Socioeconomic Status, Math Achievement, and Head Start Attendance

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Introduction

This study looks at the persistent effect of socioeconomic status on student learning and achievement from kindergarten through eighth grade. Students from lower status groups may be more likely to perform poorly in comparison to their higher status peers, and the type of childcare a young student attends may affect this. Specifically, this study focuses on students who attended publicly funded Head Start programs when they were three and four years old, right before they began kindergarten. Head Start began as part of the War on Poverty in 1965 under President Lyndon B. Johnson, and continues today with the goal of improving low-income students' school readiness.

Students from lower socioeconomic statuses perform at lower levels throughout the entirety of their academic careers (Lam, 2014). The goal of Head Start is to close this gap before students ever enter school, thus improving the overall school performance of low-income students. The effectiveness of such programs is important in evaluating existing policies as well as suggesting future policies focused on low-income families. Head Start is implemented differently between states, with some states serving significantly more low-income and impoverished youth than others do. The results of this study will emphasize the importance of implementing such programs uniformly to equalize opportunity between location, and minimizing the effect that a student's location has on their academic performance.

This study focuses on math achievement over time, as there is a stronger, more consistent association between socioeconomic status and math performance from kindergarten and through eighth grade. Math and science skills are often identified as those that American students are lacking to perform well and succeed in the global economy (Byrnes and Wasik, 2009). A recent book titled *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* promoted the broad acceptance of the idea that not enough American students are mathematically prepared for the demands of the global market, and the way students are taught math and science needs to change.

Literature Review

Considering education research at large, socioeconomic status (SES) is one of the most widely considered contextual variables. A meta-analytic study of data between 1990 and 2000 found a moderate association between SES and achievement at the student level, and a high association between SES and achievement at the school level (Sirin, 2005). However, SES is not a sole indicator of academic achievement but is linked to achievement through multiple interacting systems. For example, there is a

pattern of minority students being more likely to live in low-income households which in turn places them in lower-income neighborhoods, and their parents often have lower levels of education, they are more likely to attend under-resourced schools (Sirin, 2005). The concept of educational inequality is cyclical; students who live in poorer neighborhoods attend more under-resourced schools, thus receiving lower quality education, minimizing their opportunity for upward mobility, and placing them back in the same kinds of neighborhoods they started in.

These disparities in education begin before children even enter the public education system and these early disparities are the basis for later inequality. Thus, the early childhood years are critical for intervening in children's long-term educational careers (Ansari, 2018). There is extensive literature supporting preschool programs as effective in preparing both low-income and middle-class students academically for school, with the effects for low-income students being higher than those of their middle-class peers by ten to thirty percentage points (Ansari, 2018). Both low-income students who attended preschool and those didn't are more susceptible to academic tracking that places them in classes with less favorable outcomes than their more privileged peers (Lam, 2014). Low-income students still lack the prerequisites to make their way into tracks with better outcomes, both academically and in terms of social and cultural capital. Lam (2014) says that the lack of cultural capital that low-income students' parents can provide them, combined with the lack of learning opportunities in and outside the home puts low-income students at a significant disadvantage.

Not only is there a lack of stimulating resources in low-income homes, but there are often many more stressors that parents and their children must face. These can include financial hardships, strained relationships, and food insecurity. Lam (2014) continues to say that parent stress and psychological well-being affects parenting strategies; moreover, low-income parents are susceptible to maladaptive coping strategies which make them more likely to adopt harsh or neglectful parenting strategies. In turn, this can lead students to internalize the stress that their parents are feeling and display similar maladaptive responses (Lam, 2014). Parents' position in the socioeconomic structure directly impacts student achievement by affecting access to resources at home, and indirectly by determining the amount of social capital that students take with them to school (Sirin, 2005). Social capital is directly tied to family SES in that capital is provided by the neighborhood a student lives in, the school they attend, and the resources available in these places (Sirin, 2005). Further, students' social capital can be interfered with even more if their parent isn't involved in school activities for any number of reasons (Lam, 2014).

Expectations for students are a concept outside of social capital entirely, but both are strongly associated with family

SES. Low-SES parents tend to have lower expectations for their students, partially due to the fact that they typically have low levels of education and lack knowledge about opportunities for their children. Students internalize these low perceptions and expectations for themselves, similarly to how they are affected by parent stress (Lam, 2014). These expectations are often adopted by teachers and this cycle is referred to as the "nexus of triad expectation" (Lam, 2014, p. 329). SES and parent expectations affect students' level of opportunity before they even enter the classroom, and just becomes exacerbated by the above concept when they do (Byrnes and Wasik, 2009; Lam, 2014). This tends to explain why students are tracked into lower-performing classes and organized into ability groups beginning in primary school (Lam, 2014; Byrnes and Wasik, 2009). In such circumstances, teachers pay less attention to student achievement, and specifically, focus less attention on positive performance in the classroom (Lam, 2014). Byrnes and Wasik (2009) notes that there were differences in math content exposure for low-SES and high-SES students, with low-SES students more likely to be placed in ability groups as early as kindergarten and first grade.

The combination of the above-mentioned factors leads to the discussion of "school-readiness," which is measured by combining assessments of early math and reading skills with overall health status and behavioral measures from kindergarten teachers (Isaacs, 2012). In spite of the proven positive results of preschool, the probability that a low-income student would attend a formal childcare program outside the home decreased between 1998 and 2010, with in home resources – like technology and literacy resources – increasing for students from all backgrounds (Bassok et al., 2016). Isaacs (2012) cites preschool attendance, parenting behaviors, parents' education, maternal depression, parental exposure to tobacco, and low birth weight as factors contributing to school readiness. Continually, he notes a significant gap between the school readiness of low-income students and their middle- and high-income peers, with a 27 percentage point difference between the groups. Children from the upper-quartiles of SES were overall more prepared for each grade, presenting more skills and motivation to benefit from instruction than their lower-SES peers (Byrnes and Wasik, 2009). Less than half of low-income children are considered "school ready" at age five (Isaacs, 2012). Long term, a lack of economic success in adulthood can be traced to failure to complete high school or college, and further linked to academic strife and behavioral struggles in grade school (Isaacs, 2012).

One key mediating factor in school readiness is preschool attendance, which is successful in minimizing the effects of SES on achievement for a number of reasons. School readiness is increased by nine points overall in a simulation conducted by Isaacs (2012) for children who attended preschool, and Isaacs continues to assert that "preschool programs offer the most promise

for increasing children's school readiness" (p. 1). Studies have found positive associations between preschool participation and children's literacy and math performance at school entry, especially for lower-SES students but preschool programs can be leveraged to increase early learning for children from all income backgrounds (Ansari, 2018; Bassok et al., 2018; Isaacs, 2012). Long-term studies have shown positive effects from early childcare programs on health, educational attainment and earnings (Bassok et al., 2018).

Conversely, much of the research finds that the positive effects of preschool fade out in early elementary, as early as the spring of kindergarten in some studies (Bassok et al., 2018; Gormley et al., 2017; Isaacs, 2012). Yoshikawa and colleagues (2016) noted four major reasons that the positive effects of preschool; 1) kindergarten and first grade teachers may be more focused on catching students who didn't attend preschool up that they allow the positive effects of preschool to dwindle in those who did attend; 2) the kind of content students receive in kindergarten may need to be closely tied to the content and delivery methods they are used to from preschool; 3) skills taught in preschool (e.g. language decoding) may just be skills that students were going to pick up by third grade anyways; and, 4) the comparison groups in studies over time may affect the perceived effectiveness of preschool programs by having more structured early childcare than staying home with their parents, as was true for studies in the past.

The impacts of Head Start, specifically, have been reported to fade out. Isaacs (2012) notes that the impacts of Head Start have been smaller and prone to fade out, while Gormley et al. (2017) cites contradicting studies, some of which say Head Start is responsible for long-term, positive effects. In a study of Oklahoma's statewide, universal pre-K program, researchers found a significant relationship between pre-K enrollment and math test scores eight years later, despite the fact that some other results in this cohort fade over time (Gormley et al., 2017). At the time of the study in the 2005-06 school year, Oklahoma's pre-K program, administered directly through schools or partner programs like Head Start, served nearly 70% of four year olds in the state, regardless of their socioeconomic status (Gormley et al., 2017). In a similar study of Tennessee's Voluntary Pre-Kindergarten program during the same time period, however, benefits from pre-K participation diminished in the first years of elementary school (Bassok et al., 2018).

Claessens et al. (2014) found that the benefits of preschool attendance have been more pronounced for students from more economically disadvantaged backgrounds. In contrast, Bassok (2018) found that among low-income students in the ECLS-K cohorts, the advantages provided by preschool attendance were no longer significant as early as the end of kindergarten. The caveat for lower-income students is that preschool programs aren't a remedy for the various disadvantages faced by children over the course of their lives (Ansari, 2018).

Additionally, the quality of elementary schools that lower-income students attend after preschool may affect the fade out of short-term preschool effects, regardless of the quality of preschool attended (Claessens et al., 2014; Yoshikawa et al., 2016). For students from all backgrounds, those who had attended preschool programs retained positive effects in math through the beginning of third grade (Bassok et al., 2018).

