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Chapter 7

The K-12 Education System: Economic Impacts and Opportunities for Innovation

Kindergarten through 12th-grade (K-12) education is the cornerstone investment our society makes in the human capital of its people. U.S. elementary and secondary schools serve as engines for both individual opportunity and macroeconomic growth. However, challenges posed by economic recessions, the COVID-19 pandemic, advances in technology and artificial intelligence (CEA 2024a), and an increasingly interconnected global economy (CEA 2024b) have placed new pressure on schools to rethink how best to prepare students for the future. To meet these challenges, federal, state, and local policymakers must ensure that K-12 schools are prepared to equip all children with the skills to compete and thrive in the 21st century.

The long history of public education in the United States predates the nation's founding (Mendez, Yoo, and Rury 2017). Local movements have driven the expansion of K-12 education over the last three centuries, and decentralization and local control remain hallmarks of the system today (Kober and Rentner 2020). In the last 50 years, states have assumed an expanded role in funding education and setting education policy (Pelsue 2017). Government spending on K-12 education across the local, state, and federal levels exceeded $880 billion annually in fiscal year (FY) 2021–2022, 3.5 percent of GDP (Pelsue 2017; Cornman et al. 2024).

While federal contributions to K-12 education funding—typically about 9 percent of the system's total revenue—are small relative to those of state and local governments, the Federal Government has played a critical role in stabilizing education expenditures during recessions through the American

Recovery and Reinvestment Act (ARRA) and the American Rescue Plan (ARP) (Jackson, Wigger, and Xiong 2021); facilitating equity in spending through supplemental funding for schools serving a higher percentage of students from low-income backgrounds via Title I, Part A (Title I); promoting student health and nutrition via free and reduced-price school meals through the National School Lunch Program; and funding career and technical education (CTE) through the Carl D. Perkins Vocational and Technical Education Act (Perkins Act). Federal laws also directly influence state policy and school practices; for example, they have helped ensure the rights of students with disabilities under the Individuals with Disabilities Education Act (IDEA) and elevate more holistic measures of school performance under the Every Student Succeeds Act. Finally, federal grants and reporting requirements promote evidence-based policies, support workforce development, incentivize innovation, fund research, and expand data collection to enhance K-12 education.

Significant public investments in the K-12 school system allowed the United States to be a world leader in academic outcomes (both basic literacy and high school graduation rates) through much of the 20th century (Goldin 2006; Snyder 1993). However, school districts have faced growing challenges in hiring and retaining qualified teachers as salaries in K-12 education have not kept pace with those in the broader market. Some measures suggest that student achievement began to decline in the decade following the Great Recession. Moreover, aggregate statistics mask substantial inequities in educational resources, opportunities, and outcomes across individual districts and by student race and socioeconomic status. The COVID-19 pandemic exacerbated these longstanding challenges, causing a sharp decline in academic achievement across multiple measures (particularly for less-advantaged student populations), increasing rates of chronic absenteeism, and creating an even more pressing need to support students' basic needs as well as their social-emotional and mental wellbeing. The result is an increasingly urgent need to attract and retain qualified teachers and

support staff with competitive wages and supportive working conditions, as well as find innovative ways to scale evidence-based practices to raise student achievement.

The Biden-Harris Administration has made unprecedented federal investments in K-12 schools through the ARP, the Bipartisan Safer Communities Act (BSCA), and the Infrastructure Investment and Jobs Act. The Administration also has secured major increases to Title I funding for schools enrolling a high percentage of students from low-income backgrounds and IDEA, Part B funding for special education and related services for students with disabilities. These investments have helped accelerate post-pandemic academic recovery, modernize school infrastructure, and provide resources to address students' mental health challenges (Department of Education 2024a). However, challenges to ensuring that all students benefit from well-staffed, well-maintained, and safe schools remain.

This chapter outlines the well-established links between education and overall economic growth and summarizes the contemporary microeconomic evidence underlying the links. It then builds on existing research to show how increases in student knowledge—as measured by standardized tests—are associated with increases in GDP, discusses contemporary challenges facing K-12 education, and draws on the research literature and new analyses to identify promising policy solutions for strengthening U.S. K-12 schools for all students. Finally, the chapter explores how three key inputs to education production—labor, physical capital, and technology—all present opportunities for increasing the effectiveness of the K-12 education system. Each section of the chapter highlights the federal role in strengthening public education.

Why Education Matters: Returns to Income and Economic Growth

A long tradition of macroeconomic research links national levels of educational attainment to GDP growth (e.g., Lucas 1988; Romer 1990). In the textbook model of economic growth, overall economic output is produced using the workers in the labor force, capital inputs (e.g., infrastructure and materials), and technology. In models of endogenous growth (e.g., Mankiw, Romer, and Weil 1992; Romer 1994), education affects output through two distinct channels: (i) a human capital effect which makes workers more productive, and (ii) an innovation effect which facilitates technological advancements that increase the productivity of workers and capital (Biasi, Deming, and Moser 2022).

Evidence on the Human Capital Channel

Building on the seminal work by Mincer (1958), microeconomic research using natural experiments and studies of twin siblings from the same household with different levels of education has documented that completing an additional year of schooling (largely holding quality constant) increases an individual's yearly earnings by 6 percent to 15 percent (Gunderson and Oreopolous 2020). Recently, consensus has emerged around the importance of school quality. Leveraging variation within states over time, Doty et al. (2022) find that a 1 standard deviation increase in average eighth grade math achievement (roughly a 37 percentile point increase) is associated with an 8 percent increase in adult earnings. More direct measures of school quality based on randomized admissions lotteries document large differences in effects on student academic and life outcomes across individual schools (Angrist, Hull, and Walters 2022). Similarly, value-added models document how highly-effective teachers increase students' educational attainment and earnings (Chetty, Freidman, and Rockoff 2014). Importantly, policies to enhance school quality, such as those increasing resources, also grow adult earnings (Jackson, Johnson, and Persico 2016; Rothstein and Schanzenbach 2022).

Evidence on the Innovation Channel

Theories of endogenous economic growth argue that increases in education output also affect economic growth by enabling innovation, which can both provide direct benefits to society as a whole and enhance the productivity of individuals. Much of the evidence on education's role in generating ideas comes from research on higher education. Historically, studies link the establishment of land grant colleges to increased innovation and elevated regional incomes (Andrews 2021; Maloney and Caicedo 2022). Modern

evidence shows that the number of patents per capita is positively associated with federal and state investments in higher education (Aghion et al. 2009). Studies also document how the establishment of universities increases local innovation internationally (Valero and Van Reenen 2019) and that expanding access to science, technology, engineering, and math (STEM) post-secondary programs can lead to increases in patenting (Bianchi and Giorcelli 2020; Toivanen and Väänänen 2016).

K-12 education systems play a fundamental role in preparing students to pursue higher education and become the next generation of innovators (Biasi, Deming, and Moser 2022). Bell et al. (2019) demonstrate that one's environment, which is impacted by school quality rather than ability, largely dictates whether an individual will become an inventor. As a result, disadvantaged youth who are more likely to attend under-resourced and low-performing schools are underrepresented among inventors.

In this spirit, the Administration has committed to fighting systemic barriers to educational opportunity in multiple ways, including new investments in STEM education for underrepresented K-12 and college students and by promoting a more inclusive STEM workforce (White House 2024a). Increasing investment in higher education helps expand the knowledge frontier, and increasing investment in foundational skills taught in elementary and secondary schools helps ensure that future innovators can reach the frontier and realize their full potential.

Educational Attainment, Knowledge Capital, and GDP Growth

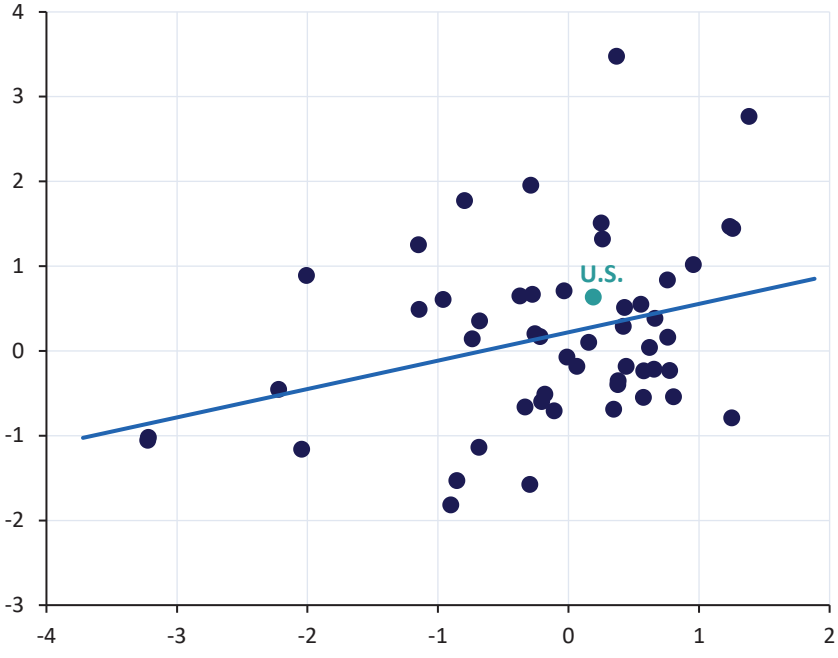
Identifying the causal effect of schooling levels on overall economic growth, as measured by GDP, is challenging. However, estimates across a variety of empirical approaches find that a one-year increase in average years of education for the entire working-age population—a change that can take several years to unfold—is associated with gains in real GDP between 5 percent and 12 percent (Barro and Lee 2013).

Studies examining both quantity of schooling and knowledge capital suggest that test scores may be a stronger predictor of economic growth than years of education. Here, test scores serve as an imperfect proxy for school quality because scores reflect both the effects of formal schooling and important factors outside of school that affect student (Altonji and Mansfield 2011). Aggregate measures are also shaped by the changing demography of students served by school systems over time. Hanushek and Woessmann (2008) find that country-level performance on international assessments between 1960 and 2000 is predictive of average annual GDP growth during the same period. Angrist et al. (2021) find similar results for a broad sample of 107 countries during the decade between 2000 and 2010.

The CEA builds on previous analyses to examine how educational skills predict future macroeconomic growth in the most recent decades. This analysis examines how average educational achievement in math and science, as captured by the 1999 Trends in International Mathematics and Science Study (TIMSS) eighth grade assessment and the 2000 Programme for International Student Assessment (PISA), taken by 15-year-olds, predicts average annual GDP growth between 2000 and 2023. The regression includes controls for real GDP per capita (logged) and average years of education among 25- to 65-year-olds, both measured at baseline in 2000. Figure 7-1 shows that the patterns found in prior studies persist in more recent data and in an approach that removes potential reverse causality by

Figure 7-1. Knowledge Capital and Economic Growth

Conditional average annual GDP growth, 2000–2023



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Sources: 1999 Trends in International Mathematics and Science Study (TIMSS); 2000 Programme for International Student Assessment (PISA); International Monetary Fund; Penn World Tables; Barro-Lee Dataset; CEA calculations.

Note: 1999 TIMSS and 2000 PISA science and math test scores are standardized within test type, grade, subject, and year at the country level and averaged across the four tests. Average annual GDP growth is conditional on average years of education and log GDP per capita in 2000, and the conditional GDP is centered around the panel average.

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relating inputs to outcomes only measured in the future. Specifically, a 1 standard deviation increase in average performance at the country level is associated with a 0.33 percentage point increase in average annual GDP growth (p=0.08) relative to a mean of 3.59 percent.[1] These analyses confirm the importance of education outputs documented in the microeconomic and macroeconomic literature.

