K.L. (2004). *The state of preschool: 2004 state preschool yearbook*. New Brunswick, NJ: National Institute for Early Education Research.
- Campbell, F. A., Ramey, C. T., Pungello, E. P., Sparling, J., & Miller-Johnson, S. (2002). Early childhood education: Young adult outcomes from the Abecedarian Project. *Applied Developmental Science, 6*, 42-57.
- Dunn, L. M. & Dunn, L. M. (1997). *Peabody Picture Vocabulary Test-Third Edition (PPVT-3)*. Circle Pines, MN: AGS Publishing.
- Dunn, Padilla, Lugo & Dunn, (1986). *Test de Vocabulario en Imágenes Peabody (TVIP)*. Circle Pines, MN: AGS Publishing.
- Frede, E. & Barnett, W.S. (1992). Developmentally appropriate public school preschool: A study of implementation of the High/Scope curriculum and its effects on disadvantaged children's skills at first grade. *Early Childhood Research Quarterly, 7*, 483-499.
- Gormley, W., Gayer, T., Phillips, D., & Dawson, B. (2004). *The effects of universal pre-k on cognitive development* (Working paper #4). Washington, DC: Georgetown University.
- Irvine, D. J., Horan, M. D., Flint, D. L., Kukuk, S. E. & Hick, T. L. (1982). Evidence supporting comprehensive early childhood education for disadvantaged children. *Annals of the American Academy of Political and Social Science, 461*(May), 74-80.
- Lamy, C. & Frede, E. (2005). *Giant steps for the littlest ones: progress in the sixth year of the Abbott preschool program*. New Jersey Department of Education, Office of Early Childhood Education, Trenton, NJ.
- Lonigan, C., Wagner, R., Torgeson, J. & Rashotte, C. (2002). Preschool Comprehensive Test of Phonological & Print Processing (Pre-CTOPPP). Department of Psychology, Florida State University.

- Pre-CTOPPP Website (2002). *Preschool Comprehensive Test of Phonological and Print Processing [Data File]. Subtest statistics for preschool comprehensive test of phonological and print processing by age group.* Available from Lonigan's Website at <http://www.psy.fsu.edu/~lonigan/data.pdf>
- Puma, M., Bell, S., Cook, R., Heid, C., Lopez, M., Zill, N., Shapiro, G., Broene, P., Mekos, D., Rohacek, M., Quinn, L., Adams, G., Freidman, J. & Bernstein, H. (2005). *Head Start impact study: First year findings.* Washington, DC: US Department of Health and Human Services, Administration for Children and Families.
- Reynolds, A. J., Temple, J.A., Robertson, D.L., & Mann, E.A. (2002). *Age 21 cost-benefit analysis of the Title I Chicago Child-Parent Centers.* (Discussion Paper no. 1245-02). Madison, WI: Institute for Research on Poverty. Available on line at <http://www.ssc.wisc.edu/irp/pubs/dp124502.pdf>.
- Schweinhart, L.J., Montie, J., Xiang, Z., Barnett, W.S., Belfield, C.R., & Nores, M. (2005). *Lifetime effects: The High/Scope Perry Preschool study through age 40* (Monographs of the High/Scope Educational Research Foundation, 14). Ypsilanti, MI: High/Scope Educational Research Foundation.
- Snow, C., Burns, M. S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.
- Wagner, R., Torgeson, J. & Rashotte, C. (1999). *Comprehensive Test of Phonological Processing (CTOPP).* Austin, TX: Pro-Ed.
- Woodcock, R. W. & Munoz, A. F. (1990). *Bateria Woodcock-Munoz Pruebas de Aprovechamiento – Revisados.* Itasca, IL: Riverside Publishing.
- Woodcock, R. W., McGrew, k. S. & Mather, N. (2001). *Woodcock-Johnson Tests of Achievement.* Itasca, IL: Riverside Publishing.
- Yarosz, D. & Barnett, W.S. (2001). Who reads to young children? Identifying predictors of family reading activities. *Reading Psychology, 22*(1), 67-81.