

A pre-kindergarten achievement gap? Scope and implications

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Abstract: This study examined the degree to which achievement gaps existed among different ethnic and racial groups before kindergarten entry. Using published data on the Early Childhood Longitudinal Study-Birth Cohort, this study found statistically significant differences in language knowledge and skills, literacy knowledge and skills, and mathematics knowledge and skills between Black children and White children, Hispanic children and White children, and Asian and White children as early as 4-years-old. The largest achievement gap was found between Hispanic children and White children, followed by Black children and White children. Asian children were found to perform better than White children on measures of literacy, mathematics, and fine motor skills. Implications of this study were discussed.

Key words: United States; achievement gap; pre-kindergarten; ECLS

1. Introduction

The persistent gap in academic achievement among different ethnic and racial groups has been a critical and contentious issue in American education, particularly since educational equity has been a national goal for the past 40 years. Since the 1954 *Brown v. Board of Education* (1954) landmark Supreme Court ruling and the publication of the *Coleman Report* (Coleman, et al., 1966), substantial governmental resources have been devoted to “closing the gap” through federal programs such as head start and activities funded through Title I¹, as well as various programs sponsored by individual states. Although these programs have increased overall access to early child care (Magnuson & Waldfogel, 2005) and provided more resources for schools serving low socio-economic backgrounds (Braun, Wang, Jenkins & Weinbaum, 2006), our national progress towards closing the achievement gap has been disappointing. Results from the nation’s report card, or the National Assessment of Educational Progress (NAEP) has revealed that the achievement gap has narrowed somewhat since the 1970s, but the difference remains substantial (Hedges & Nowell, 1998). Moreover, the existence of the gap appears early. Results from a nationally representative sample of children who were followed from kindergarten through grade 5 found that the achievement gap appeared at kindergarten entry and increased at each successive grade level (Chatterji, 2006; U.S. Department of Education, U.S. DOE, 2004).

Although there has been a plethora of research on the achievement gap and its correlates at the elementary and secondary levels (for example, Barton 2003; Miller, 1995; Phillips, Brooks-Gunn, Duncan, Klebanov & Crane, 1998), less attention has been paid to the achievement gap and its correlates during early childhood years, particularly before kindergarten. Moreover, most studies have focused only on the Black children and White children achievement gap, leaving behind examinations of the magnitude of the achievement gap between other ethnic and racial groups, particularly of Hispanic children and Asian children.

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¹ Title I (Part A) of the Elementary and Secondary School Act (ESEA) is the largest federal program in K-12 education (funded at more than \$11 billion during the 2003-04 school year), aimed at equalizing funding for high-poverty schools in the United States.

This study investigated the extent of the math and reading achievement gaps among pre-kindergarten children of different ethnic and racial subgroups. The study utilized publicly available data on the average math and reading achievement of a nationally representative sample of U.S. 4-year-old children to estimate the magnitude of the math and reading gap between Black children and White children; between Hispanic children and White children; and between Asian children and White children. Both statistical significance and practical significance of the gap were examined.

The following literature review has been organized into three sections. The first section provided a general overview on the achievement gap literature. The second section examined the magnitude of the achievement gap at school entry, and the last section reviewed the achievement gap prior to school entry.

1.1 Overview on the achievement gap

Fifty years after the *Brown v. Board of Education* (1954) landmark Supreme Court ruling, the gaps in educational achievement and attainment between ethnic and racial groups remain large. This persistent difference among different racial and ethnic groups, particularly between Black children and White children, has been well documented in a number of sources. Jencks and Phillips (1998) provided a brief historical introduction to the problem and a thoughtful review on relevant issues. Hedges and Nowell (1998) analyzed data from six surveys and presented evidence that the achievement gap has narrowed somewhat since 1970, but that the differences remain substantial. The U.S. Department of Education's (2004) *The Condition of Education 2004* characterized the mathematics achievement gap of black students and white students as narrowing during elementary school, but widening during middle school, and constant during high school. This led to the characterization of the black-white student gap as "pervasive, profound and persistent" by a recent multi-method, multi-state analysis of the achievement gap (Braun, et al., 2006).