The State of the K-12 Education System

The United States led the world in expanding access to free public education in the early half of the 20th century during what is known as the "high school movement" (Goldin and Katz 2008). The grassroots organizing driving the rapid expansion of secondary education led to an unprecedented increase in worker skills, facilitating increased economic mobility and contributing to the creation of the middle class (Goldin and Margo 1991; Haskins 2008). The gains persist today: 93 percent of U.S. 15-year-olds attend free K-12 public schools, compared to the Organisation for Economic Co-operation and Development (OECD) average of 82 percent (OECD 2020). The United States continues to lead all but three countries—Ireland, South Korea, and Iceland—in years of formal schooling, with an average of 13.3 years (Our World in Data 2023). The United States also continues to see high rates of high school attainment, with 91.8 percent of Americans age 25–64 holding a high school degree in 2022, compared to the OECD average of 80.2 percent (figure 7-2).

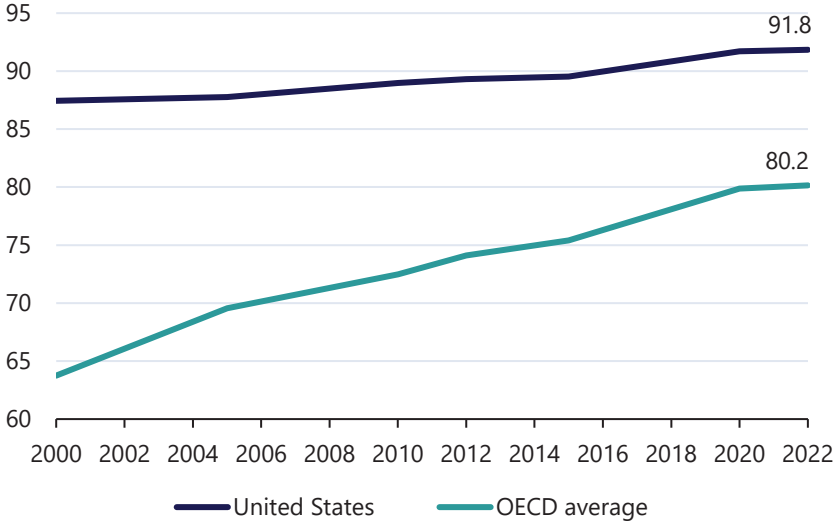
As the analyses above illustrate, educational attainment and years of schooling matter, but the quality of the education is paramount. The National Assessment of Educational Progress (NAEP), commonly known as "the nation's report card," provides one window into the quality of the U.S. K-12 education system. Between 1971 and 2012, average long-term trend NAEP scores increased steadily, suggesting rising levels of education quality (see figure 7-3). However, NAEP scores have been in decline since 2012, due in part to the cumulative ill effects of job losses, income reductions, and increased psychological distress (Ananat et al. 2013), as well as sustained budget cuts to public education, in the years following the Great Recession (Jackson, Wigger, and Xiong 2021).

Although student achievement on international assessments such as TIMSS and PISA paints a more mixed picture of achievement trends in the United States over the last two decades, one pattern is increasingly clear. Despite the historical success of the U.S. K-12 education system, many countries are now outperforming the United States on international assessments, particularly in math. As shown in figure 7-4, the United States

[1] The model applies heteroskedasticity-robust standard errors.

Figure 7-2. Share of 25- to 64-year-olds Who Completed High School

Percent



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Sources: Organisation for Economic Co-operation and Development (OECD); CEA calculations.

Note: OECD average excludes the United States. Data include degrees classified as high school graduation equivalent (International Standard Classification of Education level 3) with minor exceptions. For more detail, see 2023 Digest of Education Statistics, Table 603.10.

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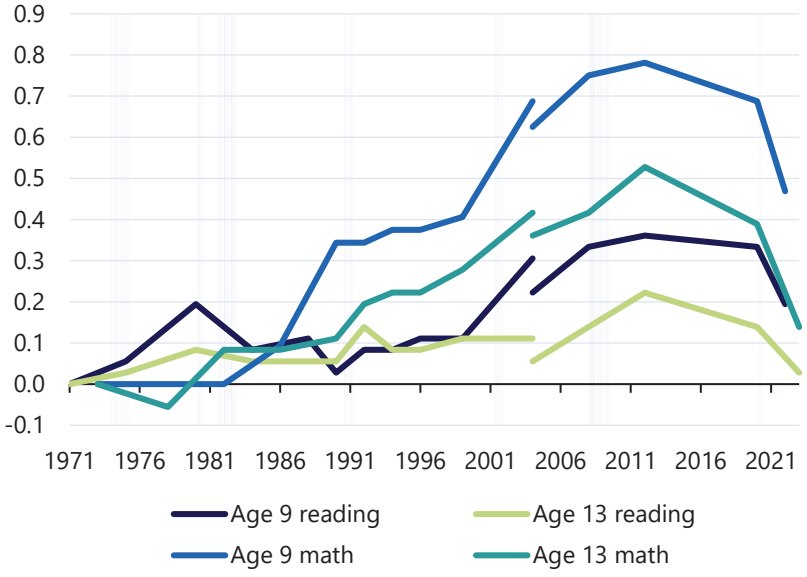
ranked 27th and 22nd on the 2023 TIMSS math assessment among fourth and eighth graders and 31st on the 2022 PISA math assessment among 15-year-olds. In reading, the United States ranked 6th on the 2021 Progress in International Reading Literacy Study assessment for fifth graders and 9th on the 2022 PISA assessment for 15-year-olds. In science, U.S. fourth and eighth graders ranked 14th and 15th on the 2023 TIMSS, respectively. Most recently, U.S. students ranked 17th in computational thinking and 22nd in computer literacy on the 2023 International Computer and Information Literacy Study. These international comparisons provide a helpful benchmark for the competitiveness of the U.S. education system, but they also can be subject to cross-cultural differences in the effort students invest in completing the tests (Gneezy et al. 2019).

Figure 7-3. NAEP Scores Over Time

Change in NAEP LTT score since 1971 in 1990/1992 standard deviations



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Sources: National Assessment of Educational Progress long-term trend assessments (NAEP LTT); CEA calculations.

Note: Gray bars indicate recessions. NAEP changed the assessment format in 2004. Lines prior to 2004 represent the original assessment format; lines after 2004 indicate the revised assessment format. Results from both the original and revised assessment format are reported for 2004.

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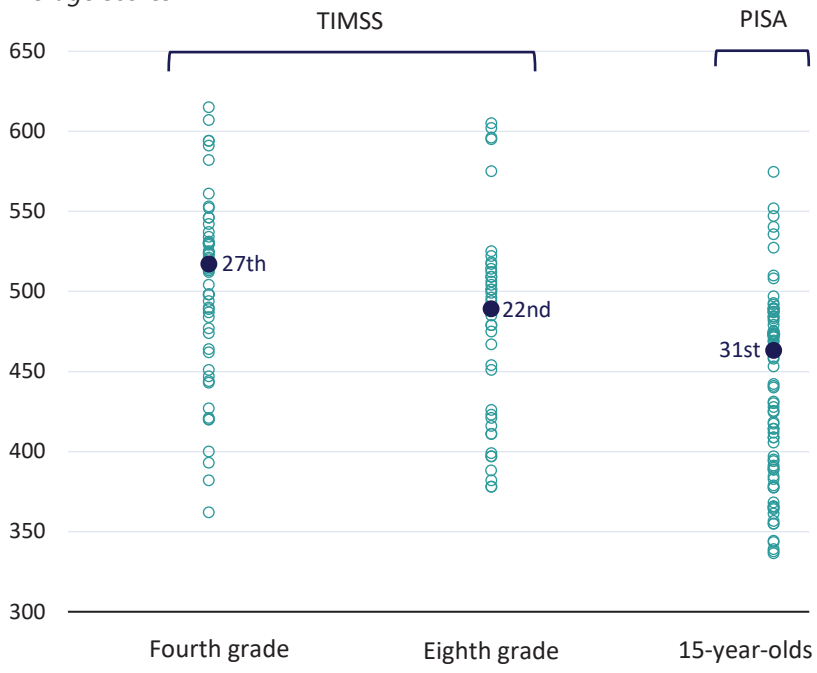
COVID-19 and Student Achievement, Engagement, and Wellbeing

In March of 2020, the COVID-19 pandemic shuttered schools across the United States and around the world. Between 2019 and 2022, estimates across multiple standardized assessments suggest that student achievement fell, on average, between 0.15-0.26 standard deviations in math and 0.07-0.12 standard deviations in English language arts (ELA) (Kuhfeld and Lewis 2024), roughly the equivalent of one half of a grade level in math and one third of a grade level in reading (Fahle et al. 2023). Students' computer and information literacy skills declined even further by 0.37 standard deviations between 2018 and 2023. Furthermore, the pandemic widened achievement gaps across measures of student performance (NAEP n.d.; Callen et al. 2024), with students in high-poverty districts experiencing the most acute negative educational (Goldhaber et al. 2023), economic (Piacentini et al. 2022), and public health effects (Alsan, Chandra, and Simon 2021).

Figure 7-4. U.S. Performance on International Math Assessments

Average scores



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Sources: 2022 Programme for International Student Assessment (PISA); 2023 Trends in International Mathematics and Science Study (TIMSS); CEA calculations.
Note: U.S. rankings are denoted in navy. Rankings reflect raw rankings and do not take into account statistical significance. 58 countries and territories took the fourth grade TIMSS, 44 took the eighth grade TIMSS, and 81 took the PISA.
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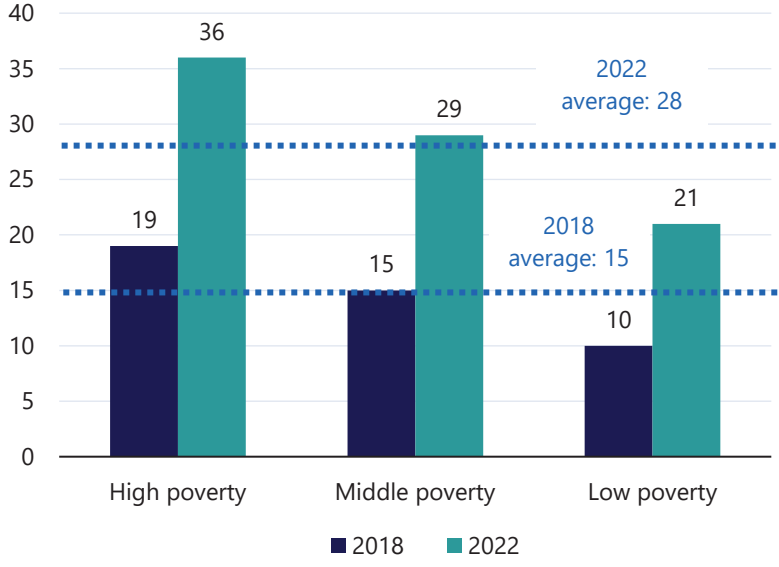
Multiple indicators suggest students are struggling to re-engage with schooling in the post-pandemic era. Chronic absenteeism—missing 10 percent of school or more—has nearly doubled relative to pre-pandemic levels, with rates as high as 36 percent in high-poverty districts (Return2Learn Tracker 2024), as shown in figure 7-5. After decreasing from 2016 to 2019, the rate of children age 3 to 17 with behavior or conduct problems increased by 20.6 percent (1.4 percentage points) from 2019 to the latter half of 2020 (Lebrun-Harris et al. 2022). A record number of special education referrals were made during the 2022–2023 school year, a reflection of the pandemic's lasting effect on students, particularly young children (CRPE 2024; Miller and Mervosh 2024). Data from a nationally representative survey in 2023 found that teachers perceived substantially higher rates of students struggling with

Figure 7-5. Rates of Chronic Absenteeism by Concentration of Students from Low-Income Backgrounds

Percent chronically absent



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Sources: Return2Learn Tracker; CEA calculations.

Note: Data are collected at the district level. Categories represent district types.

