



Breaking Ground

A First Look at American High School Skilled Trades Education

AT A GLANCE

Our country faces a critical shortage of skilled trades workers, now and for years into the future. But, due to an aging workforce and limited awareness of opportunities in the trades, the supply of workers trained for these jobs is simply not keeping pace. To date, no analysis has offered a comprehensive national view of high school-level trades education. This report aims to fill that gap.

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About JFF

JFF is a national nonprofit that drives transformation in the American workforce and education systems. For 35 years, JFF has led the way in designing innovative and scalable solutions that create access to economic advancement for all. Join us as we build a future that works.

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May 2020 Note to Our Readers

When we set out to conduct research on the state of skilled trades education in U.S. public high schools, the economy was booming, construction was abundant, and employers were clamoring for a wide range of skilled trades professionals. We designed our study to incorporate predictions of a steady flow of demand for tradespeople over the next decade. And then came the COVID-19 pandemic, thrusting the economy into turmoil.

While the labor market is likely to change significantly in the coming year, our study remains relevant. The demand for trades professionals will not fade away. The country's infrastructure needs will persist, as will the need for skilled tradespeople to maintain the electrical, HVAC, and other systems that power the hospitals, offices, and factories that make our country run.

To answer this need, we must develop a steadily flowing talent pipeline—one that extends from America's youth to adult jobseekers and provides well-paying opportunities to a broad range of people. To build that pipeline we must ensure that each student rising through our secondary education system has access to high quality trades education – to help them prepare for essential, in-demand careers that don't necessarily require a four-year college degree, and to enhance their education through relevant, hands-on learning.

In the best of times, our career and technical education system has faced challenges, which we describe in our report. In the midst of a crisis like the current pandemic, providing high-quality classroom and hands-on learning experience is incredibly challenging, if not impossible.

As the engines of the economy begin to fire again and skilled trades educators return to delivering in-person instruction and work-based learning experiences, we hope that our report provides a roadmap for overcoming challenges and building on the pockets of innovation and excellence we found in our research. This work remains essential to ensure preparation of the trades workforce that our economy will require as it recovers from the pandemic and well into the future.

Lisa Soricone
Senior Research Director

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Introduction: Why we embarked on a study of skilled trades education in America's public high schools

Our country faces a critical shortage of skilled trades workers, now and for years into the future. Demand is high and growing for the electricians, carpenters, plumbers, and others who build, maintain, and repair the infrastructure that supports the entire U.S. economy. But, due to an aging workforce and limited awareness of opportunities in the trades, the supply of workers trained for these jobs is simply not keeping pace. The gap is already slowing down projects, driving up consumer costs, and limiting the ability of American companies to adapt quickly to major changes brought on by new technology or regulations.¹

Where are the workers with the finely honed skills needed to keep our country running? Who will build the highways that trucks travel to fill grocery store shelves, maintain the systems that keep hospitals functioning to save lives, and service the electrical grid that powers everything from schools to stock exchanges? Who will build and repair our homes, our cars, and our energy sources? Where is the pipeline of talented people who love and excel at working with their hands? And how many Americans are missing out on promising career opportunities because education and training can't keep up with demand?

One vital source of future trades workers are the public high school students who participate in career and technical education (CTE) programs in the skilled trades. Trades education at the high school level should be a key onramp to good jobs and a broader workforce preparation ecosystem that includes postsecondary education and training options. High-quality skilled trades education in U.S. high schools could not only pave a path for students to access well-paying and fulfilling careers, but also meet employer demand for qualified workers and strengthen our economy at the regional, state, and national levels.

Both the significant labor needs and the meaningful career opportunities the trades can provide raise important questions about how well, if indeed at all, our education system prepares young people to enter the trades. Yet far too little is known about this potentially vibrant part of the nation's talent pipeline. Our research indicates that the current educational system's wherewithal to prepare future trades workers seems slim at worst and uneven at best. Most state education departments do not even reliably collect basic information that could tell students, staff, parents, employers, and policymakers how many young people enroll in and complete skilled trades programs in high school, let alone illuminate their journey to careers and further education after graduation. To date, no analysis has offered a comprehensive national view of high school-level trades education. This report aims to fill that gap.