1.2 Achievement gap at school entry

The gap at school entry has been well documented. Studies have found that the achievement gap appears as early as school entry and increases over time, and that the gap in mathematics achievement is larger than the gap in reading achievement. Results from a nationally representative sample of kindergarten age children showed that on math achievement, Black and Hispanic kindergarten students scored about two-thirds of a standard deviation below white kindergarten students, while Asian students outscored white students. Moreover, on the reading achievement, Black children and Hispanic children scored just under half a standard deviation lower, while Asian children, again, performed better than White children by one-third of a standard deviation (Magnuson & Duncan, 2006). By following these children from kindergarten to grade 5, studies have found that the math gap between Black children and White children widened from 5 to 16 points from kindergarten entry to grade 3 and that the reading gap widened from 3 to 14 points during the same period (U.S. DOE, 2004). In addressing the criticism that the achievement gap differed depending on the assessment used, Rock and Stenner (2005) reviewed six main assessments used to estimate school readiness in current literature (including Peabody Picture Vocabulary Test-Revised (PPVT-R) and the Early Childhood Longitudinal Study Kindergarten Battery (ECLS-K)), and calculated the school readiness gaps of Black children and White children in standard deviation units. They found the gaps to range from less than half a standard deviation (typically math and reading achievement tests of school readiness) to one standard deviation (typically, vocabulary tests of school readiness), depending on the assessment used (Rock & Stenner, 2005). More recently, researchers have begun to examine not just the magnitude but also growth in the achievement gap. Chatterji (2006) used hierarchical linear models to examine the growth of reading achievement gaps of kindergarten and grade one children. He found reading gaps increased from kindergarten entry to grade one for Black children as compared to their white counterparts; boys as compared to girls; and

children from high poverty households as compared to children from more affluent households (Chatterji, 2006).

1.3 Achievement gap before school entry

In comparison, there are fewer research studies that have examined the magnitude and growth of the achievement gap prior to kindergarten. Earlier examinations of the pre-kindergarten achievement gap focused on home language learning experiences. Following children from 42 families from the Kansas area when they were 9-month-old to 36-month-old, Hart and Risley (1995) found that by the age of 3, children in families receiving welfare had vocabularies that were half as large as those of their more affluent peers, and the disparities persisted throughout childhood. More recent studies in this area have examined the pre-kindergarten achievement gap using nationally representative data. Yeung and Pfeiffer's study (as cited in Magnuson & Duncan, 2006), using a nationally representative sample of families in the U.S., estimated the math achievement gap between black preschool age children and white preschool age school as two-third of a standard deviation; and the reading achievement gap as just under half a standard deviation. Phillips, et al. (1998), using a sample of children born to a nationally representative sample of women, estimated that 5- and 6-year-old Black children scored more than a full standard deviation below White children on a picture vocabulary test score. Findings from these earlier studies showed existence of pre-kindergarten achievement gaps in math and reading between Black children and White children; however, these studies fell short in documenting the exact magnitude of the pre-kindergarten achievement gap in math and reading across different ethnic and racial groups. This was because prior studies did not utilize a nationally representative sample of pre-kindergarten children; instead, they examined children from either a specific region of the country or children from samples of families or samples of women. This limitation in sampling has grave implications as those earlier studies could not produce reliable and generalizable estimates of the math and reading achievement gap for not only black pre-kindergarten children but also for Hispanic and Asian pre-kindergarten children.

In summary, a review of the current literature on the achievement gap between different ethnic and racial groups revealed a clear documentation of the magnitude of the achievement gap between Black children and White children from kindergarten through high schools. However, the magnitude of the achievement gap at the pre-kindergarten level has not been as well documented. Current research on this issue also has not adequately examined the extent of the math and reading achievement between other ethnic and racial groups, such as between Hispanic children and White children and between Asian children and White children.

1.4 Current study

This review of existing research on school readiness and achievement gap suggested that an important question has not been adequately addressed—the question of, to what extent is there a math and reading achievement gap among pre-kindergarten children of different ethnic and racial subgroups? In order to address this question, this study utilized publicly available data on the average math and reading achievement of a nationally representative sample of U.S. 4-year-old children to estimate the magnitude of the math and reading achievement gap between Black children and White children; between Hispanic children and White children; and between Asian children and White children. Both statistical significance and practical significance of the gap were examined.

