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How Much Can High-Quality Universal Pre-K Reduce Achievement Gaps?

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Introduction and summary

Many children of color and children from low-income families enter kindergarten without the academic skills they need to succeed. Compared to their white peers, African American and Hispanic children are anywhere from 9 to 10 months behind in math and 7 to 12 months behind in reading when they enter kindergarten.[1] These achievement gaps are concerning: Math and reading abilities at kindergarten entry are powerful predictors of later school success, and children who enter kindergarten already behind are unlikely to catch up.[2] Moreover, in the past 50 years, minimal progress has been made toward reducing these achievement gaps.[3]

Ensuring that all children are entering kindergarten with the foundational academic skills they need to succeed is a major priority for researchers, policymakers, and practitioners alike. Early childhood education programs show promise toward this goal. Research suggests that participation in a high-quality early childhood education program can enhance children's development, reduce achievement gaps at kindergarten entry, and even have long-term benefits for children's school trajectories.[4] However, access to high-quality pre-K in the United States remains quite low and highly unequal due to two problems.[5] First, although pre-K attendance has increased in the past two decades, rates of access to early education vary widely as a function of children's socioeconomic backgrounds: African American, Hispanic, and low-income children are less likely to access center-based early childhood education than their white and more affluent peers. Second, the quality of most early education programs—particularly those attended by low-income children of color—is not high enough to substantially improve academic readiness.

Recognizing the tremendous potential for high-quality preschool to improve children's outcomes, this report considers how a universal publicly funded pre-kindergarten program in the United States could decrease both disparities in access to early learning and achievement gaps at kindergarten entry. Data from two nationally representative datasets and prior results from evaluations of high-quality universal pre-kindergarten were analyzed to estimate the extent to which a national high-quality universal pre-K, or UPK, program would reduce achievement gaps at kindergarten entry based on children's race/ethnicity and income.

The following sections provide a review of the research on achievement gaps based on race/ethnicity and income; describe the effects of high-quality early education programs on children's achievement; and outline current inequalities in access to high-quality early education programs. The report concludes with empirical evidence that points to the potential of a national high-quality UPK program to reduce achievement gaps at kindergarten entry.

This evidence suggests that a high-quality UPK program would significantly reduce achievement gaps at kindergarten entry. Based on the average effect that two large-scale, highly effective programs in different parts of the country had on participating children's achievement scores, it is estimated that high-quality UPK would reduce the achievement gap at kindergarten entry in math 45 percent for African American children and 78 percent for Hispanic children, while essentially closing the entire gap in reading for both groups. Estimated effects on kindergarten entry achievement gaps between low-income and higher-income children were also large: The math gap would reduce by an estimated 27 percent and the reading gap would reduce by an estimated 41 percent. Establishing a high-quality UPK program is a critical first step toward creating equity in access to early education and ensuring that all children begin kindergarten with an equal opportunity to succeed.

Background

Gaps in achievement at kindergarten entry among children from different socioeconomic and demographic backgrounds are an enduring trend in education. Research suggests that African American and Hispanic children enter kindergarten with fewer of the academic skills necessary to succeed in school compared to their white peers.[6] Low-income children similarly lag behind their higher-income peers at kindergarten entry.[7] These disparities in skills early on likely contribute to later achievement gaps observed during elementary school.[8] Although high-quality early childhood education programs have been shown to effectively boost children's development and reduce achievement gaps, not all children have access to high-quality pre-kindergarten.[9] A high-quality, universally accessible pre-kindergarten program could narrow the achievement gaps at kindergarten entry by ensuring equal access to early learning environments that support children's development and learning—regardless of family background.

Achievement gaps based on race/ethnicity and income start early and persist

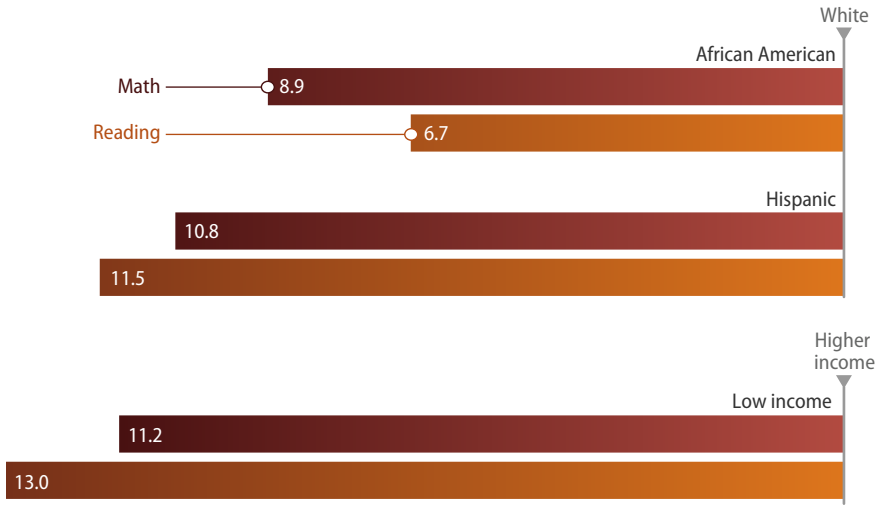
Children's academic abilities at kindergarten entry are strong predictors of their success as they progress through school, but not all children begin formal schooling with the skills they need to be ready to learn.[10] Research suggests that by the time they enter kindergarten, children in poverty can be 12 months behind their more advantaged peers.[11] The gaps in achievement among children from varying demographic and socioeconomic backgrounds at kindergarten entry are both pervasive and persistent: They begin early in life, are sustained as children advance through school, and are difficult to close.[12] Moreover, some research suggests that achievement gaps may increase rather than decrease with time.[13] These gaps in achievement often translate into lower rates of high school graduation, decreased college attendance, and, ultimately, lower wages as adults.[14]

