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U.S. National and State Trends in Educational Inequality due to Socioeconomic Status: Evidence From the 2003–17 NAEP

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Executive Summary

Educational inequality due to family socioeconomic status (SES) has been the focus of both public dialogue and education research in the United States for many years. For example, at the beginning of the century, Gamoran (2001) made the dire prediction that in the United States educational inequality based on SES would remain unchanged over the 21st century. This prediction was based on both past trends and the assumption that the education system would not change dramatically to counteract this trend. But how does this prediction line up with empirical evidence? Some empirical studies have examined the national trend using different national representative datasets but haven't reached a conclusion (Reardon 2011; Hanushek et al. 2020). The current study aims to revisit the national trend in educational inequality due to family SES and to extend the investigation into 50 states/jurisdictions by answering the following two research questions:

1. Has the socioeconomic achievement gap changed over time nationally in the United States and by state?
2. Has the performance of low-SES students improved over time?

Data from the National Assessment of Educational Progress (NAEP) grade 8 mathematics assessment were used for the analyses. To answer the first research question, the mathematics achievement gap between high- and low-SES students was calculated for each cycle of NAEP between 2003 and 2017. At the national level, the SES achievement gap has remained the same over time. State-level results suggest that 34 of the 50 states' SES achievement gaps experienced no significant change between 2003 and 2017, 14 gaps widened, and only two SES gaps narrowed.

To answer the second research question, the percentages of low-SES students achieving at or above the *NAEP Basic* achievement level as well as at or above the *NAEP Proficient* achievement level were analyzed. At the national level, more low-SES students achieved at the *NAEP Basic* and at the *NAEP Proficient* levels over time. Specifically, between 2003 and 2017, the percentage of low-SES students who achieved at or above the *NAEP Basic* level increased from 41 percent to 46 percent and the percentage who achieved at or above the *NAEP Proficient* level increased from 8 percent to 12 percent. State-level results indicate that 32 out of 50 states showed increases in the percentage of low-SES students achieving at or above the *NAEP Basic* achievement level, 4 states had no change, and 14 showed decreases. Similarly, regarding changes in states' percentages of low-SES students performing at or above *NAEP Proficient* between 2003 and 2017, 43 states showed various degrees of increases, 2 states exhibited no change, and 5 states observed decreases.

In addition, the study collected trend data on states' macro-level indicators, including economic growth, social inequality, and educational expenditures, allowing state-specific findings to be presented in the context of changes in macro-level context. Exploratory analysis of the possible associations between changes in macro-level indicators and the SES achievement gap trends was conducted as well.

In summary, the current study, using NAEP mathematics grade 8 data, investigates changes in educational inequality due to family SES in the United States and to what extent low-SES

students' performance improved between 2003 and 2017. The findings contribute to the existing literature not only by reflecting on national trends using an effective SES index, but also by providing state-level results that are presented together with contextual data and described in detail for 13 states/jurisdictions: Arizona, California, the District of Columbia, Georgia, Hawaii, Massachusetts, Mississippi, New Jersey, New Mexico, Ohio, Pennsylvania, Tennessee, and Texas. Initial explorations of relationships between state SES achievement gap trends and relevant factors are presented to motivate future research.

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Background

Introduction

In 2001, Adam Gamoran predicted that educational inequality due to differences in socioeconomic status (SES) in the United States would be maintained through the end of the century (Gamoran 2001). This prediction was based on both past trends and the assumption that the education system will not change dramatically to counteract this trend. How does it line up with the empirical evidence so far?

Surprisingly, very few studies have examined trends in educational inequality in the United States over long time periods. Robert D. Putnam's (2016) recent book*, Our kids: The American Dream in Crisis*, is one important work aiming to answer this question by providing a broader picture of how families, parenting, and schooling have changed over the past half century. It is a book of stories comparing two generations, with a focus on the changing dynamic in class-based opportunity gaps. It is also a book synthesizing previous literature on socioeconomic inequality and pointing to a widening gap between young people from different social classes over time.

First, the author presents how family structure has changed differently for people with different education levels over time. For example, college-educated women now typically delay their marriage and childbearing until a later age compared to their counterparts of a half century ago. Yet women with high school degrees or less education tend to enter marriage or start childbearing at a younger age, similar to their peers 50 years ago (p. 65). Therefore, there has been an increasing gap in the median age of mothers at first birth between women with higher and lower education levels over time. This widening age gap may influence how well-prepared parents are for having children and how many resources these parents can provide for their children in the future.

Second, in terms of changes in parenting style, Putnam illustrated how the dominant idea has shifted from "permissive parenting" to "intensive parenting," which is more time-consuming and more expensive (p. 117). The overall frequency of having dinner together as a whole family, as an example, has been declining since 1975. The decline, however, has been much faster for families with less educated parents than for those with college-educated parents (p. 124). Similarly, in terms of spending on children's education, all families more or less increased their spending over time. However, compared to each group's counterparts in 1975, families at the top decile of household income distribution had a much bigger increase in spending than families at lower deciles in 2010 (p. 126) (Kornrich and Furstenberg 2013). Therefore, in terms of parental involvement and parental investment, the class-based gap has been widening over time, which as a result may also influence the achievement gap.

Third, Putnam found that there was a growing gap between children from different socioeconomic backgrounds in terms of participation in school-related activities. For example, between 1970 and 2010, students from affluent families consistently participated in extracurricular activities, as shown by high participation rates over time. Moreover, students from poorer backgrounds tended to participate less than their more privileged counterparts did (p. 177). This may translate into a further widening of the achievement gap because organized extracurricular activities, as an important aspect of concerted cultivation, have been found to facilitate students' learning outcomes (Lareau 2011).

In short, Putnam provided a series of portraits of how privileged and less privileged families have diverged in resources over time. In almost every aspect, children from affluent backgrounds now have more advantages than their equally affluent counterparts from the past, while children from poorer backgrounds do not have any more advantages than their earlier counterparts. Therefore, the author argues that these changes may have contributed to a widening achievement gap between children from different socioeconomic backgrounds. This particular argument was based partially upon sociologist Sean Reardon's investigation into U.S. achievement gaps between students at the top and bottom 10th percentiles of family income distribution across multiple cohorts, which concluded that income achievement gaps were widening over time (Reardon 2011).

A recent publication by Hanushek and colleagues (2020), however, disagrees with Reardon's finding that income achievement gaps have been growing. The authors traced the achievement of U.S. student cohorts born between 1954 and 2011 by using national and international assessment data and found that the SES achievement gap has been stagnant for almost half a century. Correspondingly, Broer, Bai, and Fonseca (2019) analyzed 20 years of TIMSS data and found no significant changes in the mathematics achievement gap between students at the top and bottom quartiles of SES in the United States.

Reflecting upon the mixed findings at the national level, the current study extends the question of whether the U.S. socioeconomic achievement gap has changed over time to 49 U.S. states and the District of Columbia. It is reasonable to hypothesize that not all states follow the same national trend and that there may be more nuances in the SES achievement gap trend across states. The results may help states gain awareness of how other states are addressing educational inequality and what can be learned from them.

Literature Review

Educational Inequality by Family SES

Educational inequality exists in both educational opportunities and educational outcomes (Van de Werfhorst and Mijs 2010). Inequality of educational opportunities presents itself as young people from different socioeconomic backgrounds getting onto the educational ladder at different places, given equal merit (Putnam 2016). Inequality of educational outcomes, in contrast, is usually reflected by a strong association between family socioeconomic status (SES) and students' educational outcomes (Nonoyama-Tarumi 2008; Sirin 2005). The magnitude of such association is contingent on social contexts and is subject to change.

In the United States, it is established in the literature that family socioeconomic status (SES) is positively associated with academic achievement (Sirin 2005). Although public schools have been widely seen as the great equalizer in society, schools play only a minor role in creating or reducing inequality of educational opportunities and outcomes (Heckman 2012; Growe and Montgomery 2003). Inequalities in children's academic performance are substantial as children begin school (Lee and Burkam 2002), and these gaps are preserved as children progress through school (Reardon 2011).

As shown in Unequal Childhoods (Lareau 2011), the achievement gap gets larger as children grow up, mainly due to differences in family socioeconomic status. Middle-class parents tend to adopt "concerted cultivation," which features active parental involvement, scheduled extracurricular activities, the use of reasoning language at home, and more interventions in institutions. In contrast, working-class parents are more likely to side with the natural growth model, which presents less organized daily activities, more use of directive language at home, more dependence on institutions, and more conflict in child-rearing practices at home and at school.

In light of the extremely important role of family SES, education policies have focused on disadvantaged students, with the aim of closing the achievement gap through school reforms. Since 2000, the No Child Left Behind Act has targeted the lowest performing schools in each state and strongly advocated for equity for disadvantaged subgroups, including students across race/ethnicity, SES, gender, immigration status, disability status, and English language learner subgroups (Mitra 2018). With the Race to the Top in the Obama administration, legislation continued to focus on higher state education standards and the improvement of low-performing schools to address educational inequality (Mitra 2018).

However, as mentioned earlier, the previous literature (Broer, Bai, and Fonseca 2019; Chmielewski 2019; Hanushek et al. 2020; Reardon 2011) presents mixed findings in terms of whether or not educational inequality due to family SES has been lessening over time at the national level. Here we provide a detailed review of each study to illustrate its employment of data, measure of family SES, and findings.

In the first study, one of the earliest efforts, Reardon (2011) used data from 19 national and international assessments to examine the U.S. achievement gap between students at the top and bottom 10th percentiles of family income distribution across multiple cohorts from the early 1940s to 2001. The income achievement gap was found to be widening, roughly 30 to 40 percent, over the latter decades. In addition, the author examined the achievement gap between students with highly and less educated parents and found that, in contrast, the parent education achievement gap had not changed over the last 50 years.

In the second study, Broer and his colleagues (2019) analyzed 20 years of data from the Trends in International Mathematics and Science Study (TIMSS) for 13 education systems and investigated how the SES achievement gap had changed between 1995 and 2015. The measure of SES used in the study was a summative index, composed of parental education and home possession items, that was common across different cycles of TIMSS. They found no significant changes in the mathematics achievement gap between students at the top and bottom quartiles of SES in the United States. But there was a slight reduction in the SES achievement gap for science over the same period of time.

In the third study, Chmielewski (2019) employed multiple international large-scale assessments, including the First International Mathematics Study (FIMS), the Program for International Student Assessment (PISA), the Progress in International Reading Literacy Study (PIRLS), and

TIMSS, to track SES achievement gaps over the last 50 years. For the U.S. data, parents' education, a categorical variable, was adopted as the SES measure. The results showed a small decline in the parent education achievement gap over this time period.

Lastly, Hanushek and his colleagues (2020) used data from NAEP, TIMSS, and PISA to examine changes in the SES achievement gap of U.S. student cohorts born between 1954 and 2011. Their SES index was constructed using the first principal component from a factor analysis of parental education and home possession items. The SES achievement gap was then calculated between students in the top and bottom SES quartiles. The results suggest that the SES achievement gap has been stagnant for almost half a century.

With these inconclusive findings at the national level, the need to investigate potential cross-state variations in the SES trend therefore increases. Also, since the U.S. education system is run primarily by state and local governments, as the U.S. Constitution designates education as a state responsibility (Spellings 2005), public school education varies widely across the country. Therefore, this study extends the question—has the U.S. socioeconomic achievement gap changed over time?—to 49 U.S. states and the District of Columbia. The next section further describes how states/jurisdictions differ from each other and how those differences may contribute to students' achievement and educational inequality in different ways.

State Differences

Primary and secondary schools in the nation fall into three types: public, private, and charter schools. Most U.S. K-12 schools are public schools—about 90 percent of all students attend public schools—but some states have larger percentages of charter or private schools compared to others (U.S. Department of Education 2018c, table 205.10; U.S. Department of Education 2018d, table 216.90).

While student achievement does vary across the three school types, this report focuses on public schools because they make up a much larger percentage of the nation's schools than either private schools or private schools. The characteristics of state education systems explained below, therefore, relate exclusively to the elementary and secondary public schools in the country. Also, due to the large role that states play in their K-12 education systems, this section examines the differences in state education systems that may contribute to differences by state in students' performance in general as well as educational inequality.

There are disadvantaged students in every state, but the magnitude of this disadvantaged population differs, as students' needs differ across states. The level and type of need can be influenced by a state's geography, economy, and demographic factors, such as population size, the percentage of English language learner students, and the percentage of students living in poverty. On average, for example, a public school student from Connecticut is more likely to come from an advantaged background than a student from a jurisdiction such as the District of Columbia, when considering state family poverty rates (U.S. Department of Education 2018a, table 102.40).

States differ on what they can offer their disadvantaged students, in terms of funding and resources, and their educational policies and programs can help or hurt these students. Therefore, differences in how states fund, manage, and organize their schools, and what is taught within those schools, contribute to differences in education among students. Specifically, there are three main factors that contribute to the differences among state education systems in the nation: (1) school governance and funding, (2) teacher workforce, and (3) learning standards and curricula. Each of these aspects influences disparities in education systems within and across states and can lead to inequalities within states. The following sections examines the three sources of educational disparities among the 50 U.S. states and the District of Columbia.

School Governance and Funding. All U.S. K-12 public school systems have the same basic structure. Every state legislature has a state education department, along with laws regulating school finance, compulsory education, and teaching requirements. The state education department's power is mediated by a state board of education, which most, but not all, states have (Corsi-Bunker 2019). The state board of education oversees the state education department's education funding budget; sets regulations and policies, such as statewide learning standards; and establishes accountability programs (National Association of State Boards of Education 2018).

One of the most important and influential roles the state education department has is its determination of public-school funding. The amount each state spends on its students, or per pupil expenditure (PPE), comes from three sources: federal, state, and local dollars. Federal funds, on average, contribute only about 8 percent to states' overall K-12 education funds (U.S. Department of Education 2018k, table 235.20); thus, state and local funds make up the bulk of these funds. The average state government provides 47 percent of its schools' operating costs, either through income and sales tax revenues or lottery systems, and the average local government provides 45 percent of the funds, through property tax revenues (The Center for Public Justice 2019). A state's public-school funding system influences educational inequality in mainly two ways: (1) through its total amount of funding; and (2) through the division of funds within the state.

The amount of funding and resources going toward public education varies widely across states. In fact, the most recent data shows a range of $15,000 across the lowest and highest state PPEs (U.S. Department of Education 2018l, table 236.65). States that take in more money in general tend to spend more on education (Frohlich 2014). This disparity can put states like New Jersey or Massachusetts, with high median household incomes and per capita GDPs, and correspondingly, high PPEs, at an advantage compared to states with low ones, like Mississippi or Alabama. The disparity is significant, as studies show that increasing school funding would eliminate a significant proportion of the achievement gap (Jackson, Johnson, and Persico 2016).

To understand why PPE ranges so widely across the states, one must understand what goes into states' education funding. Many factors influence state spending on education, such as state size, labor costs, administrative costs, geography, and student demographics (Maciag 2018). A state such as Massachusetts, for example, with high teacher salaries and funding based on students' characteristics, spent $15,657 per student in 2014 (Lee et al. 2018; Will 2019), whereas Arizona, a state with overcrowded classrooms but also years of state budget cuts, spent only $8,465 per student in 2014[1] (Karlis 2018). These differences in state expenditure on K-12 public education alone contribute to inequalities across states, as states with higher PPEs have been associated with higher student achievement (Frohlich 2014).

Apart from the amount of education funding, the division and allocation of this funding can also contribute to inequalities across states, given that over 90 percent of public-school funds come from state and local revenues (U.S. Department of Education 2018k, table 235.20). Every state uses its own funding model to decide how much local governments contribute to K-12 education as opposed to how much the state government contributes (Ladd and Goertz 2015). States can also determine if their districts receive the same or different amounts of funds. Certain states, such as Hawaii, for example, rely only on state funds and have no property tax. Since Hawaii has only one school district in the entire state, and a flat funding system, each school receives equal funding, based on the number of students it serves (McFarland et al. 2019; Lynch 2016a). In contrast, in states that do not use flat funding systems, the amounts their districts receive differs. Nevada, for example has a regressive funding system, which means that lower income districts receive fewer funding dollars than higher income districts. Lower income districts try to make up for local property revenue discrepancies by taxing themselves at high rates, yet they cannot always raise the necessary funds, and states do not always help close these gaps (Education Law Center 2017). States such as Massachusetts, however, do make up for these funding gaps. Even though it has the same division of reliance on local versus state funds as Nevada (U.S. Department of Education 2018k, table 235.20), Massachusetts utilizes a progressive funding system, and so it funnels more money into lower income districts than into higher income districts (Baker, Farrie, & Sciarra, 2018). Given the association between state education spending and both student achievement (Frohlich 2014) and reduced achievement gaps (Jackson, Johnson, and Persico 2016), the variation in education funding across states, then, can certainly contribute to different levels of inequality across states.

Teacher workforce. Another way in which states' school systems differ is in the composition of their teacher workforce. First, states have different certification requirements for their K-12 public school educators. Some, such as Delaware, only require their primary and secondary teachers to have a bachelor's degree from a regionally accredited school, whereas others, such as California, require a bachelor's degree and the completion of a state-approved teacher preparation program (All Education Schools 2019). Given that student academic achievement has been shown to be improved by well-prepared, certified teachers, particularly those who trained at collegiate-based teacher preparation programs and are licensed by their state (American Association of Colleges for Teacher Education 2012), states with higher teacher preparation requirements may have an advantage in academic equality over those with lower requirements. Research also shows that teacher credentials tend to be unevenly distributed across student SES and that teachers with lower credentials (who, on average, teach lower income students) are associated with lower academic performance (Clotfelter, Ladd, and Vigdor 2010).

[1] When making state comparisons, PPE was adjusted using the Comparable Wage Index (CWI). See the detailed methodology documentation in Taylor, L.L., Glander, M., and Fowler, W.J. (2007). Documentation for the NCES Comparable Wage Index Data File, 2005 (EFSC 2007-397). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Another salient difference in the composition of states' teacher workforce is teacher education level. For example, according to the Schools and Staffing Survey, in 2013, 55 percent of Arkansas' teaching workforce had a bachelor's degree, whereas 35 percent had a master's degree (U.S. Department of Education 2018m, table 209.30). Contrast that with Connecticut, in which 15 percent of the teacher workforce had a bachelor's degree, compared to 64 percent with a master's degree. Advanced teaching degrees are associated with gains in student performance, and teachers with higher degrees are more likely to teach at higher income schools than at lower income ones (Betts, Zau, and Rice 2003). It is easy to see, then, how differences in the education level of the teacher workforce can further contribute to educational inequality across states.

Finally, states vary in their teachers' turnover and satisfaction rates. According to a 2012 analysis by the Learning Policy Institute, the teacher turnover rate ranged from 8 percent (in states such as Utah and West Virginia) to 24 percent (in states such as Arizona and New Mexico) (Carver-Thomas and Darling-Hammond 2017). Research shows that students in grade levels with high turnover rates have lower reading and math test scores than students in grade levels with low turnover rates, and, beyond the distribution of teacher quality, turnover creates a disruptive effect on school climate, even for students whose teachers remain in the schools with the high rates (Rondfeldt, Loeb, and Wyckoff 2013). Given that teacher turnover, on average, is higher in high-poverty schools than in low-poverty schools (Ingersoll 2001), differences in turnover rates can certainly contribute to educational inequality across states.

Additionally, teacher salaries vary widely across the country—with the range between the lowest and highest salaries for the 50 states and the District of Columbia reaching $39,300 in 2018 (Will 2019). In a WalletHub analysis of the teacher-friendliest states—based on satisfaction indicators such as salaries, but also including working conditions, career opportunities, and turnover—states such as New York, Connecticut, and Minnesota topped the list, whereas Hawaii, Arizona, and South Carolina ranked at the bottom (McCann 2019). While the research on the association between teacher satisfaction and student achievement has yielded mixed results (Banerjee et al. 2017), the differences in teacher working conditions across states, from teacher turnover rates to salaries, can contribute to the differing education systems across states.

Learning standards and curricula. One final factor that contributes to disparities among states' education systems is differences in learning standards and curricula across states and jurisdictions. The Every Student Succeeds Act (2015), the nation's national education law, requires each state to have "challenging" academic standards. Typically, each state education department creates the education standards and curricula, by grade and subject, and the state board of education approves them (Education Week 1995). However, although many states have adopted some form of the Common Core standards (Lee 2019), learning standards still vary widely. In a comparison of states' proficiency standards, the gap between states with the highest and lowest standards amounted to three to four grade levels of learning (Phillips 2014). Similarly, a research study that mapped states' proficiency standards onto the National Assessment of Educational Progress (NAEP) scales using state assessment results showed that states ranged a full achievement level (or 40 scale score points) from one another in their grade 8 reading standards (NCES 2018). This is significant because state standards shape state curricula (Lee 2019), and thus it could be postulated that states with lower educational standards develop different curricula than do states with higher standards. High-quality curricula are associated with higher academic achievement, and a strong curriculum has been shown to have a larger effect size than several other education reform efforts on student performance (Steiner 2017; Whitehurst 2009). Therefore, the disparities in state standards and curricula can lead to inequality between states.