With rapid advancements in technology, the broader CTE field—which today emphasizes opportunities in areas like STEM (science, technology, engineering, and math) and health care—is attracting a great deal of public attention, while the trades receive little to none. While pockets of innovation and creativity offer compelling opportunities, most high school students do not receive the kinds of meaningful experiences that open the trades to them as viable career options. Neither is the field taking advantage of the potential for stronger, more consistent links between schools, employers, and postsecondary education. Our nation needs a baseline understanding of the current landscape of high school skilled trades education—and a road map of what could or should happen next—to build on the promise that trades education offers to meet both individual and societal needs.

JFF set out to explore this landscape at the request of Harbor Freight Tools for Schools, a philanthropic program of The Smidt Foundation that seeks to advance excellent trades education in public high schools across America. What enhanced role could secondary skilled trades education play to ensure employers have enough highly skilled workers for these essential occupations? How can the fulfilling career opportunities offered by the trades be opened to a greater number—and more representative group—of our nation’s young people?

What we found shed light on major gaps, bright spots, and significant opportunities to change current practice to better meet the critical labor needs of our economy, and to create opportunity for young Americans.

Our Research

To understand the state of skilled trades education in America’s high schools, JFF undertook a 50-state investigation, pursuing both quantitative and qualitative sources of information. We reached out to CTE directors in each state and the District of Columbia for phone interviews. In addition, we conducted 27 interviews with experts from trades- and CTE- related organizations and local programs to provide additional insights (*see Appendix A for a full description of the research methodology and a list of those interviewed*).

Gathering quantitative data to establish a national view of trades education proved to be a challenging process. The JFF research team requested data from each state specifically on high school skilled trades programs, students, student outcomes, and teachers. We quickly learned that this request required states to assemble data in a way they typically do not do.

In the United States, CTE curricula, programming, and even reporting, are generally organized around a set of 16 “career clusters” that represent 79 career pathways.² Yet the skilled trades are embedded within multiple clusters, including Architecture and Construction; Manufacturing; Transportation, Distribution, and Logistics; and even Agriculture, Food, and Natural

Resources. Although cluster data can provide some indication of trades education trends, they offer an imperfect view, as clusters may also include programs of study unrelated to the trades.

For example, the Agriculture, Food, and Natural Resources cluster comprises courses that prepare students to be welders, machinists, or heavy equipment maintenance technicians, as well as farm managers, water quality managers, chemical engineers, animal caretakers, and veterinarians. Thus, reporting on trades education in particular required states to extract data based on the identification of trades courses or programs, rather than simply sharing overall career cluster data. Some states were able and willing to conduct this deeper inquiry; others were not. Those who were able completed a data survey, on paper or online, which served as the basis for our analysis.

Key Findings

Trades education operates in a data desert with a few oases.

Obtaining state data proved to be a significant challenge. While much discussion and attention is currently focused on CTE generally, its data infrastructure is lagging. We found many state offices understaffed, and in numerous cases, extracting data to meet our request was too time consuming or simply impossible.³ We ultimately obtained data from 38 states, though most states were unable to provide all of the data requested. These 38 states represent approximately 82 percent of the nation's public high school students.⁴

In sum, our efforts to collect quantitative data in many ways mirrored what our interviews with 50 state CTE leaders revealed: Skilled trades education sits within state CTE systems that are often fragmented, fail to sufficiently prioritize the trades, and lack sufficient resources at the state and classroom levels, particularly for the trades. However, our interviews with state agency leaders and other professionals also revealed innovations and promising practices that could guide the way forward.

High school skilled trades education offers students high-value opportunities.

Students participating in skilled trades classes can gain not only valuable technical skills and work experience, but also the academic and personal skills needed to be successful in whatever path they choose after high school. Some start earning good money in their chosen trade while still in high school.

Despite these opportunities, trades education practitioners report negative perceptions among students, families, and counselors.

This was a consistent theme echoed by educators and administrators across nearly every state. Interviewees routinely reported that trades education is too often associated with “dirty” shop

classes leading to “dead-end” jobs. This misperception leads many students and families to overlook opportunities in the trades.

Most of the skilled trades education data that states collect are not used to improve programming or ensure that programs meet labor market needs.

Rather, they are used primarily for compliance purposes. Most of the high school skilled trades data that states collect are interwoven with broader CTE data that states report to the federal government to meet requirements for receiving federal funding. Overall, the data are insufficient to paint a complete picture of student participation and results.