Prior research shows that children's reading and math achievement at kindergarten entry is quite disparate by income, parental education, race/ethnicity, and even home language.[15] Figure 1 shows these disparities by children's household income and race/ethnicity in terms of months of learning.[16] African American children are, on average, about nine months behind their white peers in math when they enter kindergarten and almost seven months behind in reading. Hispanic children are, on average, almost 11 months behind their white peers in math and 11.5 months behind in reading. Low-income children are, on average, about 11 months behind their higher-income peers in math and 13 months behind in reading. Programs and policies that ensure that children of color and children from low-income households begin kindergarten on par with their white and higher income peers can drastically improve their academic trajectories and overall well-being.

FIGURE 1

African American, Hispanic, and low-income children lag behind their white and more affluent peers in math and reading at kindergarten entry

Kindergarten achievement gaps in months of learning by subgroup, 2010



Note: "Low income" refers to children whose household incomes are at or below 200 percent of the federal poverty guidelines, or FPG. "Higher income" refers to children whose household incomes are above 200 percent FPG.

Source: Authors' estimates are based on Milagros Nores and W. Steven Barnett, "Access to High Quality Early Care and Education: Readiness and Opportunity Gaps in America" (New Brunswick, NJ: Center for Enhancing Early Learning Outcomes and National Institute for Early Education Research, 2014).

High-quality early childhood education has a positive effect on children's achievement

Ensuring universal access to high-quality early childhood education programs is a crucial first step toward closing educational and opportunity gaps for children across the socioeconomic spectrum. Over the last several decades, evidence that supports the positive effects of participating in early childhood education programs on children's cognitive, social, and emotional development has mounted.[17] For example, the High/Scope Perry Preschool Project and the Abecedarian Project were both small demonstration projects that targeted poor, predominantly African American children.[18] The Chicago Child-Parent Centers were implemented on a larger scale, also targeting low-income, predominantly African American children in Chicago.[19] Evaluations of these comprehensive early childhood education programs have shown large positive cognitive gains for participating children.[20] Although there is also evidence that cognitive effects fade over time, long-term follow-ups have found positive effects in other domains, including high school graduation, physical health, mental health, and lower rates of involvement with the criminal justice system.[21] Evidence of the effectiveness of high-quality early childhood education also comes from larger, publicly funded programs, where all age-eligible children in Oklahoma, Boston, or certain districts in New Jersey can attend the program. Evaluations of these programs have found that participating children demonstrate large gains in achievement scores over the course of the preschool year, with lasting effects seen through elementary school.[22]

Beyond the positive effects of attending an early childhood education program, research has accumulated indicating that early learning programs that are considered to be high quality produce the most significant positive effects on children's development.[23] Research comparing learning outcomes for children who are enrolled in high-quality versus low-quality programs consistently finds that children who attend higher quality programs demonstrate stronger math, language, and social skills at kindergarten entry.[24]

Although views in the field are not uniform, there is substantial consensus regarding key elements of quality.[25] High-quality early learning programs generally employ teachers who have strong educational backgrounds in child development and utilize research-based curricula that address the needs of the whole child.[26] In the classroom, teachers engage children in intentional, well-planned interactions that are warm, engaging, and intellectually stimulating.[27] Moreover, class sizes are typically small, and children have access to a variety of developmentally appropriate materials and learning activities.[28]

Research finds that, in addition to quality, the amount of time children spend in early learning programs affects the size of initial and long-term effects.[29] Children gain more from pre-K programs when they attend for more hours per day and more days per week.[30] Specifically, research suggests that children who attended full-day programs outperform children in part-day programs in math, language, and social-emotional skills.[31]