All three factors mentioned above—school governance and funding, teacher workforce, and state learning standards and curricula—can affect educational inequality within a state. Each aspect both contributes to the amount of resources schools have to best serve their students and determines how the needs of that state's student population are met. Given how much these characteristics vary across states, this report, therefore, looks at trends across the 50 states/jurisdictions individually to see how their socioeconomic status achievement gaps fared over a period of 15 years, from 2003 to 2017. Those factors that can lead to differences across states' education systems are also those that, if put into place correctly, can help students succeed. In light of this, we examine individual states' achievement gaps in the context of educational system factors such as funding, teacher and student populations, and academic standards to contextualize our socioeconomic status gap results.

Educational Inequality Measures

In the literature, there have been extensive efforts made to measure educational inequality. Ferreira, Gignoux and Aran (2011) provided a comprehensive description of methods for measuring both inequality in achievement as well as in opportunity. After discussing different options and their properties, they concluded that the amount of variance explained (R^2) obtained from an ordinary least squares regression of students' test scores on a vector C of individual circumstances, such as students' demographic background and family background, is a meaningful summary statistic since it provides an estimate of the overall inequality explained by predetermined circumstances. However, there is a certain lack of sensitivity for R^2 (our team's prior work with NAEP data showed limited changes in the variance explained over time).

Another well-known and widely used measure is the Gini coefficient (Hao and Naiman 2010). It is a measure of inequality that shows the income or wealth distribution in a country by looking at the proportion of total income that is attributed to the cumulative percentage of the population. A Gini coefficient of 1 means maximal inequality—in that one person has all the income and others have none—while 0 means perfect equality. Researchers have applied this method to education by looking at the cumulative percentage of schooling years that is attributed to the cumulative percentage of the population (Thomas, Wang, and Fan 2001), and it could be applied to test scores as well.

While these indices are understood by methodologically sophisticated researchers, it is difficult to communicate the meaning of R^2 and Gini-based indices to those outside of the research community (Green, Green, and Pensiero 2015; Hao and Naiman 2010). We therefore decided against the use of R^2 or Gini-based measures for this project. This study proposes an empirical approach that would allow researchers and policymakers to track changes in the achievement gap as well as to communicate the findings with the public audience. The next section describes the data and methods used in the study as well as the potential technical challenges that we encountered.

Methods

Data

This study uses NAEP mathematics data for grade 8 students from 2003 to 2017. NAEP is administered every 2 years to collect student assessment data and to administer survey questionnaires. This study employs the overall mathematics scale scores and information from the student and school questionnaires. The analytical sample is limited to students enrolled in public schools in 49 states[2] and the District of Columbia. In the remainder of the report, we will refer to all 50 jurisdictions for simplicity as "states." In addition, students who were unable to be assessed, although sampled, were excluded from the reporting sample by NAEP and are thus not included in this study.

Methods

Constructing the SES Measure. In order to capture how students from different family backgrounds perform over time, a measure of family socioeconomic status was constructed using four common student background items across all years. They are (1) number of books at home; (2) student's eligibility for the National School Lunch Program (NSLP); (3) highest level of education of either parent; and (4) percentage of students eligible for NSLP at sampled schools. Numerical values were assigned to each category of these variables and a summative SES index was thus constructed with a range from 0 to 12 (i.e., a 13-point index). The index creation followed the same practice proposed and tested in two earlier research efforts on the construction and validation of a NAEP SES index using assessments from grade 12 (Broer, Xie and Bohrnstedt 2017) and grade 4 (Xie and Broer 2017). However, the previous index was not designed for trend analysis and thus is not compatible with earlier assessment cycles. The SES index generated in this study can be used in trend analyses starting as early as 2003 while retaining its effectiveness as an SES measure and its simplicity for communicating its meaning to the public.

Number of books at home. Students were asked to report how many books they have at home, using four categories: (0) 0-10 books; (1) 11-25 books; (2) 26-100 books; and (3) more than 100 books.

Student's eligibility for the NSLP. This variable indicates whether a student met the eligibility requirements for free or reduced-price lunch by assigning (0) for eligible and (3) for not eligible. The decision of assigning a 3 instead of a 1 for the non-eligible group of students was made upon the consideration that NSLP eligibility is an important income proxy variable and should be having the same weight as other variables, in spite of its binary nature.

Parent's highest level of education. This information is derived from two questions asking students about their father's and their mother's highest level of educational attainment and using the highest category of either parent in the SES measure. The four categories are (0) did not

[2] Alaska is excluded from the analysis because it does not have information on our key analytical variables (i.e., number of books at home and parental education level).

finish high school; (1) graduated from high school; (2) had some education after high school; and (3) graduated from college.

Percentage of students eligible for NSLP at sampled schools. This is a school-level variable that measures the relative poverty of students attending a school (Snyder and Musu-Gillette 2015). It functions as a school/neighborhood SES variable, the inclusion of which in an SES measure was one of the recommendations of the NAEP SES White Paper (Cowan et al. 2012). We grouped the original nine categories into four and assigned the following values to each category: (0) 76-100 percent; (1) 51-75 percent; (2) 26-50 percent; and (3) 0-25 percent. We assigned the lowest percentage to the highest value because a lower percentage of NSLP-eligible students indicates a higher average socioeconomic status of students in a school.

Defining High- and Low- SES groups. After constructing the SES index, we categorized students into high- and low-SES groups by establishing the 25th and 75th percentile cut-offs of the 13-point SES index. The challenge of defining top and bottom quartiles using this index comes from the nature of a categorical distribution. For example, table 1 shows that an index value of 5 corresponds to the 21.14th percentile of Indiana students in 2003, but a value of 6 points would be the 29.20th percentile, which makes it impossible to find the exact 25th percentile. In order to obtain a quartile group, we therefore decided to randomly split the sample of students that falls close to the top or bottom quartiles (e.g., students with an index value of 6 in the Indiana 2003 sample) and then combined them with a random sample from the adjacent group (e.g., students with an index value of 5 in the Indiana 2003 sample). This approach guarantees that the top and bottom categories always have about 25 percent of total students.

This strategy was applied to each state and year individually due to significant differences in the SES distribution across states as well as minor changes in the SES distribution over years. In considering between-state variations, we showed in a previous Task 14 memo that applying a common cut-off determined at the national level to individual states would generate unbalanced groups within states. For example, at the national level, an index value of 3 would correspond to about the 21st percentile of all students. However, when applying 3 points as a common cut-off for the low-SES group to individual states, we found only 5 percent of students in Vermont would be categorized into this group, compared to 30 percent of students in the District of Columbia.

Table 1. Weighted SES distribution, Indiana: 2003

Simple SES index	Freq.	Percent	Cumulative percent
0	14	0.52	0.52
1	34	1.27	1.79
2	75	2.84	4.63
3	96	3.63	8.26
4	140	5.28	13.53
5	**202**	**7.61**	**21.14**
6	**214**	**8.06**	**29.20**
7	226	8.51	37.7
8	320	12.04	49.74
9	359	13.53	63.26
10	336	12.65	75.91
11	387	14.57	90.48
12	253	9.52	100

NOTE: Results are based on one of the imputations.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003 Grade 8 Mathematics Assessment.

Also, the distribution of SES differs across years, suggesting the value of SES may not have the same meaning in two distinct years (see table 2), and the mean SES may change over time (appendix A). For example, in Indiana, a student with an SES value of 5 would be at the 22nd percentile among his or her peers in 2003 while in 2017 such a student would be at the 35th percentile. Therefore, it is of great importance to generate SES quartile groups for each state in every year rather than to use the same cut-off for a state across multiple years. Doing so also guarantees that changes in the SES achievement gap are always made between the top and bottom SES quartile groups of a state across years.

Table 2. Weighted distribution of SES, Indiana: 2003 and 2017

	2003			2017		
SES	Proportion	Std. Err.	Cumulative Percent	Proportion	Std. Err.	Cumulative Percent
0	1%	0.001	1%	1%	0.002	1%
1	1%	0.002	2%	4%	0.004	5%
2	3%	0.003	5%	5%	0.005	11%
3	4%	0.004	8%	8%	0.006	18%
4	6%	0.005	14%	8%	0.006	26%
5	8%	0.005	22%	9%	0.006	35%
6	8%	0.005	30%	9%	0.006	44%
7	9%	0.006	39%	8%	0.006	52%
8	12%	0.006	52%	9%	0.006	61%
9	14%	0.007	65%	10%	0.006	71%
10	12%	0.006	77%	12%	0.007	83%
11	14%	0.007	91%	11%	0.007	94%
12	9%	0.005	100%	6%	0.005	100%

NOTE: Results are based on 20 imputations.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003 and 2017 Grade 8 Mathematics Assessment

Multiple Imputation

Missing values in the SES component variables were imputed using chained equations, which is well known for its flexibility in handling different types of variables (Hughes et al. 2014). The relatively high rate of missing values for SES variables in NAEP is further complicated by their nested data structure (i.e., students are nested in schools). Missing values occurring at the school level apply to all students going to the same school. For example, suppose a key variable reported by a school (for example, the percentage of students eligible for NSLP) is missing at the school level. To address this issue, we used the mice package in R to simultaneously impute the missing value at both the student and school levels in one model. In total, 20 imputed datasets were generated and used for further analysis.

Analytical Approach

To address the first research question (whether the inequality in education outcomes due to SES has changed over time), we calculated the achievement gap in mathematics between students in low- and high-SES groups for the United States and individual states from 2003 to 2017. We also tested whether changes in the achievement gap between two cycles, those in 2003 and 2017, were statistically significant for each state. This statistical test was conducted by running the following regression model:

$$\widehat{Y_i} = \beta_0 + \beta_1(SES) + \beta_2(Year) + \beta_3(SES * Year) + \varepsilon_i \ ,$$

where $\widehat{Y_i}$ is the predicted mathematics score for student i in a given jurisdiction after controlling for other predictors; SES is a dummy variable, coded 1 for high-SES students and 0 for low-SES students; Year is a dummy variable with 1 indicating 2017 and 0 indicating 2003. Therefore, β_0 is the average achievement score for low-SES students in a given jurisdiction in 2003; β_1 is the mean score difference between low- and high-SES students in that jurisdiction in 2003; and β_2 is the coefficient for a categorical variable indicating the year of assessment, which shows the mean score difference between students who participated in 2017 and 2003 (i.e., the reference group), after controlling for SES. β_3 is the coefficient for an interaction term between SES and the assessment year. This reflects how much the achievement gap between low- and high-SES students in 2017 differs from the achievement gap in 2003; therefore, the p value for β_3 indicates whether the achievement gap in 2017 is statistically different from the achievement gap in 2003. Note that all plausible values were used to derive the average mathematics scores for the achievement gaps. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment.

We also show the trend of low-SES students' performance for every state from 2003 to 2017 by calculating corresponding percentages of students from low-SES backgrounds achieving at or above the *NAEP Basic* level as well as the *NAEP Proficient* level. This additional step helps us to uncover changes in addition to changes in the gaps. For instance, one state may show no change in the size of the gap over time because the performance of both high- and low-SES students did not change. But in another state, the gap may have not changed because both the lower and upper groups either improved or declined at a similar rate over time. Since gaps can become smaller or widen for different reasons, it is important to examine how the most disadvantaged students have been doing over time, which is what the second research question examines. Specifically, we plot the percentage of low-SES students that achieved at or above the *NAEP Basic* level (262 points for grade 8 mathematics) as well as the *NAEP Proficient* achievement level (299 points) for each state over time.

Finally, we collect contextual indicators at the state level for the same period of time and summarize changes in those indicators to better understand changes in SES achievement gaps over time. In general, we focus on changes in a state's overall income inequality and educational expenditure. Table 3 describes the indicators and provides the data sources for each indicator.

Table 3. Sources for state-level indicators

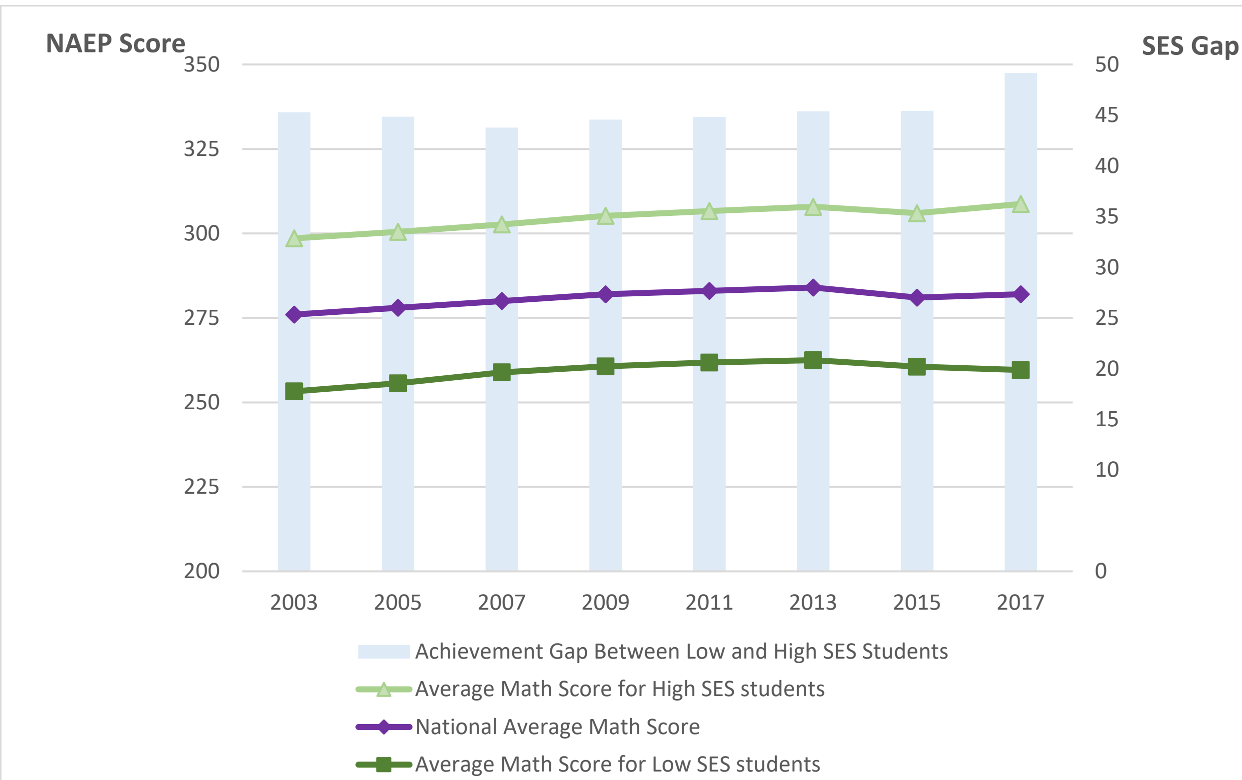
Indicator	Definition	Source	Link
Child Poverty Level	The share of children under the age of 18 who live in families with incomes below the federal poverty level.	U.S. Census Bureau, American Community Survey	https://datacenter.kidscount.org/data/tables/43-children-in-poverty-100-percent-poverty
Per Pupil Expenditure (constant 2017-2018 USD)	Total expenditures for the regular school term divided by the total number of students registered in a given school unit at a given time, adjusted for inflation.	U.S. Department of Education, National Center for Education Statistics	https://nces.ed.gov/programs/digest/d18/tables/dt18_236.65.asp
Per Capita GDP (Chained 2012 dollars)	The value of the goods and services produced in a state or jurisdiction, divided by the resident population of that state or jurisdiction and adjusted for inflation.	U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Census Bureau	https://www.bea.gov/data/gdp/gdp-state
Top 10 percent share pretax state income	Pretax state income share held by the 10th percentile group in a state or jurisdiction.	The World Inequality Database	http://wid.world/data/
Gini Coefficient	A summary measure of income inequality in a state or jurisdiction, ranging from zero, which indicates perfect equality (where everyone receives an equal share), to 1, which indicates perfect inequality (where only one recipient or group of recipients receives all the income).	U.S. Census Bureau, American Community Survey	https://www.americashealthrankings.org/explore/annual/measure/gini
Total percentage of government expenditure on education	State or jurisdiction spending on K-12 (elementary and secondary) education as a percentage of total state expenditures.	National Association of State Budget Officers	https://www.nasbo.org/reports-data/state-expenditure-report/state-expenditure-archives
Total percentage of GDP spent on education	A state's or jurisdiction's current expenditures for elementary and secondary public schools divided by the state's or jurisdiction's gross domestic product (GDP).	U.S. Department of Education, National Center for Education Statistics; U.S. Department of Commerce, Bureau of Economic Analysis	https://www.nsf.gov/statistics/state-indicators/indicator/public-school-expenditures-to-state-gdp/table

Results

Changes in the SES Achievement Gap

Figure 1 shows the overall trend in average mathematics scores for students from high- and low-SES backgrounds at the national level. The left axis represents these average scores over time, and the right axis represents the gap between students from low- and high-SES backgrounds in each year. It suggests that both high- and low-SES students' mathematics performance has improved slightly over the studied time period. With a similar rate of improvement, the SES achievement gap therefore remained approximately the same between 2003 and 2017. This finding is consistent with the results from earlier literature that used different datasets to examine the mathematics achievement gap due to SES over time in the United States (Broer, Bai, and Fonseca 2019; Hanushek et al. 2020).

Figure 1. Average mathematics score for NAEP Grade 8 Mathematics public school students, by socioeconomic status: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment, and the corresponding standard deviation for national public-school students varies by year, ranging from 36 to 39. Alaska is excluded because it does not have information on the key analytical variables (i.e., number of books at home and parental education level). Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Given the potential differences across states, we extended our analysis to 49 states and the District of Columbia (DC) in the United States, with Alaska omitted because of missing SES data. Table 4 shows changes in the SES achievement gap for each jurisdiction between 2003 and 2017, arranged by the change in the size of the gap, and indicates whether those changes are statistically significant.

Table 4. Average SES scale score gaps of public-school students in grade 8 NAEP mathematics, by state/jurisdiction: 2003–17

State	2003	2005	2007	2009	2011	2013	2015	2017	2003 vs. 2017
New Mexico	46	41	43	41	38	38	35	35	-11*
Tennessee	48	42	41	44	43	45	42	40	-8*
Georgia	52	47	43	44	45	47	49	47	-5
Florida	45	44	42	38	42	40	42	42	-4
Mississippi	39	41	36	40	41	40	40	36	-4
Illinois	52	52	48	47	45	50	44	49	-3
Massachusetts	50	48	50	52	42	50	53	47	-2
New Jersey	51	48	49	49	47	46	47	50	-1
Alabama	49	47	49	46	47	48	44	49	-1
Hawaii	36	39	38	41	36	34	37	36	0
Nevada	44	38	40	40	41	39	39	44	0
New York	47	46	44	45	43	46	37	48	1
Arkansas	41	40	35	43	38	42	39	42	1
Connecticut	53	58	56	54	52	57	55	54	1
Arizona	46	47	42	48	48	46	43	47	1
West Virginia	31	34	33	37	38	35	34	33	2
Delaware	40	38	36	35	38	43	43	43	3
South Carolina	42	43	42	43	45	49	41	44	3
Oklahoma	38	40	36	36	40	35	34	41	3
Montana	32	37	40	38	39	40	35	—	3
Rhode Island	50	50	52	45	47	52	24	53	3
Missouri	38	42	44	39	41	42	45	42	3
Wisconsin	46	43	45	42	48	46	51	50	4
Kansas	42	41	38	37	40	44	40	46	4
Utah	40	36	38	41	47	44	—	—	4
Colorado	49	49	48	51	48	52	53	—	4
Indiana	39	39	43	38	40	42	46	44	5
Vermont	35	39	37	44	43	44	24	40	5*

State	2003	2005	2007	2009	2011	2013	2015	2017	2003 vs. 2017
California	52	49	49	48	53	51	50	58	5
Pennsylvania	48	46	45	46	51	50	56	54	5
Iowa	39	35	39	39	42	42	44	44	5
Oregon	42	42	43	45	45	48	40	48	5
Idaho	40	31	38	37	41	39	44	45	6
South Dakota	34	33	32	36	36	43	40	—	6
Maryland	49	50	49	52	52	49	54	56	7
Washington	42	42	46	47	48	47	52	49	7*
Kentucky	38	37	35	37	40	42	42	45	7*
Michigan	49	48	48	54	48	49	50	56	8
Louisiana	39	37	33	39	39	35	47	—	8
Nebraska	40	42	47	44	43	41	41	48	8*
New Hampshire	33	33	36	37	37	39	32	41	8*
Texas	38	43	39	42	37	37	41	47	9*
Wyoming	29	30	32	34	34	32	38	—	9*
North Carolina	47	44	46	48	43	43	45	56	9*
Virginia	42	46	44	43	48	49	48	51	9*
Minnesota	38	46	41	43	44	46	50	49	10*
Maine	32	34	33	39	39	40	38	43	11*
North Dakota	27	28	26	28	32	36	38	40	14*
Ohio	41	45	42	44	44	47	49	58	17*
District of Columbia	33	37	37	36	41	46	53	54	21*

—Not available.
* $p < .05$.
NOTE: All plausible values of a given subscale were used to derive the average mathematics scores for the achievement gaps. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. For states that do not have 2017 data, the most recent cycle was used for comparison. States ordered by size of the difference between the 2003 and 2017 gaps. Comparisons are independent with an alpha level of .05. Although differences are shown as rounded numbers, they were calculated using unrounded values.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Similar to the national-level data, table 4 shows that there were no statistically significant changes in the SES achievement gap in 34 out of the 50 states/jurisdictions.[3] These were Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia,

[3] Comparisons are made between 2003 and 2017 for most states. However, some states opted out for the student questionnaire in 2017, including Colorado, Louisiana, Montana, South Dakota, Utah, and Wyoming. Therefore, for these states, data from the most recent cycle of their participation was used instead.

Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Montana, Nevada, New Jersey, New York, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Utah, West Virginia, and Wisconsin. For example, the achievement gap between high- and low-SES students in California was 52 points in 2003 and 58 points in 2017. The 6-point difference over time is not statistically significant.

Fourteen states/jurisdictions witnessed a significantly widening achievement gap over time. These were the District of Columbia, Kentucky, Maine, Minnesota, Nebraska, New Hampshire, North Carolina, North Dakota, Ohio, Texas, Vermont, Virginia, Washington, and Wyoming. For example, in Ohio, the achievement gap in mathematics between high- and low-SES students was 41 points in 2003, increasing to 58 points by 2017. The 17-point increase, about one half of a standard deviation, is statistically significant.

Only two states showed a decreasing achievement gap over the same time period: New Mexico and Tennessee. In New Mexico, the difference in mathematics scores between high- and low-SES students declined from 46 points in 2003 to 35 points in 2017—an 11-point reduction in the achievement gap.

Changes in Low-SES Students' Performance

To better understand the observed trends, tables 5 and 6 calculate the percentage of low-SES students achieving at or above the *NAEP Basic* level as well as above the *NAEP Proficient* level. At the national level, around 5 more percent of low-SES students achieved at the *NAEP Basic* and the *NAEP Proficient* levels over time. To be specific, 41 percent of low-SES students in 2003 achieved at or above the *NAEP Basic* level, compared to 46 percent in 2017 (table 5). Similarly, 8 percent of low-SES students achieved at or above the *NAEP Proficient* level in 2003, compared to 12 percent in 2017 (table 6).

Despite the small number of states showing decreases in their SES achievement gaps, many states did exhibit progress for their low-SES students in terms of the percentages of students performing at certain achievement levels. As table 5 illustrates, 32 of the 50 states showed increases in the percentage of low-SES students performing at or above the *NAEP Basic* achievement level. Georgia had the largest increase (going from 29 percent in 2003 to 49 percent in 2017), followed by Arizona (19 percent), the District of Columbia, Tennessee, and then Mississippi (all 18 percent), New Mexico (15 percent), Massachusetts (14 percent), New Jersey (13 percent), Hawaii (12 percent), Illinois (11 percent), and California (10 percent) (table 5). Only four states witnessed no change during this time period, meaning their percentage change between 2003 and 2017 rounded to zero, such as New Hampshire, which stayed at 60 percent. Fourteen states had decreasing percentages, with the largest decrease in North Dakota (down 10 percentage points, from 64 percent to 53 percent).

Included in the percentages of students performing at or above *NAEP Basic* are students who performed at or above *NAEP Proficient* (shown in table 6), the next higher achievement-level category. Of the 50 states/jurisdictions examined, 43 illustrated various degrees of increases in their percentages of low-SES students performing at or above *NAEP Proficient* between 2003 and 2017. Massachusetts and New Jersey had the largest gains, 13 percent and 11 percent, respectively. Two states exhibited no change in their percentages, and five exhibited decreases. North and South Dakota had the largest decreases, each at 4 percent.

Table 5. Weighted percentage of low-SES students achieving at the *NAEP Basic* level, by state and year

	Percentage at or above *NAEP Basic*								
State	2003	2005	2007	2009	2011	2013	2015	2017	2003 vs. 2017
National average	41%	44%	47%	50%	51%	52%	49%	46%	5%
Georgia	29%	35%	41%	45%	47%	46%	47%	49%	20%
Arizona	31%	39%	45%	44%	46%	48%	53%	49%	19%
Dist. of Columbia	15%	15%	18%	26%	32%	34%	29%	33%	18%
Tennessee	31%	38%	39%	42%	41%	45%	47%	49%	18%
Mississippi	24%	28%	32%	32%	37%	38%	39%	42%	18%
New Mexico	27%	28%	35%	39%	44%	44%	43%	42%	15%
Massachusetts	46%	58%	62%	64%	67%	66%	58%	60%	14%
New Jersey	43%	50%	53%	57%	61%	64%	59%	55%	13%
Hawaii	36%	35%	39%	44%	50%	56%	49%	48%	12%
Illinois	35%	38%	44%	47%	55%	52%	52%	46%	11%
California	29%	34%	36%	38%	38%	42%	43%	39%	10%
Florida	37%	42%	47%	51%	48%	50%	44%	47%	9%
Virginia	47%	50%	53%	55%	56%	55%	54%	55%	8%
Rhode Island	31%	32%	37%	44%	50%	49%	59%	39%	8%
Arkansas	36%	41%	46%	44%	52%	48%	46%	44%	8%
Nevada	33%	38%	37%	44%	46%	49%	47%	40%	7%
Pennsylvania	39%	47%	54%	54%	50%	54%	43%	46%	7%
Washington	49%	54%	52%	55%	54%	57%	53%	53%	4%
Alabama	26%	28%	29%	36%	35%	35%	31%	29%	3%
Indiana	53%	51%	54%	58%	58%	59%	57%	55%	3%
Nebraska	48%	50%	47%	50%	51%	52%	55%	51%	2%
New York	43%	44%	46%	50%	47%	49%	52%	45%	2%
Texas	47%	51%	60%	62%	69%	66%	56%	49%	2%
Kansas	50%	52%	62%	61%	60%	59%	56%	52%	2%
Maryland	39%	41%	51%	52%	49%	52%	47%	41%	2%
Delaware	45%	49%	57%	58%	57%	52%	50%	47%	2%
Vermont	56%	59%	66%	62%	63%	65%	67%	58%	2%
Colorado	46%	40%	50%	50%	54%	50%	48%	—	2%
Oklahoma	40%	41%	44%	46%	50%	49%	48%	41%	1%
Iowa	52%	55%	55%	55%	58%	54%	53%	53%	1%
West Virginia	45%	37%	43%	40%	42%	45%	41%	45%	1%
Connecticut	45%	37%	42%	50%	47%	43%	43%	45%	1%

State	Percentage at or above *NAEP Basic*								
	2003	2005	2007	2009	2011	2013	2015	2017	2003 vs. 2017
New Hampshire	59%	63%	57%	66%	64%	67%	69%	60%	0%
Idaho	50%	56%	53%	59%	57%	57%	51%	50%	0%
Utah	47%	49%	50%	49%	44%	47%	—	—	0%
Louisiana	35%	37%	43%	43%	45%	46%	35%	—	0%
Wisconsin	47%	51%	50%	54%	51%	53%	48%	46%	-1%
Missouri	49%	43%	46%	56%	51%	51%	47%	49%	-1%
Kentucky	44%	41%	51%	52%	53%	49%	48%	43%	-1%
Montana	60%	58%	56%	64%	66%	59%	58%	—	-2%
Wyoming	58%	60%	62%	61%	63%	64%	57%	—	-2%
Michigan	39%	40%	38%	38%	44%	43%	43%	37%	-3%
Oregon	50%	52%	51%	53%	52%	51%	53%	47%	-3%
North Carolina	47%	51%	49%	52%	57%	56%	49%	44%	-3%
South Carolina	45%	50%	51%	47%	48%	45%	44%	41%	-4%
South Dakota	57%	62%	64%	63%	64%	53%	52%	—	-5%
Maine	55%	55%	63%	59%	61%	60%	50%	50%	-5%
Ohio	50%	50%	55%	52%	56%	58%	51%	44%	-6%
Minnesota	61%	55%	61%	61%	61%	61%	56%	55%	-6%
North Dakota	64%	64%	71%	72%	66%	63%	59%	53%	-10%

—Not available.
NOTE: "At or above *NAEP Basic*" includes students who performed at or above the *NAEP Basic* achievement level but below the *NAEP Proficient* level as well as students who performed at or above the *NAEP Proficient* level. For the state-specific graphs in the state profiles, we calculated the differences for students who were at or above *NAEP Basic* but below *NAEP Proficient*. For states that do not have 2017 data, the most recent cycle was used for comparison. States ordered by size of difference between 2003 and 2017 percentages. Although differences are shown as rounded numbers, they were calculated using unrounded values.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Table 6. Weighted percentage of low-SES students achieving at or above the *NAEP Proficient* level, by state and year

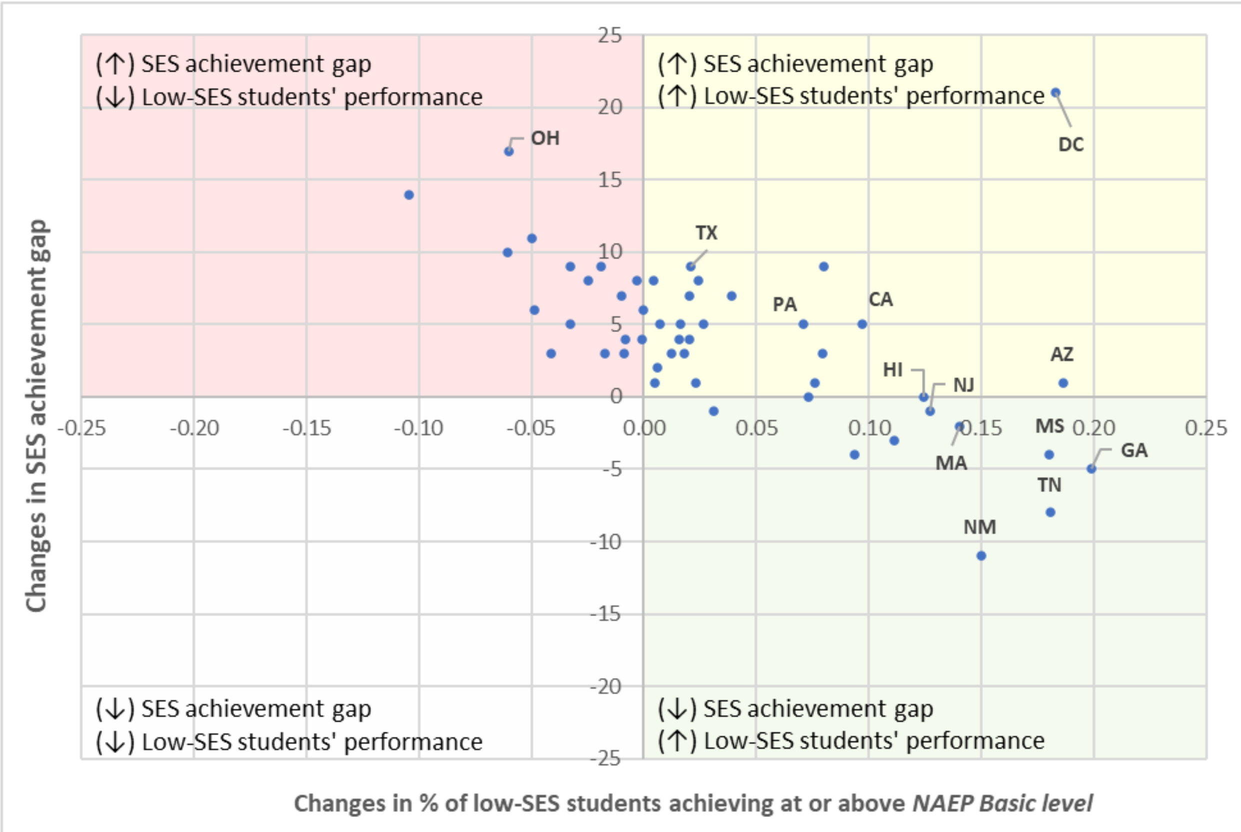
State	Percentage at or above *NAEP Proficient*								
	2003	2005	2007	2009	2011	2013	2015	2017	2003 vs. 2017
National average	8%	9%	11%	12%	12%	13%	12%	12%	5%
Massachusetts	10%	16%	21%	23%	23%	23%	20%	23%	13%
New Jersey	8%	11%	14%	17%	19%	23%	22%	19%	11%
Arizona	4%	8%	8%	9%	11%	12%	14%	13%	9%
Georgia	4%	6%	8%	8%	8%	11%	7%	13%	9%
Illinois	5%	6%	8%	11%	12%	13%	14%	13%	8%
Hawaii	5%	5%	9%	10%	14%	17%	12%	13%	7%
Mississippi	2%	3%	3%	3%	7%	7%	8%	9%	7%
Indiana	11%	11%	13%	15%	14%	16%	16%	18%	7%
Virginia	9%	10%	11%	12%	14%	10%	13%	15%	7%
Tennessee	5%	6%	7%	8%	7%	9%	13%	12%	7%
New Mexico	2%	2%	4%	5%	8%	9%	7%	8%	6%
Dist. of Columbia	1%	1%	1%	3%	6%	7%	5%	7%	6%
New Hampshire	15%	15%	16%	22%	23%	23%	24%	21%	5%
Florida	6%	8%	11%	11%	9%	13%	10%	12%	5%
Pennsylvania	7%	9%	14%	14%	12%	15%	8%	12%	5%
California	4%	6%	7%	8%	7%	8%	8%	9%	5%
Texas	10%	11%	14%	15%	21%	20%	14%	14%	5%
Rhode Island	5%	4%	5%	9%	10%	11%	19%	9%	4%
Nevada	6%	7%	8%	10%	11%	10%	11%	10%	4%
Washington	11%	15%	13%	13%	17%	16%	17%	16%	4%
New York	10%	11%	11%	14%	10%	13%	15%	14%	4%
Ohio	9%	12%	12%	13%	14%	15%	13%	12%	4%
Idaho	10%	13%	14%	17%	13%	14%	9%	14%	4%
West Virginia	7%	5%	7%	6%	6%	9%	8%	11%	4%
Iowa	12%	13%	14%	12%	14%	13%	15%	15%	4%
Maine	12%	14%	16%	15%	18%	17%	12%	16%	4%
Nebraska	11%	11%	12%	10%	11%	13%	14%	15%	3%
Colorado	9%	7%	10%	12%	14%	14%	12%	—	3%
Arkansas	6%	7%	11%	9%	11%	10%	9%	9%	3%
North Carolina	10%	12%	11%	14%	15%	16%	12%	12%	3%
Oklahoma	5%	6%	7%	9%	9%	10%	10%	8%	2%
Vermont	14%	16%	20%	19%	20%	20%	31%	17%	2%
Wisconsin	10%	12%	14%	16%	14%	14%	14%	12%	2%
Delaware	8%	10%	13%	15%	14%	13%	12%	10%	2%

State	Percentage at or above *NAEP Proficient*								
	2003	2005	2007	2009	2011	2013	2015	2017	2003 vs. 2017
South Carolina	7%	10%	12%	10%	11%	10%	11%	9%	2%
Alabama	3%	3%	3%	6%	6%	4%	4%	5%	2%
Kansas	11%	13%	17%	18%	17%	16%	13%	13%	2%
Connecticut	8%	7%	8%	11%	9%	10%	9%	10%	1%
Kentucky	8%	6%	11%	10%	11%	10%	11%	9%	1%
Utah	11%	12%	12%	12%	9%	12%	—	—	1%
Oregon	12%	15%	14%	14%	12%	12%	14%	13%	1%
Missouri	10%	9%	10%	14%	12%	11%	7%	11%	1%
Michigan	8%	9%	8%	8%	9%	10%	7%	9%	1%
Maryland	7%	7%	10%	14%	13%	14%	12%	7%	0%
Louisiana	5%	5%	7%	6%	8%	9%	5%	—	0%
Montana	19%	15%	16%	21%	24%	16%	18%	—	-1%
Wyoming	15%	12%	18%	14%	20%	19%	14%	—	-1%
Minnesota	20%	16%	18%	18%	20%	19%	20%	19%	-1%
North Dakota	19%	16%	24%	24%	22%	18%	17%	16%	-4%
South Dakota	17%	17%	19%	17%	19%	14%	12%	—	-4%

—Not available.
NOTE: For states that do not have 2017 data, the most recent assessment cycle was used for comparison. States ordered by size of difference between the 2003 and 2017 percentages. Although differences are shown as rounded numbers, they were calculated using unrounded values.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment

In addition, figure 2 (below) shows how states can be grouped by changes in their SES achievement gap and changes in the percentage of their low-SES students achieving at or above *NAEP Basic*, regardless of the statistical significance in those changes. The most promising group is in the bottom-right quadrant, which consists of states with reducing SES achievement gaps as well as increasing portions of low-SES students achieving at or above *NAEP Basic* over time. In addition, the upper-right quadrant presents a less-than-ideal situation where states saw more low-SES students achieving at or above *NAEP Basic* over time but experienced increasing SES achievement gaps. Finally, the most concerning group is in the upper-left zone, where states observed widening SES achievement gaps as well as decreasing portions of low-SES students achieving at or above *NAEP Basic* over time. It is theoretically possible that the SES achievement gap can become smaller in an environment of declining performance, with higher SES students experiencing a stronger decline than lower SES students. No state, however, fell into that category (lower left quadrant).

Figure 2. Change in percentage of low-SES students achieving at or above *NAEP Basic* versus change in SES achievement gap, by state: 2003 and 2017



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Alaska is excluded because it does not have information on the key analytical variables (i.e., number of books at home and parental education level).
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003 and 2017 Grade 8 Mathematics Assessment.

The next section highlights 14 states showing different trends in SES achievement gaps and changes in their low-SES students' performance. Findings are then situated within macro-level changes in each state, such as economic development, income inequality, and education investment in general, as well as individual SES groups' performance by achievement level.

State Highlights

Arizona. Arizona presents a paradox of an education system, with several of its schools topping the lists of best public schools in the country, yet with an average graduation rate that is one of the lowest in the nation (*U.S. News and World Report* 2019; U.S. Department of Education 2018e, table 219.46). Since the No Child Left Behind Act (NCLB) was passed in 2001, Arizona has held its students to high standards and continued to do so with its 2010 College and Career Readiness Standards, but its funding for K-12 public education represents one of the lowest in the country (Suerth 2015). It has embraced education reforms—Arizona has one of the largest charter school enrollment rates in the country (U.S. Department of Education 2018d, table 216.90) and has enacted merit pay for teacher salaries—and recently has made gains on national assessments (Aldeman et al. 2017). In fact, Arizona's state mean score on the grade 8 NAEP mathematics assessment used to trail the national mean score (its state mean was 271 in 2003, and the national mean was 276), but by 2017, it had caught up to the nation). Despite this progress, however, the state still has low overall graduation rates for its Hispanic students, who make up almost half of its school-going population (U.S. Department of Education 2018e, table 219.46; U.S. Department of Education 2018b, table 203.70).

The report's finding that Arizona's[4] SES achievement gap did not change from 2003 to 2017 (figure 3) illustrates the state's persistent socioeconomic inequality. A 46-point gap existed between students from low- and high-SES backgrounds in 2003 that was not statistically different from the 47-point gap between those groups in 2017. Apart from 2 years, 2007 and 2013, in which the gap declined to 42 and 43 points, respectively, the SES gap remained relatively stable over the 15-year period. Students from low-SES backgrounds made progress over this period, with the percentage performing at or above *NAEP Basic* increasing from 31 percent to 49 percent, and, among these students, the percentage performing at or above *NAEP Proficient* increasing from 4 percent to 13 percent. This 9-percentage-point difference was one of the largest in the nation. The average score increased as well, going from 248 to 260 (a 13-point gain). High-SES students kept pace with their low-SES counterparts, with their average scale score increasing from 293 in 2003 to 307 in 2017 (a 14-point gain). Since both student groups made almost equal strides in score gains on the grade 8 mathematics assessment, the wide gap between them did not change, but overall, state performance improved.