2. Method

This following method section has been organized into four parts. The first part provided a general overview of the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B). The second part described the demographic distributions of the participants of the study. The third part explained the data collection of ECLS-B, including the

variables used in this study. The last part of the method section described the statistical analyses used in this study.

2.1 Overview of ECLS-B

The Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), a U. S. Department sponsored study, is the only nationally representative study that focuses on the early home and educational experiences of children from infancy to kindergarten entry. This was achieved by following a cohort of approximately 10,000 children born in the United States in 2001 through 2007 through four waves of data collection. The approximate age of children at each wave of data collection was the following: 9-month-old, 2-year-old, 4-year-old, and 6-year-old (U. S. Department of Education, u.d.). These four waves of data collection occurred during 2001, 2003, 2004-2005, and 2006-2007 (U. S. Department of Education, u.d.). Currently, only restricted use data from the first three waves are available for secondary data analysis (U. S. Department of Education, u.d.). This study is focused on 4-year-old children or preschoolers. While I am waiting for the permission to use the restricted-used data, I analyzed extant data reported by the U. S. Department of Education (2008) as my primary data source for this current study.

2.2 Participants

This study analyzed extant data on 4-year-old children that were reported by U. S. Department of Education (2008). Approximately 8,750 children participated in this third wave of data collection. Of these children, 51% were male, 49% were female. In terms of ethnicity and race, 54% were White, non-Hispanic, 14% were Black, non-Hispanic, 25% were Hispanic, 3% were Asian, non-Hispanic, and 5% were Other (U. S. Department of Education, 2008). However, only about 75% of children were 4-year-old (between 48 months and 57 months), 16% were younger and 9% were older. The analysis that followed report results only for the 75% of children who were between 48 months and 57 months in 2004-2005 (U. S. Department of Education, 2008).

2.3 Data collection procedures of ECLS-B

Trained field researchers for the ECLS-B conducted home visits during the 2005-2006 to interview parents, administer a questionnaire, and directly assess children's cognitive (i.e., language, literacy, and math knowledge and skills) and fine motor skills (U. S. Department of Education, 2008).

2.3.1 Parent interview

During the home visit, each trained ECLS-B field researcher asked the parent (usually mother, but could be father or guardian) to provide information about the sampled child, themselves, the home environment, their parenting attitudes, family characteristics, family structure, child care use, household income, and community and social support. The interviews were conducted primarily in English but provisions were made for parents who only spoke Spanish (U. S. Department of Education, 2008).

2.3.2 Direct child assessment

During the home visit, each trained ECLS-B field researcher also directly assessed the child's language, literacy, mathematics, and color knowledge in a quiet, well-lit area of the home using adaptive assessment strategy (U. S. Department of Education, 2008). Under this strategy, when a child started having problems answering a set of items that were more difficult, they were routed to a different area (U. S. Department of Education, 2008), thereby, reducing the child's frustration and time needed to complete the assessment. As a result of the adaptive testing strategy, the Item Response Theory (IRT) modeling was used to estimate each child's performance on all of the items in each domain. IRT uses patterns of correct and incorrect answers to obtain estimates on a scale that may be compared for different assessment forms (U. S. Department of Education, 2008).

2.4 Study variables

The following section described the dependent variables that were examined in this current study. The variables were presented in five parts, including: (a) an overall measure of mathematics knowledge and skills, (b)

an overall measure of literacy knowledge and skills, (c) the two sub-measures of language knowledge and skills, including receptive vocabulary and expressive language, (d) the two sub-measures of early reading knowledge and skills, including phonological awareness and conventional print knowledge, and (e) a measure of fine motor skills.

2.4.1 Overall mathematics knowledge and skills

This composite variable captured a child's number sense, geometry, counting, operations, and patterns. It has a possible range of 0 to 44. For children who were 4-year-old at assessment, the overall mathematics knowledge and skills score ranged from 6 to 42 with a national standard deviation of 7 (U. S. Department of Education, 2008).