A recent book titled *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Future* promotes two major ideas: 1) too few American students are adequately prepared in the fields of math and science to compete in the global economy; and 2) the systems responsible for educating youth in math and science need reform (Byrnes and Wasik, 2009). Significant changes to math curriculum occurred in the 1960s and 1980s due to similar calls from researchers (Byrnes and Wasik, 2009). Math achievement is largely discussed because studies have shown that middle school math score are a predictor of later success (Gormley et al., 2017). Additionally, the current literature on math achievement is largely fragmented due to the fact that there is disagreement about how exactly to measure achievement (Byrnes and Wasik, 2009). One study mentions nine factors divided into three subsets: student aptitude-attribute factors, instructional factors, and psychological environment (Byrnes and Wasik, 2009), while others mention five subset categories.

The effectiveness of preschool programs is affected by several factors, including funding. Between 2000 and 2009, state spending on public preschool programs increased every year, with Head Start expanding to serve younger students during this time, despite still receiving much less funding than public education overall (Isaacs, 2012). Additionally, the quality of preschool varies greatly across the types of programs, as well as within various settings, making it difficult to truly measure the impact of any one kind of early childcare (Isaacs 2012).

Research Questions and Hypotheses

This study seeks to answer the following questions: (1) Does familial socioeconomic status have a positive effect on children's academic performance in mathematics? (2) Does Head Start attendance reduce the effect SES has on children's academic performance in mathematics? According the literature cited above, I expect students from lower economic backgrounds to achieve at lower levels than their middle- and high- income counterparts. Additionally, I expect to see that the positive effect of SES on math achievement from kindergarten through eighth grade is reduced by Head Start attendance. Several studies identify SES as a key predictor in academic achievement for numerous reasons, including the neighborhoods low-SES families live in, family dynamics, parent education, parenting style, access to enrichment resources, and so on. Head Start is a publicly funded preschool program with an emphasis

on serving low-SES students and families, thus its primary goal should be to minimize the effect SES has on academic achievement over time.

Data and Measurement

This study uses data from the Early Childhood Longitudinal Study: Kindergarten Cohort 1998-9 (ECLS-K 1998-9) from the National Center for Education Statistics. At baseline measurement, there were 16,015 valid cases drawn from a representative sample of schools and students nationwide. Only the kindergarten and first grade samples are truly representative because students were recruited for a second time in first grade, due to state-specific requirements about when students must begin school. The study faced student attrition over the duration of the study, making the sample size (n=12,830) in the third grade measurement, (n=10,050) in the fifth grade measurement, and (n=8,503) in the final, eighth grade sample. The weighted response rate in the base year was 74% for schools (940 of 1,280 sampled schools) and 92% for child participation within those schools.

Socioeconomic status (WSESQ1) was measured by combining both parent's education level, both parent's occupational prestige, and the overall family income. This was organized into quintiles in the original study, recoded into three categories (Low SES, Middle SES, and High SES) for this study. The first and second quintiles were combined to form the "Low SES" category (n=5,285), the third quintile remained as the "Middle SES" category (n=2,974), and the fourth and fifth quintiles were combined to create the "High SES" category (n=6,739). The recoded variable was named "SESCAT1."

ECLS-K collected data at the child, parent, teacher, and school levels. For this study, I used child-level data measuring math achievement. In the kindergarten through fifth grade measurement years, computer-assisted assessments were administered by trained assessors. The eighth grade assessment was a self-administered paper/pencil test. To be considered proficient in a content area for all grade-level assessments, students must have answered two of the three questions correct in that particular category. In the data, levels of achievement were divided into ten categories: (1) non-mastery of the lowest proficiency level, (2) number and shape, (3) relative size, (4) ordinality and sequence, (5) addition/subtraction, (6) multiplication/division, (7) place value, (8) rate and measurement, (9) fractions, and (10) area and volume. "Not applicable" responses were coded as missing. Variable names in the data are C2R4MPF (kindergarten), C4R4MPF (first grade), C5R4MPF (third grade), C6R4MPF (fifth grade) and C7R4MPF (eighth grade).

The data provided early childcare attendance in two variables with the following indicators: (1) the child has attended Head Start (P1HSEVER), and (2) the child has attended other formal childcare outside the home (P1CEVER). These dichotomous variables were combined to

form a new variable (ECATTEND_R) with four categories: (1) both types of early childcare at some point, (2) Head Start only, (3) other early childcare only, and (4) neither type of early childcare. This was necessary to separate students who had attended *only* Head Start from all other students in the study.

For kindergarten and first grade measurement years, data was collected both in the fall and the spring. This study uses spring collection points because this is largely when data was collected in following years was collected.

Results

Initial crosstabs from spring kindergarten data show that the largest percentage of low-SES students achieved Level 2 (Relative Size) proficiency (35.42%), while the largest percentage of middle- and high-SES students achieved Level 3 (Ordinality and Sequence) proficiency (41.93% and 44.96%, respectively). Chart 1 shows the trend that low-SES students performed lower overall than their middle- and high-SES peers. The association between SES and math achievement in kindergarten (Gamma=0.451) is strong and highly significant ($p<.001$).

*INSERT TABLE 4.

*INSERT CHART 1.

The SES effect on math achievement for students who attended Head Start was minimized, the largest percentage of students from all statuses achieving Level 2 (Relative Size) proficiency (37.25% for low-SES; 42.52% for middle-SES; and 40.18% for high-SES students). Chart 2 shows the peak for all SES levels at Level 2. The association between SES and math achievement in kindergarten for students who attended Head Start (Gamma=0.176) is relatively weak in comparison to that observed above, and still significant ($p<.001$).

*INSERT TABLE 5.

*INSERT CHART 2.

Analysis of data from the second measurement year display a similar, however less pronounced, trend between SES and math achievement, with the largest percentage of all SES groups achieving Level 4 (Addition/Subtraction) proficiency (46.74% for low-SES; 52.38% for middle-SES; and 46.92% for high-SES students). High-SES students were still the most likely to reach the highest levels of proficiency with 29.87% achieving Level 5 (Multiplication/Division) and 6.48% achieving Level 6 (Place Value) compared to 10.18% of low-SES students at Level 5 (a marginal difference of 19.69 percentage points), and 1.66% of low-SES students at Level 6 (a marginal difference of 4.82 percentage points). The association between SES and math achievement (Gamma=0.419) remains strong and highly significant ($p<.001$) in first grade.

*INSERT TABLE 6.

*INSERT CHART 3.

In the first grade analysis, the effect of SES on math achievement for students who attended Head Start is minimized similarly to the trend in the kindergarten analysis. The largest percentage of students from all statuses achieved Level 4 (Addition/Subtraction) proficiency (43.7% for low-SES; 50.75% for middle-SES; and 53.21% for high-SES students). High SES students remained more likely to achieve higher levels of proficiency, but with smaller margins than for students who had not attended Head Start; 11.01% achieved Level 5 (Multiplication/Division) while 7.69% of low-SES students achieved Level 5, a marginal difference of 3.32 percentage points. The association between SES and math achievement in first grade for students who attended Head Start (Gamma=0.173; $p<.001$) is much lower than the overall observed effect of SES on math achievement.

*INSERT TABLE 7.

*INSERT CHART 4.

Again, a positive correlation between SES and math achievement is observed in the third grade data, with the largest percentage of students from low- and middle-SES achieving Level 5 (Multiplication/Division) proficiency (36.22% and 33.05%, respectively) and the largest percentage of students from high-SES achieving Level 6 (Place Value) proficiency (34.88%). Middle-SES students were much more likely than low-SES students to achieve Level 6 proficiency (30.78% versus 21.99%, an 8.79 percentage point difference). High-SES students were much more likely to achieve Level 7 (Rate and Measurement) proficiency than low- and middle-SES students by margins of 16.66 percentage points and 10.21 percentage points, respectively. Still in third grade, the positive association (Gamma=0.406; $p<.001$) between SES and math achievement remains strong and highly significant.

*INSERT TABLE 8.

*INSERT CHART 5.

Continuing trends from previous study years, the SES effect on third grade math achievement is significantly decreased by Head Start attendance, with the largest percentage of students from all status levels achieving Level 5 (Multiplication/Division) proficiency; 36.19% of low-SES, 40.91% of middle-SES, and 45.74% of high-SES students. Additionally, students from all status groups share the same likelihood of performing above the mode, with 17.43% of low-SES, 17.61% of middle-SES, and 14.89% of high-SES students achieving Level 6 (Place Value) proficiency and high-SES students being only slightly more likely to achieve Level 7 (Rate and Measurement) at a difference of 7.14 percentage points between high/low-SES. The association between SES and math achievement (Gamma=0.155; $p<.001$) continues to drop in third grade for those who attended Head Start.

*INSERT TABLE 9.

*INSERT CHART 6

Not surprisingly, fifth grade data shows the same trend: SES has a positive impact on math achievement, with higher-SES students performing notably better than their middle- and low-SES peers. Low- and mid-SES students were most likely to achieve Level 6 (Place Value) proficiency (37.22% and 36.09%, respectively), while high-SES students were the most likely to achieve Level 7 (Rate and Measurement) (35.61%). High-SES students were much more likely to achieve at even higher levels, with 20.9% achieving Level 8 (Fractions) with only 5.64% of low-SES students, a difference of 15.26 percentage points. The positive association between SES and math achievement (Gamma=0.426; $p<.001$) remains strong through the fifth grade.

*INSERT TABLE 10.

*INSERT CHART 7.

The story remains interesting in the fourth year of the study, with the positive effect of SES on fifth grade math achievement being lessened by Head Start attendance. Students from all status groups were almost equally as likely to achieve Level 6 (Place Value) proficiency, with 37.16% of low-SES, 33.33% of middle-SES, and 38.57% of high-SES students. Chart 8 displays a nearly even distribution of math achievement for students from all backgrounds, with the largest variance occurring at Level 7 (Rate and Measurement) proficiency where there is an 8.56 percentage point difference between low- and middle-SES students. Head Start attendance dramatically reduces the positive impact of SES on fifth grade math achievement (Gamma=0.123; $p<.05$), with the statistical significance for this portion of the study falling.