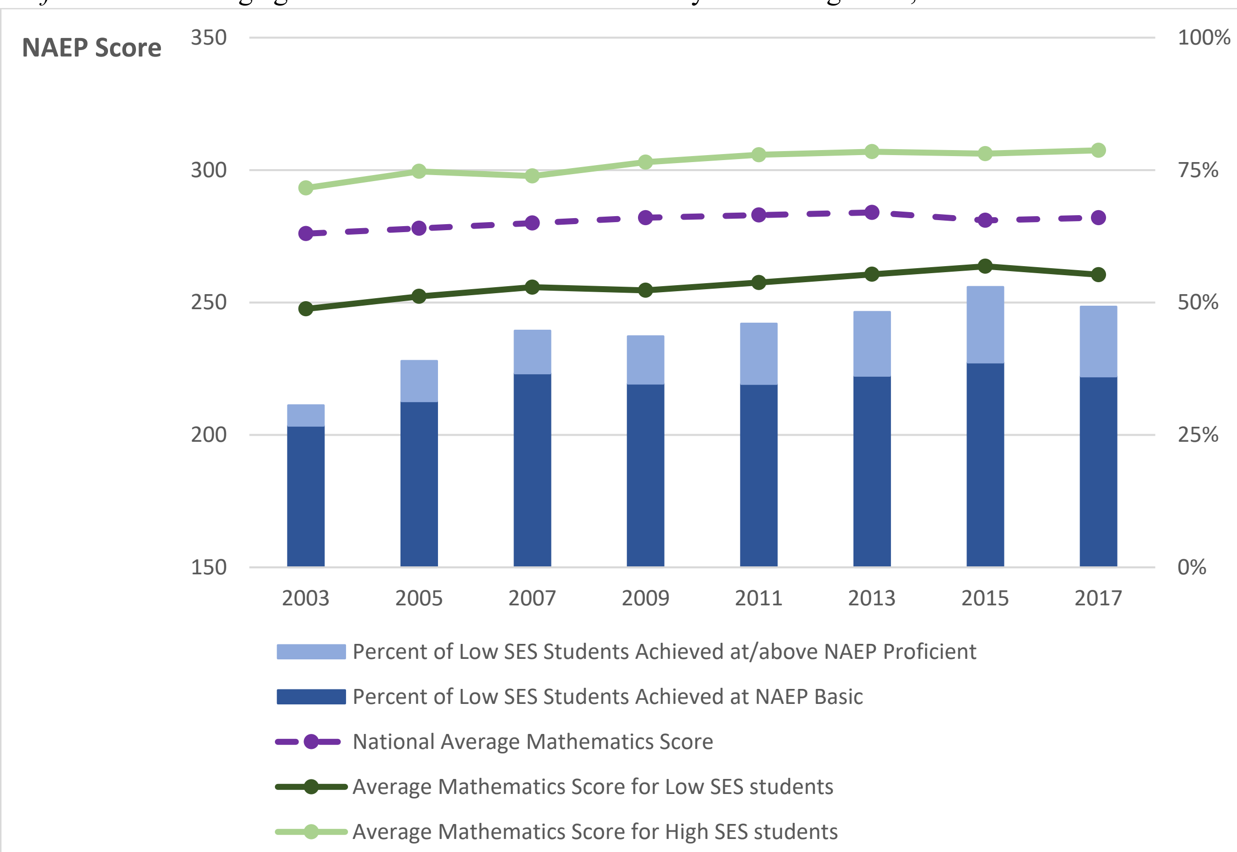
By looking at three indicators that capture spending on education, we see a decline in Arizona's K-12 education funds. According to Leachman, Masterson, and Figueroa (2017), Arizona has enacted some of the deepest cuts to general funding for elementary and secondary schools since the Great Recession of 2008–09. Compared to the nation, the state's per pupil expenditure (PPE) was already low in 2003 ($8,561), and by 2017 it had declined to $8,094. Other indicators of Arizona's education expenditure echo this decrease in K-12 education spending. The percentage of its GDP spent on education declined from 3.06 percent in 2003 to 2.81 percent in 2016, and the percentage of its state expenditure on education decreased from 18.8 percent to 16.69 percent. Both of these indicators, which are below the national averages, reflect the years of governmental budget cuts the K-12 public school system has experienced.

An exploration of inequality indicators gives more insight into Arizona's unchanged SES achievement gap. The income inequality within the state essentially remained the same or worsened slightly. The state's child poverty level also stayed the same over the years, at 21 percent, but it should be noted that this rate is slightly higher than the national average of 18 percent. Arizona's Gini coefficient, a measure of household income inequality, barely increased from 2003 to 2017, going from 0.45 to 0.47, mirroring the national average increase from 0.46 to 0.48. One indicator of income inequality that did worsen was the percentage of pre-tax income received by Arizona's highest earners, with the top 10 percent of earners receiving 48 percent of the state's pre-tax income in 2014, up from 44 percent in 2003.

[4] State gaps were considered relatively high or low if they were 4 points larger or smaller than the national gap for that year (see figure 1).

In addition to decreased education spending and slightly greater income inequality, the state experienced decreasing economic development. Arizona's per capita GDP declined during this time period, from $42,346 in 2003 to $42,164 in 2017. One positive aspect to note is the improvement in performance of both low- and high-SES students, with 13- and 14-point gains, respectively. Going forward it will be essential to keep an eye on how low-SES students perform, though, as they are vulnerable to changes in macro-level economic context, education policies, and investments. With Arizona's 47-point SES achievement gap in 2017, the state has room to improve the performance of its low-SES students and thereby narrow this rather wide disparity.

Figure 3. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, Arizona: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

California. With over 6 million students in its K-12 schools, California has the largest state public school education system in the country (U.S. Department of Education 2019a, table 203.20). While its economy has grown steadily since 2010 (Myers 2019), changes in its education funding laws have made it difficult for the state to provide funds to meet all of its students' needs, particularly for its 59 percent of NSLP-eligible students (Brighouse et al. 2018;

U.S. Department of Education 2017, table 204.10). In 2013, the state did pass the Local Control Funding Formula (LCFF), which attempted to funnel more funds into districts with high numbers of high-needs students. While many districts embraced this new funding structure, others used the flexibility of LCFF to allocate funds to other services besides assisting low-income students (Nittle 2016). As an additional challenge, California's ELL students make up 20 percent of its school population and their performance on state assessments lags behind that of most other student groups, particularly low-income students and students of all races/ethnicities (California Department of Education 2018). Overall, however, performance rose over the 15-year study period: in 2003, the state's mean grade 8 NAEP mathematics score was 267, compared to a national mean of 276, but in 2017, the state mean was 277, compared to a national mean of 282.

Despite this overall progress, California's SES achievement gap remained the same over this time period (figure 4). This relatively high gap—58 points in 2017—is one of the largest in the country, reinforcing the persistent inequalities for the Golden State's disadvantaged student groups. Even though California's 58-point SES gap in 2017 was not significantly different from its 52-point gap in 2003, the 2017 gap was still larger than it had been in any other year and is 9 points larger than the nation's (49 points).

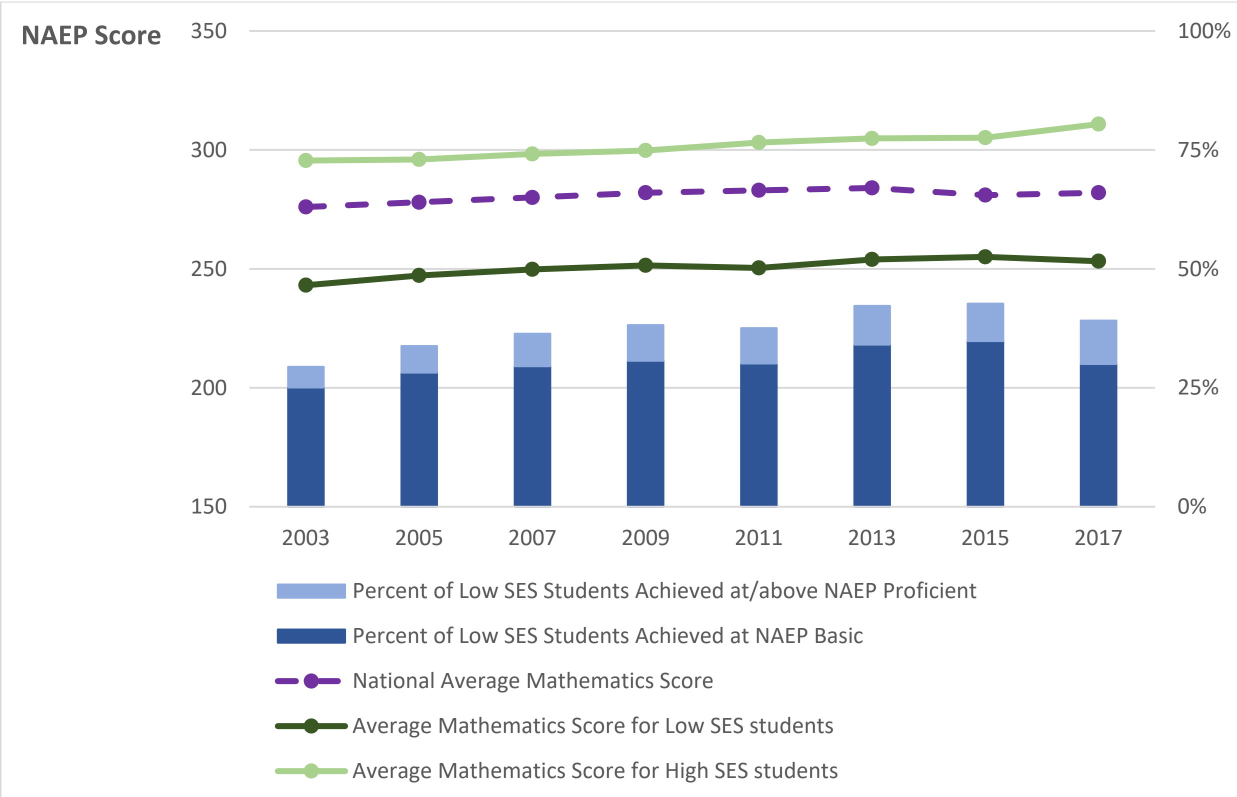
Although low-SES students' average scale scores saw a 10-point increase during this time, these gains were not enough to match those of high-SES students, whose average scores on grade 8 NAEP mathematics improved by 15 points over this period. This pattern is also supported by changes in the percentage of low-SES students performing at the various NAEP achievement levels, which shows this group has improved slightly but not enough to close the gap. Specifically, the percentage of students performing at *NAEP Basic* went from 25 percent in 2003 to 30 percent in 2017, and the percentage performing at or above *NAEP Proficient* went from 4 percent to 9 percent.

California's education spending can provide some context for this unchanging achievement gap. In 2003, California spent $10,290 per K-12 public school student, which was in line with what the rest of the states in the country spent. Over time, the per pupil expenditure increased over 10 percent, reaching $11,893 in 2016, but was still lower than the national average. However, two measures of California's overall education spending—the percentage of GDP spent on education and the percentage of state expenditure on K-12 education—declined. California spent 3.15 percent of its GDP on K-12 education in 2003, compared to 2.75 percent in 2016. Similarly, according to the National Association of State Budget Officers (2018), the state's overall expenditure on education fell by 4 percentage points. Overall, considering all of these changes, California's investment in K-12 public education stayed about constant between 2003 and 2017.

There was only a slight increase in income inequality in California during this time period as evidenced by an increase from 0.46 to 0.49 in the Gini coefficient, a similar increase as in the nation overall. In addition, the percentage of pre-tax income received by the top 10 percent of earners increased to 52 percent of the state's pre-tax income in 2014, up from 46 percent in 2003.

Within the context of California's relatively low education spending and high and slightly worsening income inequality, the findings from this study show the urgency of helping its vulnerable student groups make larger gains to keep up with and even surpass the gains of its high-SES students.

Figure 4. Percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, California: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

District of Columbia. For decades, public schools in Washington, DC, have been in the spotlight for their overall low performance, high dropout rates, and low graduation rates (Simon 2019; Jaffe 2017). The District of Columbia also exhibits a high child poverty rate and a high level of income inequality (Population Reference Bureau 2017). Under the era of No Child Left Behind (NCLB), a system-wide reform was carried out in the District to hold schools and teachers accountable for students' test scores and graduation rates (Mead 2017). According to the District of Columbia Public Schools, average scale scores in multiple subjects have continued to rise since 2003, getting closer to the national public-school averages (Office of the State Superintendent of Education 2018). Improvement in the average achievement, however, does not capture the full picture. The findings from this study show that the gap between high- and low-SES students increased from 33 points in 2003 to a substantially higher 54 points in 2017. A closer look at the data shows that the gap stayed the same between 2003 and 2009, as students from different family backgrounds in the District all improved their performance at a similar rate. However, after 2009, the achievement gap started widening rapidly as high-SES students improved their performance at a faster rate than low-SES students (figure 5).

This finding is also supported by changes in the percentages of low-SES students achieving at the *NAEP Basic* or *NAEP Proficient* levels. In 2003, 14 percent of low-SES students in Washington, DC, achieved at *NAEP Basic* while only 1 percent achieved at or above *NAEP Proficient*. By 2011, 25 percent of low-SES students achieved at *NAEP Basic* while 6 percent achieved at or above *NAEP Proficient*, which represents one of the largest increases among all states. However, after 2011, the performance of low-SES students again remained stagnant.

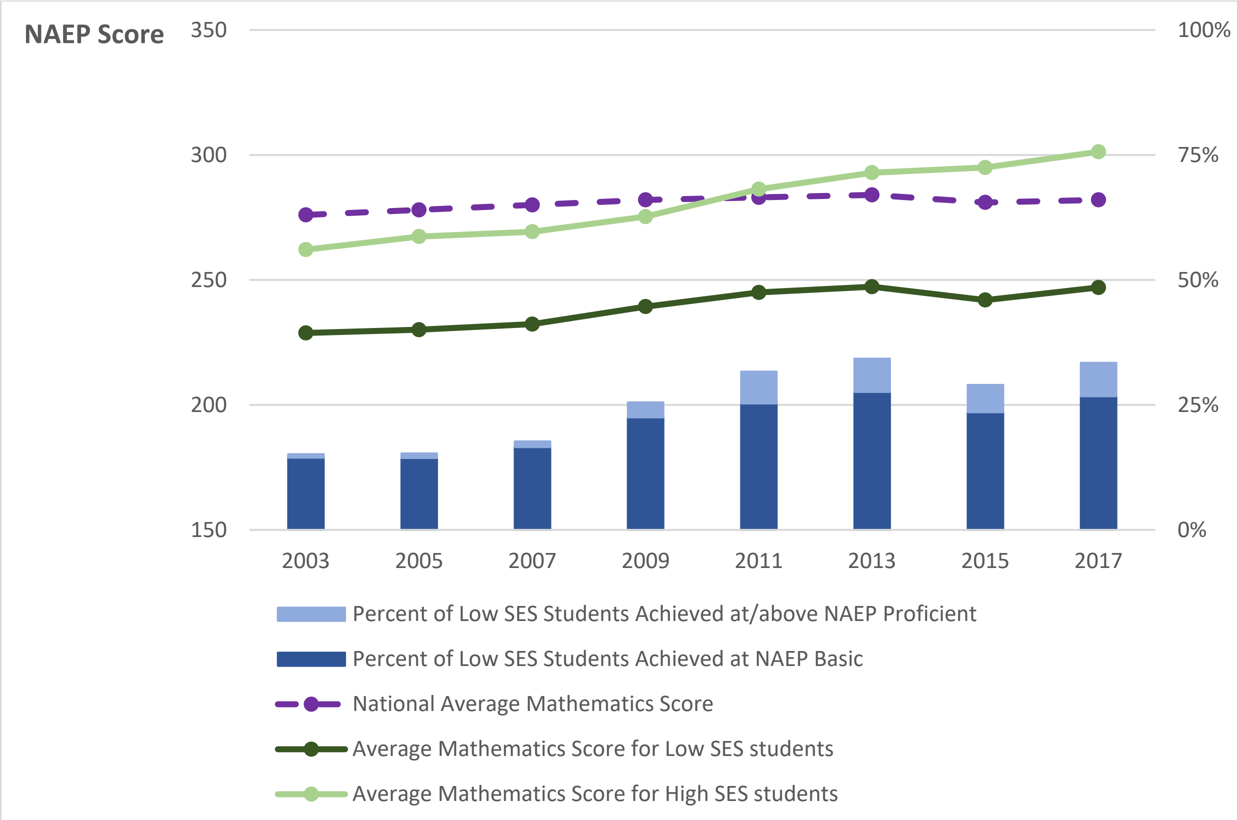
To gain a better understanding of the findings, we further examined changes in a larger social context, specifically focusing on educational investment and social inequality. First, compared to the nation's average, the District of Columbia always spends more on its students, but perhaps more important, its expenditure on public school students has been growing at a faster rate than the national average. Specifically, the District spent $16,141 on each of its students in 2003, which is higher than the national average of $10,960 for the same year. The District further increased its expenditure to $22,009 per school pupil in 2017 (an increase of 36 percent), while the national average spending increased only to $12,330 (an increase of 13 percent). Second, the child poverty rate in the District of Columbia has always been high, although it declined over the 15-year study period (Population Reference Bureau 2017). For example, in 2003, more than one-third of children (36 percent) under age 18 in the District lived in families with incomes below the federal poverty level, which was twice as high as the national average child poverty rate for that year (18 percent). Although the child poverty rate in the District declined to 26 percent by 2017, it was still higher than the corresponding year's national average rate (18 percent).

Finally, in terms of income inequality, the District of Columbia has always had a high Gini coefficient (about 0.52 to 0.54), which ranked as the highest in the country in 2017. The gap in the mean value of SES between the high- and low-SES quartile groups also increased, by 2 points on a 13-point scale, suggesting the poor got poorer and the rich got richer (see appendix A). This high level of inequality was also reflected by an overall increase in the top 10 percent of earners' share of the District's pre-tax income, which increased from 48 percent in 2003 to 52 percent in 2017, despite a decline during the Great Recession of 2008–09.

In conclusion, the District has a high level of income inequality as well as a large and persistent disparity in educational outcomes between students from different socioeconomic backgrounds despite strong overall performance gains over time. However, the introduction of a lottery system for public schools in 2014[5] paired with an increase in spending per pupil, among other policies, could help in the DC public school system's efforts to close the gap between low SES students and high SES students in the future.

[5] The DC school lottery first started in the 2014-15 school year. In 2019 more than 25,000 applications were made of which 65% were matched. For more information see https://www.myschooldc.org/resources/data

Figure 5. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 mathematics score by SES background, District of Columbia: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

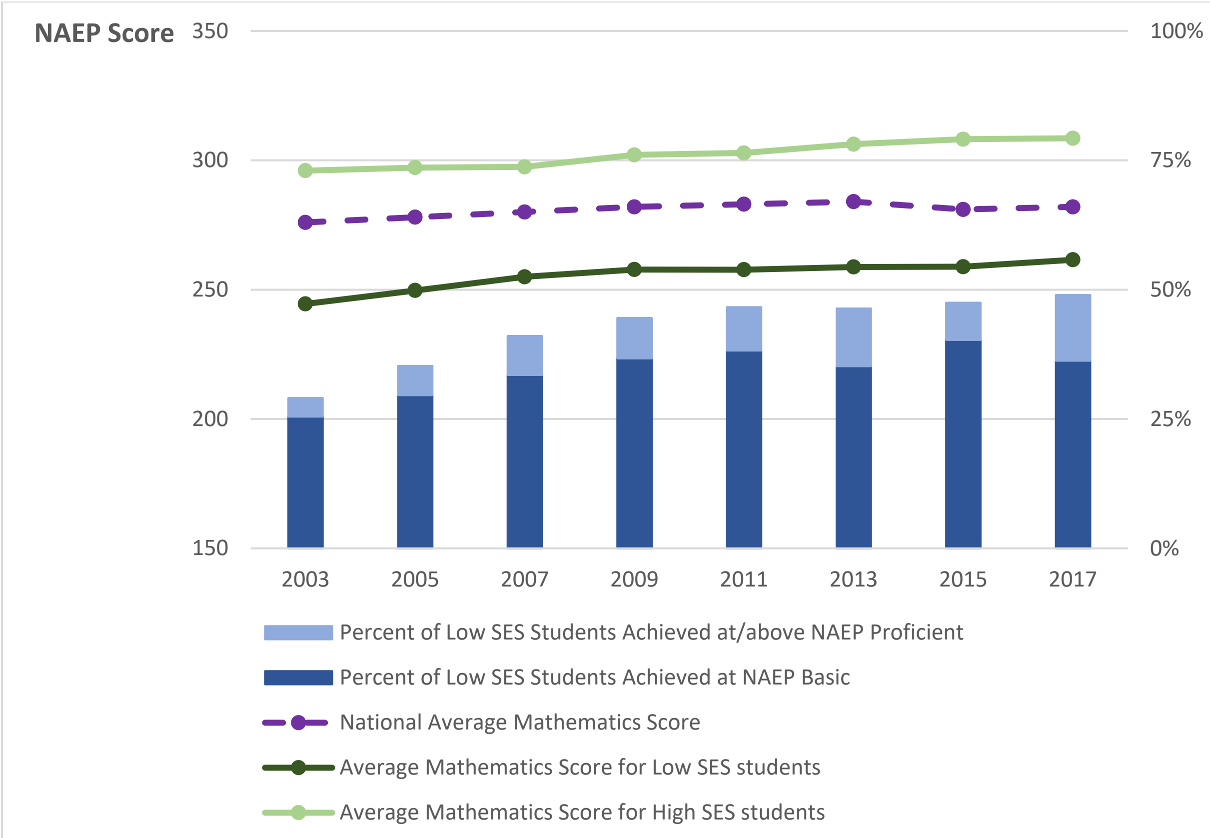
Georgia. Georgia had over 2,200 public elementary and secondary schools serving approximately 1.77 million students in fall 2017 (U.S. Department of Education 2019a, table 203.20). It is one of the 11 states that experienced a dramatic increase in its total public-school enrollment between 2000 and 2016 (McFarland et al. 2019, p. 43). Georgia also had a high child poverty rate, with 21 percent of its children under age 18 living in families at or below the poverty line in 2017 (p. 24). In terms of student achievement, the state performs close to the nation, in general. For example, the adjusted cohort graduation rate of public high school students in Georgia is 81 percent, slightly lower than the U.S. national average rate of 85 percent. When examining its students' NAEP performance, the average mathematics score of both its grade 4 and grade 8 students was similar to the national average score for public school students in 2017 (282 points).