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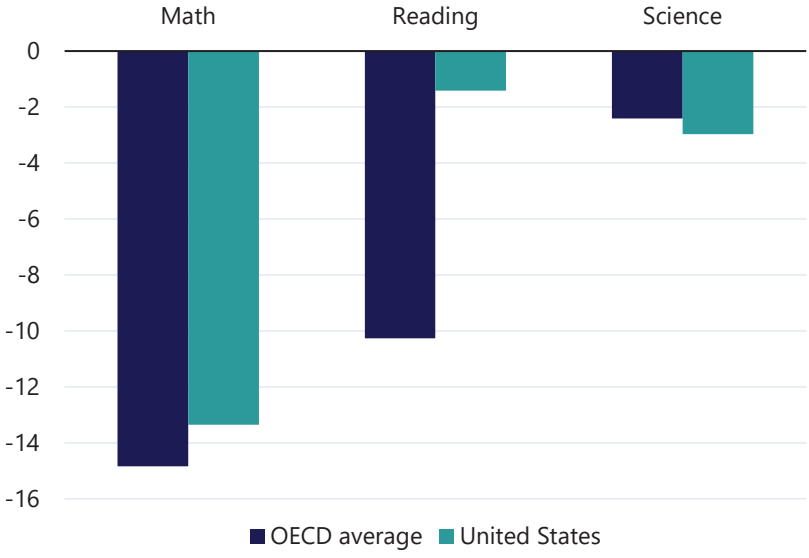
depression, anxiety, and behavioral expectations than they did prior to the pandemic (Jacob 2024).

Federal Investments in K-12 Education Promoting Recovery

The negative effects of the pandemic on students' success in school would likely have been worse without the investments made by the U.S. Federal Government to stabilize revenues and support recovery efforts. U.S. K-12 schools benefitted from an unprecedented $189.5 billion in federal aid through the Elementary and Secondary School Emergency Relief (ESSER) funds, $122 billion of which were funded by the Administration's historic $130 billion investments in K-12 schools as part of the ARP (Department of Education 2024b). The Administration has also played a key role in expanding access to school-based mental health professionals and clinics to support student engagement and wellbeing. For example, the CEA estimates that the number of school-based social workers increased by 64 percent and

Figure 7-6. Change in PISA Scores, 2018–2022

Change in PISA score values



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Sources: Organisation for Economic Co-operation and Development (OECD); 2022 Programme for International Student Assessment (PISA); CEA calculations.

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the number of school nurses increased by 16 percent between the 2018–2019 and 2023–2024 school years.[2] This growth in student-facing support staff was made possible in large part by federal funding provided by the ARP and the BSCA, as well as the Health Resources and Services Administration and Medicaid.

Student performance on the PISA suggests the United States weathered the pandemic better than many peer nations (see figure 7-6). Declines in U.S. performance on the 2022 PISA were less than 10 percent of the average decline among OECD member countries in reading and approximately 86 percent of the average decline in math (CEA 2023).

Recent studies document the important impacts federal relief dollars have had on student academic recovery. Both Dewey et al. (2024) and Goldhaber and Falken (2024) find that, on average, each $1,000 in ARP-funded per-pupil spending for a single year increased math scores by approximately 0.009 of a standard deviation with estimates of similar magnitude for ELA scores. Given that the combined average amount of funds allocated by ESSER II (part of the Coronavirus Response and Relief Act)

[2] Analyses are based on the Current Population Survey and reflect 12-month averages from August to July.

and the ARP per district was over $3,100, a rough estimate suggests that these federal funds could raise student achievement by 1 percentile point on average.[3] Because the distribution of the vast majority of federal relief funding was based on Title I formulas that provide aid proportional to the number of students from low-income backgrounds, high-poverty districts benefitted from higher levels of funding and were able to narrow the academic achievement gap—exacerbated by the pandemic—between low- and high-poverty districts (Dewey et al. 2024).

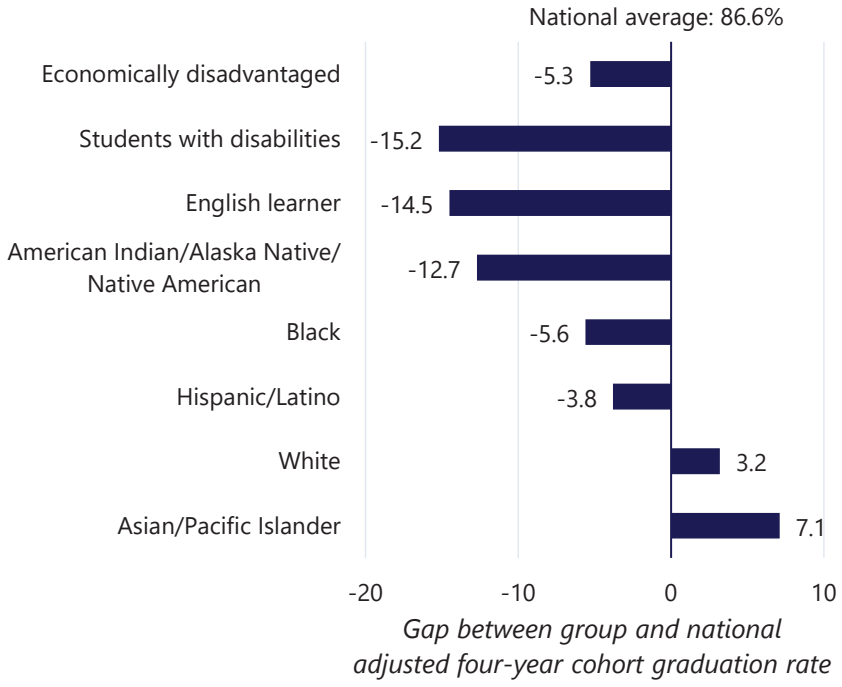
Addressing Structural Challenges and Disparities in Education Outcomes

The devastating effects of the COVID-19 pandemic elevated the critical role of K-12 education in supporting students and families and serving as a core feature of the social safety net. The pandemic also compounded structural challenges that have long persisted in U.S. education. Efforts to recover from the pandemic's ill effects in the short run and strengthen the education system in the long run will require the country to address the underlying inequities in the system.

The decentralized structure of the U.S. education system and its history of de facto and de jure racial segregation have resulted in wide variation and persistent disparities in access to safe, well-staffed, and well-resourced schools (Margo 1990; Antman and Cortes 2023; Anstreicher, Fletcher, and Thompson 2022; Johnson 2019). For example, districts in the top decile of student attainment have four-year high school graduation rates of 97.5 percent or higher, while districts in the bottom decile have graduation rates of 75 percent or lower.[4] Put differently, a student moving from a bottom- to a top-performing district would be exposed to peers that are 30 percent more likely to graduate on time. As shown in figure 7-7, four-year graduation rates also differ dramatically among students based on their socioeconomic status, disability status, language spoken at home, and race/ethnicity. Similar achievement gaps are apparent on the NAEP, affirming the importance of efforts to address disparities in education funding and opportunities (figure 7-8).

[3] Scaling the estimated effects from Dewey et al. (2024) to the average allocated amount of ESSER II and ARP dollars per student ($3,100) suggests an average total estimated effect of 0.028 standard deviations. The CEA then follows Von Hippel (2024) to convert this to a percentile point change.
[4] To avoid pandemic-induced distortions, data are from the 2018–2019 academic year for this calculation only. Graduation rates at the local education agency (LEA) level are not available past the 2020–2021 academic year.

Figure 7-7. Four-year High School Graduation Rates



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Sources: Ed Data Express; CEA calculations.

Note: Data are from the 2021–2022 academic year adjusted four-year graduation cohort. Students are classified as economically disadvantaged based on individual state criteria such as eligibility for the National Student Lunch Program. New Mexico and Oklahoma did not report data and are not included in national estimates.

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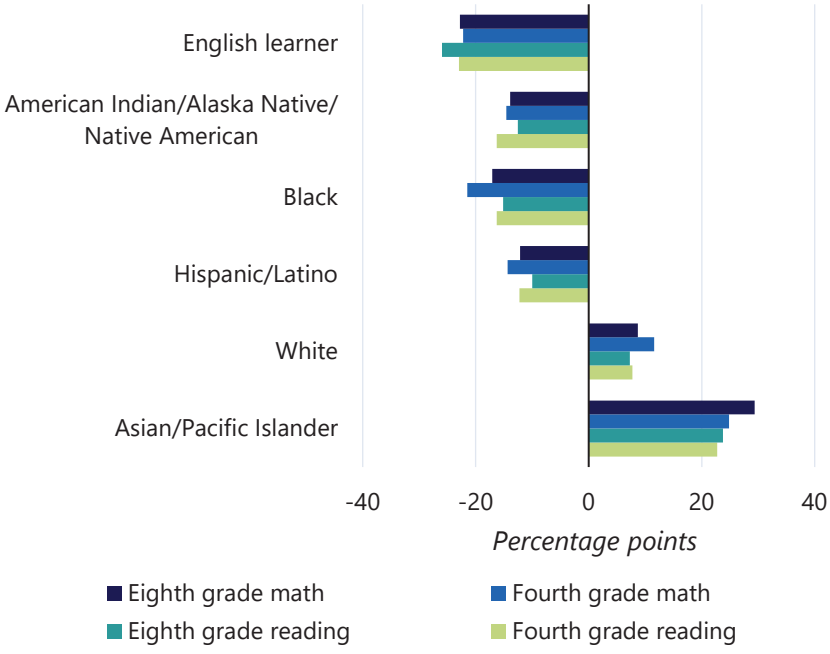
Opportunities for Improvement

Labor, capital, and technology can be thought of as central inputs into both canonical models of economic growth as well as education production. In the context of K-12 education, the framework highlights the central role that educators (labor), school infrastructure and instructional resources (physical capital), and other technologies (from school governance and organizational practices to new education tools) play in shaping the success of the education system.

Any discussion of the U.S. Federal Government's role in enhancing the education production function must acknowledge a central constraint: It contributes a limited share of K-12 funding. During non-recessionary periods, this share hovers around 9 percent. The remaining 91 percent is distributed approximately equally between state and local funding (see

Figure 7-8. Proficiency by Student Group

Percent difference from national average



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Sources: National Assessment for Educational Progress; CEA calculations.
Note: Percent proficient includes students at or above percent proficient (including percent advanced). Data are from the January through March 2022 testing period.
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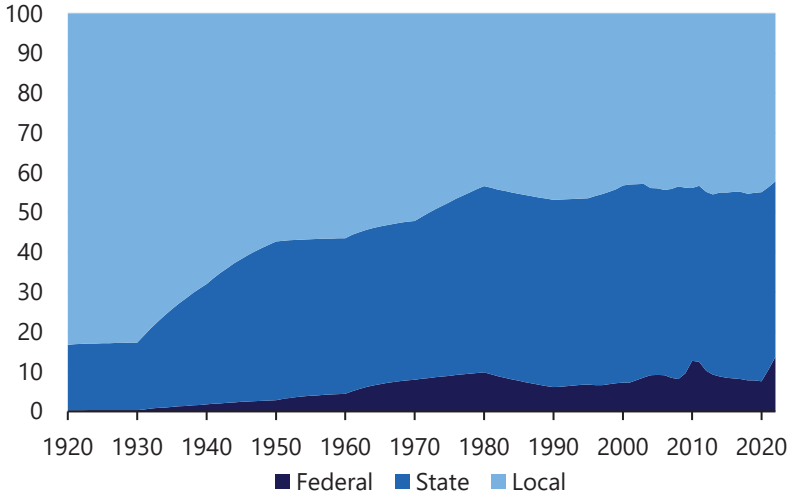
figure 7-9). Despite this limitation, the Federal Government plays a critical role in making funding more equal across districts and stabilizing funding across time.

Equalizing Funding Across Districts

The continued reliance on local and state revenue sources has led to an unequal distribution of funding across U.S. school districts. High-expenditure districts (the 90th percentile) spend 2.4 times as much per pupil, a $17,770 difference, compared to low-expenditure districts (the 10th percentile). This wide variation reflects real disparities, rather than local differences in cost of living, as shown in figure 7-10. A CEA analysis finds that cost-of-living adjustments (COLA) based on county-level regional price parities explain only 3.5 percent of the gap between the top and bottom deciles ($620) in unadjusted expenditures.