*INSERT TABLE 11.

*INSERT CHART 8.

In the final year of analysis – eighth grade – the positive effect of SES on math achievement is still largely visible low-SES students being the most likely to achieve Level 6 (Place Value) proficiency (31.22%) or Level 7 (Rate and Measurement) proficiency (31.63%), middle-SES students most likely to achieve Level 7 proficiency (36.66%), and high-SES students most likely to achieve between Level 7 and Level 9 (Area and Volume) proficiency: 27.56% at Level 7, 28.62% at Level 8 (Fractions), and 26.6% at Level 9. Chart 9 shows the trend the low-SES students are performing much lower than their middle- and high-SES peers, with nearly 80% of low-SES students performing at Level 7 or below and more than 80% of high-SES students achieving Level 7 *or above*. The positive association between SES and math achievement (Gamma=0.438; $p<.001$) remains strong and highly significant through middle school.

*INSERT TABLE 12.

*INSERT CHART 9.

For students who attended Head Start, the SES gap in eighth grade math achievement is greatly reduced, and students from all status groups are likely to achieve Level 6 (Place Value) or Level 7 (Rate and Measurement) proficiency. For low-SES students, 35.58% achieved Level 6 and 26.79% achieved Level 7, middle-SES students achieved the same levels at rates of 27.43% and 34.51%, respectively, and high-SES students achieved the same levels at rates of 32.79% and 39.34%, respectively. Low- and middle-SES students were actually slightly more likely to achieve Level 8 (Fractions) or Level 9 (Area and Volume) proficiency, with 16.36% of low-SES students performing at Level 8/9 and 20.35% of middle-SES students performing at Level 8/9, while only 14.76% of high-SES students performed above Level 7. The association between SES and eighth grade math achievement (Gamma=0.138; $p<.05$) continues to show a great impact from Head Start attendance which minimizes the effect of SES and equalizes student performance across status levels.

*INSERT TABLE 13.

*INSERT CHART 10.

Overall, the positive association between SES and math achievement longitudinally remains strong and highly significant, being mediated by Head Start attendance. In each grade level measured, students who attended Head Start show much lower SES effect on their math achievement, with the association dropping below Gamma=0.15 in the final two years of measurement.

*INSERT CHART 11.

Discussion

Socioeconomic status has a consistently strong and positive effect on math proficiency over time, meaning higher SES students perform better. Head Start considerably narrowed the achievement gap between low-SES and middle/high-SES students on measures of math performance. According to existing literature, it is likely that an association between Head Start attendance and math performance would be witnessed in the kindergarten, first grade, and maybe even third grade measurements. It is surprising to find that Head Start consistently reduced the effect of SES on math performance from kindergarten all the way through eighth grade.

In the kindergarten year data, the expectation is that students achieve Level 3 (Ordinality and Sequence proficiency), which is true for middle- and high-SES students in the initial analyses between SES and achievement. When Head Start effects are observed, all students, regardless of status level are equalized to Level 2 (Relative Size) proficiency level. We would expect any early childcare program to equalize student achievement by raising the proficiency level of underperforming students, but in this case, student achievement is equalized by pulling higher-status and potentially higher achievers back. This could be for a number

of reasons, but Yoshikawa and colleagues' (2016) research suggests that in this case, teachers might be paying more attention to the underperforming students and not building as much on the foundation that middle- and high-SES students in Head Start already have.

By first grade, this phenomenon wasn't visible anymore and Head Start seemed to equalize students by placing them at the same, expected proficiency level: Level 4 (Addition/Subtraction). Initial analysis showed a continued strong, positive effect of SES on math achievement, with high-SES students much more likely to achieve above the expected Level 4, and low-SES students below. The expected result was witnessed in this year of the study; the positive effect of SES on math achievement was mediated by Head Start attendance in the year before school, and high-SES students were likely to achieve above Level 4 at lower margins than in the initial analysis, and percentages for achieved proficiency level were more comparable across the board for students from different status groups.

The same trends continue into the third grade analysis, with initial crosstabs showing a sustained, positive, strong effect of SES on student math achievement. The expected math proficiency level for third grade was Level 3 (Multiplication/Division). Low-SES students were the most likely to achieve the expected level or below, middle-SES students performed about right in the middle, and high-SES students were significantly more likely to achieve a Level 6 (Place Value) or above. Looking at the chart for this data shows pretty clear trends, and disparities in the performance levels of different status groups. It is clear that low-SES students are performing far behind their peers on measures of math achievement. For students who attended Head Start, however, we see the same trend as in the first grade analysis, that student performance is equalized by allowing students from all status groups to achieve at the expected level at more comparable rates. High-SES students are still slightly more likely to achieve above the expected Level 5, but by much smaller margins than was seen in the initial analysis, meaning in third grade, the positive effects of Head Start on math achievement are still visible, contradicting some previous research about the impacts of early childcare attendance.

The same magnitude of effect exists for SES on math achievement in fifth grade, but this is where we should expect to see some fadeout of the positive effects of Head Start if they didn't occur sooner. Initial analyses show very similar trends to those laid out above: low-SES students are more likely to perform at the expected level or below while high-SES students are likely to perform at the expected level or above. In fifth grade, the overall expected level of achievement is Level 6 (Place Value) proficiency. For students attending Head Start, this trend again nearly disappears; students from all status levels are likely to perform at each proficiency level at similar rates. Although results from this analysis are less statistically significant ($p<.05$) than

previously mentioned results, we can still make assumptions about the population with this data, and it's pleasantly surprising to see that Head Start continues to mediate the positive effect of SES on student math achievement through fifth grade. At this level, students were almost equally as likely to perform at the expected level, regardless of their socioeconomic status.

In the final year of analysis, the positive effect of SES on student math achievement remains, and just as strong as the effect evident in kindergarten. The expected level of achievement for eighth grade math was Level 7 (Rate and Measurement). Most low-SES students achieved Level 6 or 7, while middle-SES peers were on target at Level 7, and high-SES peers were very likely to have achieved a Level 7 or higher. For students who attended Head Start, it was much more likely than in the initial analysis that a low-SES student would perform above a Level 6 or 7, and made it more consistent that middle- and high-SES students were performing on target at a Level 7. Again we see that Head Start equalized the achievement levels for students from all status groups, despite whatever external stressors students from low-SES backgrounds may be facing. It is important to note that students from lower-SES families face many stressors outside of school that affect their achievement, and Head Start – or any early childcare for that matter – is not a remedy for the thing that happen outside of school. In light of this, the persisting effects of Head Start in mediating SES's positive effect on math achievement are even more notable.

Implications

This study has several implications for policy and future research, beginning with further study regarding the efficacy of Head Start. Nationwide, Head Start serves less than 40% of 3- to 4-year-old students in poverty, and less than 20% of students this age considered low-income (130% of the poverty line). This number drops significantly more for children under age 3. This study showed that Head Start mediates the effect of SES on math outcomes through eighth grade for students who had attended, so it becomes incredibly important to continue studying the impact of Head Start, expanding it to serve more impoverished and low-income students, and implementing in a way that is more standardized or uniform across states. Largely, states have the control over how Head Start is implemented, and funding varies by state making the program look very different from one state to another, even though the overall goals remain the same. Where a student lives shouldn't be a determinant of their opportunity educational success, which in turn leads to career success.

Additionally, public preschool doesn't necessarily need to take the form of a nationwide program, but could be state specific as long as it's universal and serves youth despite their socioeconomic status. The consistent, strong effect of SES on math achievement proves that attention needs to be paid to minimizing this effect on

performance, equalizing the opportunities children have to succeed. Access to effective early childcare seems to be one way that policymakers and educators can work to close the achievement gap between students from lower socioeconomic backgrounds and their middle- and high-SES peers.

Disclaimers and Limitations

The focus of Head Start is on serving low-SES students and families, and thus has thresholds for the numbers of middle- and high-SES students they can accept. Due to this, the sample size of middle- and high-SES students who attended Head Start is much smaller than low-SES students. At baseline middle-SES students represented about 17% of Head Start attendees, and high-SES students represented about 9% with the rest of the students coming from low-SES backgrounds. The percentage distribution remained consisted, but the total sample size fell from 1,229 students who had attended Head Start in the year before school to 663.

Future analysis of this data should control for more factors, including race, gender, ELL (English Language Learner) status, and state/geographic region. Race is often cited in education research as a factor in determining achievement because minorities are more likely to live in low-income neighborhoods and face systemic pressures than whites. Additionally, since education is largely controlled at the state-level, it would be interesting to either see state-level studies regarding the effectiveness of early childcare in mediating the effects of SES on math achievement, or to control for state/region to determine differences across the country.

Another common discussion about early childcare is that of socioemotional outcomes and psychosocial skills. Future research should consider this and consider if the academic benefits of preschool are counteracted by poorer socioemotional outcomes that are often cited for preschool attendees. This also may vary across type of childcare, rather than simply categorizing childcare as Head Start and Other. There are numerous settings included in the “other early childcare” that I mention above, and it would be worth examining these more closely in terms of both math achievement, and considering the socioemotional outcomes of preschool.

Finally, an ideal study would use a continuous measure of SES rather than the categorical one, and I would like to redo the analysis with this to see if the results are consistent. The continuous measure is more comprehensive and allows for examination of individual cases rather than generalized groups.