Access to high-quality early education programs is unequal

Despite the evidence that high-quality early education improves children's learning and development, research suggests that many children in the United States are in early learning programs of mediocre to low quality. The cost of fee-based early care and education is prohibitive for many families, with average yearly child care expenses exceeding median rent in every state.[32] Many families that lack the resources to afford high-quality fee-based centers rely on public programs like Head Start to receive comprehensive early education and care. Although federal policies that support quality environments in Head Start centers have improved over the last decade, the quality of individual classrooms remains variable.[33] Moreover, Head Start primarily targets children and families who live below the poverty line and reaches less than half of eligible families—42 percent in 2012.[34] Other families utilize child care subsidizes to pay for care, but state subsidy programs do not reach all eligible families, and subsidies do not necessarily cover the full cost of tuition—especially at high-quality, center-based programs.[35]

As a group, state-sponsored preschool programs serve less than one-third of 4-year-old children in the United States.[36] Moreover, state policies vary widely in the degree to which they support early childhood program quality. Only two states and the District of Columbia provide programs with policies that support high-quality learning environments, are adequately funded to meet quality standards, and are universally accessible to all children—regardless of family income or risk status.[37] Meanwhile, at least 10 state programs that target children who possess a variety of risk factors—including poverty, homelessness, or being a dual language learner—meet six or fewer quality standards outlined by the National Institute for Early Education Research.[38] These data suggest that many at-risk children—even those in public programs, which are generally regarded as higher quality—receive less-than-adequate care.

A national universal pre-K program could reduce achievement gaps

Although there is overall consensus that high-quality early childhood education programs improve children's learning and can reduce achievement gaps at kindergarten entry, some pre-K proponents disagree about the relative advantages and disadvantages of universal and targeted programs.[39] A universal program is one in which all children who meet an age requirement, regardless of income or other risk factors, can enroll. Oklahoma's Early Childhood Four-Year-Old Program, New Jersey's Abbott Preschool Program, Boston's Public School Prekindergarten Program, and New York City's Pre-K for All are all examples of universal programs.[40] In contrast, targeted programs are means-tested; most commonly, children and families must meet an income requirement to be eligible to participate.[41] Eligibility may also be determined by other risk factors, such as whether a child has a developmental disability or delay, is an English Language Learner, or has a teen parent. The national Head Start program is a well-known example of a targeted early learning program.[42] Many state-funded pre-kindergarten programs are also targeted.[43]

The unique benefit of UPK programs is that while not every child is required to attend, every child is eligible to enroll—thereby reducing barriers to participation for families who qualify for but cannot access means-tested programs due to limited capacity; who do not qualify for means-tested programs; or who are overburdened by the high cost of fee-based early care and education. Recent evaluations of high-quality UPK programs indicate that children who stand the most to gain from participating in high-quality early learning—namely African American, Hispanic, and low-income children—do in fact tend to make the strongest gains in achievement at kindergarten entry.[44] A universal program might be an even more powerful way to close achievement gaps than a targeted program, as it would be able to enroll more low-income children and children of color.

High-quality early learning programs have long been touted as cost-effective mechanisms for narrowing achievement gaps, however much of this work has focused on the provision of targeted programs to children in poverty.[45] Few specific estimates of how UPK could reduce achievement gaps have been produced.

Katherine Magnuson and Jane Waldfogel simulated the extent to which increasing enrollment in and the quality of early education programs could reduce the achievement gaps between African American and white and Hispanic and white children, assuming that the effect of attending pre-K would be the same for each child.[46] However, more recent research suggests that this is not the case; instead, effects tend to be larger for low-income children and children of color.[47]

The following sections describe the results of analyses conducted by the authors, following a similar approach to that used by Magnuson and Waldfogel but expanding on their work in important ways. Namely, the analyses described below incorporate results from more recent studies of large-scale UPK programs, and examine how universal access to high-quality early education would differentially boost achievement scores at kindergarten entry for children from different socioeconomic and demographic backgrounds, thereby moving toward closing existing gaps in achievement at kindergarten entry.

Estimating current rates of access to high-quality early childhood education

Using data from two nationally representative datasets, the Early Childhood Longitudinal Study, Birth Cohort, or ECLS-B and Early Childhood Longitudinal Study, Kindergarten Cohort, or ECLS-K:2011, the authors estimate both the proportion of children who have access to high-quality early learning programs and how access varies by children's race/ethnicity and income. Analyses confirm limited access to high-quality learning environments: Roughly one-third of all 4-year-old children who were enrolled in a center-based program were in classrooms rated as high quality. If estimates are limited to include only full-day programs, the access rate for 4-year-olds falls to 10 percent. For additional details on the methodology for this report, please see Appendix A.

Access to high-quality early education varies substantially by children's race/ethnicity and income. White children were more likely than African American and Hispanic children to be in a high-quality classroom. Additionally, children from higher-income households, defined as those above 200 percent of the federal poverty guidelines, were also more likely to access high-quality, center-based care.[48] Figure 2 depicts current access to high-quality early learning by children's race/ethnicity and household income.[49] Due to low rates of current enrollment in high-quality care, African American, Hispanic, and low-income children stand to gain the most from a UPK program.