To the degree the data reveal trends, they show a misalignment between student participation and labor market demand for skilled trades workers.

Some subjects like automotive services and welding are enrolling students at much higher rates than other areas like construction, manufacturing, plumbing, and electrical. If these practices continue, the result will be even more significant shortages of skilled workers in the trades areas most in need of labor supply.

The data also show glimpses of the positive outcomes many high school trades students achieve in graduation and college enrollment. But participation among student subgroups is uneven; some, like girls and students of color, are not well represented.

Trades education faces looming teacher shortages and significant funding constraints.

With an aging teacher workforce and stiff competition from higher-paying jobs in industry, skilled trades teacher positions will be increasingly difficult to staff. States, districts, and programs face overall resource challenges that can limit access to quality programming and up-to-date equipment and materials.

These challenges stand in stark contrast to the exciting developments and renewed interest in CTE overall, as well as the innovations in skilled trades education that show how powerful these approaches can be.

CTE is widely supported and on the tips of policymakers’ tongues; labor shortages are causing employers to look to high schools in ways they previously hadn’t, in order to build their talent pipelines; and there is renewed interest in apprenticeship and pre-apprenticeship, an area in which the trades have long offered strong models and outcomes. Given this attention, we are in a rare moment of opportunity for alignment among educators, industry, policymakers, and students to fulfill the promise that trades education offers.

Roadmap to the Report

This report summarizes what we learned in our exploration of skilled trades education in the nation's public high schools. We offer it to state education leaders; to policymakers at all levels of government; to concerned educators, counselors, and parents; and to employers and those operating and developing apprenticeship and other workforce development programs—in other words, to all who understand, or wish to understand, the stakes for our communities and country.

The report is organized as follows:

Part 1. Trades in the labor market: A story of need and opportunity

Part 2. Data: What we know—and don't know—about public high school skilled trades education students, teachers, and outcomes

Part 3. Skilled trades education today: Not your parents' vocational

Part 4. The state of the field: Challenges and promising practices

Part 5. Recommendations: A call for increased understanding and action

We hope that this report will:

- Stimulate discussion and reflection among educators, parents, business and labor leaders, and policymakers across the country;
- Raise the profile of skilled trades as an important area of CTE that merits more attention;
- Encourage the development and strengthening of trades education programs; and, ultimately,
- Contribute to making high-quality trades education available to more young people as they determine their education and career paths beyond high school.

It's time to pay attention—and to do far more to prepare young people for the careers that build our country and keep it running.

The Skilled Trades Covered in This Report

For the purposes of this report, we employ the definition of the “skilled trades” used by Harbor Freight Tools for Schools: “Professions that emphasize the expert use of tools and materials to build or repair products and structures, and which lead to good jobs with strong potential for advancement and high wages.”

The large majority of skilled trades coursework covers the following trades areas:

- Advanced manufacturing
- Carpentry
- Construction (which can include masonry and other specialties, and sometimes serves as an overall descriptor for courses that include multiple other trades on this list)
- Electrical
- Heating, ventilation, and air conditioning (HVAC)
- Plumbing
- Transportation mechanics and repair
- Welding

We recognize that many high school students study the skilled trades within agricultural courses. However, course categorization practices at the state and local levels make it difficult to determine the extent of trades-specific study within each of these classes. Accordingly, though we recognize trades education may occur in these courses, we have not included agriculture classes in this study.

Part 1. Trades in the labor market: A story of need and opportunity

A Need for Trades Workers Now and in the Future

Demand for skilled trades workers in the United States is not merely high, it is soaring—the highest of any occupational area in the country, as well as globally.⁵ Skilled tradespeople—including electricians, welders, mechanics and others—are in greater demand than sales representatives, engineers, or IT professionals. For the past decade, the trades have ranked among the top five hardest roles to fill.⁶

Demand is high for multiple reasons, including an economic upturn that's driving a boom in construction. The United States also faces a crumbling national infrastructure. Only skilled tradespeople can repair and update the roads, bridges, dams, transit systems, airports, and seaports that keep our economy and our communities moving.⁷

The skilled trades include over 11 million workers in the United States.⁸ Labor market data show a clear and steady need for many more trades workers over the next decade, with 1.3 million job openings annually through 2028.⁹