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APPENDIX

Table 1. Univariate Descriptive Statistics

	n	%		n	%
Socioeconomic Status			Early Childcare Attendance		
Low SES	5710	35.7	Had both types of early child care at some point	725	5.0
Middle SES	3169	19.8	Head Start only	1817	12.6
High SES	7136	44.6	Other Early Childcare only	7654	53.0
			Attended neither type of early childcare	4247	29.4

Source: ECLS-K 1998-9

Table 2. Univariate Descriptive Statistics: Math Proficiency

	Kindergarten	First Grade	Third Grade	Fifth Grade	Eighth Grade
	%	%	%	%	%
Non-mastery of the lowest proficiency level	1.6	0.3			
Level 1: Number and shape	13.0	1.6	0.0	0.0	
Level 2: Relative size	29.3	4.8	0.1	0.0	
Level 3: Ordinality, sequence	38.0	21.5	4.5	1.2	0.6
Level 4: Addition/subtraction	14.8	47.9	18.8	5.3	1.4
Level 5: Multiplication/division	2.1	19.9	31.2	15.9	6.4
Level 6: Place value	0.1	3.9	29.3	33.6	21.6
Level 7: Rate and measurement	0.0	0.2	14.2	29.1	30.6
Level 8: Fractions			1.8	13.0	22.1
Level 9: Area and Volume			0.1	1.7	17.2
Total	18947	16129	14023	10881	8992

Source: ECLS-K 1998-9

Table 3. Early childcare attendance by Socioeconomic status

		Socioeconomic status in three		
		Low SES	Middle SES	High SES
Early Childcare Attendance	Had both types of early child care at some point	7.07%	4.52%	2.34%
	Head Start only	22.96%	9.97%	2.53%
	Other Early Childcare only	33.16%	53.71%	75.08%
	Attended neither type of early childcare	36.80%	31.80%	20.05%
Total		4255	2236	4743

Gamma=.037 p=.006

Source: ECLS-K 1998-9

Table 4. Kindergarten math achievement by SES

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C2 RC4 MATH HIGHEST PROF LVL MASTERED	NON-MASTERY OF THE LOWEST PROFICIENCY LEVEL	2.99%	1.18%	0.39%
	LEVEL 1: NUMBER AND SHAPE	22.23%	10.05%	4.81%
	LEVEL 2: RELATIVE SIZE	35.42%	31.61%	21.64%
	LEVEL 3: ORDINALITY, SEQUENCE	30.16%	41.93%	44.96%
	LEVEL 4: ADDITION/SUBTRACTION	7.34%	13.42%	23.36%
	LEVEL 5: MULTIPLICATION/DIVISION	0.51%	1.14%	4.07%
	LEVEL 6: PLACE VALUE	0.02%	0.07%	0.27%
	LEVEL 7: RATE AND MEASUREMENT	0.00%	0.00%	0.01%
	Total	5285	2974	6739

Gamma=.451 p<.001

Source: ECLS-K 1998-9

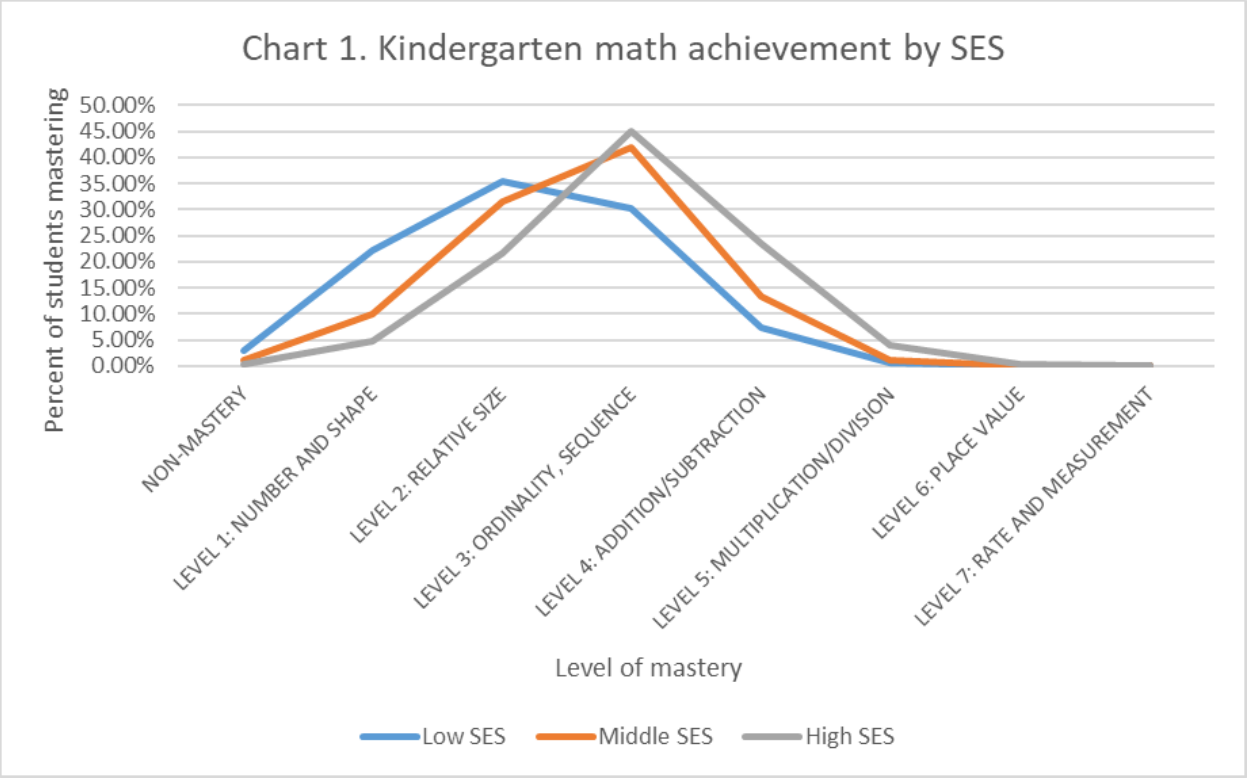

Table 5. Kindergarten math achievement by SES for students who attended Head Start

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C2 RC4 MATH HIGHEST PROF LVL MASTERED	NON-MASTERY	4.18%	2.42%	0.89%
	LEVEL 1: NUMBER AND SHAPE	25.93%	18.84%	13.39%
	LEVEL 2: RELATIVE SIZE	37.25%	42.51%	40.18%
	LEVEL 3: ORDINALITY, SEQUENCE	25.27%	29.47%	33.04%
	LEVEL 4: ADDITION/SUBTRACTION	6.48%	6.76%	11.61%
	LEVEL 5: MULTIPLICATION/DIVISION	0.88%	0.00%	0.89%
	Total	910	207	112