Taken together, the evidence indicates that:

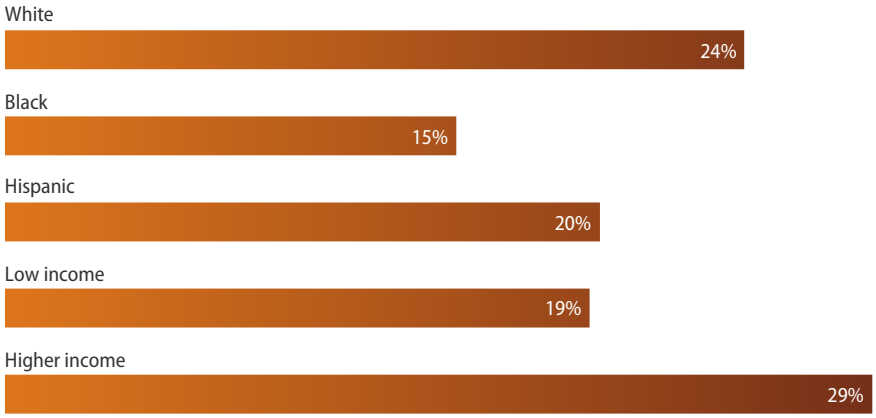
- There are large gaps in reading and math skills by the time children enter kindergarten.
- High-quality early childhood programs have positive effects on children's learning and development.
- Access to high-quality early education—which has been shown to reduce achievement gaps at kindergarten entry—is extremely limited and unequal.

The analyses presented in the remainder of this paper seek to quantify the extent to which achievement gaps could be closed through the implementation of a national high-quality UPK program.

FIGURE 2

African American, Hispanic, and low-income children access high-quality programs at lower rates

Estimated rates of current national enrollment in high-quality center-based early childhood programs



Note: "High-quality" classrooms were those rated as a 5 or higher on the Early Childhood Environmental Rating Scale.

Sources: Author's calculations are based on data from National Center for Education Statistics, *Early Childhood Longitudinal Study: Birth Cohort (ECLS-B)* (U.S. Department of Education, 2009); National Center for Education Statistics, *Early Childhood Longitudinal Study: Kindergarten Class of 2010–2011 (ECLS-K: 2011)* (U.S. Department of Education, 2014).

Universal Pre-K in Tulsa and Boston

The subsequent analyses estimate the extent to which a national high-quality UPK program could close the achievement gap between low- and higher-income children and Hispanic and African American children and their white peers. The estimates are based on the results of evaluations of Oklahoma's Early Childhood Four-Year-Old Program in Tulsa and the Boston Public Schools Pre-K Program.[50] These studies were chosen for this report for the following reasons:

- Both programs are high-quality and operate at a large scale. They have adequate funding and possess the structural features of high-quality programs, including small class sizes, low teacher-to-child ratios, and well-qualified teachers. Direct observations of these programs documented high-quality instruction.[51]
- Both programs are universal, with all 4-year-old children eligible to attend regardless of income.[52]
- Rigorous evaluations of each program were conducted, which means that they provide reliable estimates of the effect of participating in a UPK program on children's reading and math skills.[53]
- Both evaluations provided estimates of program effects by children's race/ethnicity and household income. The vast majority of other studies included only disadvantaged populations or did not produce estimates for income or racial/ethnic subgroups.[54]
- The combination of the two programs spans broadly different populations and contexts across the United States.

For more information on the programs in Tulsa and Boston, please see Appendix B.

In both Tulsa and Boston, participation in UPK programs had a positive effect on children's math and reading achievement scores at kindergarten entry. Table 1 presents the average effect of the Tulsa and Boston programs by children's race/ethnicity and household income.[55] On average, all children saw achievement gains as a result of participating in high-quality UPK.

The estimated impacts of a national high-quality UPK program on achievement gaps presented in this report are based on average effects from evaluations of Tulsa's and Boston's programs. Together the two programs span more diversity in program design, demographics, and geography than either would alone.

TABLE 1

Average achievement gains following participation in Boston and Tulsa's UPK programs

In months of learning

	Math	Reading
White	2.93	7.35
African American	7.33	14.29
Hispanic	13.15	22.06
Low income	8.31	15.44
Higher income	5.13	10.03

Note: "Low income" refers to children whose household incomes are at or below 200 percent of the federal poverty guidelines, or FPG. "Higher income" refers to children whose household incomes are above 200 percent FPG.

Sources: William T. Gormley and others, "The Effects of Universal Pre-K on Cognitive Development," *Developmental Psychology* (41) (2005): 872–884; Hirokazu Yoshikawa, Christina Weiland, and Jeanne Brooks-Gunn, "When Does Preschool Matter?". Unpublished working paper (2015).