Figure 7-9. Public K-12 Education Revenue Sources

Percent of total revenue



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Sources: National Center for Education Statistics; Common Core of Data; Bureau of Labor Statistics; CEA calculations.

Note: Prior to 1995, estimates for the revenue in non-decennial years are imputed assuming linear growth. Data are plotted through the 2021–2022 academic year. X-axis labels represent the spring year of the academic calendar.

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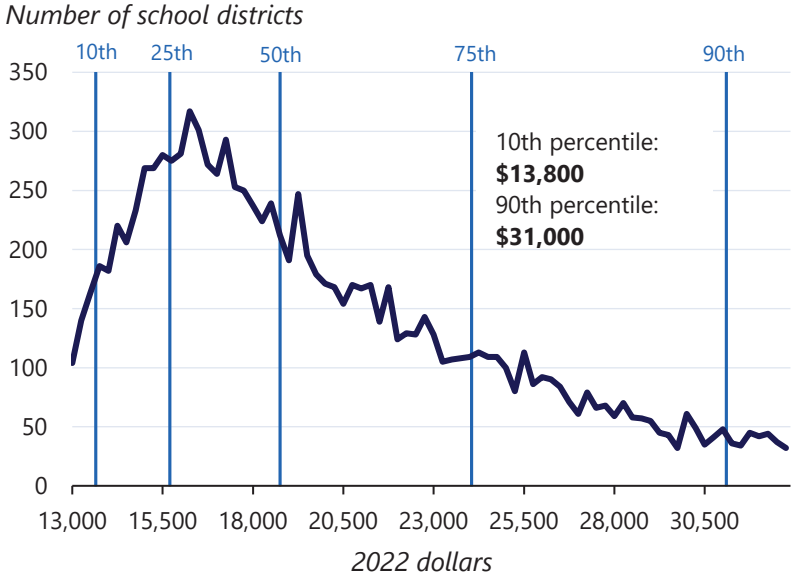
Two primary factors drive funding inequities. First, large differences exist in local property tax bases, which constitutes the primary source of local funding and roughly 36 percent of all public education revenue (NCES 2024a). High-local revenue districts (the 90th percentile) raise 5.7 times as much money per pupil than low-local revenue districts (the 10th percentile), a COLA-adjusted gap of $14,900 per pupil. High-local revenue districts drive the variability: The difference between the 10th and 50th percentile of local funding per pupil is relatively small ($4,200 COLA-adjusted) compared to the difference between the 50th and 90th percentile ($10,700 COLA-adjusted).

Second, states spend vastly different amounts on education. For example, the top five states spend over double the amount of state revenue on education that the bottom five states spend on education—$11,800 versus $5,400 COLA-adjusted. While spending differences across states exacerbate inequities in education funding nationally, many states allocate funds to districts in progressive ways to reduce inequities (Chingos and Blagg 2017).

The Federal Government has played an important role in mitigating spending inequities across local communities and states since the passage of the Elementary and Secondary Education Act (ESEA) in 1965. ESEA

Figure 7-10. District per Pupil Expenditures Adjusted for Cost of Living



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Sources: National Center for Education Statistics; Common Core of Data; McMahon (2024); CEA calculations.

Note: Per pupil expenditures are calculated at the local education agency level for the 2021–2022 academic year. Values are censored at the 5th and 95th percentile and binned into multiples of 250. Analysis is limited to regular public school districts with graded schools and at least 50 students. Expenditures are adjusted using county-level regional price parities compiled by McMahon (2024).

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established Title I, which allocates roughly $17 billion per year in funds across four formulas based on two primary components: need and non-federal education spending (NCES n.d.; Gordon and Reber 2023a). The first component, the number of students in need (largely determined by student poverty levels), is designed to support supplemental education activities for children from low-income backgrounds. Without Title I and other federal funds, the expenditure ratio between high- and low-expenditure districts would be 15 percent higher (2.8 vs. 2.4). For some districts, the funding is critical. For example, it makes up 8 percent of total funding in Detroit. The second component, state and local revenue per pupil, increases positively based on funding levels. While the approach potentially exacerbates state-level funding differences, it is designed to incentivize states—especially those with high proportions of low-income students—to invest more in education. Evidence suggests it plays a limited role (Gordon and Reber 2023b).

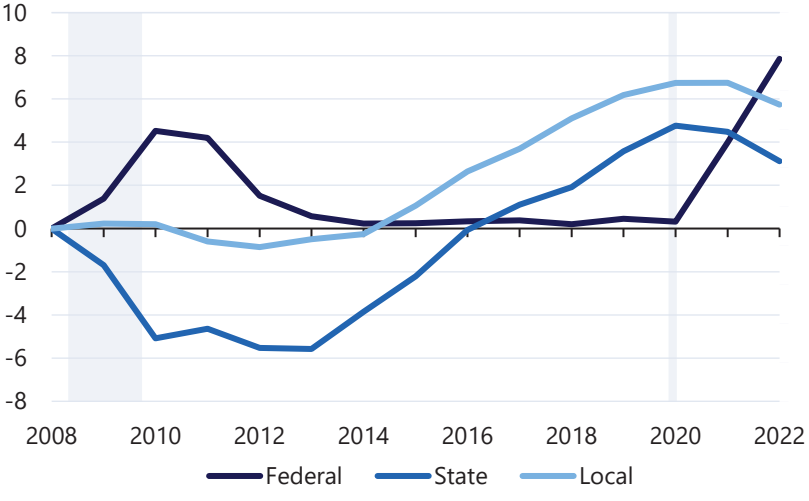
The inequitable distribution of public education funding has lasting impacts on student educational opportunities and outcomes. The school finance reform literature, which leverages a series of court-ordered funding reforms, shows that school funding increases both short-term achievement and long-term outcomes, such as educational attainment and earnings (Lafortune, Rothstein, and Schanzenbach 2018; Hyman 2017; Jackson, Johnson, and Persico 2016), particularly for the most disadvantaged students (Biasi 2023; Jackson et al. 2024; Jackson and Mackevicius 2024).

Stabilizing Funding Levels Over Time

Funding from the Federal Government has served as a backstop against fiscal shortfalls during economic downturns. As shown in figure 7-11, state and local funding is pro-cyclical, meaning it increases in periods of economic growth and contracts during recessions. Because most state governments cannot run deficits to fund current expenditures, they are not able to quickly raise money to respond to crises (Rueben and Randall 2017). Only the Federal Government is able to provide immediate financial resources above and beyond "business as usual" spending to allow districts to respond to

Figure 7-11. K-12 Revenue Sources as a Share of Total 2007–2008 Revenue

Percent change



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Sources: National Center for Education Statistics; Common Core of Data; Bureau of Labor Statistics; CEA calculations.

Note: Gray bars indicate recessions. Y axis represents the change in real dollars from 2008 to the indicated year, divided by the total amount of revenue in 2008. X-axis labels represent the spring year of the academic calendar.

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acute challenges, such as public health emergencies and extreme weather events.

The Federal Government smooths fluctuations in spending associated with the business cycle by increasing funding during recessions. State revenues fell by $46 billion from peak to trough of the Great Recession and $14 billion during the COVID-19 pandemic through 2021–2022, the most recent available data. Both the Obama-Biden Administration's ARRA and the Biden-Harris Administration's ARP helped districts minimize budgetary cuts when state and local revenues declined during recessions (Anglum, Shores, and Steinberg 2021; Department of Education 2021a). ARP funds not only stabilized expenditures, but also covered significant additional costs related to reopening and operating schools safely during a pandemic as well as supporting academic recovery due to school closures.

The counter-cyclical funding helps mitigate the negative human capital losses that accrue as a result of K-12 spending cuts. However, programs like the State Fiscal Stabilization Fund, created by the ARRA to address state budget shortfalls, are one-time appropriations passed in reaction to recessions. Instead of requiring new legislation during each economic downturn and potentially delaying essential aid, the Federal Government could establish a dynamic funding formula that serves as an automatic stabilizer to insure against harmful budget cuts (Boushey et al. 2019).

Ultimately, the equalization and stabilization roles of the Federal Government are intertwined. High-poverty districts are often the most vulnerable to shocks. As the ESSER's impact on the COVID-19 pandemic recovery shows, federal aid targeted to high-needs populations plays a crucial role in ensuring that crises do not exacerbate inequality.

School funding affects student outcomes by improving school quality, whether through labor inputs (hiring more and higher-quality teachers and support staff), capital inputs (investing in environments conducive to learning and high-quality curricula), or technological inputs (having access to the most up-to-date tools as a mechanism to enhance learning and better prepare students for the increasingly digital economy).

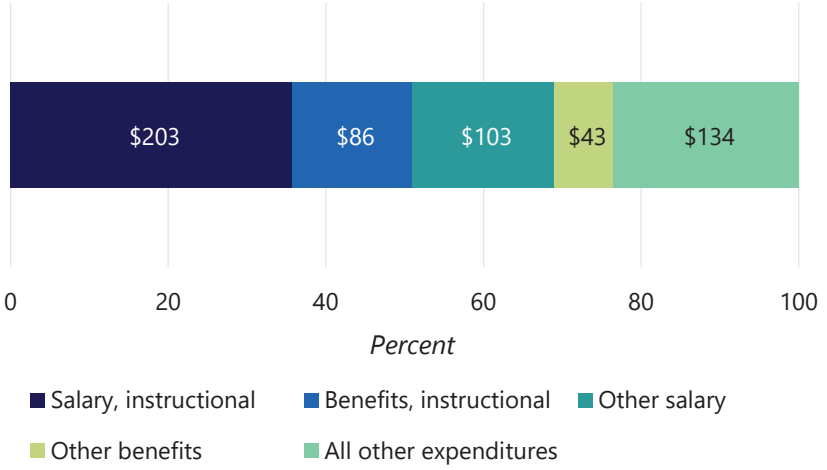
Labor Inputs

Education is a labor-intensive sector, with educators at the core of the production process. As shown in figure 7-12, salary and benefits for instructional staff alone constitute more than half of the K-12 budget. Thus, efforts to improve education productivity and maximize public investments in K-12 schools are directly related to the size and effectiveness of the teacher workforce (Jackson, Rockoff, and Staiger 2014).

An extensive body of evidence documents the large and lasting effects teachers have on their students' academic attainment and labor market

Figure 7-12. Salary and Benefits as a Share of K-12 Expenditures

Billions of dollars



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Sources: National Center for Education Statistics; Common Core of Data; CEA calculations.

Note: This figure excludes non-elementary and secondary expenditures. Data are from the 2021–2022 academic year.

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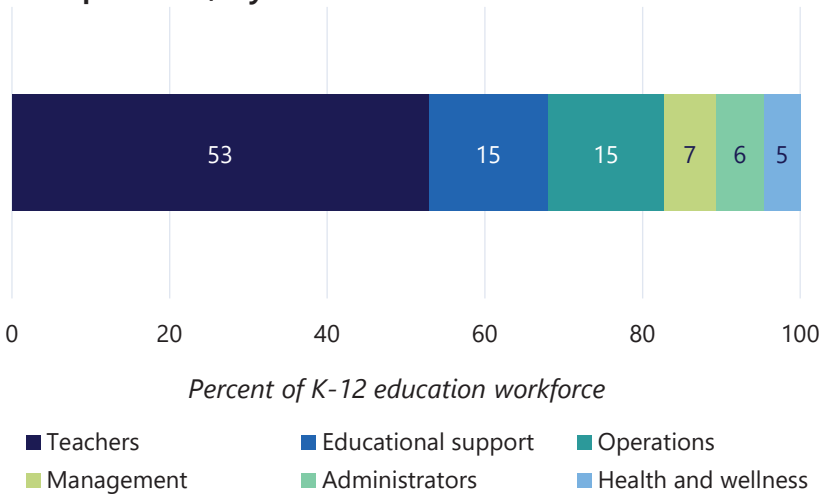
outcomes (Chetty, Friedman, and Rockoff 2014; Petek and Pope 2023). Educators also support students' non-cognitive skills and socio-emotional development (Jackson 2018; Kraft 2019) and serve as informal mentors who share essential social capital for navigating academic challenges and the college application process (Kraft, Bolves, and Hurd 2023). Having a highly-qualified teacher in every classroom is critical for students' academic success, socio-emotional development, and preparation for the workforce.