Gamma=.176 p<.001

Source: ECLS-K 1998-9

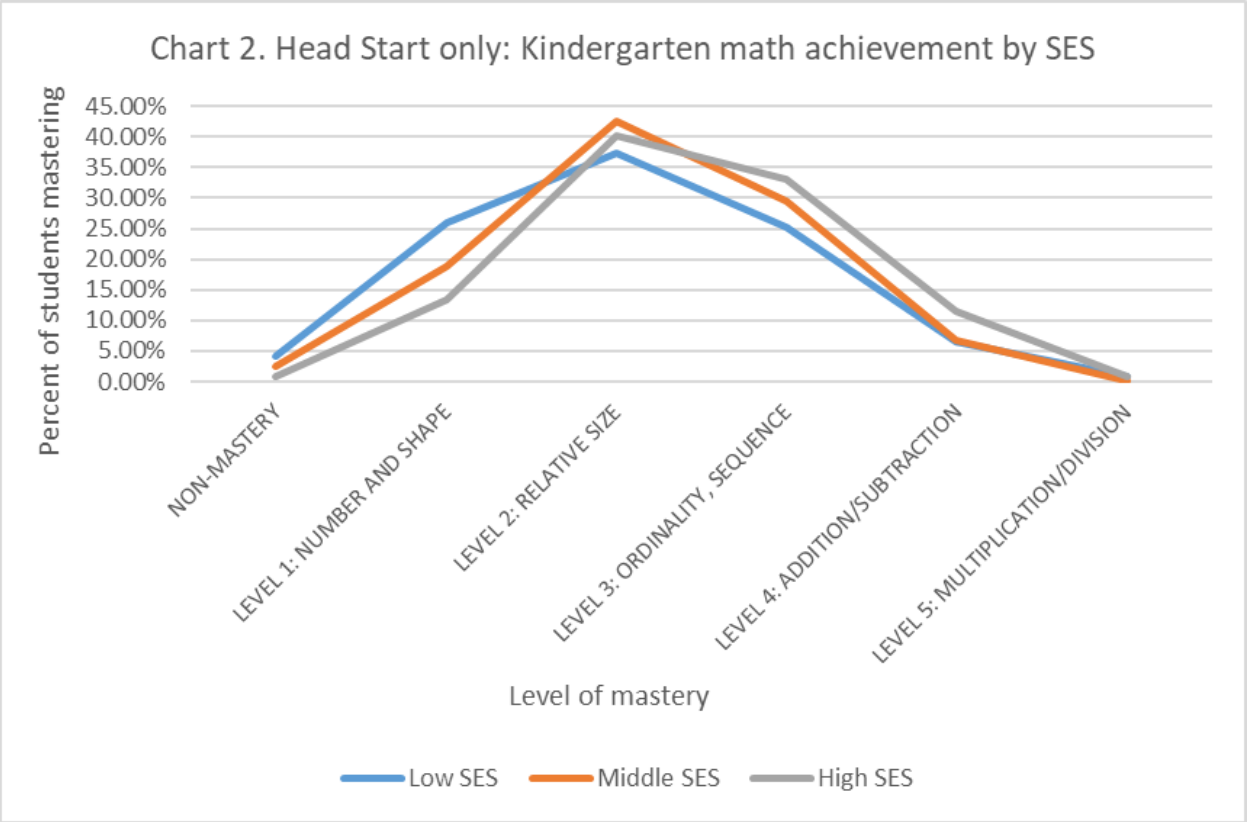

Table 6. First grade math achievement by SES

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C4 RC4 MATH HIGHEST PROF LVL MASTERED	NON-MASTERY	0.46%	0.17%	0.07%
	LEVEL 1: NUMBER AND SHAPE	3.21%	1.05%	0.40%
	LEVEL 2: RELATIVE SIZE	8.44%	3.74%	1.72%
	LEVEL 3: ORDINALITY, SEQUENCE	29.24%	21.86%	14.20%
	LEVEL 4: ADDITION/SUBTRACTION	46.74%	52.38%	46.92%
	LEVEL 5: MULTIPLICATION/DIVISION	10.18%	17.37%	29.87%
	LEVEL 6: PLACE VALUE	1.66%	3.26%	6.48%
	LEVEL 7: RATE AND MEASUREMENT	0.06%	0.17%	0.33%
	Total	5167	2942	6682

Gamma=.419 p<.001

Source: ECLS-K 1998-9

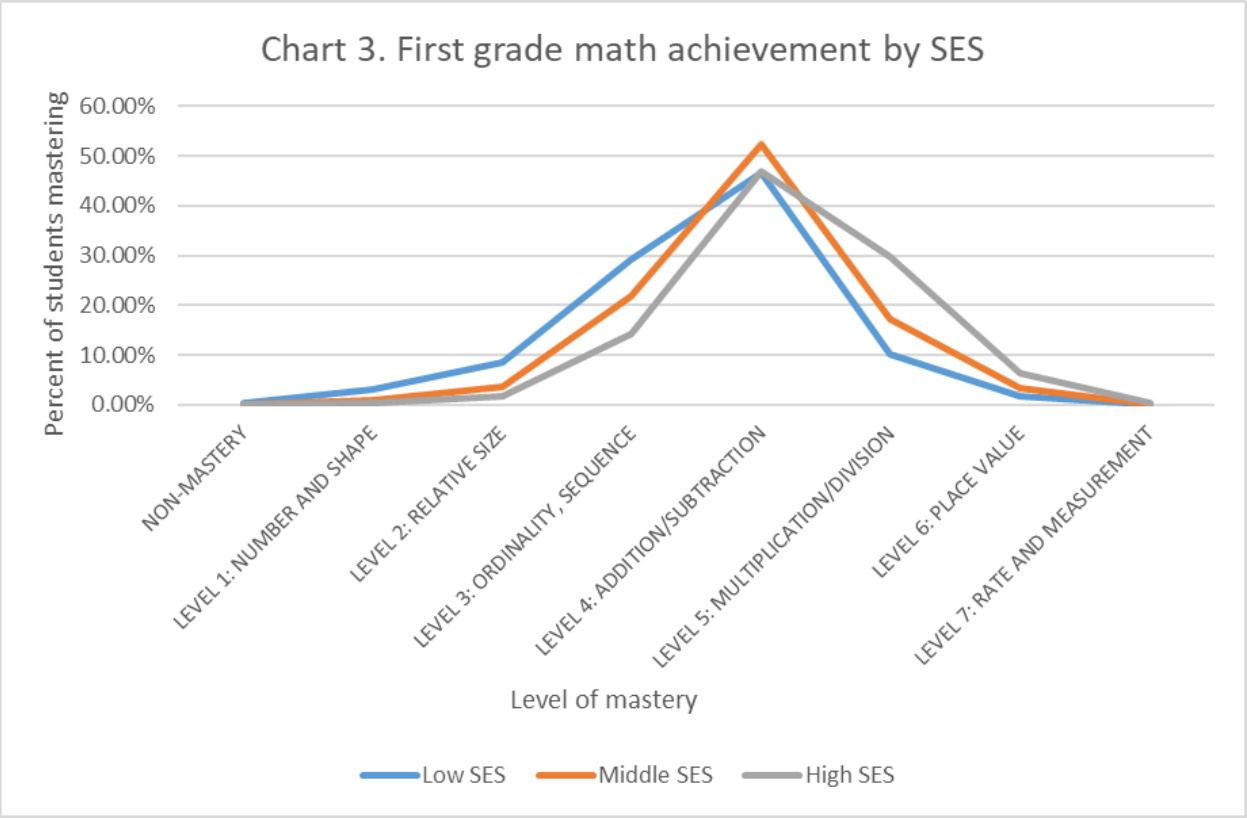

Table 7. First grade math achievement by SES for students who attended Head Start

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C4 RC4 MATH HIGHEST PROF LVL MASTERED	NON-MASTERY	0.89%	0.50%	0.00%
	LEVEL 1: NUMBER AND SHAPE	3.57%	0.50%	2.75%
	LEVEL 2: RELATIVE SIZE	10.81%	6.03%	6.42%
	LEVEL 3: ORDINALITY, SEQUENCE	32.22%	32.16%	25.69%
	LEVEL 4: ADDITION/SUBTRACTION	43.70%	50.75%	53.21%
	LEVEL 5: MULTIPLICATION/DIVISION	7.69%	9.55%	11.01%
	LEVEL 6: PLACE VALUE	1.11%	0.00%	0.92%
	LEVEL 7: RATE AND MEASUREMENT	0.00%	0.50%	0.00%
	Total	897	199	109

Gamma=.173 p<.001

Source: ECLS-K 1998-9

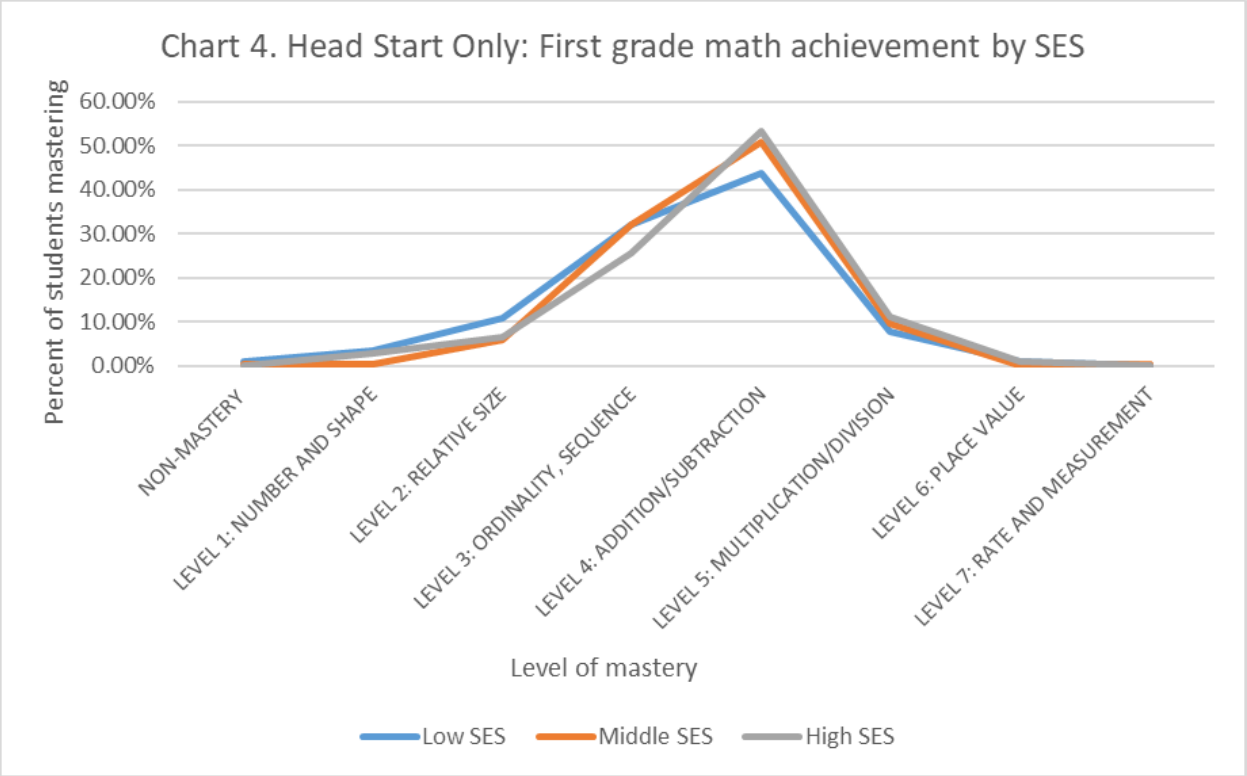

Table 8. Third grade math achievement by SES

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C5 RC4 MATH HIGHEST PROF LVL MASTERED	LEVEL 1: NUMBER AND SHAPE	0.05%	0.00%	0.00%
	LEVEL 2: RELATIVE SIZE	0.14%	0.08%	0.00%
	LEVEL 3: ORDINALITY, SEQUENCE	7.90%	4.02%	1.69%
	LEVEL 4: ADDITION/SUBTRACTION	27.16%	18.42%	11.06%
	LEVEL 5: MULTIPLICATION/DIVISION	36.22%	33.05%	26.18%
	LEVEL 6: PLACE VALUE	21.99%	30.78%	34.88%
	LEVEL 7: RATE AND MEASUREMENT	5.96%	12.41%	22.62%
	LEVEL 8: FRACTIONS	0.59%	1.25%	3.23%
	LEVEL 9: AREA AND VOLUME	0.00%	0.00%	0.34%
	Total	4415	2563	5852