The SES achievement gap in Georgia has been constant over time since all students, regardless of their family background, have improved their performance gradually. In 2003, high-SES students on average scored 296 points on the NAEP grade 8 mathematics assessment while low-SES students on average scored 244 points, a 52-point difference (figure 6). By 2017, high-SES students on average had increased their score to 309 points, compared to 262 points for low-SES students, resulting in a 47-point gap. Although there was 5-point reduction in the SES achievement gap between 2003 and 2017, it was not statistically significant.

Meanwhile, when examining the percentage of low-SES students achieving at the *NAEP Basic* and *NAEP Proficient* levels, an encouraging improvement was observed in Georgia. In 2003, only 4 percent of low-SES students scored at or above the *NAEP Proficient* level, a figure which tripled to 13 percent in 2017. Similarly, the percentage of low-SES students achieving at the *NAEP Basic* level increased from 25 percent in 2003 to 36 percent in 2017. It is important to note that this overall 20-percentage-point difference in low-SES students performing at or above *NAEP Basic* was the largest in the nation. Therefore, despite the nonsignificant changes in the SES achievement gap over time, Georgia's disadvantaged students' performance has been improving.

Such improvement is worth emphasizing, especially given that the state witnessed overall worsening income inequality and decreased educational expenditure during the same time period. First, 19 percent of children in Georgia were living in families below the federal poverty line in 2003, and this dramatically increased after the Great Recession of 2008–09 and stayed at or above 25 percent between 2010 and 2015. Second, the Gini coefficient increased from 0.42 in 2003 to 0.48 in 2017, while the top 10 percent of earners' share of the state's pre-tax income increased from 42 percent in 2003 to 50 percent in 2014, both of which suggest widening income inequality. Third, Georgia's average educational expenditure per pupil decreased slightly, from $10,593 in 2003–04 to $10,242 in 2015–16, even as the nation on average spent more ($8,310 in 2003-04 vs. $12,330 in 2015-16). However, the nonsignificant changes in Georgia's SES achievement gap and the improvement in its low-SES students' performance are encouraging. Additional research is needed to better understand what is behind these changes.

Figure 6. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, Georgia: 2003–17



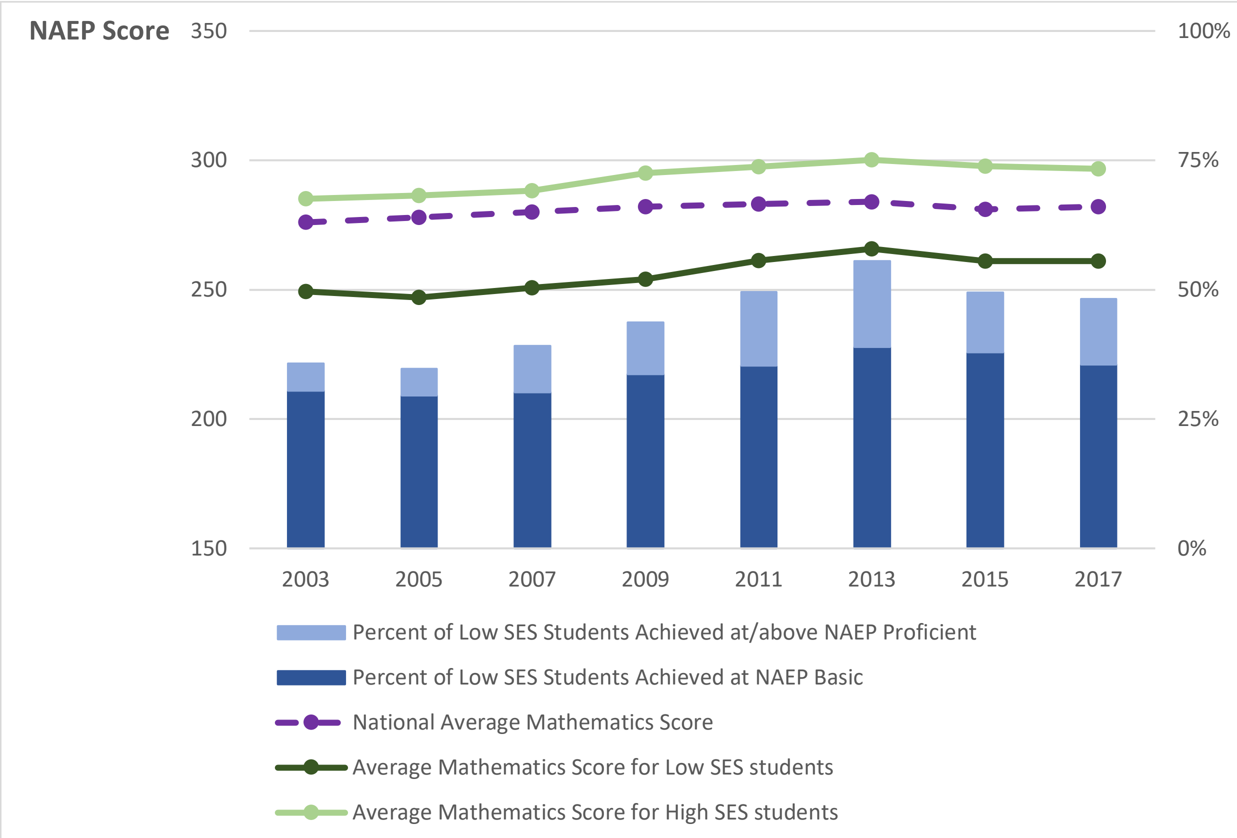
NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Hawaii. Hawaii has a single statewide school district in which one superintendent of education and one board of education govern all its public schools. In the most recent decade, Hawaii has been deeply involved in educational reforms, such as Race to the Top (RTTT), to transform its public schools. As one of the early recipients of RTTT in 2010, Hawaii started its transition to the Common Core State Standards, to a new teacher performance system, and to turning around low-performing schools (Hawaii State Department of Education n.d.[a]). Although the average mathematics score for grade 8 students in Hawaii public schools has been improving, it is still too early to evaluate the effect of RTTT since the improvement started even before Hawaii's involvement with it (AIR 2014). For example, Hawaii's grade 8 students' NAEP mathematics score improved an average of 11 points between 2003 and 2017 (from 266 points to 277 points), while the national average increased only 6 points (from 276 points to 282 points). That is, the gap vis-à-vis the nation declined from 10 points in 2003 to 5 points in 2017 (Hawaii State Department of Education n.d.[a]).

As the only state in the United States that has a statewide school district, schools in Hawaii receive equal funding and resources based on the number of students they serve. Additional adjustments are made for the number of students with identified characteristics, including gifted and talented, economically disadvantaged, limited English proficiency, and transiency (Hawaii State Department of Education n.d.[b]). Under the equal funding system, Hawaii shows a relatively small SES achievement gap compared to the nation. Our study shows that the SES achievement gap for grade 8 students in Hawaii stayed at 36 points between 2003 and 2017 because both high- and low-SES students made the same absolute increase over the time period (in comparison, the gap in public schools nationally was 45 points in 2003 and 49 points in 2017). Specifically, high-SES students improved their average mathematics score from 285 to 297 points, while low-SES students' score improved from 249 to 261 points (figure 7). The improvement of low-SES students' performance is also reflected in the increasing percentage of low-SES students who achieved at or above the *NAEP Basic* level (36 percent in 2003 vs. 48 percent in 2017), among whom more achieved at the *NAEP Proficient* level as well (5 percent in 2003 vs. 13 percent in 2017).

Additionally, a glimpse at the changes in the larger context indicates that income inequality has been stable in Hawaii and educational expenditure has been increasing. In terms of social inequality, Hawaii has always had a lower child poverty rate than the rest of the nation. In terms of income inequality, the top 10 percent earners' share of pre-tax income stayed at 37 percent between 2003 and 2017, and the Gini coefficient stayed at about 0.45. In terms of educational expenditure, Hawaii has always spent around 3 percent of its GPD on education, which is slightly lower than the nation's average. However, Hawaii increased its expenditure per pupil from an average of $11,037 in 2003 to $14,317 in 2017—a 30 percent increase. In short, the changes in macro-level indicators align with the increase in students' performance and a relatively constant SES achievement gap.

Figure 7. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, Hawaii: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

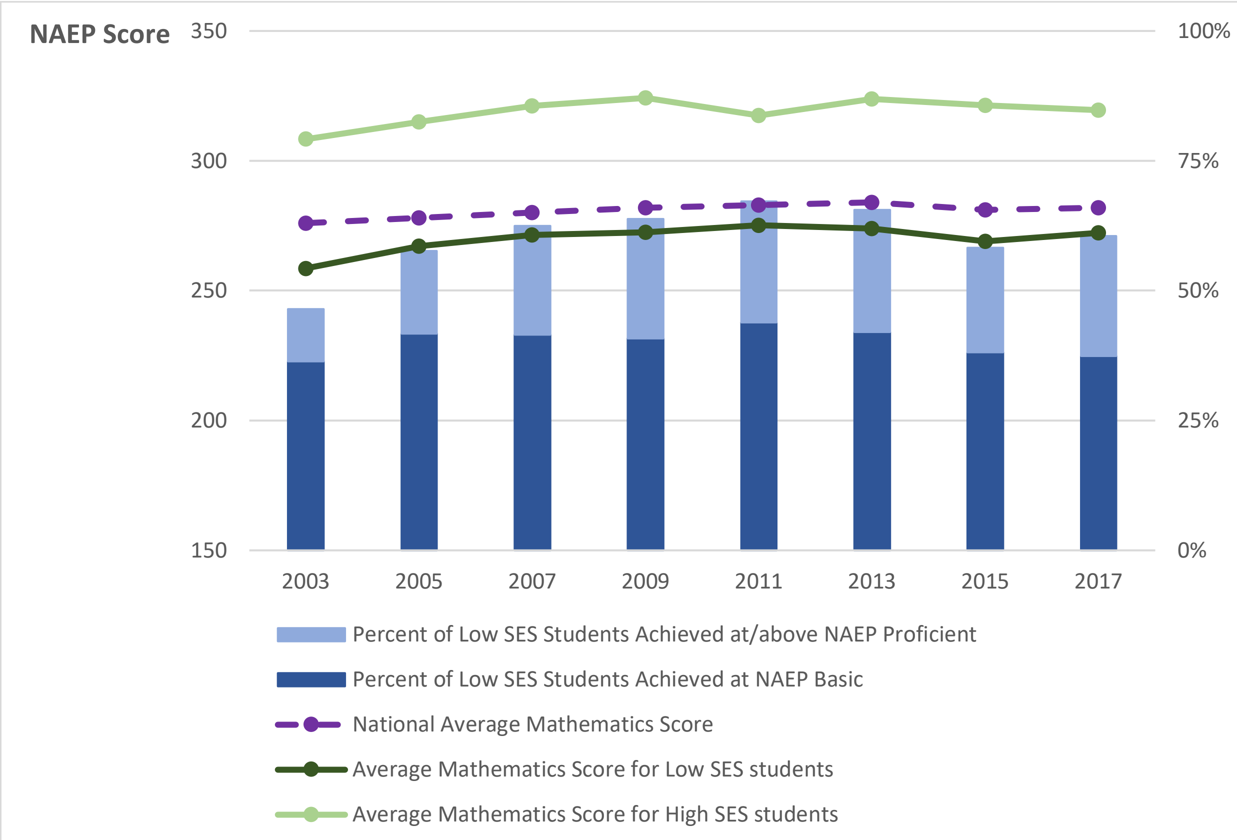
Massachusetts. Following years of educational reform, Massachusetts is widely known for its outstanding public-school system (Wong 2016). In 1993, the state launched comprehensive reforms for its public education system, aiming to set high academic standards, hold schools and teachers accountable, and equalize funding for its public schools across districts (Chester 2014). These reforms have been found effective in allocating state aid to disadvantaged school districts and improving low-SES students' test scores (Dee and Levine 2004; Guryan 2001). In recent decades, its students have ranked among the top performers in both national and international assessments (Massachusetts Department of Elementary and Secondary Education 2016).

Our findings show that students in Massachusetts, regardless of their family backgrounds, improved their performance on the NAEP mathematics assessment over the 15-year study period. However, the achievement gap between high- and low-SES students was consistently relatively high. In 2003, students from high-SES families scored 308 on average on the NAEP grade 8 mathematics assessment, while low-SES students scored 259 points on average, generating a 50-scale-score-point difference (figure 8). In 2017, high-SES students' average mathematics score increased to 320 points, while low-SES students improved their score to 272 points, creating a 47-point difference. With both groups improving at the same rate, the SES achievement gap stayed about the same between 2003 and 2017.

Despite the persistent SES achievement gap, it is worth noting that low-SES students in Massachusetts have continuously improved their performance. In 2003, 46 percent of low-SES students achieved at or above *NAEP Basic* (36 percent at *NAEP Basic* and 10 percent at or above *NAEP Proficient*). By 2017, 60 percent of low-SES students were achieving at or above *NAEP Basic,* among whom 23 percent achieved at or above *NAEP Proficient*. In other words, almost two-thirds of low-SES students scored at or above *NAEP Basic* in 2017—a figure that ranked Massachusetts the highest state in the country.

When examining macro-level changes, Massachusetts' overall inequality has been widening while its total educational expenditure has remained relatively constant. All inequality indicators—including the child poverty rate (12 percent in 2003 vs. 14 percent in 2017), the Gini coefficient (0.46 in 2006 vs. 0.49 in 2017), and the top 10 percent of earners' share of pre-tax income (48 percent in 2003 vs. 54 percent in 2017)—worsened over the study period. Meanwhile, the state continued to spend about 3.3 percent of its GPD on public schools over time. Nevertheless, Massachusetts has certain characteristics that may cushion the widening inequality, such as its overallocation of funding to disadvantaged districts and its well-qualified public teaching force. For example, the percentage of Massachusetts' teachers with an advanced degree increased from 60 percent in 2003–04 to almost 75 percent in 2011–12, making it the most highly educated teaching force in the country. Additional analyses are needed to understand Massachusetts' persistent SES gaps.

Figure 8. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, Massachusetts: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Mississippi. Mississippi is a state whose K-12 public education system consists of schools in high-poverty, mostly rural communities (Davis and Wright 2019b). Its percentage of students eligible for the National School Lunch Program—74 percent—is the highest in the country (U.S. Department of Education 2017, table 204.10), and 49 percent of African American students attend schools that are highly segregated (U.S. Department of Education 2018b, table 203.70; Orfield and Frankenberg 2014). Since the turn of the century, the state legislature has fully funded its education budget only twice (Davis and Wright 2019a). In addition to funding shortages, the state has also experienced a teacher shortage that has grown worse in the last 20 years. Compared to national averages, Mississippi trailed the nation in 2017 grade 8 NAEP mathematics by over 10 points. On a positive note, the state has been ranked as one of the top states for healthy schools (Mader 2019), and its graduation rates have been catching up to the nation's (83 percent in 2017 compared to a national rate of 85 percent) (U.S. Department of Education 2018e, table 219.46). Additionally, Mississippi's grade 8 NAEP mathematics scores have been increasing at a faster rate than the nation's.

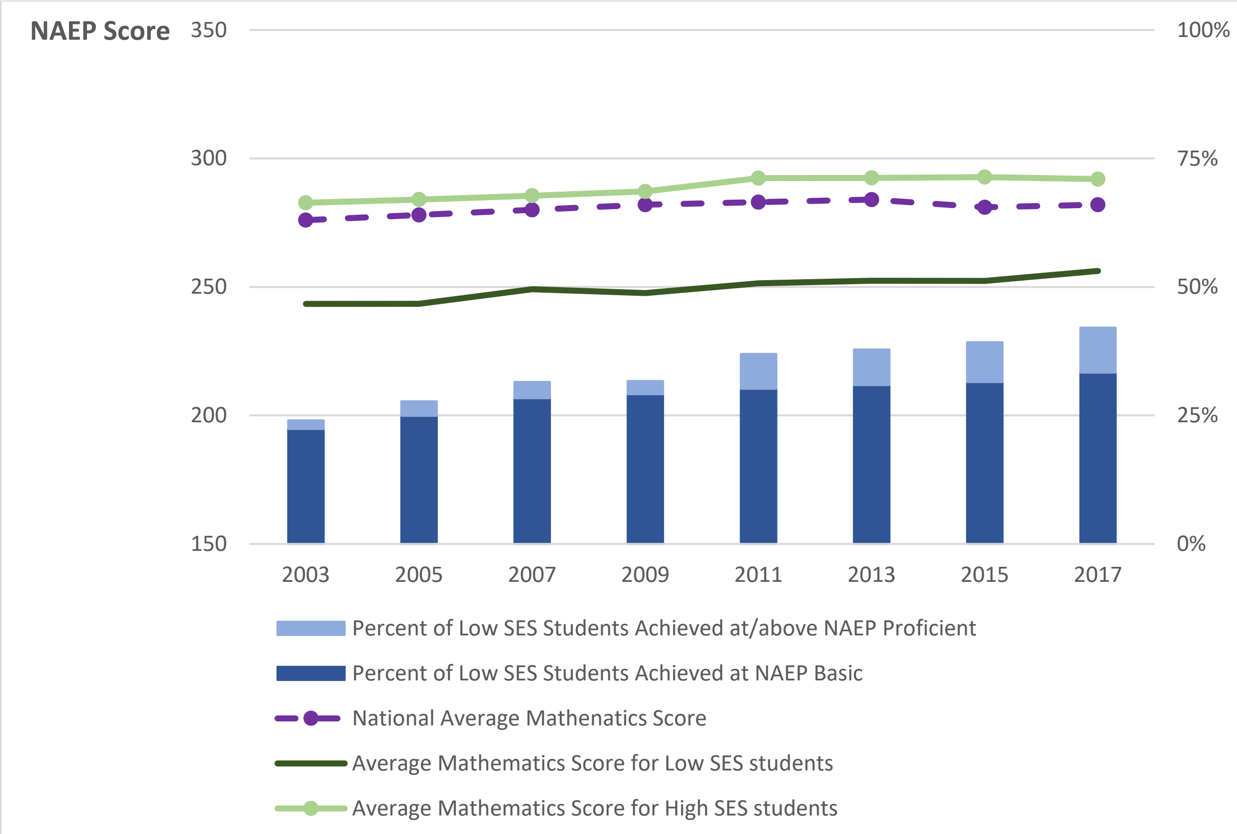
2017 gap of 36 points (figure 9). Nevertheless, it is worth noting that this gap is relatively small compared to the gap at the national level (49 points), and there was a 13-point score improvement for low-SES students compared to only a 9-point improvement for high-SES students. The state's average math score also increased 10 points over the last 15 years. This overall progress is further illustrated by its 18 percent increase in low-SES students performing at or above *NAEP Basic*, one of the largest in the nation. Breaking that down by achievement level, the percentage of low-SES students performing at *NAEP Basic* increased from 22 percent in 2003 to 33 percent in 2017, and the percentage performing at or above *NAEP Proficient* increased from 2 percent to 9 percent during that same period.

In spite of Mississippi's promising strides, an examination of the state's income indicators helps to contextualize its stagnant achievement gap. Mississippi's income inequality remained relatively constant from 2003 to 2017; its Gini coefficient stayed at about 0.48; and its top 10 percent of earners received 42 percent of the state's pre-tax income in 2003 and 45 percent in 2017. In addition, the child poverty rate showed only a small improvement, declining from 29 percent in 2003 to 27 percent in 2017. It is important to point out, though, that the poverty rate is one of the highest in the nation, given the national average of 18 percent. Therefore, even though Mississippi's income inequality, on average, stayed the same over this time period, the state's extremely high child poverty rate likely presents challenges to its public education system.

Mississippi's overall economy and education expenditure also provide context for its stable SES gap. The state's GDP per capita displayed a modest increase, from $31,975 in 2003 to $34,029 in 2017. These numbers, however, are still very low compared to the national 2017 average of $56,749. Education expenditure indicators show mixed results: Mississippi's per pupil expenditure increased from $7,892 to $9,052 (which is still lower than the 2003 national per pupil expenditure of $10,960), but its percentage of GDP spent on education remained the same at 3.88 percent. The percentage of Mississippi's K-12 education expenditure in relation to its overall state budget went down almost 5 percentage points. Taken together, these indicators suggest that the state's education spending remained about the same between 2003 and 2017.

In conclusion, our study shows that the SES achievement gap remained the same, but low-SES students showed slightly greater gains than high-SES students. Considering the economic challenges the state faces, it is a positive sign that Mississippi is outpacing the nation in its rate of NAEP score growth. The hope is that the state will also begin to close its SES achievement gap going forward.