2.4.2 Overall literacy knowledge and skills

This composite variable measured a child's skill at letter recognition in both receptive and expressive modes, letter sounds, and early reading (e.g., recognition of simple words, phonological awareness, and knowledge of print convention). The variable has a possible range of 0 to 37. For children who were 4-year-old at assessment, the overall literacy knowledge score ranged from 5 to 35 with a national standard deviation of 7 (U. S. Department of Education, 2008).

2.4.3 Language knowledge and skills

Receptive vocabulary knowledge and skills. This variable measured a child's ability to demonstrate that he/she understood the meaning of words (for instance, asking a child to point to a picture that represented a word spoken by the interviewer). It has a possible range of 0 to 15. For children who were 4-year-old at assessment, the receptive vocabulary knowledge and skills ranged from 5 to 14 with a national standard deviation of 2 (U. S. Department of Education, 2008).

Expressive language. This composite variable measured how well a child was able to retell two stories by making reference to a set of pictures that were provided as prompts. It has a possible range of 0 to 5 (where 0 = no response, 1 = short, isolated phrases; 2 = disconnected thoughts; 3 = recognizable story line in limited detail; 4 = a recognizable story in coherent, fluent sentences; and 5 = articulate, detailed sentences, vivid vocabulary, and complex constructions). For children who were 4-year-old at assessment, the expressive language score ranged from 0 to 5 with a national standard deviation of 1 (U. S. Department of Education, 2008).

2.4.4 Early reading knowledge and skills

Phonological awareness knowledge and skills. This variable captured a child's understanding of the sounds and structure of spoken language, including rhyming, blending, segmenting, deleting, and substituting words, syllables, and sounds. It has a possible range of 0 to 8. For children who were 4-year-old at assessment, the phonological awareness knowledge score ranged from 2 to 7 with a national standard deviation of 1 (U. S. Department of Education, 2008).

Conventions of print knowledge and skills. This variable captured a child's understanding of what print represented and how it worked. It has a possible range of 0 to 8. For children who were 4-year-old at assessment, the conventions of print knowledge and skills score ranged from 1 to 7 with a national standard deviation of 1 (U. S. Department of Education, 2008).

Lastly, fine motor skills were also measured.

2.4.5 Fine motor skills

This variable measured a child's skill in drawing basic forms and shapes, including a vertical line, a horizontal line, a circle, a square, a cross, a triangle, and an asterisk. It has a possible range of 0 to 7. For children who were 4-year-old at assessment, the fine motor skills score ranged from 0 to 7 with a national standard

deviation of 2 (U. S. Department of Education, 2008).

2.5 Statistical procedures

I analyzed extant data published by the U.S. Department of Education (2008). For each of the seven dependent variables listed above, I calculated a mean difference for Black children as compared to White children, for Hispanic children as compared to White children, and for Asian children as compare to White children. Using the mathematical functions from the Microsoft Excel software program, I computed a t-test for independent groups (Urdan, 2005) for each pair of mean difference to determine whether the difference was statistically significant at the .05 level. Furthermore, effect sizes (d-indices) were computed by dividing the mean difference between the two subgroups by the estimated national standard deviation for the entire distribution (Hedges & Nowell, 1999).

3. Results

In alignment with the research questions, the following results section has been organized into three parts. The first part presented the magnitude of the achievement gap between a nationally representative sample of Black 4-year-old children and White 4-year-old children on measures of mathematics knowledge and skills, literacy knowledge and skills, and fine motor skills. The second part documented the extent of the mathematics, literacy, and fine motor skills achievement gaps between nationally representative sample of Hispanic 4-year-old children and White 4-year-old children. The third part presented findings on the level of the achievement gap between nationally representative Asian 4-year-old children and White 4-year-old children on measures of mathematics knowledge and skills, literacy knowledge and skills, and fine motor skills.

3.1 Achievement gap between black children and white children

Mean differences between different ethnic and racial groups on measures of overall mathematics knowledge and skills, overall literacy knowledge and skills, specific language knowledge and skills, specific early reading knowledge and skills, and fine motor skills were presented in Table 1. All reported results were statistically significant at the .05 level. A negative sign indicated a mean difference favoring White children. This meant that across all measures of mathematics, literacy, and fine motor skills, black 4-year-old children, on average, scored lower than White children and that the difference was statistically significant.