The trades face an aging workforce. In 2018, fully half of skilled trades workers in the United States were 45 years and older, including almost a quarter over age 55.¹⁰ The need for replacement workers exceeds the need to fill new jobs, as current skilled tradespeople change careers or retire.¹¹ A JFF analysis shows that, among the 1.3 million annual openings, for each new job in the trades created annually, there are 15 openings due to replacements (*see Appendix B for a list of job openings by trade area*).¹²

The need is most acute in manufacturing, where there are projected to be over 294,000 openings each year, but less than 3,800 represent new positions.¹³

Economic Opportunity in the Trades

The trades offer opportunities for well-paying career paths, often without requiring young people to incur significant college debt, which now averages close to \$30,000 per student.¹⁴ Leaving high school with marketable skills, many students can work while they attend college, or participate in apprenticeships that offer college credit along with a salary. In 2018, construction trades workers earned an average of over \$49,000, with first-line supervisors earning an average of \$70,000.¹⁵ Electricians earned an average salary over \$59,000, with plumbers,

pipefitters, and steamfitters reaching a similar average level of over \$58,000.¹⁶ For construction workers who advance to higher levels of management, average salaries reach over \$90,000.¹⁷

Well-designed high school trades programs that lead to postsecondary training and industry-based credentials position students to pursue multiple pathways to opportunity. Many jobs in the skilled trades require some college or additional training. Increasingly, high school programs are offering dual enrollment options in which students can earn college credit or even associate's degrees while in high school, thereby accelerating their path to higher education and employment. Nationally, more than 1 million—of the nation's 15 million—high school students are taking college courses through community colleges. A 2017 study found that 88 percent of community college dual enrollment students continued in college after high school, and most earned a degree or transferred within six years.¹⁸

However, education after high school is not the sole route to a good job in the trades. As CTE directors interviewed for this study reported, trades students often have opportunities to earn well above minimum wage even while they are in high school, and students who have excelled in the trades can earn a solid salary right after graduating. Some trades graduates go straight to full-time work; some continue learning while working part time in order to continue advancing along their career paths.

Apprenticeships are another way the trades offer students the chance to “earn and learn.” Registered Apprenticeships exist for a full range of trades careers, integrating paid on-the-job training, related classroom instruction, ongoing assessments against skill standards, and acquisition of nationally recognized, portable industry credentials. In 2018, more than 180,000 Registered Apprentices were active in construction and manufacturing alone.¹⁹ Modern apprenticeships can also incorporate college credit and degrees. For example, an apprenticeship with the International Association of Heat and Frost Insulators and Allied Workers provides classroom instruction that includes math, applied physics, mechanical drawing, and digital technology, and apprentices can earn 45 college credits at no cost.²⁰ The New York City Plumbers' Union apprenticeship program leads participants to a full associate's degree.²¹ Colorado's CareerWise apprenticeship program for high school students incorporates college credit as a way to help make college more affordable.²² Individuals who complete an apprenticeship are better off than their peers, research has shown: one study found that apprenticeship completers earn \$240,000 more over the course of their careers than similar nonapprentices.²³

While the trades offer employment opportunities with unions and businesses of all sizes, the field also offers opportunities for encouraging entrepreneurship. Once they obtain their training, journeyman status and/or licenses, many trades workers launch their own independent businesses as plumbers, carpenters, painters, electricians, and contractors. These businesses create opportunities for owners and those they hire as businesses grow.

The diagrams below demonstrate the range of potential next steps beyond high school that students can pursue in two broad trades fields: construction and manufacturing. Though these pathways may not include some of the highest earners in the trades, they offer an example of the multiple routes available to trades students throughout their education and careers. In the first example (Figure 1), a graduate of a high school construction program has potential for a career that results in a family-supporting salary, whether their first move after graduation is to pursue an apprenticeship, a community college credential, or a four-year college degree. In the second example (Figure 2), an advanced manufacturing student has access to educational choices that range from a short-term certificate to a two- or four-year degree, whether immediately after graduation or pursued in succession over time.