Projected impact of a national universal pre-K program on kindergarten achievement gaps

Using the estimated effects on children's achievement scores from evaluations of pre-K programs in Tulsa and Boston, the authors simulated the effects of providing a nationally scaled high-quality UPK program, assuming 100 percent enrollment in the program. Results suggest that a high-quality UPK program could substantially reduce achievement gaps in both math and reading. Although all estimations resulted in a narrowing of the achievement gap at kindergarten entry, the size of the reductions did vary somewhat between reading and math and between subgroups. Table 2 summarizes the results expressed as percent reductions in kindergarten entry achievement gaps and as months of learning.[56] Below, effects are described separately by children's race/ethnicity and household income.

TABLE 2

Estimated reductions in kindergarten achievement gaps after implementing a high-quality UPK program

In months of learning

	Current gap	Gap after UPK	Reduction in months	Percent reduction
African American vs. white				
Math	8.91	4.89	4.02	45%
Reading	6.7	0.1	6.6	98%
Hispanic vs. white				
Math	10.77	2.41	8.36	78%
Reading	11.51	-0.67	12.18	106%
Low income vs. higher income				
Math	11.21	8.17	3.04	27%
Reading	12.96	7.66	5.3	41%

Note: "Low income" refers to children whose household incomes are at or below 200 percent of the federal poverty guidelines, or FPG. "Higher income" refers to children whose household incomes are above 200 percent FPG.

Sources: Authors' estimates are based on Milagros Nores and W. Steven Barnett, "Access to High Quality Early Care and Education: Readiness and Opportunity Gaps in America" (New Brunswick, NJ: Center for Enhancing Early Learning Outcomes and National Institute for Early Education Research, 2014); authors' calculations of gap reductions are based on data from National Center for Education Statistics, *Early Childhood Longitudinal Study: Birth Cohort (ECLS-B)* (U.S. Department of Education, 2009); National Center for Education Statistics, *Early Childhood Longitudinal Study: Kindergarten Class of 2010–2011 (ECLS-K: 2011)* (U.S. Department of Education, 2014); William T. Gormley and others, "The Effects of Universal Pre-K on Cognitive Development," *Developmental Psychology* (41) (2005): 872–884; Hirokazu Yoshikawa, Christina Weiland, and Jeanne Brooks-Gunn, "When Does Preschool Matter?". Unpublished working paper (2015).

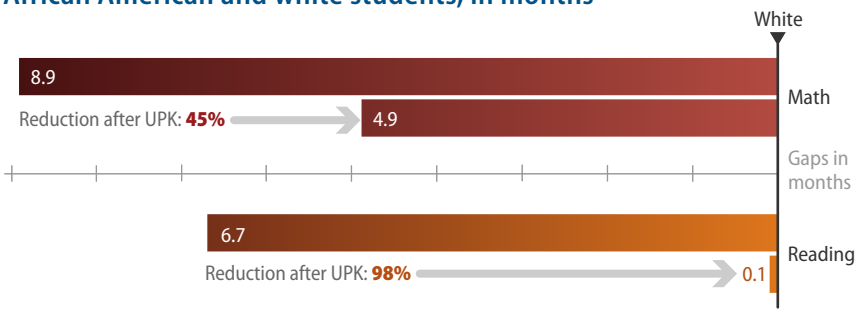
Achievement gaps based on race/ethnicity

Estimates of the current gap in achievement scores at kindergarten entry show that African American and Hispanic children enter kindergarten with lower average reading and math scores than white children. Results suggest that UPK would be effective in reducing the achievement gap for children in these demographic groups.

African American children are currently nine months behind their white peers in math and about 6.7 months behind in reading. Analyses suggest that a high-quality UPK program would reduce gaps in math skills 45 percent—which is equivalent to four months of learning—while gaps in reading would be completely erased. (see Figure 3)

FIGURE 3

Estimated reduction in kindergarten math and reading achievement gaps between African American and white students, in months