Table 1 Mean differences in average language, literacy, mathematics, and fine motor skills among 4 years old children^a

	Overall mathematics	Overall literacy	Language knowledge and skills		Literacy		Fine motor skills
			Reflective vocabulary	Expressive language	Phonological awareness	Conventions of print	
Black ^b	-3.6	-2.2	-1.2	-0.2	-0.3	-0.4	-0.3
Hispanic ^c	-4.1	-3.5	-1.8	-0.5	-0.5	-0.7	-0.2
Asian ^d	2.1	3.3	-1.3	-0.5	0.4	0.6	1.0

Notes: All reported results were statistically significant at the .05 level.

^a4 Years Old Children include children between 48 through 57 months or 4 years old to 4 years, 9 months old.

^bBlack children were compared to white, non-Hispanic children.

^cHispanic children were compared to white, non-Hispanic children.

^dAsian children were compared to white, non-Hispanic children.

Source: U.S. Department of Education, National Center for Education Statistics. (2008). *Preschool: First findings from the preschool follow-up of the early childhood longitudinal study, birth cohort (ECLS-B)*. (NCES 2008-025). Retrieved January 5, 2008, from <http://nces.ed.gov/pubs2008/2008025.pdf>.

Effect size of the mean difference between different ethnic and racial groups on measures of overall mathematics knowledge and skills, overall literacy knowledge and skills, specific language knowledge and skills, specific early reading knowledge and skills, and fine motor skills were presented in Table 2. Effect size can be interpreted as the mean difference expressed in standard deviation units and a negative sign indicated a mean difference favoring White children. Thus, a -0.3 effect size can be interpreted as on average, Black children scored about one-half a standard deviation lower than White children on their overall literacy knowledge and skills measure.

Table 2 Effect sizes of mean differences in average language, literacy, mathematics, and fine motor skills among four-year-old children^a

	Overall mathematics	Overall literacy	Language knowledge and skills		Literacy		Fine motor skills
			Reflective vocabulary	Expressive language	Phonological awareness	Conventions of print	
Black ^b	-0.5	-0.3	-0.6	-0.2	-0.3	-0.4	-0.2
Hispanic ^c	-0.6	-0.5	-0.9	-0.5	-0.5	-0.7	-0.1
Asian ^d	0.3	0.5	-0.7	-0.5	0.4	0.6	0.5

Notes: ^a4 Years Old Children include children between 48 through 57 months or 4 years old to 4 years, 9 months old.

^bBlack children were compared to white, non-Hispanic children.

^cHispanic children were compared to white, non-Hispanic children.

^dAsian children were compared to white, non-Hispanic children.

Source: U.S. Department of Education, National Center for Education Statistics. (2008). *Preschool: First findings from the preschool follow-up of the early childhood longitudinal study, birth cohort (ECLS-B)*. (NCES 2008-025). Retrieved January 5, 2008, from <http://nces.ed.gov/pubs2008/2008025.pdf>.

On the overall mathematics knowledge and skills measure, there was a -3.6 mean difference between Black children and White children or expressed in standard deviation unit, Black children scored, on average, half of a standard deviation lower than White children.

On the overall literacy knowledge and skills measure, Black children scored, on average 2.2 (or one-third of a standard deviation unit) lower than White children. Black children consistently scored lower than White children on all sub-measures of language and early reading knowledge and skills. The magnitude of the achievement gap between Black children and White children in language and early reading skills sub-measures ranged from one-fifth of a standard deviation unit in expressive language to a little above half a standard deviation unit in reflective vocabulary.

On the fine motor skills measure, Black children scored on average 0.3 points (or one-fifth of a standard deviation unit) lower than White children.

3.2 Achievement gap between Hispanic children and White children

Hispanic children had the largest gap as compared to White children in measures of overall mathematics knowledge and skills, overall literacy knowledge and skills, and in the sub-measures of language and early reading skills.

On the overall mathematics knowledge and skills measure, Hispanic children scored, on average, 4.1 or approximately half of a standard deviation lower than White children.