Figure 9. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 mathematics score by SES background, Mississippi: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

New Jersey. New Jersey is often ranked as one of the top K-12 public school education systems in the nation (Lloyd 2018). After a 1998 court ruling that required the state to equalize funding and resources across its school districts, New Jersey installed a high-quality preschool program, made improvements to school infrastructure, and balanced funding across schools (Education Law Center 2011–2019). Overall, as a state, New Jersey has performed well, scoring above the national average on reading and mathematics assessments (U.S. Department of Education 2018g, table 221.60; U.S. Department of Education 2018j, table 222.60). Specifically, when considering grade 8 NAEP mathematics performance, the state's 2003 mean score was 281 (compared to a national average of 276), and by 2017, its mean had risen to 292 (compared to the nation's average of 282). Despite this progress, persistent inequalities exist in its public school system, particularly for students of color as well as in its urban districts, many of which experienced state takeovers in the last two decades (Orfield, Ee, and Coughlan 2017; Miller 2017). Therefore, despite New Jersey's overall high performance as a state, it still suffers from educational inequality.

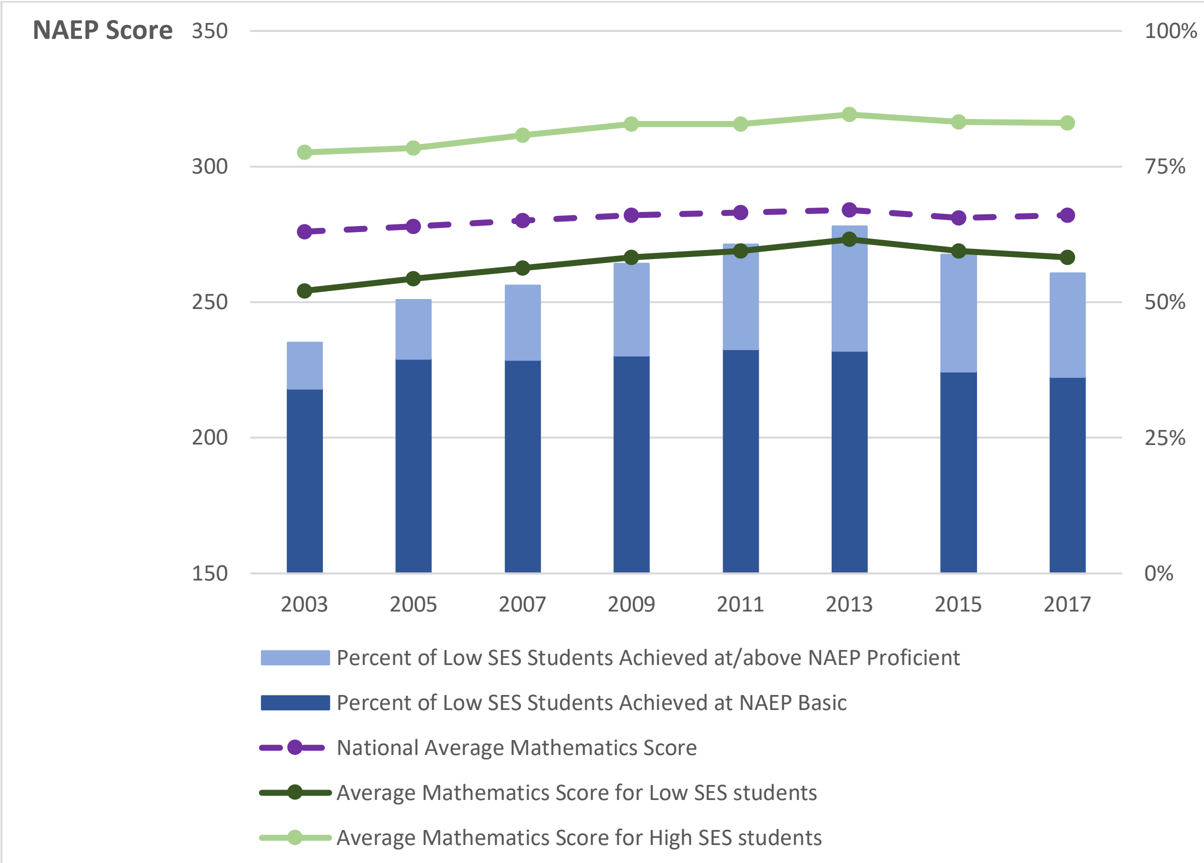
This is evidenced by our finding that the state's socioeconomic status achievement gap between its low- and high-SES students remained roughly the same from 2003 to 2017 at about 50 NAEP mathematics scale score points (figure 10). Equal progress from both low- and high-SES students from 2003 to 2017 explains this unchanging disparity. Low-SES students' average scores increased from 254 to 266, a 12-point gain, while high-SES students' average scores increased from 305 to 316, an 11-point gain. In focusing on the performance of low-SES students, the percentage who performed at or above *NAEP Basic* went from 43 percent to 55 percent, and among these students, the percentage who performed at or above *NAEP Proficient* went from 8 percent to 19 percent, a high percentage gain compared to other states. Therefore, despite the state's lingering SES gap, the performance of New Jersey's low-SES students is generally moving in a positive direction.

Exploring New Jersey's education spending over the 15-year period suggests the state consistently spent a lot on a per pupil basis (U.S. Department of Education 2018l, table 236.65). Increasing economic development (its GDP per capita increased from $58,095 in 2003 to $62,263 in 2017) accompanied this increase in K-12 expenditure. The state's PPE went from $17,124 in 2003 to $19,828 in 2017—61 percent more than the national average of $12,330. While the percentage of GDP spent on K-12 public education stayed mostly constant, according to the National Association of State Budget Officers (2018), New Jersey's state expenditure toward K-12 education stayed at about 23 percent.

In contrast, the state exhibited stagnant income inequality during this time period. New Jersey's Gini coefficient did not change (0.48), and the percentage of the state's pre-tax income received by its top 10 percent of earners increased slightly, from 47 percent in 2003 to 50 percent in 2017. The child poverty rate only increased from 12 percent to 14 percent and was low compared to the national percentage of 18 percent. The state's low rate of NSLP-eligible students (38 percent) aligns with this low poverty rate (U.S. Department of Education 2017, table 204.10).

In the context of small increases in education spending and economic development as well as unchanging income inequality, our findings suggest the SES achievement gap did not change significantly over the 15-year study period. Additionally, New Jersey's impressive state average grade 8 NAEP mathematics scores over the years have been pulled up by its high-SES students' performance, rather than by equal progress of students across both the high- and low-SES groups. Given the sharp decline in performance of low-SES students since 2013, New Jersey might want to focus on this group of students.

Figure 10. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, New Jersey: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

New Mexico. New Mexico has made important strides in its educational achievement in recent years. Nevertheless, the state still has low proficiency levels, particularly for its low-income Hispanic and Native American populations, who make up 61 percent and 10 percent, respectively, of its school population (U.S. Department of Education 2018b, table 203.70; U.S. Department of Education 2018f, table 221.50; U.S. Department of Education 2018h, table 221.70; U.S. Department of Education 2018i, table 222.55). Grade 8 NAEP mathematics scores for New Mexico still trail the national mean scores, with the state scoring 263 in 2003 (when the national average was 276) and 269 in 2017 (when the national average was 282). Added to these trends are a grading system of schools from the NCLB era, in which many schools were marked as failing, and a severe teacher shortage (Morales 2019). There has been some good news, however, in recent years—New Mexico has adopted higher reading and math standards since the NCLB was enacted, increased its turnaround efforts, installed an early literacy program, and seen increases in the rates of students taking and passing AP exams (Miller 2018). These statistics reflect hopeful changes for New Mexico's education system. Fittingly, our report finds a large reduction in its achievement gap between students of low and high SES status.

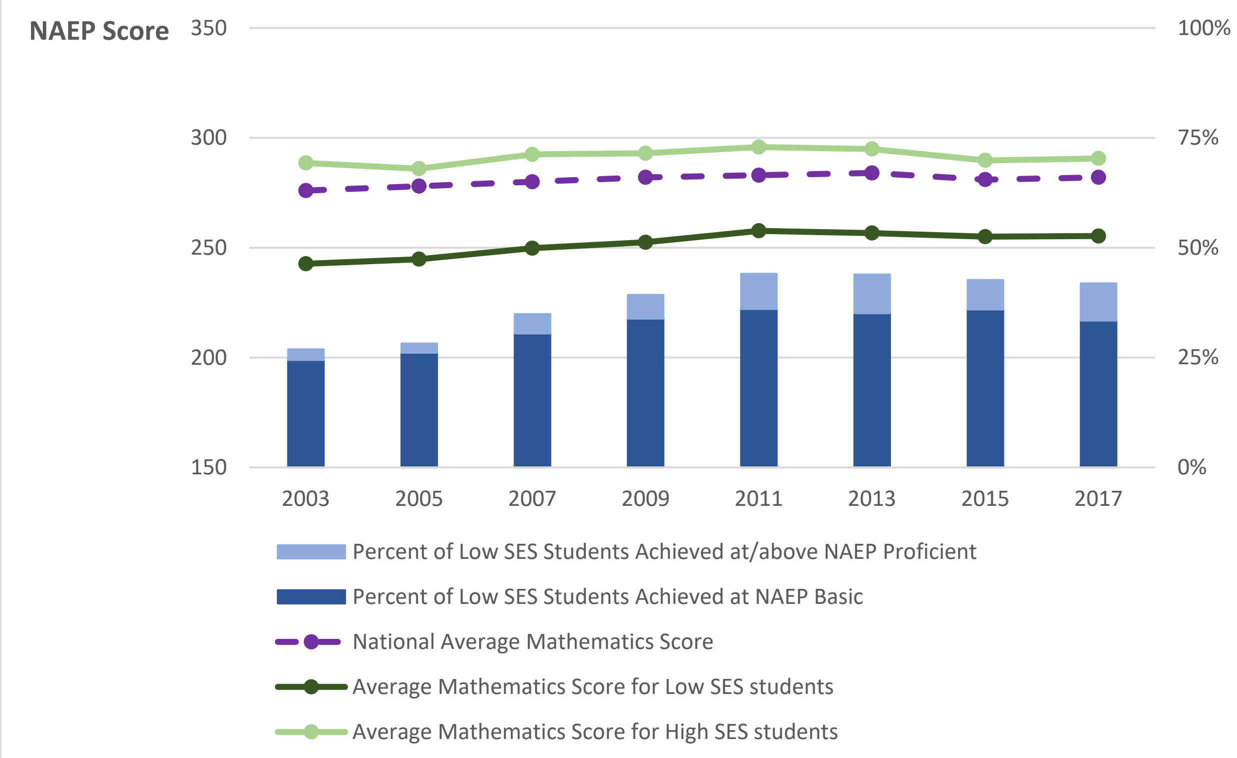
The SES achievement gap for New Mexico decreased from 46 points in 2003 to a relatively small 35 points in 2017 (figure 11). This large reduction—11 points—is attributed to the improving performance of low-SES students over this time period, with the average scale scores of low-SES students increasing by 13 points, from 243 in 2003 to 255 in 2017. The average scores of high-SES students, on the other hand, stayed at about 290. This 11-point difference, then, illustrates how the gains made by low-SES students drove this reduction. In fact, the percentage of low-SES students performing at *NAEP Basic* but below *NAEP Proficient* increased from 24 percent to 33 percent, and the percentage of those performing at or above *NAEP Proficient* increased from 2 percent to 8 percent over this time period. This 15-percentage-point increase in low-SES students performing at or above *NAEP Basic* was one of the largest in nation.

Despite the state's budgets cuts over the years (Morales 2019), its per pupil expenditure increased slightly, from $9,708 in 2003 to $10,371 in 2017. Meanwhile, New Mexico's state education expenditure decreased during this period, with the percentage of state expenditure on K-12 education declining from 23 percent to 17 percent; however, the percentage of its GDP spent on education remained the same. Taking these indicators into account, one can conclude that New Mexico's education expenditure did not change much in total during this time period.

The state's economy remained mostly stable, with New Mexico's per capita GDP barely increasing, moving from $41,081 to $43,465, a relatively low increase compared to that in the national average ($8,908). Income inequality, however, increased slightly during the 2003 to 2017 time period. The state's Gini coefficient increased slightly, from 0.45 in 2003 to 0.48 in 2017, and the top 10 percent of earners received 5 percent more of the state's pre-tax income in 2017 than they did in 2003. New Mexico's child poverty rate, though, stayed the same at 27 percent, which is higher than the national rate of 18 percent and certainly presents a concern.

Even though New Mexico faces challenges in its education system, such as teacher shortages and low proficiency rates, its SES achievement gap, using grade 8 NAEP mathematics scores as the measure, saw the largest reduction of any state in our dataset between 2003 and 2017. Considering that its education spending and economic development did not change much, and its income inequality increased only a little, it is a hopeful finding to see that the SES achievement gap decreased by 11 points as a result of the large gains made by its low-SES population. However, high-SES students in New Mexico still have a lot of progress to make, given that their scores were mostly unchanged during this time period. The state, therefore, should focus on improving the achievement of all of its student groups, including its high-SES students and its English language learners and Native American students. Doing so would help bring its state average scores more in line with the national averages.

Figure 11. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, New Mexico: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Ohio. In 1997, the Ohio Supreme Court ruled that Ohio's education funding system was unconstitutional due to the state's heavy reliance on property taxes (Geneva 2016). Twenty years later, in 2017, the state still had not narrowed the funding gap between its low- and high-income districts (Fleeter 2018). And as Ohio has diverted public education funds away from public schools and toward charter schools and voucher programs in the last several years, local districts have been forced to raise the money they need for themselves (Strauss 2016). A recent EdBuild report (2016) also showed that Ohio has the most economically segregated school districts in the country. Low-income districts, such as in Dayton and Cleveland, are also some of the most racially segregated (Orfield and Frankenberg 2014) and difficult to staff (Sweigart 2018). This could possibly contribute to the low graduation rate of Ohio's economically disadvantaged students (73 percent) compared to the state's average rate (84 percent) (U.S. Department of Education 2018e, table 219.46).

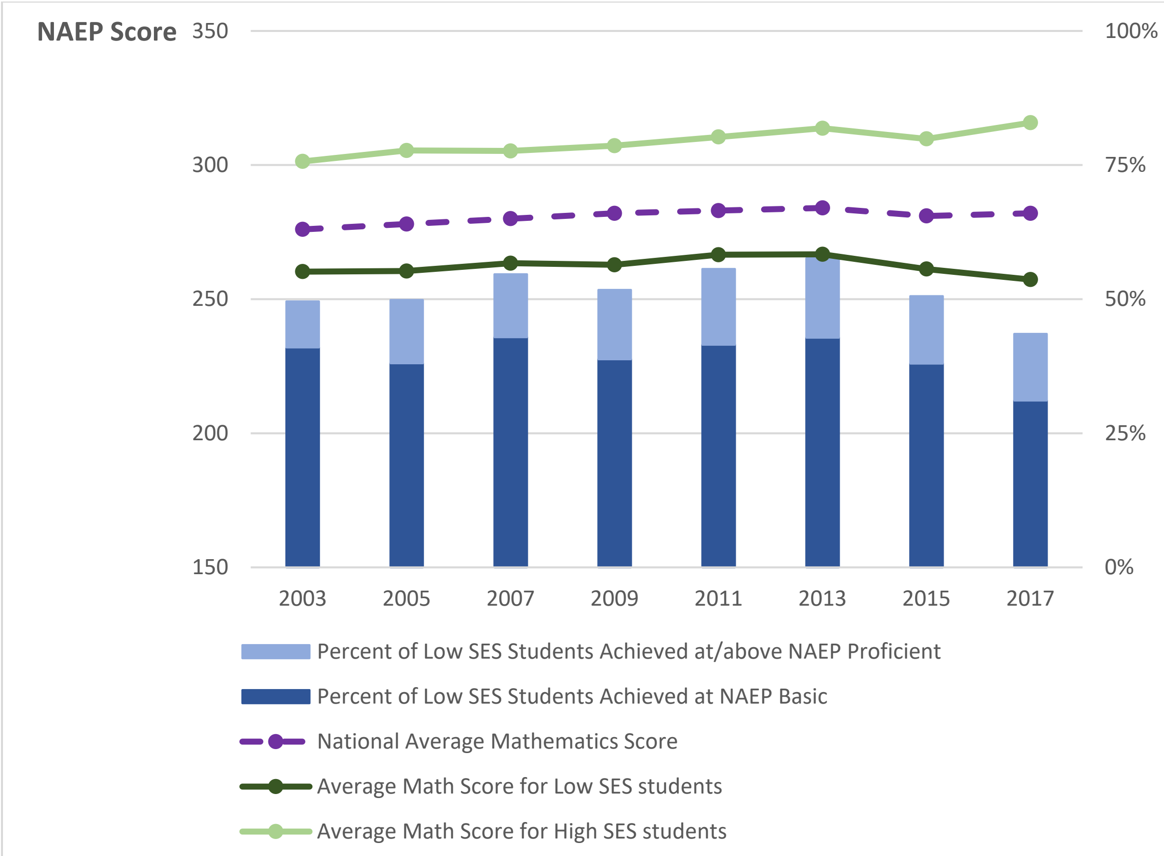
On the other hand, overall, Ohio does well in terms of mathematics achievement; its average grade 8 NAEP mathematics scores have always been above the national average (figure 12). It also has expanded a high-quality preschool program in recent years (Candisky 2016). Despite taking these steps forward, Ohio has experienced budget cuts for public education since 2011 (Strauss 2016), and from 2003 to 2017, its NAEP mathematics SES achievement gap widened by

17 points, going from 41 points in 2003 to 44 points in 2011 and then to 58 points in 2017. Its 17-point gap in 2017 was one of the largest in the nation that year, second only to the District of Columbia's. During this period, high-SES students' scores went up by 14 points, from 301 to 316. In contrast, low-SES students' scores decreased slightly, from 260 in 2003 to 257 in 2017. Concomitantly, the percentage of low-SES students performing at or above *NAEP Basic* went down from 50 percent to 44 percent.

Does Ohio's income and economic changes over the years provide context for its alarmingly large achievement gap? For the most part, they don't. In terms of income inequality, the state's Gini coefficient stayed the same, at 0.46, and its child poverty rate stayed constant at 20 percent—only slightly higher than the national 2017 average of 18 percent. However, its top 10 percent of earners did increase their share of the state's pre-tax income from 39 percent in 2003 to 44 percent in 2017. While the state's PPE went up slightly, from $11,762 in 2003 to $12,427 in 2017, the rate of increase (6 percent) was much slower than the national rate (13 percent). Additionally, funding has barely changed since 2009, particularly for disadvantaged districts; as a result, local districts have tried to make up the loss of state funds through additional local tax levies (Fleeter 2018). Two other education spending indicators also declined between 2003 and 2017. The percentage of the state's GDP spent on education decreased from 3.7 percent to 3.3 percent, and the percentage of the state budget spent on K-12 education decreased from 19 percent to 17 percent. These declines occurred even though Ohio's per capita GDP per capita increased from $45,707 to $51,456 during this time period.

In summary, the state has invested less in public education over time, and local districts have been trying to make up the difference, while, at the same time, there has been a small increase in income inequality. In addition, Ohio's SES achievement gap widened markedly over the study period, especially from 2013 to 2017. The magnitude of the increase in the gap is a cause for concern and should prompt policymakers and researchers to conduct further studies to find ways to reduce it in the future.