Figure 1. Career Pathway in Construction²⁴

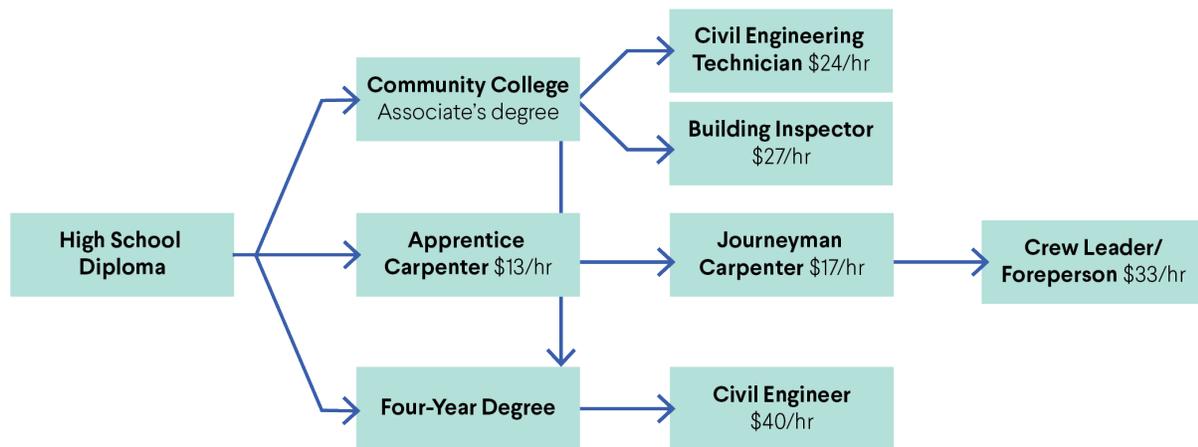
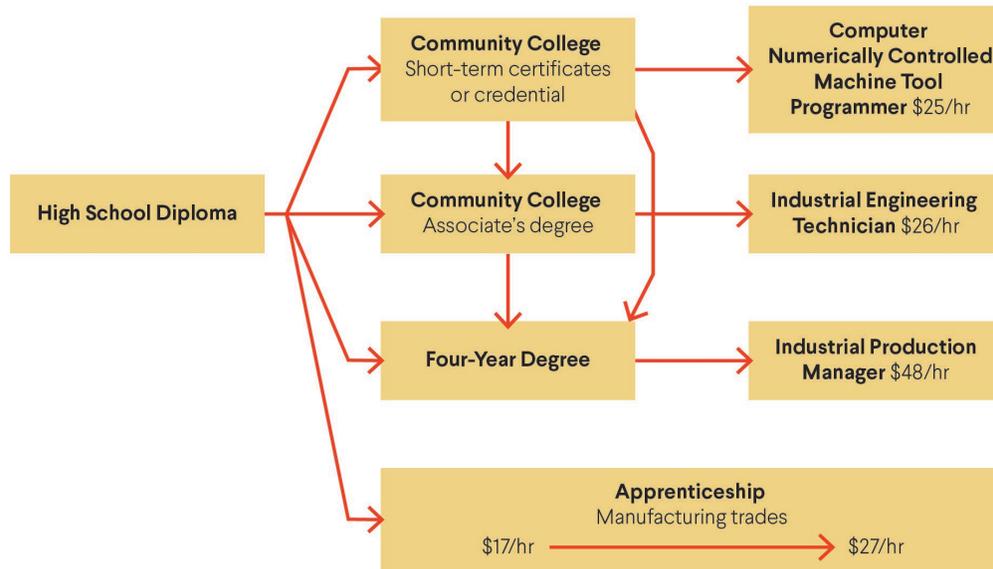


Figure 2. Career Pathway in Advanced Manufacturing²⁵



The bottom line is that high school trades education can offer students many opportunities beyond graduation. Moreover, the trades give students a full range of choices beyond high school—full-time employment, combining work and school, training programs, apprenticeships, and two- and four-year postsecondary education options—that can lead to satisfying, well-paid careers in sectors clamoring for skilled workers. Important questions remain about whether we—educators, counselors, employers, state departments of labor, and elected officials—are ensuring that all students understand the opportunities that trades offer, that interested students can access quality programs in high school, and that trades students are well-informed about their options upon graduation.

Part 2. Data: What we know—and don't know—about public high school skilled trades students, teachers, and outcomes

There is clearly significant demand for skilled trades workers and great potential economic opportunity for people who enter the trades. So how are high school skilled trades programs across the country doing in opening the doors to those career pathways, and in onboarding a supply of candidates to fill these jobs?