On the overall literacy knowledge and skills measure, Hispanic children scored, on average 3.5 or half a standard deviation unit lower than White children. Across the different language and early reading sub-measures, Hispanic children had the largest mean difference as compared to White children. These mean differences ranged from -0.2 to -4.1 or expressed in standard deviation units, the magnitude of the gap ranged from half of a standard

deviation in expressive language, overall literacy, and phonological awareness to almost one full standard deviation in reflective vocabulary.

In terms of fine motor skills, the mean difference between Hispanic children and White children was -0.2 or a difference of about one-tenth of a standard deviation unit favoring White children.

3.3 Achievement gap between Asian children and White children

Asian children scored, on average, 2.1 or one-third of a standard deviation higher than White children on the overall mathematics knowledge and skills measure.

On the overall literacy knowledge and skills measure, the mean difference between Asian children and White children was 3.3 or a difference of half a standard deviation unit favoring Asian children. Asian children scored, on average, lower than White children on the two language knowledge and skills sub-measures. The gap expressed in standard deviation units ranged from half of a standard deviation in expressive language to two-thirds of a standard deviation in reflective vocabulary. Asian children scored, on average, higher than White children on the two early reading knowledge and skills sub-measures. The gap expressed in standard deviation units ranged from approximately half of a standard deviation in phonological awareness to approximately one-half of a standard deviation in convention of print.

On the measure of fine motor skills, Asian children, on average, scored better than White children by 1.0 point or a half standard deviation unit.

4. Discussion

Findings from this study indicate that there is a pre-kindergarten achievement gap. The largest minority and majority difference in mathematics knowledge and skills and literacy knowledge skills is found between Hispanic children and White children. The gaps range from half a standard deviation unit on measures of overall mathematics knowledge and skills, overall literacy knowledge and skills, and phonological awareness knowledge and skills, to almost one full standard deviation on the measure of reflective vocabulary knowledge and skills. These findings add to the current literature on the achievement gap in at least two ways: (1) By documenting the magnitude of the pre-kindergarten achievement gap between nationally representative sample of Hispanic 4-year-old children and nationally representative sample of white 4-year-old children on measures of overall mathematics knowledge and skills and overall literacy knowledge and skills and on sub-measures of literacy. (2) These findings add to the literature by highlighting the extent of educational inequality experienced by Hispanic children in the United States, reminding policymakers, researchers, and educators, to consider the educational experiences of this growing minority subgroup in the achievement gap debate.

Findings from this study reveals that there is an achievement gap between Black children and White children 4 years old, ranging from one-tenth of a standard deviation unit (on fine motor skills), one-fifth of a standard deviation unit (on measures of expressive language), to one-half of a standard deviation unit (on measures of reflective vocabulary and overall mathematics knowledge and skills). The size of these gaps are similar to what has been found at the kindergarten level (Rock & Stenner, 2005), indicating that Black children, prior to kindergarten, start out on average, on lower levels than White children on measures of mathematics and literacy and reading. As closing the achievement gap has been a national goal for 40 years, policymakers should consider this new evidence as they are making decisions on the allocation and prioritization of federal education money.

Findings from this study reveals that the achievement gap between Asian children and White children ranges from over half of a standard deviation favoring White children on the measure of reflective vocabulary knowledge and skills to approximately half of a standard deviation favoring Asian children on measures of overall

mathematics, overall literacy, and fine motor skills. Findings from this study support recent findings at the kindergarten level, where nationally representative Asian kindergarten children were found to outscore nationally representative White kindergarten children (Magnuson & Duncan, 2006). This area is ripe for deeper examination. Questions are raised such as why do Asian children outperform White children on some measures of literacy (e.g. early reading knowledge and skills) but not others (e.g., language knowledge and skills)? And, questions such as to what extent these differences are explained by socioeconomic status, by family structure and practices, by school program and quality, are waiting to be examined.

This study attempts to address two limitations in the current literature on the achievement gap by (1) estimating the magnitude of the achievement gap between nationally representative samples of 4-year-old children, and by (2) calculating the achievement gap for Hispanic children and White children, Asian children and White children, and for Black children and White children. However, the study is limited in that the analyses could not go beyond the comparison in central tendency as the author had to analyze data that were reported. Future studies should consider further examining the achievement gap by using measures of variability (Hedges & Nowell, 1999) and by modeling change in the achievement gap over time (Chatterji, 2006).

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