Gamma=.406 p<.001

Source: ECLS-K 1998-9

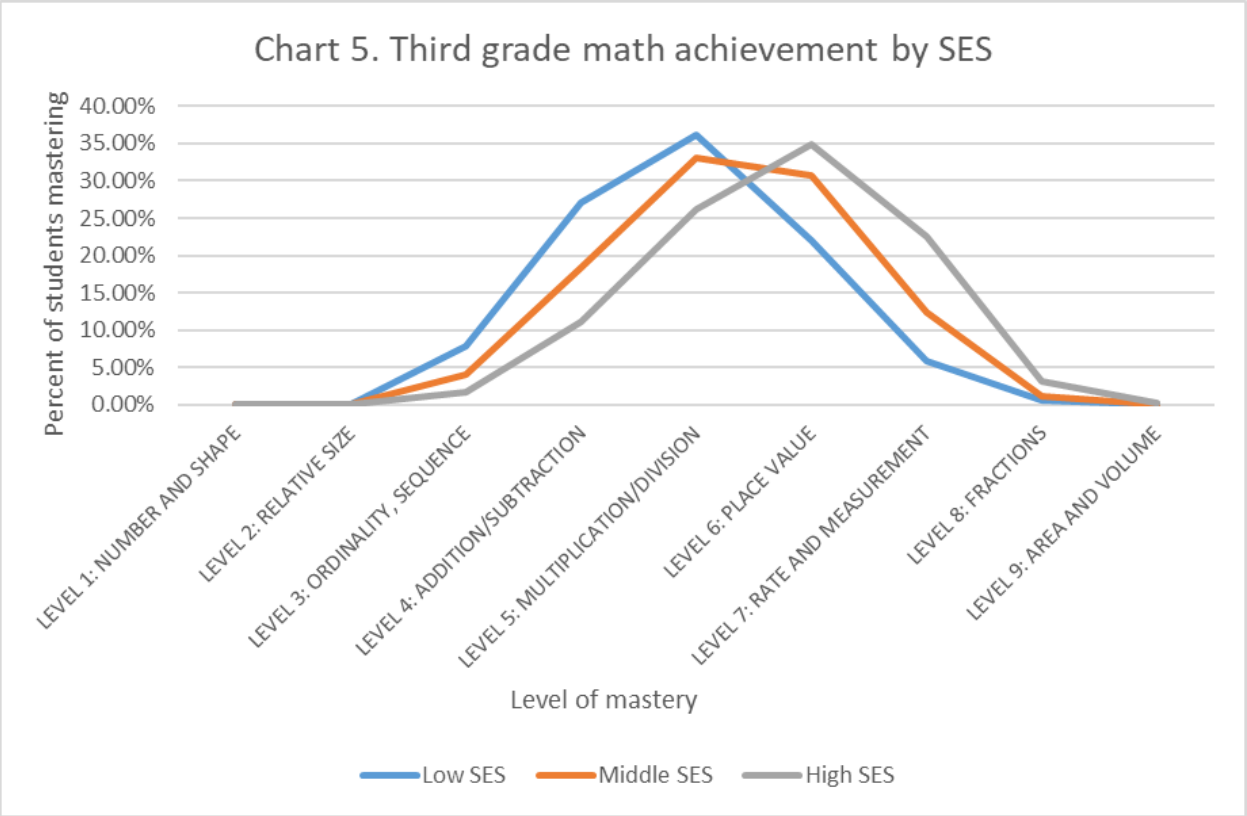

Table 9. Third grade math achievement by SES for students who attended Head Start

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C5 RC4 MATH HIGHEST PROF LVL MASTERED	LEVEL 2: RELATIVE SIZE	0.40%	0.57%	0.00%
	LEVEL 3: ORDINALITY, SEQUENCE	11.66%	6.82%	3.19%
	LEVEL 4: ADDITION/SUBTRACTION	29.36%	27.27%	23.40%
	LEVEL 5: MULTIPLICATION/DIVISION	36.19%	40.91%	45.74%
	LEVEL 6: PLACE VALUE	17.43%	17.61%	14.89%
	LEVEL 7: RATE AND MEASUREMENT	4.56%	6.25%	11.70%
	LEVEL 8: FRACTIONS	0.40%	0.57%	1.06%
	Total	746	176	94

Gamma=.155 p<.001

Source: ECLS-K 1998-9

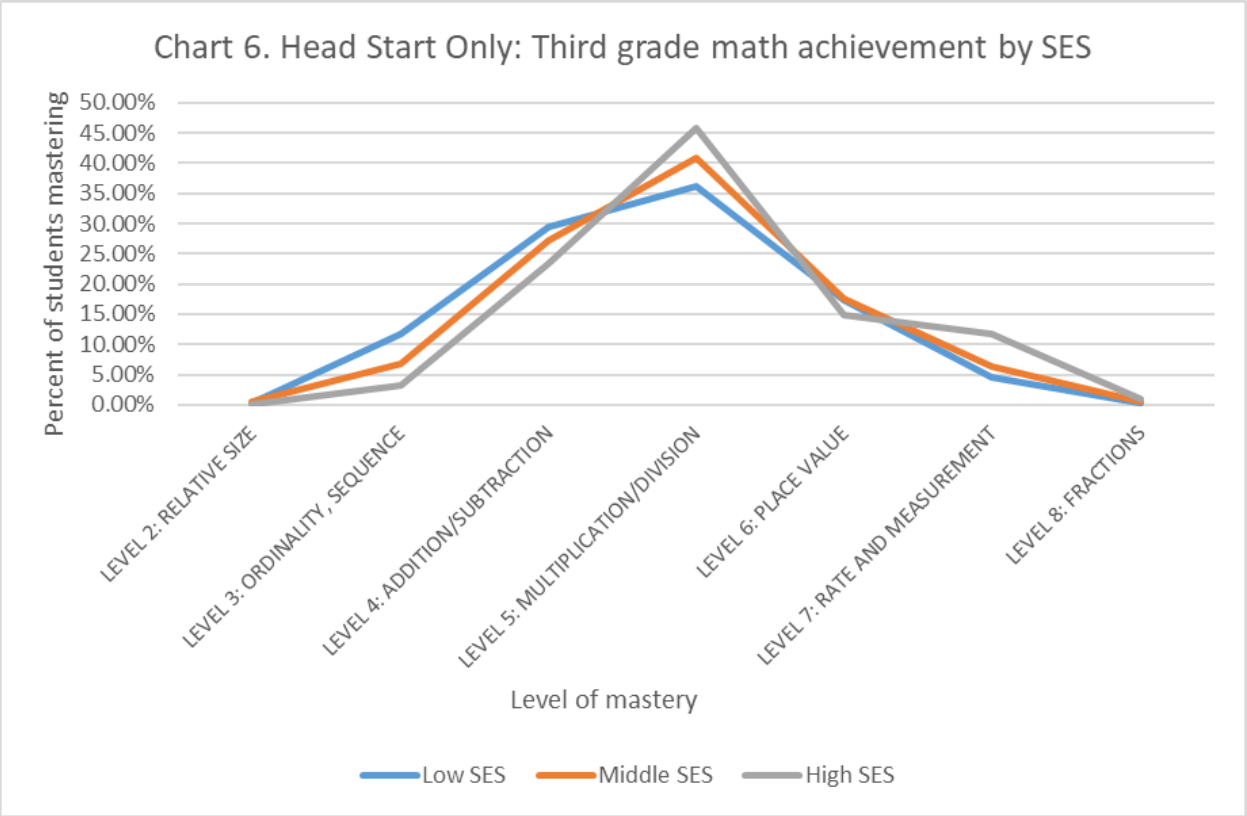

Table 10. Fifth grade math achievement by SES

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C6 RC4 MATH HIGHEST PROF LVL MASTERED	LEVEL 1: NUMBER AND	0.03%	0.00%	0.00%
	LEVEL 2: RELATIVE SIZE	0.06%	0.05%	0.00%
	LEVEL 3: ORDINALITY, SEQUENCE	2.33%	0.84%	0.46%
	LEVEL 4: ADDITION/SUBTRACTION	9.54%	4.21%	2.11%
	LEVEL 5: MULTIPLICATION/DIVISION	23.93%	16.71%	8.45%
	LEVEL 6: PLACE VALUE	37.22%	36.09%	29.17%
	LEVEL 7: RATE AND MEASUREMENT	20.76%	31.73%	35.61%
	LEVEL 8: FRACTIONS	5.64%	9.57%	20.90%
	LEVEL 9: AREA AND VOLUME	0.49%	0.79%	3.31%
	Total	3439	2017	4594