Figure 12. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, Ohio: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

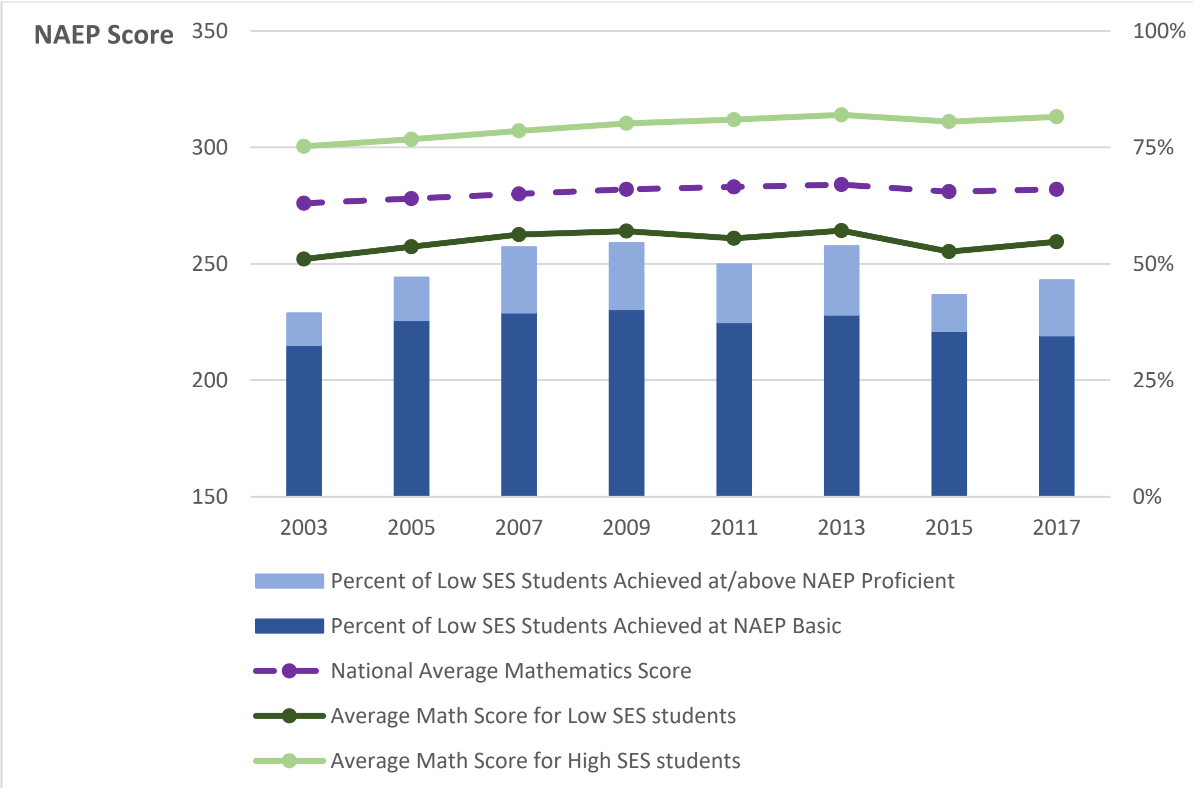
Pennsylvania. Despite above-average performance on national assessments, Pennsylvania struggles with persistent achievement gaps between its low- and high-income communities (U.S. Department of Education 2018f, table 221.50; U.S. Department of Education 2018i, table 222.55). As recently as 2008, the state had one of the most regressive funding systems in the nation, with low-income districts receiving 33 percent less in education funds than high-income districts (Education Law Center 2017). Pennsylvania's state legislature has since tried to equalize funding, and now, low- and high-SES districts receive roughly the same amount (Baker, Farrie, & Sciarra 2018). The state has implemented several successful programs since the beginning of the century, such as Pre-K Counts, which helps at-risk students gain access to early education, and Classrooms for the Future, which provides technology for classrooms (Bagnato, Salaway, and Suen 2009; Government Technology 2007). While the state has continually performed above the national average on the grade 8 NAEP mathematics assessment, students' performance and graduation rates still vary across income levels (Education Law Center 2017; U.S. Department of Education 2018e, table 219.46). Our study also shows that the socioeconomic status gap in Pennsylvania for NAEP grade 8 mathematics increased.

The gap between low- and high-SES students in Pennsylvania increased from 48 to 54 points, which is a large gap compared to the nation's (figure 13). This gap widened especially in the 6 years from 2011 to 2017. The source of this increase can be seen in high-SES students' larger gains compared to those of low-SES students: high SES students' average scores went from 300 in 2003 to 313 in 2017, an increase of 13 points, whereas low SES students' average scores went from 252 to 259, an increase of only 7 points. The percentages of low-SES students performing at the various achievement levels reflect this modest increase: the percentage of students performing at or above *NAEP Basic* went from 39 percent to 46 percent between 2003 and 2017, and most of this increase was due to the 5 percent of students among them who performed at or above *NAEP Proficient*.

An investigation of contextual income and expenditure indicators only somewhat informs the widening of Pennsylvania's already large achievement gap. Both the state's Gini coefficient and child poverty rate stayed the same, at about 0.48 and at 17 percent, respectively, which are both average for the country. And while the pre-tax income of the top 10 percent of its earners increased from 42 percent to 46 percent, the state's economic performance improved, with GDP per capita increasing from $45,451 to $55,602. During the same period, however, the percentage of GDP spent on public education stayed the same. Therefore, Pennsylvania's increase in per pupil expenditure from $12,258 in 2003 to $15,792 in 2017 is mostly due to an increase in the state's GDP and education's share of it, not a stronger prioritization on education spending.

Pennsylvania's mean scores went up from 2003 to 2017. However, breaking down these average achievement trends into low- and high-SES student groups tells a different story. The state's increase in its existing inequality, along with some of the most economically segregated neighborhoods in the country (EdBuild 2016), can likely explain the widening of its large SES achievement gap over the 15-year study period. Given Pennsylvania's above-average mean NAEP scores, as well as the impressive scores of its high-SES students, the state is well positioned to raise the performance of its low-SES students and close the SES achievement gap in the future by continuing its strong education policy programs and by placing special emphasis on low SES students.

Figure 13. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, Pennsylvania: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Tennessee. At the beginning of this century, Tennessee was spending below the national average on public education and exhibited below-average math and reading scores (U.S. Department of Education 2018g, table 221.60; U.S. Department of Education 2018l, table 222.60; U.S. Department of Education 2018l, table 236.65). Although it administered annual tests to its students before NCLB, its statewide standards were not as rigorous as they could have been, and, in 2007, a U.S. Chamber of Commerce report called out Tennessee for the wide gap between its state assessment proficiency results and its NAEP proficiency results (Tennessee Office of the Governor n.d). When the state won a $500 million grant under the Race to the Top competition in 2010, Tennessee started to transform its education system: it instituted higher academic standards, a new state test aligned to those standards, and robust accountability systems (Aldrich 2018). It also increased its emphasis on student achievement by tying teacher evaluations to student performance on state assessments and by creating the Achievement School District to take over failing schools. Overall, the state saw increasing graduation rates—up to 90 percent in 2017—and average test scores that grew more in line with national scores (U.S. Department of Education 2018e, table 219.46). Our findings show that while a socioeconomic status gap still exists in Tennessee, it decreased significantly between 2003 and 2017.

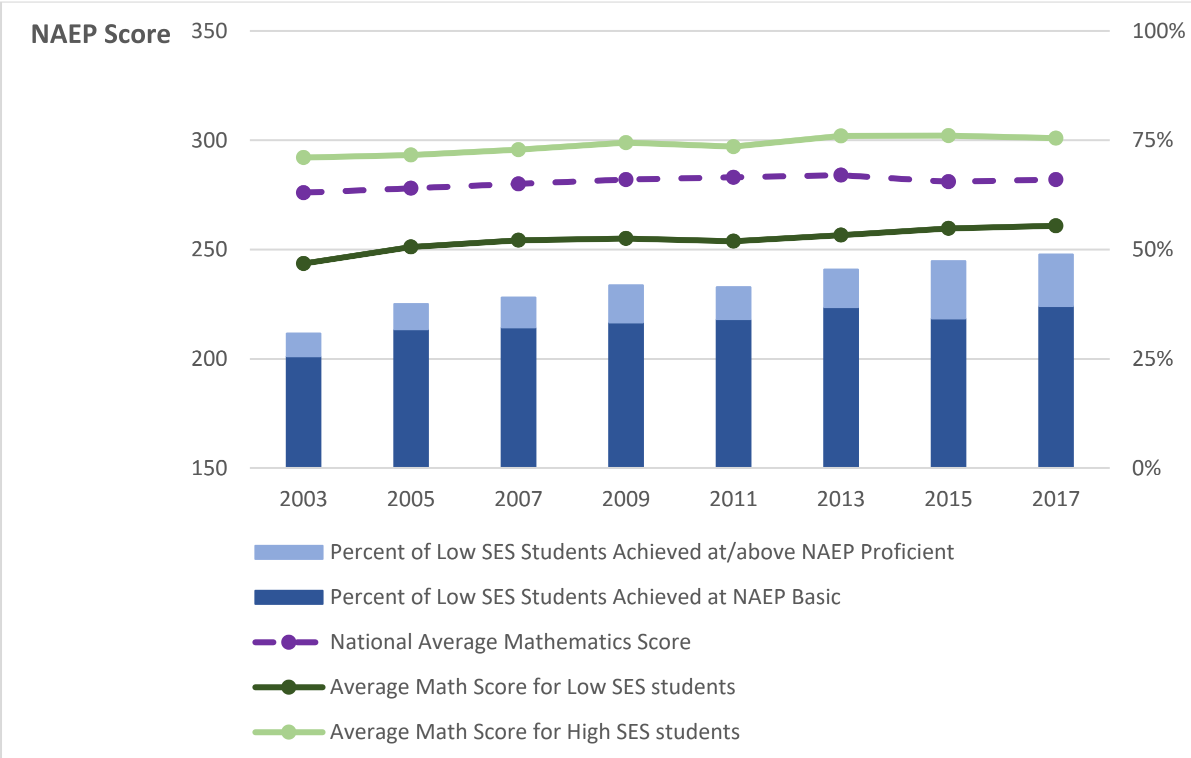
Tennessee's 2003 48-point SES gap was statistically greater than its 2017 SES gap of 40 points (figure 14). This reduction in the size of the gap was one of the largest that occurred among the 50 studied jurisdictions. Furthermore, the 40-point gap in 2017 was much smaller than the nation's (49 points). A deeper examination of the data shows that the 8-point reduction in the gap was due to greater progress from low-SES students than from high-SES students. While both groups' average scale scores varied during the 15-year period, low-SES students saw a larger increase (17 points) than did high-SES students (9 points). It is worth noting that the 17-point increase is one of the largest increases for low-SES students across all states. Additionally, the percentage of low-SES students performing at *NAEP Basic* increased from 26 percent in 2003 to 37 percent in 2017, and the percentage performing at or above *NAEP Proficient* increased from 5 percent to 12 percent. These increases were also some of the largest in the nation.

By examining Tennessee's education expenditure trends, we observe that its K-12 education spending increased slightly. The state's per pupil expenditure went from $8,335 in 2003 to $9,243 in 2017. However, the state has always had a low PPE, which has resulted in recent lawsuits over Tennessee's education funding formula, the Basic Education Program (Tatter 2016).

In contrast, there was a slight improvement in Tennessee's economic performance (its per capita GDP went from $42,379 in 2003 to $46,741 in 2017) but a slight increase in income inequality. Although Tennessee's Gini coefficient remained the same at 0.48, and its child poverty level stayed at about 20 percent (Population Reference Bureau 2017), the one inequality indicator that increased markedly during this period was the top 10 percent of earners' share of the state's pre-tax income, which increased from 42 percent in 2003 to 47 percent in 2017.

In summary, the 8-point reduction in the SES gap, one of the few reductions seen in any of the jurisdictions covered in this report, suggests that Tennessee has made more progress than might have been expected and, therefore, should be studied in more detail. Future research should focus on the driving forces behind the positive trends described above. Nevertheless, while the state reduced its educational inequality from 2003 to 2017, it still had a 40-point gap between its low- and high-SES students. But if the recent trend continues, Tennessee should reach its goal of entering the top half of NAEP state rankings in the near future (Tatter 2015).

Figure 14. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and average grade 8 NAEP mathematics score by SES background, Tennessee: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

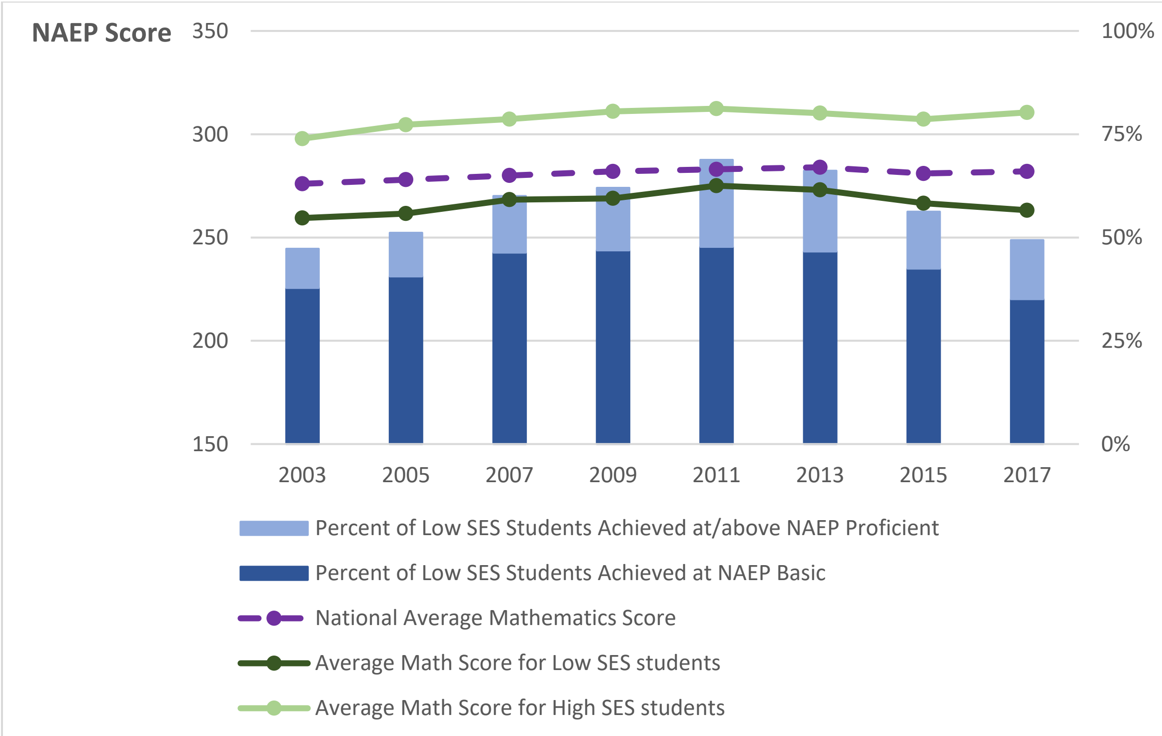
Texas. Texas has one of the largest public education systems in the country, serving over half a million students as of 2017. Public schools in Texas receive funding from state revenue as well as local property taxes. In recent years, the state has experienced a sizable change in the composition of its student body—a higher share of Hispanic students, ELL students, and economically disadvantaged students (Texas Education Agency 2018). For example, the percentage of students eligible for free/reduced-price lunch increased from 45 percent in 2000 to 59 percent in 2014 (U.S. Department of Education 2017, table 204.10). Considering the larger population of economically disadvantaged students, it was hoped that state revenue would be used to equalize funding for schools and alleviate the discrepancies in local property taxes. Unfortunately, the percentage of total education funds coming from the state declined from 48.5 percent in 2007 to 42 percent in 2017 (DeMatthews and Knight 2018). Taking all of these demographic and funding changes into consideration, it is therefore important to examine how overall student performance as well as SES achievement gaps have changed over time.

Overall, the mathematics achievement of Texas's grade 8 students is in line with the nation's average when considering only NAEP data from 2003 and 2017. However, unlike the nation's gradually improving trend (from 276 points in 2003 to 282 points in 2017), Texas showed a large improvement (from 277 points in 2003 to 290 points in 2011), followed by a decline (to 282 points in 2017).

Texas saw a 2003 38-point gap increase significantly to 47 points in 2017 (figure 15). As a result, Texas was one of 14 states that saw a significant widening in its SES achievement gap during this period. Over the 15 years, the SES achievement gap reached its lowest level, at 37 points, in 2011, an accomplishment that was paired with average achievement reaching its highest level, at 290 points. These accomplishments appear to be due to a significant improvement in low-SES students' performance between 2003 and 2011. Whereas only 10 percent of low-SES students in Texas achieved at or above the *NAEP Proficient* level in 2003, by 2011 this figure had doubled to 21 percent. After 2011, however, the percentage started to drop, and by 2017 only 14 percent of low-SES students were achieving at or above the *NAEP Proficient* level. In brief, changes in low-SES students' performance help explain changes in the state's SES achievement gap as well as the overall achievement.

Putting the findings into a larger context, Texas has experienced a declining investment in education as well as increasing income inequality. The percentage of GDP spent on education decreased from 3.65 percent in 2003 to 3.10 percent in 2016, and the percentage of total state expenditure on education dropped from 28.8 percent in 2003 to 24.5 percent in 2015. Per pupil expenditure increased from $9,534 in 2003 to $9,738 in 2015, an increase of only 2 percent. Both the absolute amount of the increase in the PPE, as well as its magnitude, were considerably smaller than the country's as a whole, going from $10,960 in 2003 to $12,330 in 2015 (a 13 percent increase). In other words, Texas has been struggling with investment in its growing student population. During the same period, the percentage of pre-tax income received by Texas's top 10 percent of earners increased from 43 percent in 2003 to 50 percent in 2014, suggesting a widening wealth inequality. Changes in macro-level indicators provide important context for understanding the challenges Texas has been facing to ensure sufficient funding for its students and reducing the SES achievement gap.

Figure 15. Weighted percentage of low-SES students performing at *NAEP Basic* and at or above *NAEP Proficient* and grade 8 NAEP average mathematics score by SES background, Texas: 2003–17



NOTE: All plausible values of a given subscale were used to derive the average mathematics scores. Apparent differences may not be statistically significant. Scales range from 0 to 500 for the grade 8 NAEP mathematics assessment. Comparisons are independent with an alpha level of .05.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Exploratory Analysis of Changes in Macro-Level Context

To go beyond individual state-level examples, we conducted exploratory analyses of relationships between states' SES trends and changes in their macro-level indicators. Specifically, we ran bivariate scatter plots and obtained correlation coefficients and lines of best fit for the associations between changes in the size of states' SES achievement gaps between 2003 and 2017 and the following indicators:

1. change in per pupil expenditure (PPE) (appendix B)

2. change in difference in average SES between high- and low-SES groups (appendix C)

3. change in Gini coefficient (appendix D),

4. change in average scores (appendix E), and

5. change in proportion of ELL students among all enrolled public-school students (appendix F).

Several indicators showed no correlation with changes in states' SES achievement gaps between 2003 and 2017. Specifically, the changes in states' PPE ($r = 0.04$), Gini coefficients ($r = -0.05$), and proportion of ELL students ($r = -0.03$) showed no correlation with the changes in their gaps over this 15-year period. However, a few indicators did exhibit positive associations with SES gap reductions.

The change in the difference between the low- and high-SES groups' average SES index levels for each state was highly correlated with the change in their SES achievement gaps ($r = 0.60$, appendix C). This means that states whose differences were stable or even decreasing in terms of absolute SES index points between their low-SES (lowest quartile) and high-SES (highest quartile) students over time tended to have smaller achievement gaps, whereas states with increasing SES differences between high- and low-SES groups tended to have widening achievement gaps (see appendix A, "Difference in average SES between high- and low-SES groups" column). Therefore, as the two SES groups came closer together in terms of their SES level, so did the achievement gap.

For example, in the District of Columbia, the difference between its low- and high-SES students increased by 2 SES index points between 2003 and 2017—its low-SES students became poorer over time and its high-SES students became wealthier—and its SES achievement gap widened by 21 points. In New Mexico, on the other hand, the difference between its low- and high-SES students decreased by -0.43 points—with both low- and high-SES students' SES index levels decreasing over time,[6] but with high-SES students doing so at a higher rate—and its SES achievement gap decreased by 11 points.

In addition to changes in SES index levels between high- and low-SES groups, the change in states' average scores was also significantly correlated with the change in their SES achievement gaps ($r = -0.47$, appendix E). This strong negative correlation illustrates that if the average grade 8 NAEP mathematics score for a state went up between 2003 and 2017, the state's SES achievement gap tended to go down or at least stay the same. Some examples of this include Tennessee, whose average score went from 268 to 279 (up 11 points) while exhibiting an 8-point reduction in its achievement gap. On the other hand, Louisiana's average score stayed at 267 over this 15-year period, and its SES achievement gap widened by 8 points.

These two state indicators—difference in low- and high-SES index levels and state average scores—can provide some context framing this study's research findings. However, given that most state-level inequality indicators did not show significant correlations with states' SES achievement gaps, a more in-depth analysis of these bivariate relationships is needed in the future to understand what could be shaping states' changing SES gaps.

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[6] This does not mean that New Mexico overall saw an SES increase. Our SES index can be used for comparative purposes but we do not claim measurement invariance over time for it, which means trends in absolute SES cannot be taken at face value, as the meaning of the SES index components (e.g., the number of books at home) may have changed over time. This is why SES index cut-off values for low- and high-SES students were calculated for each year and state separately instead of using fixed cut-off values.

Conclusion

This study examines changes in educational outcomes between low- and high-SES students over time in the United States, at both the national and state/jurisdiction levels, thereby contributing to the literature on educational inequality. With the decentralized education system in the United States, states differ on matters of importance such as school governance, funding allocation, the teacher workforce, and learning standards and curricula. Over time, the magnitude of changes in states' economic development, educational expenditure, and income inequality also varies, and it is important to examine whether educational outcomes are affected by these changes. Also, we explored the relationship between state-level factors and SES gap trends changes by collecting macro-level data and connecting dots between changes in state-level factors and changes in SES gaps. The main focus of this study, however, was to answer the following two research questions: (1) *Has the socioeconomic achievement gap changed over time in the United States and its states?* and (2) *Has the performance of low-SES students improved over time?*

To answer the first research question, our study examined six cycles of grade 8 NAEP data. At the national level, our findings suggest that the SES achievement gap remained approximately the same between 2003 and 2017. This finding is consistent with previous literature that used different datasets to examine the mathematics achievement gap due to SES over time in the United States (Broer, Bai, and Fonseca 2019; Hanushek et al. 2020). At the state level, our findings showed that 34 of the 50 states' SES achievement gaps experienced no significant change between 2003 and 2017, 14 gaps widened, and only 2 SES gaps narrowed. The findings provide references for states to track changes in their students' SES achievement gap in addition to their average academic performance. For instance, District of Columbia Public Schools have seen consistent progress in their students' average NAEP scores in multiple subjects since 2003, and the achievement gap vis-à-vis the national average has been closing over time, as highlighted on the official website of the Office of the State Superintendent of Education.[7] However, the jurisdiction also experienced a large increase in the SES achievement gap during the same time period (figure 5). On the other hand, New Mexico and Tennessee saw a significant reduction in their SES achievement gaps over the studied time period.