This is not an easy question to answer. Our study is the first contemporary and comprehensive effort to seek out this basic landscape data. To reiterate, JFF asked all 50 states and the District of Columbia to provide basic data about their skilled trades programs and participants: what programs are offered, who participates, and what outcomes trades students achieve. Thirteen states failed to provide any data. Only five states provided data in all categories requested. In total, we received data from 38 states—a group representing 82 percent of public high school students in the United States, as noted above (*see Figures A1 and A2 in Appendix A for an overview of state data responses*).

Despite these limitations, the data suggest important trends in high school skilled trades education that reinforce the need for more attention to this area of CTE and the opportunities for economic mobility it can offer.

Labor Market Demand Cannot Be Met by Current Supply

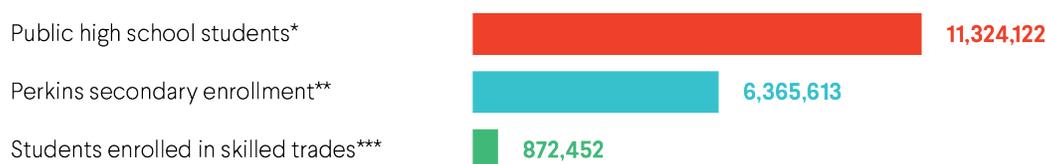
Participation in Trades Education

It is difficult to get a precise count of students engaged in high school trades education. Identifying trades students can be challenging, as trades classes are labeled differently across school districts, and the trades can sit within several of the career clusters that are used for federal reporting. For example, welding is counted as part of manufacturing in some districts and part of agriculture in others. The lack of good estimates of participants makes it difficult to determine whether the programs align with labor market needs—or to answer important policy questions about funding, staffing, and other resource allocation.

Among the more than 15 million high school students in 2016-17, 32 states reported more than 870,000 students in trades education (*see Figure 3*).²⁶ Among these 32 states, this represents 8 percent of the high school population and roughly 14 percent of the 6.3 million participants in CTE programs.²⁷ Some of these students will go on to complete a program of study and pursue a career in the trades. Others may take a single course, such as introductory

woodworking, with no intention of exploring a related career. Though it is clear a small portion of high school students enroll in trades courses, we also note that our data underestimate total enrollment.

Figure 3. Trades Education Enrollment Relative to U.S. High School and CTE Students 2016-17²⁸ (n=32 states)



*NCES https://nces.ed.gov/programs/digest/d18/tables/dt18_203.10.asp.

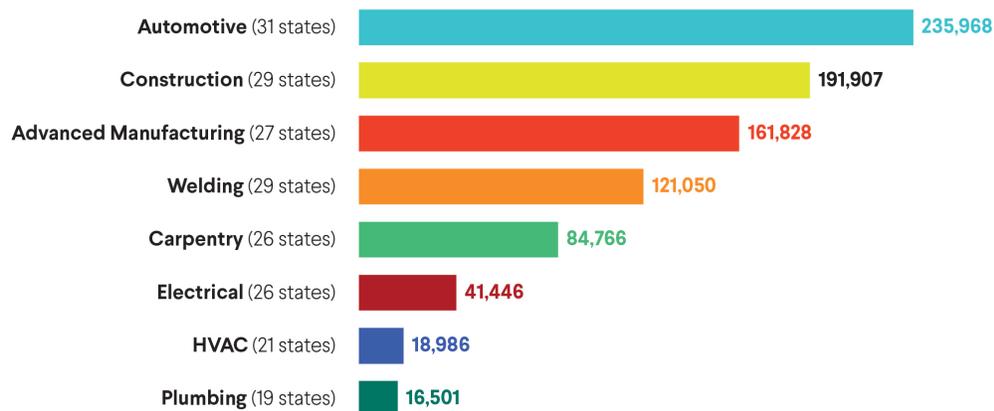
**Perkins Data Explorer. <https://perkins.ed.gov/pims/DataExplorer/CTEParticipant>.

***JFF research. Based on data from 32 states for 2016-17.

Participation in trades education varies across states. Based on data provided by 31 states, relative to their high school populations, Utah (29 percent) and Iowa (26 percent) have the highest proportions of students enrolled in the trades, more than the majority of states, which fall between 5 percent and 19 percent (*see Appendix C*).