Gamma=.426 p<.001

Source: ECLS-K 1998-9

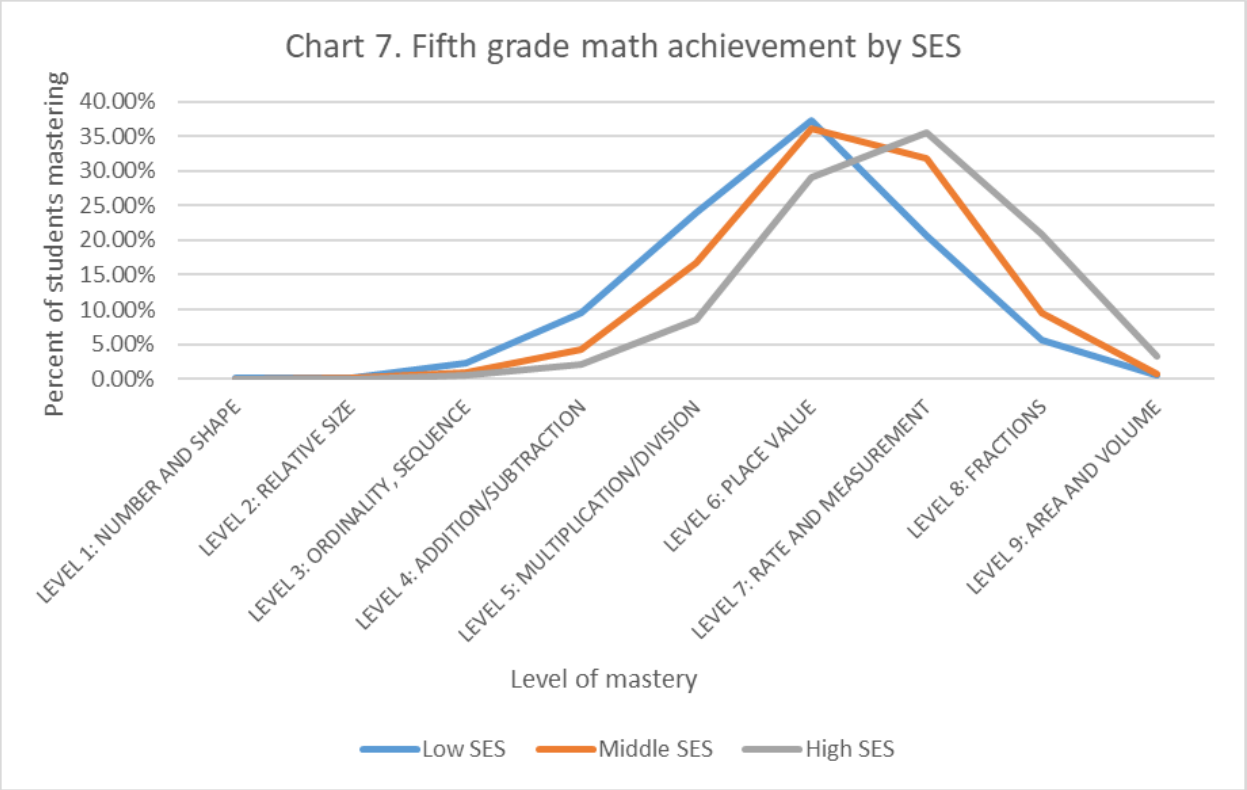

Table 11. Fifth grade math achievement by SES for students who attended Head Start

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C6 RC4 MATH HIGHEST PROF LVL MASTERED	LEVEL 3: ORDINALITY,	4.20%	2.04%	4.29%
	LEVEL 4: ADDITION/SUBTRACTION	11.95%	9.52%	5.71%
	LEVEL 5: MULTIPLICATION/DIVISION	27.63%	27.89%	25.71%
	LEVEL 6: PLACE VALUE	37.16%	33.33%	38.57%
	LEVEL 7: RATE AND MEASUREMENT	13.89%	22.45%	18.57%
	LEVEL 8: FRACTIONS	4.36%	4.76%	7.14%
	LEVEL 9: AREA AND VOLUME	0.81%	0.00%	0.00%
	Total	619	147	70

Gamma=.123 p=.024

Source: ECLS-K 1998-9

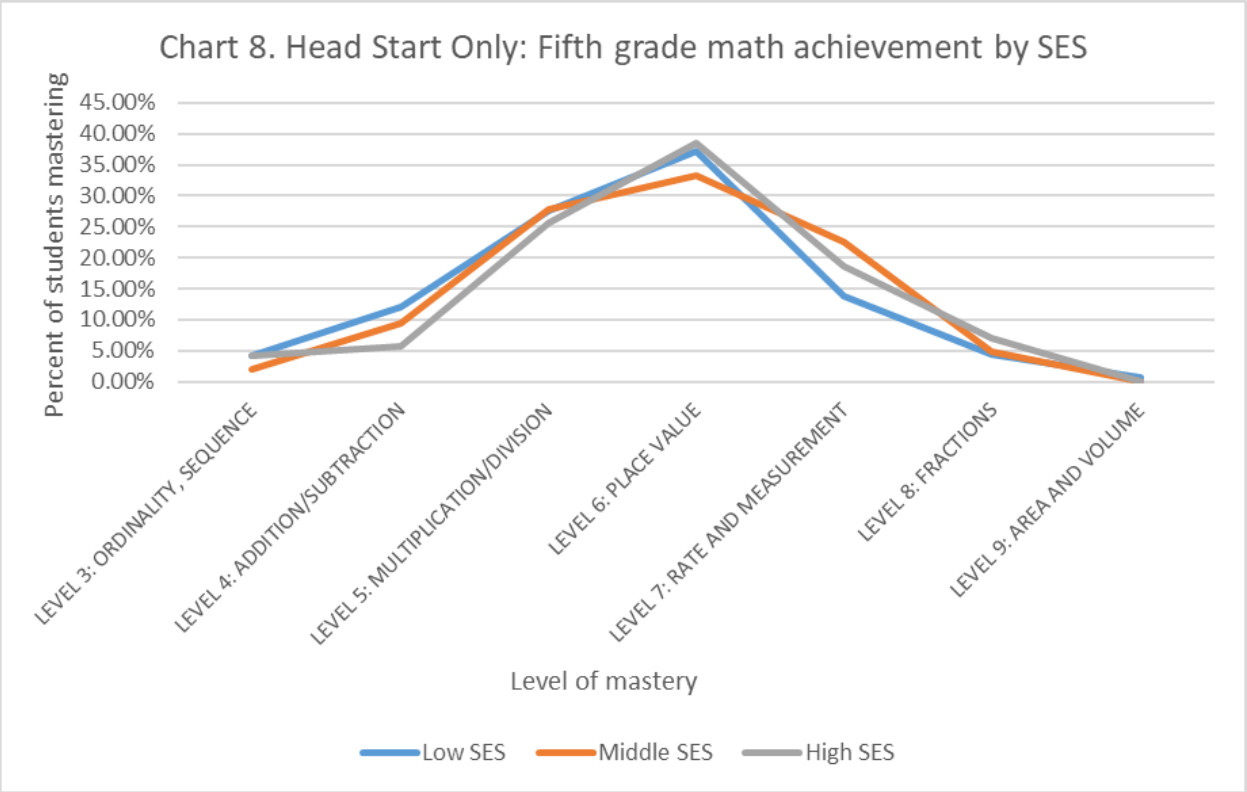

Table 12. Eighth grade math achivement by SES

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C7 RC4 MATH HIGHEST PROF LVL MASTERED	LEVEL 3: ORDINALITY,	0.96%	0.88%	0.20%
	LEVEL 4: ADDITION/SUBTRACTION	2.98%	0.88%	0.42%
	LEVEL 5: MULTIPLICATION/DIVISION	12.39%	5.49%	2.41%
	LEVEL 6: PLACE VALUE	31.22%	22.01%	14.20%
	LEVEL 7: RATE AND MEASUREMENT	31.63%	36.66%	27.56%
	LEVEL 8: FRACTIONS	13.79%	21.54%	28.62%
	LEVEL 9: AREA AND VOLUME	7.02%	12.55%	26.60%
	Total	2719	1713	4071