Although classroom teachers and other education support staff constitute almost 70 percent of all K-12 employees, non-instructional staff also play a key role in education production (see figure 7-13). Schooling is a joint production process in which staff, from the superintendent to education support staff such as bus drivers and food service workers, must all work collectively to create positive and supportive learning conditions for students. For example, school counselors affect students' educational attainment at a level similar in scale to classroom teachers (Mulhern 2023). Principals shape the culture and climate for teaching and learning in their schools through their leadership and staffing decisions (Grissom, Egalite, and Lindsay 2021; Liebowitz and Porter 2019).

Figure 7-13. K-12 Education Workforce Composition, by Role



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Sources: Current Population Survey accessed via IPUMS; CEA calculations.
Note: Data include the 2022 and 2023 calendar years. Sample includes only currently employed individuals and covers staff in both public and private K-12 education. Values sum to over 100 due to rounding.
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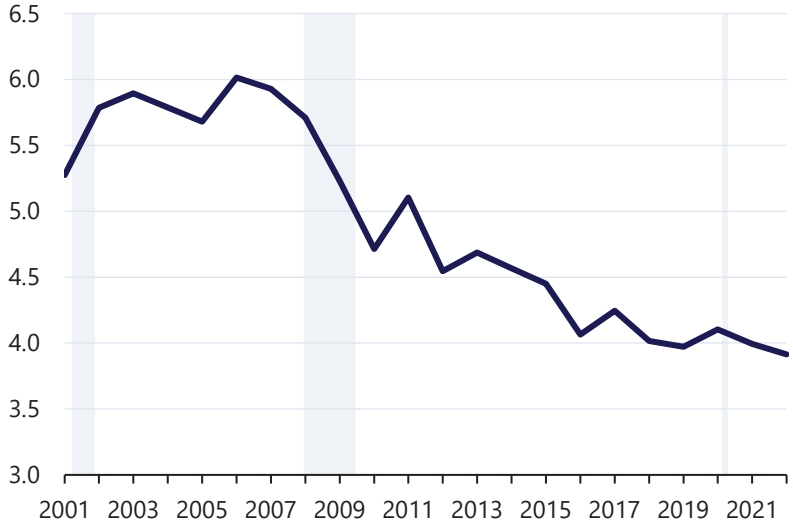
Staffing All Classrooms with Qualified Educators

Recruiting and retaining qualified educators has become an increasing challenge in the United States. Kraft and Lyon (2024) find the percentage of high school seniors and college freshmen interested in becoming K-12 teachers has declined by as much as 40 percent since 2010. The fall in interest has translated into substantial declines in new teacher supply and created significant challenges for staffing every classroom with a qualified teacher (Nguyen, Lam, and Bruno 2024). For example, the number of new state-issued licensures to teach in public schools declined from 280,000 in 2001 to 210,000 in 2022, a 24 percent drop.

Personnel shortages are a product of both labor market supply and demand. Although direct measures of public school teacher demand are not available in the aggregate, overall demand can be proxied broadly based on the total number of school-age children in the United States. Figure 7-14 shows that new flows into the teaching profession as measured by new licensures did not keep pace with aggregate demand during the last two decades. Between 2001 and 2022, the number of new licensures per school-age child

Figure 7-14. New Teacher Licensures

Licensures per 1,000 school-age children



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Sources: Title II of the Higher Education Act; American Community Survey accessed via IPUMS; National Center for Education Statistics; CEA calculations.

Note: Gray bars indicate recessions. School-age is defined as age 5 to 17. Data are not reported for school year 2008–2009, so that data point is imputed linearly. In 2020 and 2021, two and one states, respectively, did not report licensures, so data are also imputed linearly for those states. Academic year licensure data are adjusted using population estimates from the spring of the academic calendar. X-axis labels represent the spring year of the academic calendar.

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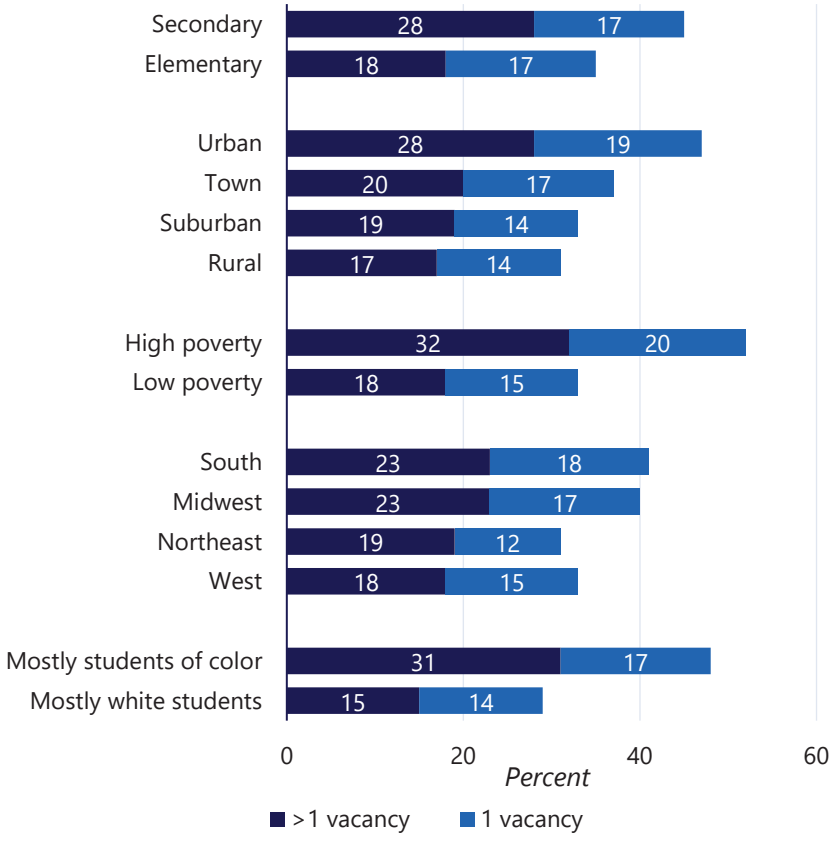
declined by 26 percent.[5] Encouragingly, other data suggest that new teacher supply may be beginning to recover with a 4.7 percent increase in the annual number of bachelor's and master's education degree completers between 2019 and 2022 (NCES 2024b). At the same time, a delayed post-pandemic increase in teacher turnover adds further upward pressure on teacher demand (Barnum 2023).

State-by-state estimates suggest that one in eight K-12 public school teaching positions are either vacant or staffed by underqualified teachers (e.g., those with emergency credentials or out-of-field teachers) (Tan, Arellano, and Patrick 2024). Two months into the 2023–2024 school year, 37 percent of schools had a least one unfilled teaching vacancy. Data from the nationally representative School Pulse Panel revealed that 79 percent

[5] The trend shown in figure 7-14 is nearly identical when scaling licensures by the number of public school students.

Figure 7-15. Percent of Schools with Teacher Vacancies After the Start of the School Year



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Sources: National Center for Education Statistics School Pulse Panel; CEA calculations.
Note: Vacancies include all teaching positions. Data come from the October 2023 survey. Schools are classified as having mostly students of color if the non-white share of the student population is over 75 percent. Schools with a non-white share of 25 percent or less are classified as having mostly white students.
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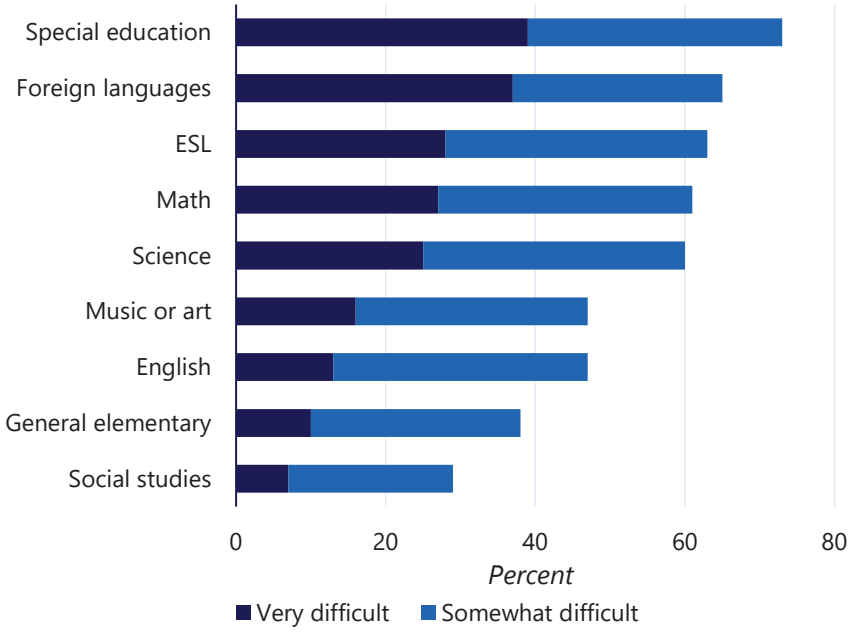
of public school leaders reported they experienced difficulty filling at least one teaching position in August 2023. This figure dropped to 74 percent in August 2024, suggesting some degree of easing in the tight teacher labor market (NCES 2024c). Although some staff turnover is expected and healthy, failing to fill vacancies by the start of the school year has direct negative effects on student academic achievement (Papay and Kraft 2016).

While the broad national trends in teacher supply are concerning, understanding the localized nature of the teacher labor market is central

to addressing negative pressures on overall supply. In practice, the market functions as a collection of hundreds of localized markets for K-12 teachers in specific subjects, districts, and schools (Edwards et al. 2024; Goldhaber, Falken, and Theobald 2023). Teachers also have preferences about where they live and the working conditions of the schools in which they teach, causing many schools in disadvantaged neighborhoods to struggle to attract qualified teachers. As figure 7-15 illustrates, recent staffing difficulties are concentrated in urban schools, high-poverty schools, and school districts predominantly serving students of color.[6] Considerable variation also exists in the difficulty of staffing certain positions, with school leaders reporting more acute challenges filling vacancies in special education, English as a second language, foreign languages, and STEM subjects (see figure 7-16).

Figure 7-16. Percent of Schools With Difficulty Filling Teacher Vacancies, by Subject



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Sources: National Center for Education Statistics School Pulse Panel; CEA calculations.
Note: Data come from the August 2024 survey. Sample is restricted to schools with vacancies. ESL stands for English as a second language.
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[6] This measure does not account for differences in school size which, all else equal, is positively correlated with the probability a school has one or more vacancies and could be confounded with other school characteristics (Edwards et al. 2024).

While it is possible that post-pandemic enrollment declines in some public schools may help ease the pressure in these teacher labor markets (Goulas 2024), it will not address the underlying challenge of recruiting talented future educators or allocating teachers efficiently across subjects and geographic areas.

Causes of Staffing Challenges

While teachers enter the profession for myriad reasons, compensation must remain competitive with other occupations for similarly-skilled workers to attract and retain effective teachers. The CEA estimates that mean real weekly wages paid to college-educated workers who were not K-12 teachers rose by 15.4 percent between 2000 and 2023 as worker productivity also rose, in part due to technological innovation in other sectors of the economy (Pardue 2024). This large increase in average weekly earnings for other college-educated workers appears to be driven by rising wages in the upper part of the earnings distribution, as median weekly real wages rose only 1.5 percent during this period. Wages for elementary and secondary school teachers did not keep pace, with mean weekly real wages rising by only 4.3 percent and median weekly real wages falling by 4.8 percent.[7] An implication of this dynamic is that to avoid teacher shortages, wages (and therefore total education costs) must increase over time for reasons unrelated to productivity gains in the education sector (Baumol 1967).[8]

The CEA examines how teachers' relative wages have changed over time compared to workers of similar ages and degrees by estimating Mincer earnings models, which compare wages across occupations in each year between 2000 and 2023, after accounting for age and educational attainment. The analysis builds on studies of the average teacher wage penalty (Allegretto 2024) by using unconditional quantile regressions to estimate differences in relative wages at the bottom and top of the earnings distribution.[9] Results shown in figure 7-17 reveal that the average wage gap is driven by a negative wage premium (i.e., wage penalty) concentrated in the middle (50th percentile) and upper (75th percentile) portions of the salary distribution. The size of the wage penalty at the median of the distribution increased from 8.9 percent in 2000 to 20.6 percent in 2023. The teacher wage penalty in the upper range of the wage distribution is even larger and has increased from 35.4 percent to 52.2 percent over this same period.