Among skilled trades courses, programs in automotive, advanced manufacturing, and construction enroll the most students. Enrollment in particular trades is a function both of student interest and programs offered. As state CTE directors reported, many schools and districts do not offer a full range of trades courses due to constraints such as teacher shortages and equipment costs. Figure 4 provides a snapshot of enrollment by trade, though not all states provided enrollment data for all trade areas.²⁹ Even without complete data, we can see trends that suggest that some areas, like HVAC and plumbing, are enrolling relatively few students compared with others. These patterns can have implications for the ability of education systems to meet labor needs, as we discuss later in the report.

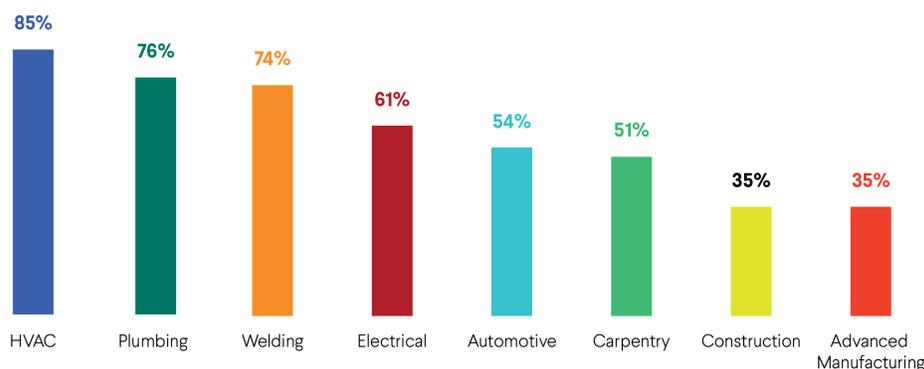
Figure 4. Enrollment by Trade Area, 2016-17 (data from 32 states, *n* varies by trade area)



Source: JFF research.

Substantial numbers of students concentrate (i.e., complete multiple courses in a sequence) in a skilled trade, though proportions vary considerably across the trades.³⁰ Student concentrator data is valuable because it indicates that these students have a sustained interest in the trades, want to pursue more in-depth learning, and have a higher potential to pursue a trades career. We examined concentrators as a proportion of enrollments in eight states that provided both enrollment and concentrator data for the 2011 freshman cohort (a group of states that include over 2.7 million high school students).³¹ The percentage of concentrators across trades sectors varies from 35 percent to 85 percent. The highest rates of concentration are among HVAC and plumbing students, while the lowest are among construction and carpentry students. It may be that many students sample introductory construction and carpentry classes to acquire some basic skills for personal use, while those who select areas like HVAC and plumbing are more interested in applying these skills for work; or it may be that schools that offer only a handful of trades courses are more likely to do so in areas of general interest like woodworking. More research would be needed to better understand these trends.

Figure 5. Percentage of Concentrators Among Trades Students (2011-12 freshman cohort) ($n = 8$ states)³²



Source: JFF research.

A few states show especially high numbers of concentrators. In Tennessee, this trend is likely due to the state's strong development of pathways that encourage students to focus early on building toward a career.³³ In addition, since 2012, the state has encouraged stronger evaluation and alignment of local CTE programs to regional demand. As a result, several in-demand occupations related to the trades have experienced significant concentrator growth. For example, from 2014-15 to 2018-19, secondary CTE concentrators in advanced manufacturing increased from 545 concentrator graduates to 1,678, an increase of 208 percent.³⁴

Not all students will concentrate, of course, and exploring careers, including the trades, through even one class is an important part of a high school education. However, for students who are interested, concentrating in the trades can help them obtain more skills and credentials to prepare for further education and careers. Research has noted important benefits associated with in-depth CTE coursework, including higher graduation rates, lower dropout rates and increased credential acquisition.³⁵ A new study shows that the advanced courses that are part of concentrations are associated with higher wages.³⁶ To help more students experience the benefits of concentrating in trades areas, students need more access to well-developed career pathways, more guidance on post-graduation options, and a better understanding of the realities of modern workplaces, which are cleaner, safer, and more technologically advanced than in past eras.