Gamma=.438 p<.001

Source: ECLS-K 1998-9

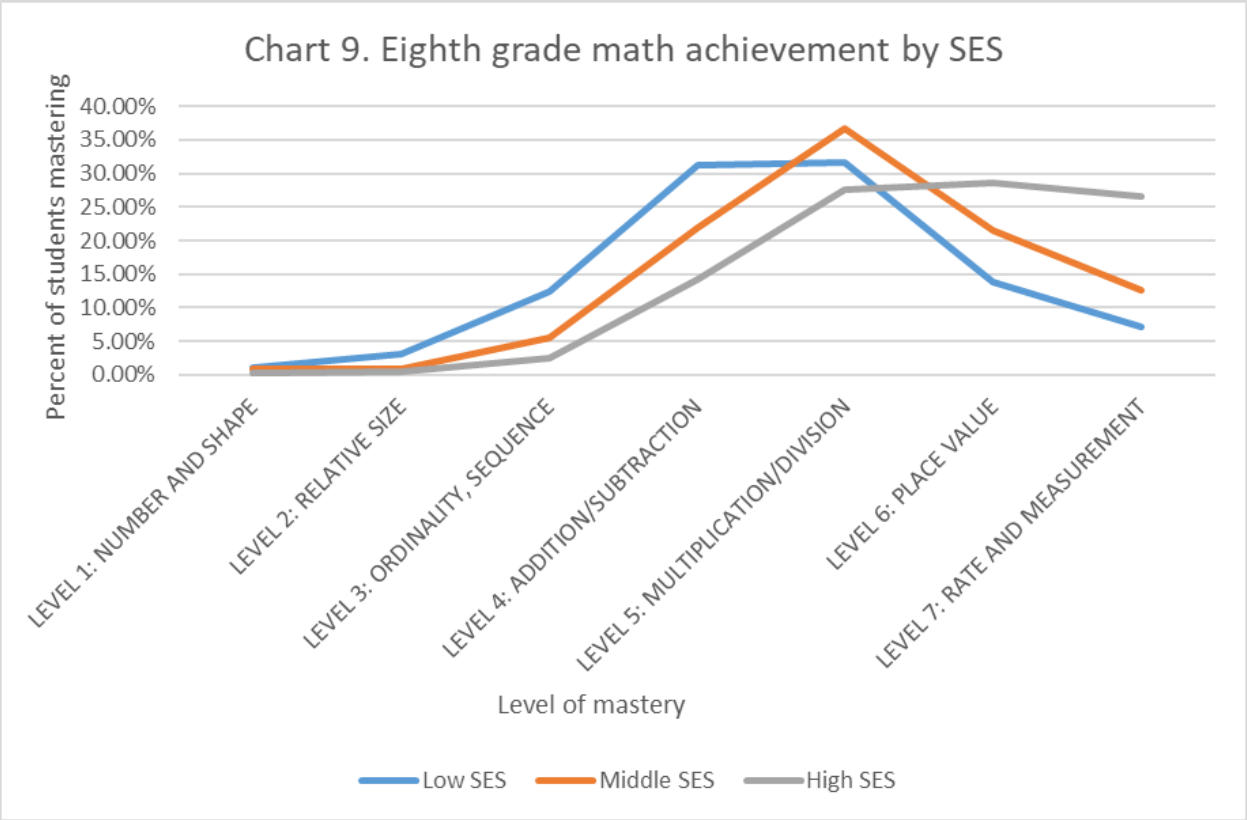

Table 13. Eighth grade math achievement by SES for students who attended Head Start

		Socioeconomic status in three categories		
		Low SES	Middle SES	High SES
C7 RC4 MATH HIGHEST PROF LVL MASTERED	LEVEL 3: ORDINALITY,	1.64%	2.65%	0.00%
	LEVEL 4: ADDITION/SUBTRACTION	4.70%	3.54%	1.64%
	LEVEL 5: MULTIPLICATION/DIVISION	14.93%	11.50%	11.48%
	LEVEL 6: PLACE VALUE	35.58%	27.43%	32.79%
	LEVEL 7: RATE AND MEASUREMENT	26.79%	34.51%	39.34%
	LEVEL 8: FRACTIONS	10.84%	9.73%	8.20%
	LEVEL 9: AREA AND VOLUME	5.52%	10.62%	6.56%
	Total	489	113	61

Gamma=.138 p=.019

Source: ECLS-K 1998-9

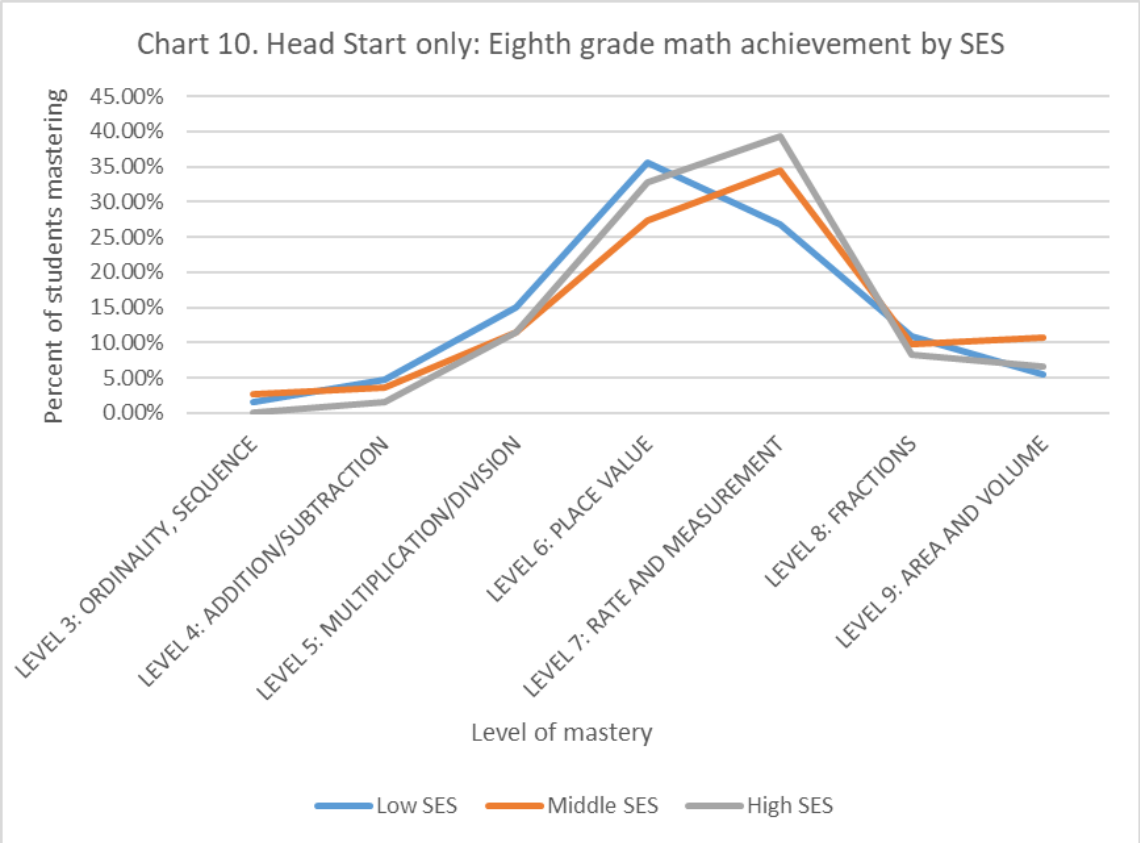
Chart 10. Head Start only: Eighth grade math achievement by SES
Percent of students mastering
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
LEVEL 3: ORDINALITY, SEQUENCE
LEVEL 4: ADDITION/SUBTRACTION
LEVEL 5: MULTIPLICATION/DIVISION
LEVEL 6: PLACE VALUE
LEVEL 7: RATE AND MEASUREMENT
LEVEL 8: FRACTIONS
LEVEL 9: AREA AND VOLUME
Level of mastery
Low SES
Middle SES
High SES

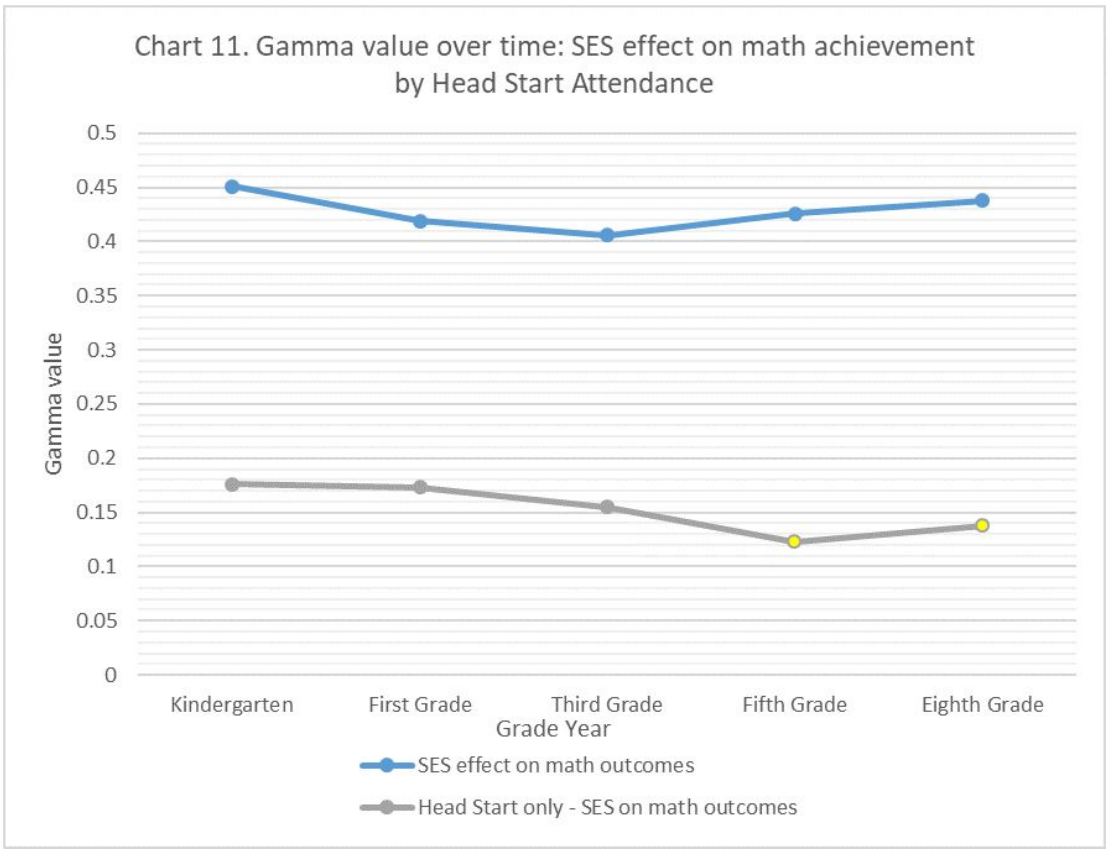
Chart 11. Gamma value over time: SES effect on math achievement by Head Start Attendance
Gamma value
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Kindergarten
First Grade
Third Grade
Fifth Grade
Eighth Grade
Grade Year
SES effect on math outcomes
Head Start only - SES on math outcomes