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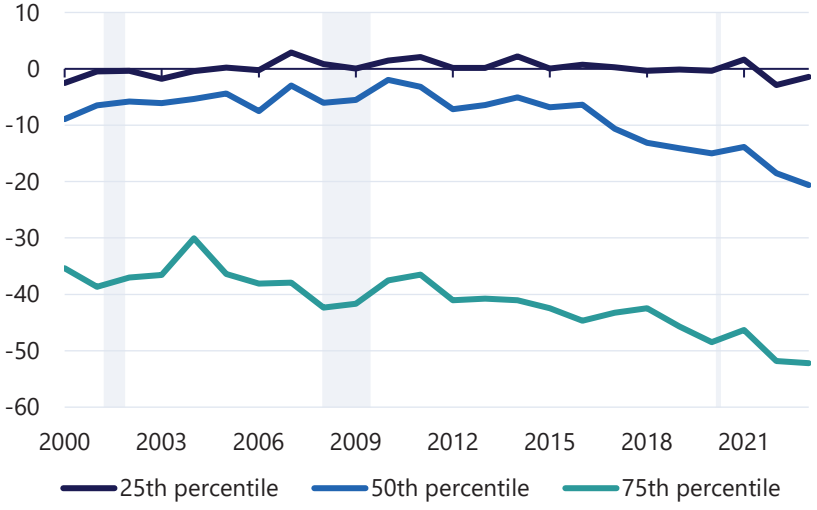
[7] Sample includes both public and private school teachers.

[8] Baumol (1967) points out that in certain sectors of the economy like teaching, productivity gains are less forthcoming than in others, such as manufacturing. The differences are inherent to the sector or "product." Doubling class sizes, for example, may appear to boost measured productivity, but not if learning suffers.

[9] The CEA's focus on weekly relative wages serves to alleviate concerns about salary comparisons based on hourly wages, given differences in hours worked across occupations.

Figure 7-17. Teacher Wage Disparity by Wage Percentiles

Percent



Council of Economic Advisers

Sources: Current Population Survey accessed via IPUMS; CEA calculations.
Note: Gray bars indicate recessions. Sample is restricted to full-time workers, age 18-64. Wage disparity is estimated by fitting unconditional quantile regressions of a Mincerian wage model, which controls for age (quadratic) and education levels (indicators). Wages are computed using the Economic Policy Institute definition of weekly pay and do not include benefits. Pre-K and kindergarten teachers are excluded, but both private and public elementary and secondary teachers are included.
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These overall patterns illustrate the differential effects of the compressed wage ranges for teachers, which are worsened by the fact that wage growth outside of teaching has been concentrated at the upper end of the earnings distribution during the last two decades (Gould and Kandra 2022). Although the analyses here focus exclusively on wages, similar analyses find that incorporating benefits only partially offsets these wage penalties, with large gaps in total compensation remaining (Allegretto 2024).

Both overall teacher supply and the characteristics of who decides to enter and remain in the profession are shaped by the lower average wages and constrained earnings distribution for teachers (Hoxby and Leigh 2004; Chingos and West 2012). Although some individuals forgo higher potential earnings to serve as teachers because they see it as a calling, relying on altruism and individual passion for pedagogy is an insufficient labor force strategy. Research documents how the teaching profession becomes less attractive to potential entrants during periods of stronger economic growth

when there exist more outside options for higher paying jobs (Nagler, Piopiunik, and West 2020). For example, Brummet et al. (2024) find that wages among former teachers who exit the profession are far more variable than those who stay in the profession, with more than a quarter of those exiting earning more outside of teaching. Among CTE teachers, research shows that those with career experience in growth industries such as health services, information technology, and STEM fields are more likely to exit the profession and have higher average earnings outside of teaching (Kistler, Dougherty, and Woods 2024).

A second obstacle is the rising cost of undergraduate degrees relative to the stagnant real wages for K-12 teachers, which has dramatically lowered the value proposition of paying for college to become a teacher (NCES 2023). Currently, 36.6 percent of public school teachers have outstanding student loan debt (Learning Policy Institute 2024). The CEA finds that the average cost of a four-year degree relative to average real weekly salaries increased by 35.5 percent for K-12 teachers between 2000 and 2023, while increasing only 17.5 percent and 6.1 percent for college-educated workers in nursing and accounting.

Large-scale layoffs in the K-12 education sector during economic downturns can have prolonged negative consequences on the teacher labor market. Given the large share of district budgets dedicated to salaries and benefits and the sensitivity of state funding to fluctuations in income and sales tax revenue, districts have few options to reduce their budgets without conducting layoffs. The size of the K-12 education sector contracted by more than 300,000 positions in the wake of the Great Recession, with an estimated 120,000 teachers losing their jobs (Evans, Schwab, and Wagner 2019; Griffith 2020). These job losses are particularly harmful for recruiting new entrants into the profession given that many districts conduct layoffs based on inverse seniority, meaning the newest hires are first to lose their positions, regardless of performance (Kraft and Bleiberg 2022). The COVID-19 recession caused large-scale layoffs among primarily school-based operational staff who were not needed during the time period when schools transitioned to remote learning (Gould 2020).

Finally, non-monetary benefits enjoyed by teachers, such as professional autonomy, family-friendly work schedules, and job security, are not as compelling as they once were. Although teachers enjoy holiday vacations and summers off, they report working nine hours more per week on average (53 vs. 44) and are twice as likely to say they experience frequent job-related stress and burnout than other college-educated full-time workers (Doan, Steiner, and Pandey 2024). National surveys suggest teacher autonomy and authority over instructional decisions declined in the last decade as test scores dropped and reformers looked to more directly manage instructional content and practices (Kraft and Lyon 2024). Teachers' work also does not

allow them the flexibility to work remotely or on a hybrid schedule. The in-school work requirement amounts to a tax on teachers' wages, given that workers report valuing flexible work arrangements—now enjoyed by over 36 percent of college-educated workers (see chapter 2 of this volume)—at 5 percent to 8 percent of their pay (Aksoy et al. 2022; Davis 2024; Mas and Pallais 2017). New laws in some states allowing schools to sanction or dismiss teachers who teach concepts deemed divisive, such as topics related to racism and sexual orientation, also likely undercut teachers' sense of professional autonomy and job security (Woo et al. 2023).

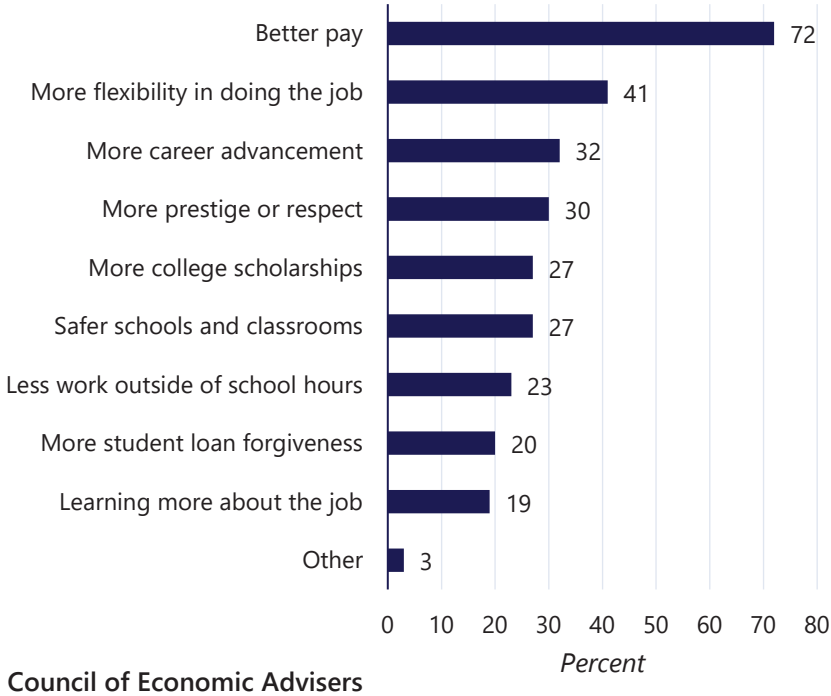
Policies to Attract and Retain Qualified Educators

The need for policies aimed at ensuring the United States has well-prepared and supported educators in all classrooms is growing. Efforts to improve labor quality and productivity in the K-12 education sector must attend to both designing the profession to attract the next generation of teachers and maximizing the potential of the current workforce. Data collected during national administrations of the ACT test in 2017–2018 provide a window into how policymakers might make the teaching profession more attractive to young people as they develop career interests (Croft, Guffy, and Vitale 2018). Among the reasons cited by high school test takers who said they were "potentially" interested in teaching, 72 percent indicated better pay would increase their interest (see figure 7-18). This suggests that market wages are often not high enough to attract potentially interested students to the profession.

The teaching profession is at a double disadvantage because of both low wages and perceptions among college students that teachers' salaries are lower than they actually are (Christian, Ronfeldt, and Zafar 2024). At least 13 states have taken steps to increase teacher pay substantially in recent years by raising minimum starting salaries and/or elevating wages across the profession (Arkansas, Delaware, Hawaii, Iowa, Maryland, Missouri, Nevada, New Mexico, Ohio, Oklahoma, South Carolina, South Dakota, and Utah), and evidence suggests these efforts can help attract people to the profession (Hendricks 2015; Hough and Loeb 2013). In figure 7-19, a CEA analysis shows that across an 18-year period between 2001 and 2019 (the last year before pandemic-associated disruptions), states where public school teachers' relative wages increased also saw meaningful increases in the number of new state licensures to teach in K-12 public schools, on average.[10] Model-based estimates with state and year fixed effects, although imprecise, suggest a $100 increase in weekly wages (roughly equivalent to

[10] The CEA estimates relative wages by comparing the weekly median earnings of public elementary and secondary school teachers to other non-teacher college-educated workers.

Figure 7-18. Factors Potentially Increasing High Schoolers' Interest in K-12 Teaching



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Source: ACT Research and Policy.

Note: Sample is restricted to students who indicated potential interest in teaching. Figure displays top three reasons that would increase respondents' interest in becoming a K-12 teacher. Data are from 2018.

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a $5,200 annual salary raise) increases the number of new licensures by 2.0 percent (p=0.16).[11]

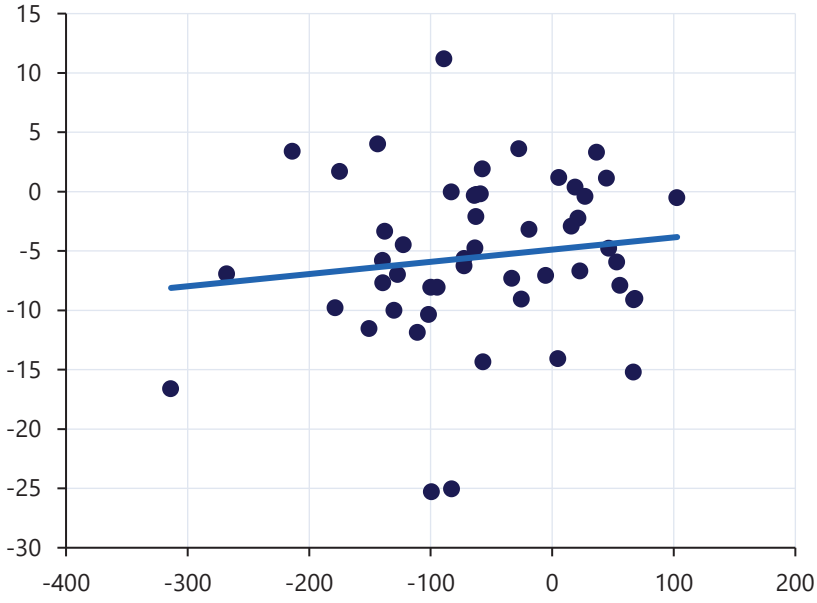
The Federal Government has an important role to play in catalyzing efforts to raise teacher pay to be more competitive with market wages on average, as well as to create opportunities for more pronounced wage growth in the profession. Edwards et al. (2024) find that the rate at which wages increase in the first 10 years of the career strongly predicts teacher retention.