For the second research question, we examined to what extent the performance of low-SES students has changed over time and found an increase of about 5 percent of low-SES students who achieved at the *NAEP Basic* and the *NAEP Proficient* levels over the studied time period. Although only a few states observed a reduction in their SES achievement gaps, many did show improvement in their low-SES students' performance. When examining changes in the percentages of students performing at or above the *NAEP Basic* achievement level, 32 out of 50 states showed increases, 4 witnessed no change, and 14 showed decreases (table 5). Georgia had the largest increase (from 29 percent in 2003 to 49 percent in 2017), while North Dakota had the largest decrease (from 64 percent in 2003 to 53 percent in 2017).

In addition, we calculated changes in the percentages of students performing at or above the *NAEP Proficient* achievement level between 2003 and 2017 (table 6). Of all 50 states, 43 states illustrated various degrees of increases, 2 states exhibited no change, and 5 states observed

[7] See https://osse.dc.gov/release/district-columbia%E2%80%99s-naep-scores-show-continued-progress-closing-gap-nation-over-time.

decreases. Massachusetts and New Jersey had the largest gains, 13 percentage points and 11 percent points, respectively, whereas North and South Dakota had the largest decreases, each at 4 percentage points.

With both changes in SES achievement gaps and low-SES students' performance, one can get a more comprehensive picture of how a state's educational inequality has changed. Using the District of Columbia as an example, the SES gap stayed the same between 2003 and 2009, as students from different family backgrounds all improved their performance at a similar rate. However, the SES gap widened rapidly after 2009, as high-SES students improved their performance at a faster rate than their low-SES counterparts. The SES achievement gap trend in the District of Columbia and the need to further improve low-SES students' performance is an aspect that policymakers should not lose sight of, despite the District's strong improvement in terms of overall performance.

Finally, the findings will allow states to gain an awareness of how other states are addressing educational inequality. The methodology can, of course, also be updated for each new NAEP cycle, providing the public and policymakers with a tool to track a state's initiatives toward closing the SES gap over time.

Among all 50 jurisdictions included in the study, only two, New Mexico and Tennessee, showed a reduction in the SES achievement gap over the studied time period. In New Mexico, the SES gap narrowed due to low-SES students improving their scores, while high-SES students' scores remained stagnant (figure 11). In contrast, in Tennessee, the SES gap narrowed due to both low- and high-SES students making improvements in their performance, but with the low-SES student group improving at a faster rate (figure 14). The scenario in Tennessee is ideal, and although uncommon, it is worth striving for. It would be of interest to investigate in more depth what factors contributed to Tennessee's performance. For 34 of the states, the 2003 gap remained essentially unchanged through 2017, suggesting that both high- and low-SES students changed their performance, when it changed, in the same direction at the same speed. When this happened in a generally improving performance trend, the fact that achievement gaps did not close much may be of less concern given that low-SES students saw steady gains in such states (see the green quadrant in figure 2).

The remaining 14 states experienced an increase in their SES achievement gap, raising the question as to why this was the case. Future research is needed to explore in more depth the associations between changes in local economic contexts (including educational investments as a portion of GDP and income inequality) and changes in the SES achievement gap across states as well as within states. Such studies will provide better data from which more nuanced policy implications for states' education systems may then be drawn.

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Appendix A

Table A-1. Changes in average SES, by state: 2003 and 2017

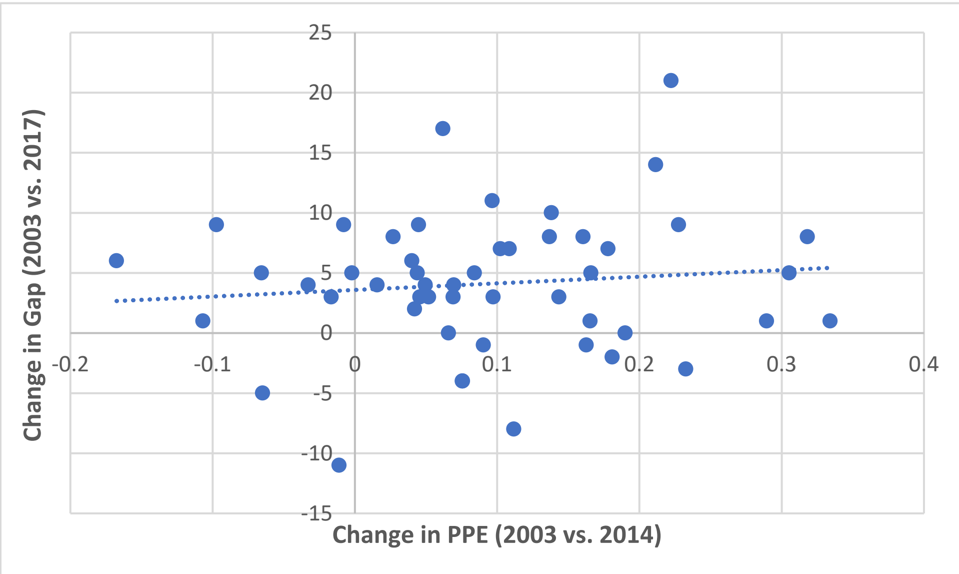
States/ Jurisdictions	Average SES of low-SES Group		Average SES of high-SES Group		Average SES for all sampled students			Difference in average SES between high- and low-SES groups		
	2003	2017	2003	2017	2003	2017	2017 vs. 2003	2003	2017	2017 vs. 2003
National Public	3.0	2.0	11.2	10.6	7.3	6.3	-1.0	8.2	8.6	0.4
Alabama	2.7	1.8	10.8	10.1	6.7	5.7	-1.0	8.2	8.4	0.2
Arizona	1.7	1.2	10.7	10.2	6.1	5.5	-0.6	9.0	9.0	0.0
Arkansas	2.8	2.0	10.3	9.7	6.6	5.7	-0.9	7.6	7.7	0.1
California	1.8	1.2	11.1	10.4	6.4	5.6	-0.9	9.3	9.2	-0.1
Colorado	3.8	N/A	11.9	N/A	8.6	N/A	N/A	8.1	N/A	N/A
Connecticut	3.9	2.9	11.9	11.6	8.5	7.6	-0.9	8.1	8.7	0.6
Delaware	4.0	3.0	10.8	10.9	7.6	7.1	-0.5	6.8	8.0	1.1
District of Columbia	1.7	1.1	8.6	10.2	4.9	4.8	-0.1	6.9	9.2	2.3
Florida	2.5	1.7	10.5	9.8	6.5	5.7	-0.9	8.0	8.1	0.1
Georgia	2.6	1.9	11.0	10.6	6.8	6.1	-0.7	8.4	8.8	0.3
Hawaii	3.1	2.4	10.6	10.0	6.9	6.3	-0.7	7.5	7.6	0.1
Idaho	3.5	2.9	11.0	10.6	7.5	7.1	-0.4	7.5	7.7	0.3
Illinois	2.6	2.1	11.7	11.0	7.7	6.5	-1.2	9.1	8.8	-0.2
Indiana	4.0	2.6	11.3	10.9	7.9	7.0	-1.0	7.3	8.3	1.0
Iowa	4.6	3.2	11.5	11.1	8.5	7.5	-1.0	6.9	7.9	1.0
Kansas	3.7	2.4	11.5	11.0	8.0	6.9	-1.1	7.8	8.7	0.9
Kentucky	2.7	2.0	10.7	9.8	6.9	5.9	-0.9	7.9	7.8	-0.1
Louisiana	2.1	N/A	9.7	N/A	5.8	N/A	N/A	7.6	N/A	N/A
Maine	4.6	3.5	11.5	11.1	8.4	7.5	-0.9	6.9	7.6	0.7
Maryland	4.1	2.5	11.5	11.0	8.2	7.0	-1.3	7.4	8.5	1.1
Massachusetts	3.8	3.1	11.7	11.7	8.5	8.0	-0.5	7.9	8.6	0.6
Michigan	4.2	2.7	11.5	11.3	8.2	7.3	-0.9	7.3	8.6	1.2
Minnesota	4.7	3.4	11.7	11.4	8.8	8.0	-0.8	7.0	8.0	1.1
Mississippi	2.2	1.5	10.1	9.2	6.0	4.9	-1.0	7.9	7.6	-0.3
Missouri	3.7	2.8	11.4	10.9	7.9	7.1	-0.8	7.7	8.2	0.5
Montana	4.5	N/A	11.4	N/A	8.3	N/A	N/A	6.9	N/A	N/A
Nebraska	4.1	2.5	11.5	11.0	8.2	7.2	-1.0	7.4	8.5	1.1
Nevada	3.2	1.4	11.1	10.3	7.5	5.6	-1.9	8.0	8.9	0.9
New Hampshire	5.5	4.5	11.7	11.6	9.2	8.6	-0.6	6.2	7.1	0.9

States/ Jurisdictions	Average SES of low-SES Group		Average SES of high-SES Group		Average SES for all sampled students			Difference in average SES between high- and low-SES groups		
	2003	2017	2003	2017	2003	2017	2017 vs. 2003	2003	2017	2017 vs. 2003
New Jersey	3.8	2.5	11.8	11.5	8.3	7.5	-0.9	8.0	8.9	0.9
New Mexico	1.7	1.0	9.9	8.8	5.6	4.6	-1.0	8.2	7.8	-0.4
New York	2.5	1.8	11.5	10.5	7.2	6.3	-1.0	9.0	8.7	-0.3
North Carolina	3.0	2.0	10.9	10.2	7.1	6.1	-0.9	7.9	8.2	0.3
North Dakota	5.1	3.9	11.5	11.4	8.8	8.2	-0.6	6.5	7.5	1.0
Ohio	3.7	2.4	11.5	11.1	8.0	7.0	-1.0	7.8	8.7	0.9
Oklahoma	2.5	1.6	10.7	10.0	6.8	5.7	-1.1	8.2	8.4	0.2
Oregon	3.8	1.8	11.1	10.6	7.8	6.1	-1.7	7.3	8.8	1.4
Pennsylvania	3.9	2.7	11.6	10.9	8.2	7.0	-1.2	7.7	8.2	0.5
Rhode Island	2.3	1.7	11.7	11.1	7.6	6.5	-1.1	9.4	9.4	0.0
South Carolina	2.7	2.0	10.7	10.3	6.8	6.1	-0.7	8.0	8.2	0.2
South Dakota	4.2	N/A	11.4	N/A	8.3	N/A	N/A	7.2	N/A	N/A
Tennessee	3.1	2.2	11.0	10.2	7.3	6.2	-1.0	7.9	8.0	0.2
Texas	1.7	1.1	10.9	10.2	6.4	5.3	-1.0	9.3	9.1	-0.2
Utah	4.6	N/A	11.7	N/A	8.7	N/A	N/A	7.1	N/A	N/A
Vermont	4.8	3.8	11.8	11.4	8.8	8.0	-0.8	6.9	7.6	0.7
Virginia	4.1	3.1	11.6	11.2	8.3	7.4	-0.9	7.5	8.1	0.6
Washington	3.4	2.5	11.2	11.1	7.5	7.2	-0.4	7.8	8.7	0.9
West Virginia	2.9	2.4	10.5	9.5	6.9	5.7	-1.2	7.6	7.1	-0.5
Wisconsin	4.2	3.2	11.6	11.3	8.4	7.7	-0.7	7.4	8.1	0.8
Wyoming	4.9	N/A	11.4	N/A	8.5	N/A	N/A	6.5	N/A	N/A

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2013 and 2017 Grade 8 Mathematics Assessment.

Appendix B

Figure B-1. Percentage change in per pupil expenditure (PPE)[8] versus change in SES achievement gap, by state: 2003 and 2014/2017

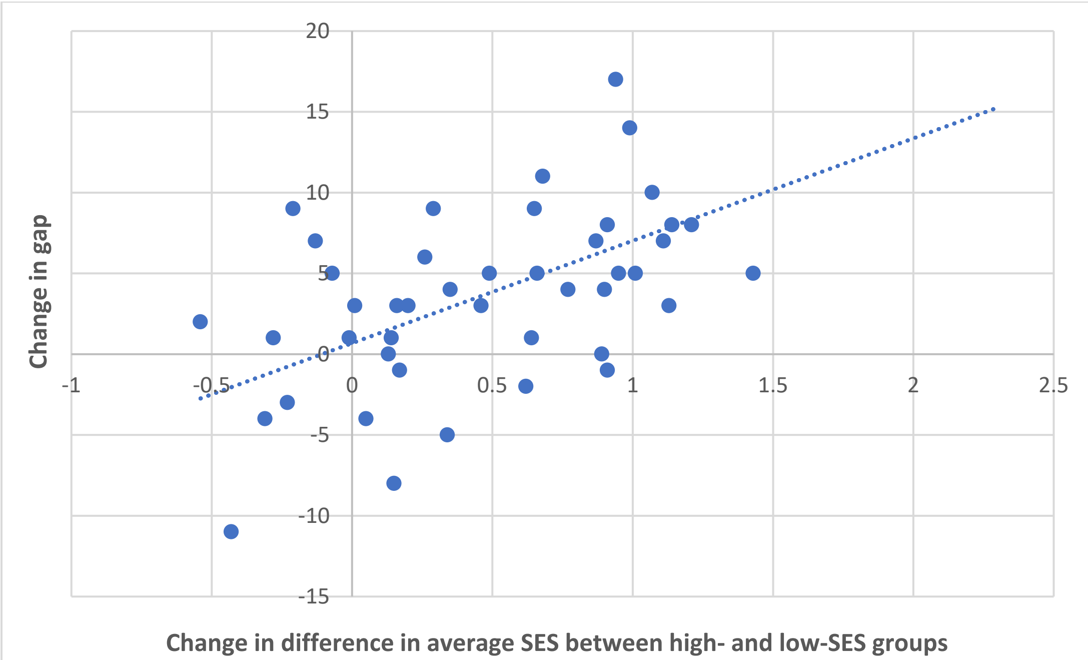


NOTE: *r* = 0.10 and y = 5.4948x + 3.588. Adjusted PPE data are from the 2013–14 academic year, the most recent year for which data were available at the time this report was written. The changes in PPE were calculated between 2003 and 2014, respectively. This analysis includes all 50 states.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment; Statistics of State School Systems, 1969–70; Revenues and Expenditures for Public Elementary and Secondary Schools, 1979–80; and Common Core of Data (CCD), "National Public Education Financial Survey," 1989–90 through 2015–16.

[8] PPE was adjusted using the Comparable Wage Index (CWI). See detailed methodology documentation at Taylor, L.L., Glander, M., and Fowler, W.J. (2007). *Documentation for the NCES Comparable Wage Index Data File, 2005* (EFSC 2007-397). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Appendix C

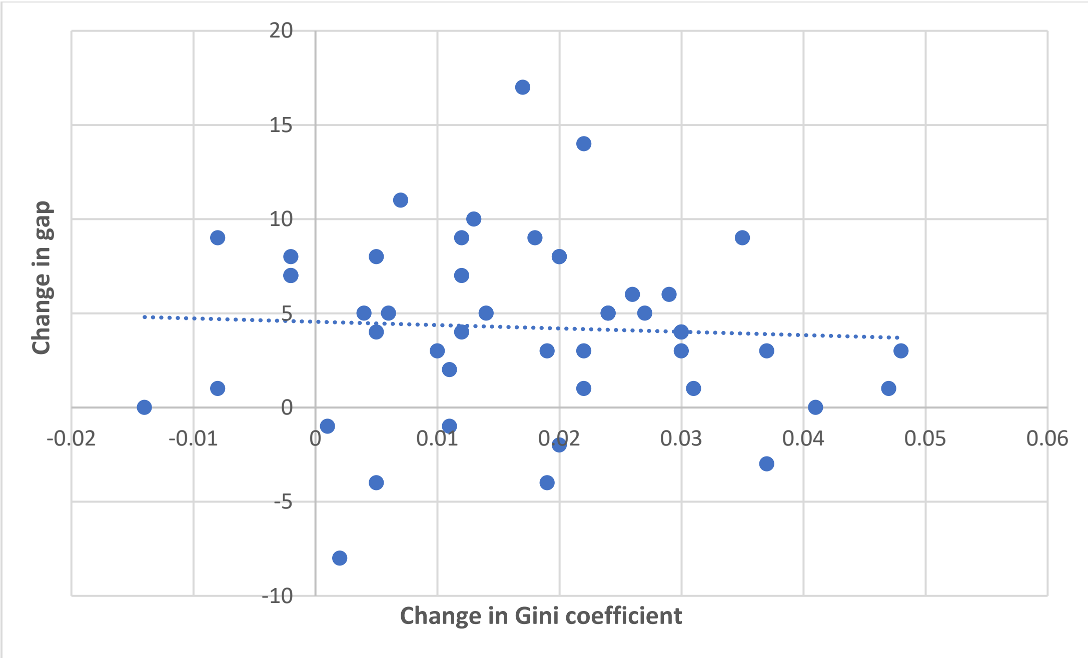
Figure C-1. Change in difference in average SES between high- and low-SES groups versus change in SES achievement gap, by state: 2003 and 2017



NOTE: $r = 0.60$ and $y = 6.35x + 0.65$. Difference in average SES between high- and low-SES groups per state was taken from appendix A.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Appendix D

Figure D-1. Change in Gini coefficient versus change in SES achievement gap, by state: 2003 and 2017



NOTE: r = -0.05 and y = -17.73x + 4.55. This analysis includes only 47 states, as the District of Columbia, Georgia, and New Mexico were removed as outliers.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003-17 Grade 8 Mathematics Assessment; America's Health Rankings analysis of America's Health Rankings composite measure, United Health Foundation, AmericasHealthRankings.org, accessed 2020.

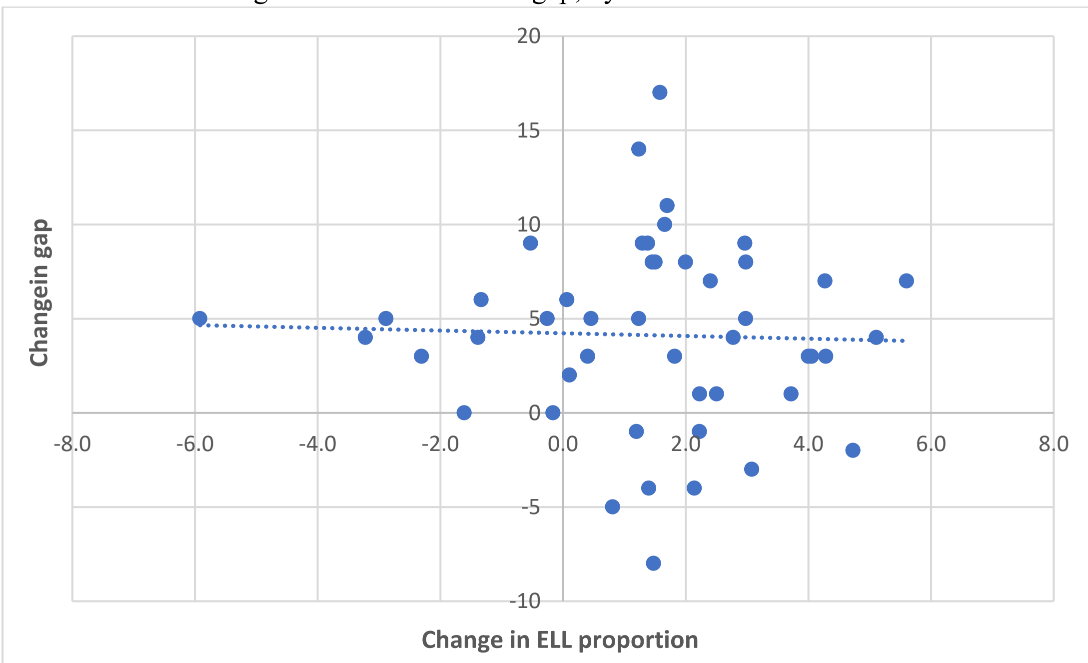
Appendix E

Figure E-1. Change in average score versus change in SES achievement gap, by state: 2003 and 2017

NOTE: *r* = -0.47 and y = -0.58x + 6.63. This analysis includes only 47 states, as the District of Columbia, New Mexico, and Ohio were removed as outliers.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment.

Appendix F

Figure F-1. Change in proportion of English Language Learner (ELL) students among all enrolled public-school students versus change in SES achievement gap, by state: 2003 and 2017



NOTE: r = -0.03 and y = -0.07x + 4.23. The closest available year of data for ELL student proportions was 2005. For that year, several states' ELL student data were imputed to account for survey nonresponse levels. State-level imputations were based on the percentages reported by the state for other years applied to the enrollment for the given year. This analysis includes only 47 states, as Arizona, the District of Columbia, and New Mexico were removed as outliers.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2003–17 Grade 8 Mathematics Assessment; Common Core of Data (CCD), "Local Education Agency Universe Survey," 2000–01 through 2017–18.