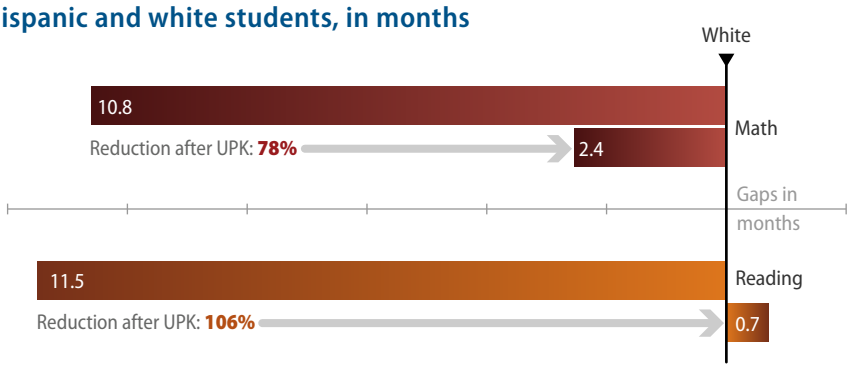


Sources: Authors' estimates are based on Milagros Nores and W. Steven Barnett, "Access to High Quality Early Care and Education: Readiness and Opportunity Gaps in America" (New Brunswick, NJ: Center for Enhancing Early Learning Outcomes and National Institute for Early Education Research, 2014); authors' calculations of gap reductions are based on data from National Center for Education Statistics, *Early Childhood Longitudinal Study: Birth Cohort (ECLS-B)* (U.S. Department of Education, 2009); National Center for Education Statistics, *Early Childhood Longitudinal Study: Kindergarten Class of 2010–2011 (ECLS-K: 2011)* (U.S. Department of Education, 2014); William T. Gormley and others, "The Effects of Universal Pre-K on Cognitive Development," *Developmental Psychology* (41) (2005): 872–884; Hirokazu Yoshikawa, Christina Weiland, and Jeanne Brooks-Gunn, "When Does Preschool Matter?". Unpublished working paper (2015).

The current gaps in math and reading between Hispanic and white children are equal to about 11 months of learning and almost a year of learning, respectively. Analyses estimate that gaps in math would be reduced 78 percent, narrowing the gap to 2.4 months of learning. (see Figure 4) Gaps in reading skills between Hispanic and white children would be eliminated: a net gain of about 12 months of learning.

FIGURE 4

Estimated reduction in kindergarten math and reading achievement gaps between Hispanic and white students, in months



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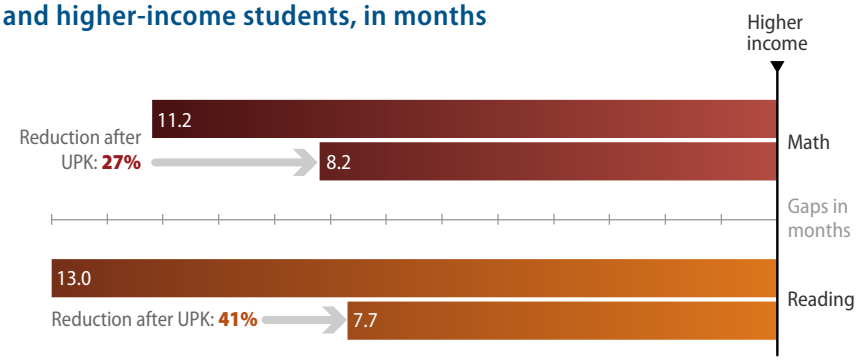
Income-based achievement gaps

Low-income children also enter into kindergarten with poorer achievement scores, on average, than their more affluent peers. While a high-quality UPK program would still have a significant effect on children's achievement, gaps in academic achievement scores at kindergarten entry across income groups appear to be more difficult to close.

Currently, children from low-income households are behind their higher-income peers in math by about 11.2 months; with UPK, this gap would be reduced 27 percent to about 8.2 months of learning. Children would show even greater gains in reading skills: Gaps would be reduced 41 percent, from about 13 months to 7.7 months of learning. (see Figure 5)

FIGURE 5

Reduction in kindergarten math and reading achievement gaps between low-income and higher-income students, in months



Note: "Low income" refers to children whose household incomes are at or below 200 percent of the federal poverty guidelines, or FPG. "Higher income" refers to children whose household incomes are above 200 percent FPG.

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Conclusion

Disparities in access to high-quality educational opportunities and in the development of foundational academic skills among children from different socioeconomic and demographic backgrounds begin early in life. The result is that many children enter kindergarten behind their peers academically. While high-quality early learning programs have been shown to boost children's development and reduce the achievement gap, access to high-quality programs is low and highly uneven across families from different backgrounds—even among publicly funded programs.[57]

In the absence of a nationwide universal pre-K policy, some states, cities, and school districts have taken steps to implement their own UPK programs. Although these programs have policies in place to offer preschool to all children who meet age requirements, they vary in the actual reach, intent, and quality of the programs. For instance, even when program eligibility is based solely on child age, so-called universal programs are not always available to all children who want to attend. Limited capacity may be temporary, as taking a program to scale requires substantial time and resources; in other cases, programs that are intended to be universal may never receive the resources needed to serve all children.[58]

Implementing a high-quality UPK program should be a national policy priority. Research tells us that high-quality UPK has the potential to both substantially increase access to early learning programs and reduce disparities in foundational academic skills at kindergarten entry.[59] The analysis presented in this report further supports that high-quality UPK could dramatically reduce or even eliminate gaps in reading and math achievement at kindergarten entry between children of color—specifically African American and Hispanic children—and their white peers, as well as gaps between low-income children and their higher-income peers.