There also remain important opportunities to better leverage compensation as a tool to address localized shortages and retain high performers with opportunities for career advancement. The Federal Government could encourage innovative compensation approaches, including differentiated pay programs for educators who teach in hard-to-staff subjects and schools. Federal funds could also be used to promote efforts to develop career ladders, where teachers would have opportunities to earn promotions based

[11] The model applies cluster robust standard errors at the state level.

Figure 7-19. Changes in Licensures and Public School Teacher Pay, by State

Change in new teacher licensures per 10,000 people



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Sources: Current Population Survey accessed via IPUMS; Title II of the Higher Education Act; American Community Survey accessed via IPUMS; CEA calculations.
Note: Relative pay is calculated as the difference between public school teacher weekly pay and weekly pay for all non-teacher, college-educated workers using the Economic Policy Institute definition of weekly wages. Total new teacher licensures are adjusted by the working age population for the end year of the academic year period. The change in both licensures and relative wages are calculated as the difference between the 2018 and 2019 average and the 2001 and 2002 average.
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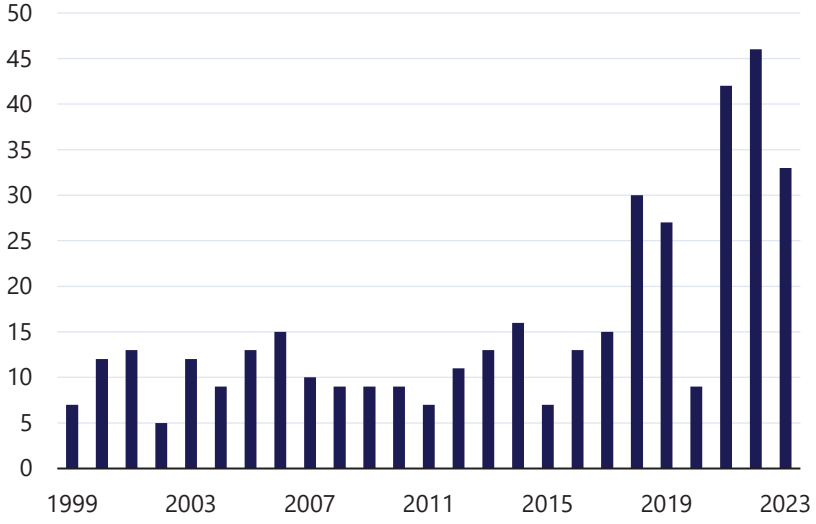
on their performance. Such a system would better leverage the expertise of excellent teachers by having them spend part of their day serving as instructional coaches, curriculum developers, or new teacher mentors. Teacher career ladders offer a way to address the third most cited factor by ACT test takers that would increase their interest in teaching: "More opportunities for career advancement" (Croft, Guffy, and Vitale 2018). Such an approach stands in contrast to more common supplemental stipends and merit-pay programs based on annual performance measures, which fail to provide a clear signal to potential educators about their earning potential (Chiang et al. 2017).

Meaningful differences in staffing challenges across schools and regions also point to the importance of removing barriers to professional mobility and investing in place-based teacher training. One such barrier is the lack of transferability of state teaching licensures in many contexts (Evans, Francies, and McDole 2020). The Federal Government could both help subsidize membership costs for states to join the Interstate Teacher Mobility Compact and use its convening power to encourage state leaders to streamline the licensure reciprocity process and reduce barriers to licensure portability and employment (Teacher Compact n.d.). Reducing barriers for transferring teaching licensures across states via expanded reciprocity could help increase the mobility of teacher labor supply (Goldhaber et al. 2015).

Research suggests that Grow Your Own teacher preparation programs supporting paraprofessionals and other community members to earn a bachelor's degree and teacher's license can increase the local supply of educators (Hashim and Laski 2024; Blazar et al. 2024). Saunders et al. (2024) find that teacher residency programs that provide an extended period of supervised professional practice increase teacher retention. The Administration has invested in these promising pathways and other programs to support growth in new teacher labor supply through expanded funding for the Teacher Quality Partnership Grant, IDEA Part D, and the Hawkins Program (White House 2024b). Under the Administration, the registered apprenticeship programs for K-12 teachers, which share many traits with Grow Your Own and residency programs, have been extended to 47 states and territories. Allowing candidates to earn pay and benefits while working toward their degree and/or teacher's license can significantly increase pathways into the education sector, reduce or eliminate the cost of becoming a teacher, and provide future educators with valuable classroom experience. Expanding student-teaching placements in hard-to-staff schools can also increase new teachers' openness to working in these settings and provide them with valuable training to succeed (Goldhaber et al. 2022).

Reducing the private cost of teacher preparation through expanded federal grants and loan forgiveness programs provide a direct lever for policymakers to shape new teacher supply and quality. As shown in figure 7-18, 27 percent of high school students potentially interested in teaching indicated that college scholarships were a top factor that could increase their willingness to become teachers; 20 percent cited loan forgiveness. The Public Service Loan Forgiveness (PSLF) program allows for outstanding federal student loan balances to be forgiven for public service workers who have completed 10 years of full-time service and made qualifying monthly payments on their loans for 120 months (Federal Student Aid 2024). As a result of significant procedural fixes the Administration made to the program, the number of public servants with debt approved for discharge increased from less than 7,000 prior to the Administration to more than 1 million in October

Figure 7-20. Instances of Gunfire on K-12 School Campuses During School Hours



Council of Economic Advisers

Sources: *The Washington Post*; CEA calculations.

Note: Data do not include instances of gunfire that occur after school hours, unintentional firing that does not cause injury, or shootings on college campuses.

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2024 (CEA 2024c). Research also shows that students are more likely to enter public service when financial aid is packaged as a conditional grant rather than a forgivable loan (Field 2009). Continuing efforts to increase funding for programs like the Teacher Education Assistance for College and Higher Education (TEACH) Grant Program and the Noyce Teacher Scholarship Program, which provide tuition scholarships in exchange for teaching in high-need fields and schools, would be a strategic investment in the next generation of educators (Turner 2021; NSF n.d.).

The ACT survey results also point to the critical importance of reducing gun violence in schools and their surrounding communities. Frequent school shootings are a uniquely American phenomenon (World Population Review 2024). As shown in figure 7-20, conservative estimates suggest there have been at least 415 school shootings, 30 of which were mass shootings, since the event at Columbine High School in 1999 (Cox et al. 2024). In addition to having immediate and long-term negative effects on exposed students (Beland and Kim 2016; Rossin-Slater et al. 2020; Deb and Gangaram 2023; Cabral et al. 2024; Levine and McKnight 2024), the traumatic events lead to increased turnover among teachers and school staff (Cabral et al. 2024). Shootings have increased markedly since the 2017–2018 school year,

when 27 percent of students potentially interested in teaching indicated that safer schools and classrooms would increase their interest in the profession (figure 7-18). The Administration has taken a range of actions to reduce gun violence overall and in schools, such as creating the Stronger Connections grant program which provides $1 billion in funding to support safer schools and more inclusive learning environments, establishing the Office of Gun Violence Prevention and the Emerging Firearms Threats Task Force, issuing executive orders to increase safe gun storage, and enhancing background checks for firearm buyers under the age of 21 (Department of Education 2024c; White House 2024c).

Policies to Maximize Educators' Potential

Efforts to attract skilled workers to the teaching profession are most effective when they are paired with policies and programs designed to maximize teachers' potential. Research shows that teacher-school match quality is an important component of educators' overall effectiveness and that teacher effectiveness differs across settings and student populations (Jackson 2013; Delgado 2023). Districts can support principals to successfully navigate the teacher hiring process with early and information-rich practices and by providing them with autonomy over who they hire (Liu and Johnson 2006; James, Kraft, and Papay 2023). This is made possible when districts and school leaders have the flexibility to publicly post vacant positions at the beginning of the hiring cycle and hire the candidate best suited for the position regardless of seniority.

Schools can support teachers' professional growth on the job through professional development, such as high-quality induction and mentoring programs (Ronfeldt and McQueen 2017), teacher coaching (Kraft, Blazar, and Hogan 2018), and peer observation and feedback (Papay et al. 2020; Burgess, Rawal, and Taylor 2021). Finally, school leaders can work to develop cultures and climates that promote teachers' professional growth and retention (Bryk et al. 2010; Kraft and Papay 2014), as well as students' academic success (Kraft, Marinell, and Yee 2016; Porter et al. 2023). The U.S. Federal Government can support these efforts through expanded funding of Title II, Part A and competitive grant programs.

Capital Inputs

A growing body of research documents how the condition of school infrastructure affects teacher and student outcomes (Biasi, Lafortune, and Schönholzer 2024; Jackson and Mackevicius 2024). Approximately one half of school districts participating in a recent U.S. Government Accountability Office (GAO) survey reported that they needed to replace or repair their capital infrastructure, such as heating, ventilation, air conditioning, or plumbing

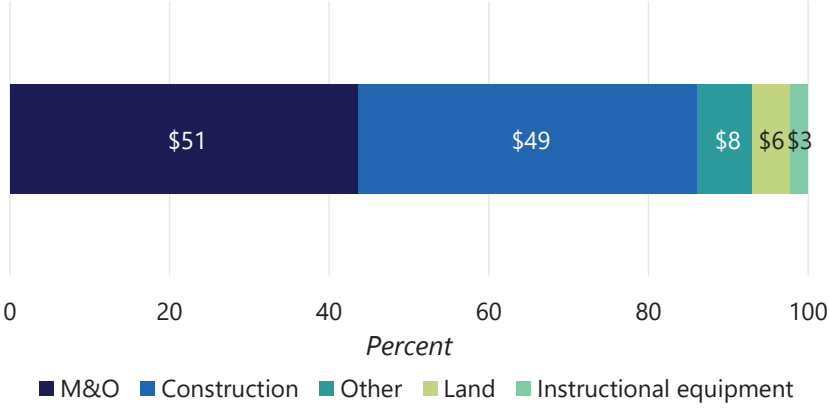
(GAO 2020). Investments to modernize school buildings have considerable benefits (Neilson and Zimmerman 2014) and will become increasingly important as the adverse effects of climate change place increasing pressure on K-12 infrastructure (Will and Lieberman 2023).

Lead abatement and air conditioning improvements are two concrete and urgent interventions with proven benefits for federal policymakers to target. In the 12 states with available testing data, 44 percent of schools had one or more water samples with a significant concentration of lead (Cradock et al. 2019). Children can also be exposed to lead during recess via the surface of playground equipment (Almansour et al. 2019). Any level of lead is dangerous for children and can lead to long-term cognitive impairment and increased levels of aggression and agitation (American Academy of Pediatrics 2024). Lead-hazard control grants issued by the U.S. Department of Housing and Urban Development have been shown to reduce lead poisoning, and each 1 percentage-point drop in lead poisoning yields test score gains of 0.04 standard deviations in math and 0.08 standard deviations in reading, roughly equivalent to a 1.5 percentile increase in math and a 3 percentile increase in reading (Sorensen et al. 2019). The Administration took action to reduce these risks by allocating $3 billion in funding to identify and replace lead pipes in May 2024 (EPA 2024a) and issuing a final rule in October 2024 requiring lead pipes that carry drinking water to be replaced within 10 years (EPA 2024b).