While it is encouraging that states are taking steps to better support the nation's youngest learners, a substantial national investment is necessary in order to implement a high-quality UPK program that meets the needs of all children. No child deserves to start his or her education at a disadvantage. Ensuring that all children enter kindergarten with the skills they need to succeed—and thereby reducing or eliminating achievement gaps at kindergarten entry—is a critical first step in closing academic achievement gaps in later grades, gaps in graduation rates, and potential pay disparities later in life. High-quality universal pre-kindergarten has the potential to reduce these gaps and should be a priority for federal policymakers as they seek to give all children a fair shot at success.

Appendix A: Methodology

The authors utilize multiple sources of data to simulate the extent to which a universal high-quality early childhood program could reduce the existing kindergarten entry achievement gaps in math and reading:

1. The current national rates of enrollment in high-quality early learning programs
2. Existing estimates of the effects by subgroups of two high-quality publicly funded early childhood programs in two different parts of the country

Ultimately, the purpose of this report is to quantify how universal access to exemplary prekindergarten programs would reduce the kindergarten entry achievement gaps based on race/ethnicity and income.

First, the authors used estimates of existing math and reading kindergarten readiness gaps that had previously been calculated using the ECLS-K 2011, a nationally representative data set of children entering kindergarten for the first time.[60] Gaps were translated into months of learning to make them more meaningful. To do so, the authors used the ECLS-K 2011 to estimate the average difference in math and reading skills between older and younger children at kindergarten entry and divided this estimate by the age difference in months between older and younger children. Gaps were calculated comparing African American and Hispanic children to their white peers, and low-income children to their higher-income peers. For the purposes of this paper, low income is defined as a family income less than 200 percent of the federal poverty level.[61] Only children identified as white, African American, or Hispanic were included in the analyses due to the limited sample sizes of other racial/ethnic groups.

Second, the percent of children currently attending high-quality center-based early childhood programs was estimated. The authors used the ECLS-K 2011 to determine the percent of children in each racial/ethnic and income subgroup who were enrolled in any center-based early learning. The authors then used the ECLS-B data to estimate the percentage of 4-year-olds in each racial and ethnic

and income subgroup in center-based care who were in programs rated as high-quality. These two estimates were multiplied to obtain an approximation of the percent of children in each subgroup who were enrolled in high-quality center-based early education.

For example, analyses identified that approximately 49 percent of all Hispanic 4-year-olds were in any center-based early learning program. Of those, about 40 percent were in a center-based program rated as high-quality. By multiplying these two numbers, it is estimated that about 20 percent of Hispanic 4-year-olds are in high-quality pre-K. Therefore, a high-quality UPK program would increase enrollment of 4-year-old Hispanic children 80 percentage points.

For the purposes of this analysis, high-quality was defined as a score of 5 or higher on the Early Childhood Environment Rating Scale, or ECERS—a widely used standardized classroom observation instrument that assesses the quality of materials, space, and interactions between children and teachers on a scale of 1 to 7.[62] It is important to note that using the ECERS as a measure of quality may overestimate the percentage of children who are enrolled in truly high-quality programs that could be expected to produce large and lasting benefits for children.[63] If this were the case, the approach described above would underestimate the percentage of children who would benefit from a new high-quality UPK program.

Third, the authors utilized existing estimates of effects by racial/ethnic and income subgroups from two universal high-quality publicly funded preschool programs in different regions of the country—Oklahoma's Early Childhood Four-Year-Old Program in Tulsa and the Boston Public School's Public Prekindergarten Program (see Table 3)—in order to calculate the net gain in reading and math for each subgroup.[64] The authors averaged the estimates from Tulsa and Boston in order to provide a more stable and more representative picture of what might be produced nationally than either of the separate estimates. The percentage of children in each subgroup who do not attend high-quality pre-K was multiplied by the estimated effect of high-quality early learning for that subgroup. In other words, if no children in a given subgroup are currently enrolled in a high-quality program, then that subgroup receives 100 percent of the benefit of attending a new high-quality UPK program. However, if 25 percent of children in a subgroup are currently enrolled in high-quality early learning then that subgroup receives 75 percent of the benefit, or effect, of high-quality UPK program—and so on.

TABLE 3

Average achievement gains following participation in Boston's and Tulsa's UPK programs

In standard deviation units

	Math	Reading
White	0.18	0.35
African American	0.45	0.68
Hispanic	0.81	1.05
Low income	0.51	0.74
Higher income	0.32	0.48

Note: "Low income" refers to children whose household incomes are at or below 200 percent of the federal poverty guidelines, or FPG. "Higher income" refers to children whose household incomes are above 200 percent FPG.

Sources: William T. Gormley and others, "The Effects of Universal Pre-K on Cognitive Development," *Developmental Psychology* (41) (2005): 872–884; Hirokazu Yoshikawa, Christina Weiland, and Jeanne Brooks-Gunn, "When Does Preschool Matter?". Unpublished working paper (2015).

Lastly, the authors compared the estimated net increase in achievement at kindergarten entry for each subgroup in order to calculate the reductions in the achievement gaps based on kindergarteners' race/ethnicity and income. For example, if net effects were larger for African American children than for white children, the gap would be narrowed. However, if effects were larger for white children than for African American children, the gap would be increased.

TABLE 4

Estimated reductions in kindergarten achievement gaps after implementing a high-quality UPK program

In standard deviation units

	Current gap	Gap after UPK	Gap reduction
African American vs. white			
Math	0.55	0.3	0.25
Reading	0.32	0.01	0.31
Hispanic vs. white			
Math	0.66	0.15	0.51
Reading	0.55	-0.03	0.58
Low income vs. higher income			
Math	0.69	0.5	0.19
Reading	0.62	0.37	0.25

Note: "Low income" refers to children whose household incomes are at or below 200 percent of the federal poverty guidelines, or FPG. "Higher income" refers to children whose household incomes are above 200 percent FPG.

Sources: Authors' estimates are based on Milagros Nores and W. Steven Barnett, "Access to High Quality Early Care and Education: Readiness and Opportunity Gaps in America" (New Brunswick, NJ: Center for Enhancing Early Learning Outcomes and National Institute for Early Education Research, 2014); authors' calculations of gap reductions are based on data from National Center for Education Statistics, *Early Childhood Longitudinal Study: Birth Cohort (ECLS-B)* (U.S. Department of Education, 2009); National Center for Education Statistics, *Early Childhood Longitudinal Study: Kindergarten Class of 2010–2011 (ECLS-K: 2011)* (U.S. Department of Education, 2014); William T. Gormley and others, "The Effects of Universal Pre-K on Cognitive Development," *Developmental Psychology* (41) (2005): 872–884; Hirokazu Yoshikawa, Christina Weiland, and Jeanne Brooks-Gunn, "When Does Preschool Matter?". Unpublished working paper (2015).

It is important to note that these estimates of achievement gap reductions assume that 100 percent of children enroll in UPK. However, it is possible that some children will not attend, which might slightly increase or decrease the impact of UPK on gap reduction at kindergarten entry.

Appendix B: Description of included programs

Oklahoma's Early Childhood Four-Year-Old program began in 1980 with the goal of serving all children—regardless of family income—and currently enrolls more than 75 percent of the state's 4-year-olds in full- and part-day classrooms. When Head Start and preschool special education enrollment is included, 90 percent of Oklahoma's children are served by public programs. The state pre-K program is considered a high-quality program and requires all teachers to have at least a bachelor's degree and early childhood education certification and to be paid on the public school salary scale. It has comprehensive Early Learning Standards that address multiple domains of children's development and limits class sizes to 20 children with one lead and one assistant teacher, for a maximum teacher-to-child ratio of 1 to 10.[65] Teachers provide instructionally and emotionally supportive classroom environments and, although there is room for improvement in these areas, teachers have done better than in other state-funded preschool programs.[66]

Boston Public Schools' Pre-K Program is also considered high-quality. In addition to having an adequate level of teacher compensation and overall funding, the program utilizes research-based curricula and continuous teacher coaching throughout the year. All teachers in Boston's program must have a bachelor's degree to obtain initial licensure; after that, teachers have five years to obtain a master's degree and become professionally certified. Boston's pre-K teachers are paid on the same pay scale as K-12 teachers.[67] Prior research has found that classrooms in the Boston program are of high quality as measured by emotional and instructional interactions between teachers and children.[68] All children are served in full-day classrooms.

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48 Subsequently a threshold of 185 percent of the federal poverty level is also used to define low- versus high-income. This discrepancy in definitions is due to the limitations of the available data and is not expect to bias the results.

49 For the purposes of estimating current access to high-quality early learning, "high-quality" is considered a score of 5 or higher on the Early Childhood Environmental Rating Scale, or ECERS. The ECERS is a widely used standardized classroom observation instrument on a scale of 1 to 7 that is based on the quality of materials, space, and interactions between children and teachers.

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55 Average impacts across Tulsa, Oklahoma, and Boston in standard deviation units are as follows: Math: White: 0.18; African American: 0.45; Hispanic: 0.81; Low-income: 0.51; Not low-income: 0.32; Reading: White: 0.35; African American: 0.68; Hispanic: 1.05; Low-income: 0.74; Not low-income: 0.48.

56 Projected reductions in kindergarten achievement gaps from a universal high-quality ECE program in standard deviation units are as follows: Math: African-American -White: 0.25; Hispanic-White: 0.51; Income: 0.19; Reading: African-American-White: 0.31; Hispanic-White: 0.58; Income: 0.25.

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