Approximately one third of schools reported needing to replace or repair their heating, ventilation, and air conditioning (HVAC) system in the GAO survey (GAO 2020). As the number of school days with temperatures above 80 degrees increases due to climate change, areas that were cool year-round prior to 1970 (when nearly 40 percent of school buildings were built) now need air conditioning to create a tolerable learning environment (Phillips and Penney 2024). Research shows that a 1-degree hotter school year causes a 1 percent decrease in learning that year without air conditioning (Park et al. 2020), with increasingly common extreme heat having even larger effects (EPA 2024c). Air conditioning systems can also improve ventilation, lowering the risk of transmission of respiratory illnesses, such as COVID-19, and filtering pollutants, such as dust, smoke, and mold (CDC 2024; Bottrell 2019; Howard et al. 2021). Poorly maintained air conditioning systems can become home to mold, increasing incidences of asthma (Jenkins Environmental n.d.). Biasi, Lafortune, and Schönholzer (2024) find that investments in air conditioning yield test score increases of 0.2 standard deviations, or 7.4 percentiles. Encouragingly, nearly one half of school districts surveyed by the Center for Green Schools said they planned to use ESSER III funds (i.e., ESSER funds allocated by the ARP) to upgrade their HVAC systems (Sauter and Heming 2022).

Figure 7-21. School Facilities Improvement Spending, by Category

Billions of dollars



Council of Economic Advisers

Sources: National Center for Education Statistics; Common Core of Data (CCD); CEA calculations.

Note: School facilities improvement spending includes all categories of capital spending as designated by the CCD, as well as maintenance and operations (M&O), which is categorized as support spending. Data are from the 2021–2022 academic year.

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Addressing Capital Funding Inequities

On average, districts allocated 86 percent of their facilities improvement budget on construction costs and maintenance and operations in 2022 (see figure 7-21). Over half of all school districts fund capital infrastructure projects primarily through local taxes, especially property taxes. For high-poverty school districts, which have limited property tax revenue from which to draw, state support is crucial for financing capital projects (GAO 2020). However, 14 states do not provide capital funding to school districts, and in those that do, state funding rarely makes up the difference: High-poverty districts (defined as those with greater than 65 percent economically disadvantaged students) spend 37 percent less per school on capital investments than low-poverty districts (Filardo 2021). As a result, students from low-income backgrounds are less likely to attend schools in buildings that are in good shape and less likely to attend schools in districts with a high amount of capital outlay than students from relatively more affluent backgrounds (Blagg, Terrones, and Nelson 2023). Accordingly, hot school days disproportionately affect students of color, who are more likely to attend

high-poverty schools that lack the proper air conditioning and ventilation systems (Park et al. 2020).

Hallmark investments by the Administration, such as ARP funds and the Bipartisan Infrastructure Law, are examples of how the U.S. Federal Government can strengthen schooling infrastructure to the benefit of students. Local education agency administrators reported that they planned to use $26 billion of ESSER III funds to improve school facilities and operations in 2024 (DiMarco and Jordan 2022). The Renew America's Schools Program, launched by the U.S. Department of Energy in 2022, with a subsequent round of funding announced in 2024, has made $500 million available to school districts to improve energy infrastructure (DOE 2024), enabling schools to sustainably invest in air conditioning. Additionally, the Administration announced in May 2024 that it will fund 3,400 new clean school buses, a $900 million investment, via the Clean School Bus Rebate Program (EPA 2024d).

Technology Inputs

Recent technological advancements, such as computer-adaptive learning programs (CAL) and generative artificial intelligence, present both opportunities and challenges for the U.S. K-12 education system. Given the historical resilience of the traditional classroom model during past periods of major technological innovations (Reich 2020), the CEA is skeptical of prognostications that the new technologies will imminently replace teachers or brick-and-mortar schools. Teaching involves multiple complex tasks, such as lesson planning, providing direct instruction, identifying individual student challenges, differentiating instruction to students' individual needs, and managing classroom behavior (Holmstrom and Milgrom 1991). Human relationships and social interactions play a central role in the learning process. However, CAL and AI-powered tools hold considerable potential for augmenting teacher productivity and student learning.

Jackson and Makarin (2018) illustrate how the potential benefits of education technology depend on (i) the effectiveness of the new tool, (ii) the time savings it provides teachers, and (iii) the ease of adoption and use. The framework makes clear that education technologies are most likely to be effective when they perform sufficiently well to be a productive replacement for teachers' task-specific work,[12] allow teachers to focus on other productive tasks for which they have a comparative advantage, and are easy

[12] Research outside the education sector affirms that AI boosts productivity by roughly 20 percent to 25 percent for particular tasks in a range of white-collar jobs, including software development (Cui et al. 2024), professional writing for office jobs (Noy and Zhang 2023), customer service (Brynjolfsson, Li, and Raymond 2023), and tasks in management consulting (Dell'Acqua et al. 2023). In all cases, the gains are heterogeneous and most pronounced for workers who otherwise would have been less productive than their peers.

to use. It also implies that new technologies will not be a panacea, as their value depends on the skillset of each individual (likely being most helpful for the otherwise least effective teachers) and the degree to which students and teachers are able to use it with fidelity.

Teachers report using AI most frequently for individual tasks, such as customizing instruction through AI-enhanced CAL programs and generating instructional materials (Diliberti et al. 2024). Taylor (2018) finds that the integration of computer-aided instructional software designed to provide individualized instruction improves student achievement in less-effective teachers' classrooms but may reduce student performance in higher-performing teachers' classrooms. Similarly, Jackson and Makarin (2018) find that providing teachers with high-quality online off-the-shelf lesson plans improves outcomes overall, with the largest gains among the weakest teachers. Research on CAL programs finds substantial impacts in some settings (Escueta et al. 2020), but also that many teachers and students do not use the tools for the recommended amount of time (Holt 2024; Oreopoulos et al. 2024). Without implementation support and equal access to the internet and digital devices, new technology may remain on the periphery of teaching and learning and even exacerbate existing inequities in K-12 schools.

AI-powered tutoring programs and tutor assistance programs may also become productivity-enhancing complements to teachers and tutors. One study shows that CAL programs can be effectively integrated into high-dosage tutoring models, allowing programs to double student-tutor ratios while largely sustaining their effectiveness (Bhatt et al. 2024). Large language models can be trained on transcripts from expert human tutors to enhance their ability to diagnose student errors and identify productive remediation techniques, such as guided questioning (Wang et al. 2024a). A randomized control trial of Tutor CoPilot, which provides real-time guidance to tutors, found that the technology improved student performance on mini-assessments given at the end of each session and had the largest benefits for lower-rated and less-experienced tutors (Wang et al. 2024b). Still, open questions remain about the benefits of AI-powered tutoring for students' long-run skill development. One study found that an AI tutor using Open-AI's ChatGPT-4 improved student performance in high school math, but that students in the treatment group performed worse relative to control students when they no longer had access to the AI tutor (Bastani et al. 2024).

Arguably, the potential benefits of AI in education will be in providing tools available to teachers and students, each for specific tasks, to complement people-centric teaching and learning, rather than as an all-in-one technology. Training for teachers on how to deploy technology from a wide-ranging AI toolkit will be essential for success (aiEDU 2024). Federal policy can help facilitate the creation of such a toolkit, and the Institute of Education Sciences can fund research on which tools are most effective in

specific contexts and for specific purposes (Institute of Education Sciences n.d.).

The Federal Government's Role in Agenda Setting

While the U.S. Federal Government accounts for a small share of all public school funding, it has considerable influence on public education through laws, regulations, and agenda setting. For example, the No Child Left Behind Act (NCLB)—the 2001 reauthorization of ESEA—required annual testing in all states to identify schools that failed to make "adequate yearly progress" overall and among specific student subgroups (National Center for Education Evaluation 2008). The law linked test-based performance measures to sanctions and rewards, led to rapid advancements in data collection infrastructure, heightened attention on student achievement gaps, and set new standards for being considered a highly-qualified teacher. Research finds that NCLB improved academic achievement for students in general and for students from low-income backgrounds in particular (Dee and Jacob 2011; Reback, Rockoff, and Schwartz 2014). The Every Student Succeeds Act—the 2015 ESEA reauthorization—maintained test-based accountability but granted increased autonomy to states regarding school improvement and accountability systems (Department of Education 2024d). It also included requirements to provide more information to parents and expanded the set of metrics that are used in accountability to include graduation rates as well as the option to use suspensions, absenteeism, teacher qualifications, resource equity, and other metrics. School districts around the country now measure student wellbeing and school climate, disseminate this information to parents, and use it to inform policy decisions.

The Federal Government also plays a key leadership role in shaping policies through targeted grants and investments. The Administration's investments in K-12 education, particularly through ARP funding, sparked a rapid recovery of K-12 public education jobs to pre-pandemic levels, supported critical academic acceleration efforts, increased Title I aid, and made pursuing a teaching career more affordable through reforms to the TEACH grant and PSLF (Department of Education 2021b). Enhanced federal funding for the Perkins Act has helped to accelerate the much-needed expansion of CTE in public high schools. CTE prepares students with the skills necessary for high-demand sectors of the economy. Additionally, rigorous evaluations show that CTE academies and programs have positive effects on students' academic achievement and attainment and substantially increase graduates' earnings in the labor market (Page 2012; Dougherty 2018; Hemelt, Lenard, and Paeplow 2019; Bonilla 2020; Brunner, Dougherty, and Ross 2023).

The Administration successfully launched the National Partnership for Student Success, a nationwide effort led by the U.S. Department of

Education, AmeriCorps, and Johns Hopkins University that successfully recruited, trained, supported, and engaged an additional 320,000 people to serve as tutors, mentors, and student-success coaches in just two years (Balfanz and Byrnes 2024). The BSCA championed by the Administration made historic investments in school-based mental health services and school safety. The Administration has also targeted competitive federal grant programs to activities intended to increase student attendance and engagement and improve student achievement, held convenings of policymakers, and provided guidance on best practices (such as home visits, tracking real-time attendance data, and promoting full-service community schools) (Department of Education 2024e; White House 2024d). Thus, federal leadership can influence policy and make meaningful and impactful change.

Conclusion

The K-12 education system has long been and continues to be the primary public investment the United States makes in the human capital of its people. Elementary and secondary education prepares students with the foundational knowledge and skills they need to thrive in higher education and the labor market, as well as to realize their intellectual and academic potential. The work of educators and schools is fundamental to the U.S. economy and provides large returns on the investments made by both individuals and the government at every level.

Ensuring that the United States benefits from a world-class K-12 education system and keeps pace with the rapidly evolving landscape of the future of work remains imperative. Meeting the challenge will require schools to be fully staffed with quality educators; provide healthy, safe, inclusive, and modern learning environments; and leverage technological advancements in productive ways. Perhaps the greatest opportunity to improve the productivity of K-12 education is to attract and retain the best and brightest to serve as educators through subsidies for higher education, competitive market wages, differentiated career pathways, and supportive working conditions. Modernizing the capital infrastructure of schools, especially those in disrepair or with outdated systems, will enhance both teaching and learning. New approaches to integrating CAL and generative AI into the education system to complement teachers' work holds promise but will require thoughtful development and experimentation to ensure these technologies serve as productivity-enhancing tools that build core knowledge and skills while keeping human interactions at the center of education.

The Federal Government will have a central role in supporting the continued strength of—and innovation in—K-12 education, as well as ensuring that all students enjoy equitable access to the full benefits of high-quality schooling. This will include ongoing direct financial investments in K-12

schools to ensure more equitable funding and insure against fiscal shortfalls during economic downturns. It will also involve catalyzing research and development and experimentation in the sector through grants to practitioners and researchers. Efforts to improve the analytic capacity of districts and state education departments, as well as to collect detailed and real-time data on teacher labor markets and student outcomes, will help inform ongoing efforts for targeted improvements. These investments will pay dividends for current and future generations, with broad-based benefits to economic growth for the United States as a whole.