Labor Market Misalignment

At a national level, program offerings show some attempt to address labor market demands, but not in all areas. Among the 36 states that provided data on programs (meaning one or more courses in a trade area), the most commonly offered are in construction and advanced manufacturing, which are also the areas of highest demand nationally, based on projected total job openings.³⁷ The smallest number of programs is in plumbing, although the

demand for plumbing is higher than that for HVAC and welding. This aggregated view may obscure substantial differences and gaps at state, regional, and local levels.

Figure 6. Trades Education Programs Offered 2016-17 (*n* = 36 states)³⁸

Trade Area	Total Job Openings 2018-2028	Programs Offered
Construction	4,110,341	9,273
Advanced Manufacturing	2,248,591	7,445
Automotive	910,440	6,880
Carpentry	840,361	1,357
Electrical	711,395	1,308
Plumbing	505,558	708
Welding	418,031	2,171
HVAC	331,746	1,114
TOTAL	10,076,463	30,256

Total Job Openings are provided for the 36 states that provided program data.

Sources: Total Job Openings: Emsi 2019; Programs Offered: JFF research.

Student enrollment in trades courses nationally, however, does not align with the need for trades workers in the coming decade. Enrollment—which we take to indicate a student’s interest in the trades and potential for a trades career—falls far short of, and is often mismatched to, projected job openings in various trades. The largest shares of projected job openings (2018-2028) are in construction and advanced manufacturing, yet we found that students across grades 9-12 are enrolling in these areas at lower rates than other trades. While welding enrollments are 30 percent of total openings and automotive enrollments represent 27 percent, construction and advanced manufacturing enrollments represent only 5 percent and 8 percent of total openings, respectively, and plumbing enrollments represent only 3 percent of total openings. These findings indicate that the current system of high school trades education is not attracting anywhere near the sufficient number of students to meet our most critical trades labor needs.

Figure 7. Trades Education Enrollments 2016-17 in Relation to Job Openings 2018-2028

Trade Area	Total Job Openings 2018-2028 (n = 32 states)	Enrollments 2016-17 (n varies by trade)*	Enrollments as a Percentage of Openings
Construction	3,992,744	191,907	5%
Advanced Manufacturing	2,149,971	161,828	8%
Automotive	876,778	235,968	27%
Carpentry	817,878	84,766	10%
Electrical	700,721	41,446	6%
Plumbing	490,302	16,501	3%
Welding	403,684	121,050	30%
HVAC	318,589	18,986	6%
Total	9,750,667	872,452	10%

Total Job Openings are provided for the 32 states that provided enrollment data.³⁹

*Enrollment n for states reporting varies by trade area: Construction (29), Advanced Manufacturing (27), Automotive (31), Carpentry (26), Electrical (26), Plumbing (19), Welding (29), HVAC (21)

Sources: Total Job Openings: Emsi 2019; Enrollment: JFF research.

While enrollments reflect student interest, as well as program offerings, concentrators represent an especially important part of the pipeline of potential trades workers. Among the 13 states providing concentrator data for the cohort of students who were freshmen in 2011, we again found significant misalignment with labor market demand, leaving key areas like construction with significant gaps. Concentrators among the 2011 cohort represent 43 percent of projected annual job openings in automotive trades and 33 percent of openings in welding, whereas concentrators represent only 8 percent of HVAC openings, 5 percent of construction openings, and 3 percent of plumbing openings. Although our data is based on a limited number of states, it suggests a larger trend of misalignment between program output and labor market needs.

Figure 8. Average Annual Openings 2018-2028 and 2011 Freshman Cohort Concentrators, (n = 13 states)⁴⁰

Trade Area	Average Annual Openings 2018–2028	Concentrators	Concentrators as a Percentage of Openings
Construction	166,515	9,051	5%
Advanced Manufacturing	77,705	8,591	11%
Automotive	36,447	15,648	43%
Carpentry	30,024	6,724	22%
Electrical	28,245	3,210	11%
Plumbing	20,078	660	3%
Welding	17,822	5,795	33%
HVAC	14,142	1,115	8%
Total	390,978	50,794	13%

Sources: Annual Openings: Emsi 2019; Concentrators: JFF research.

Remarkably, no individual state that provided data had strong participation alignment relative to labor market demand. We found repeated patterns of dramatic underparticipation in construction and manufacturing, and less, but still notable, misalignment in automotive studies and welding.

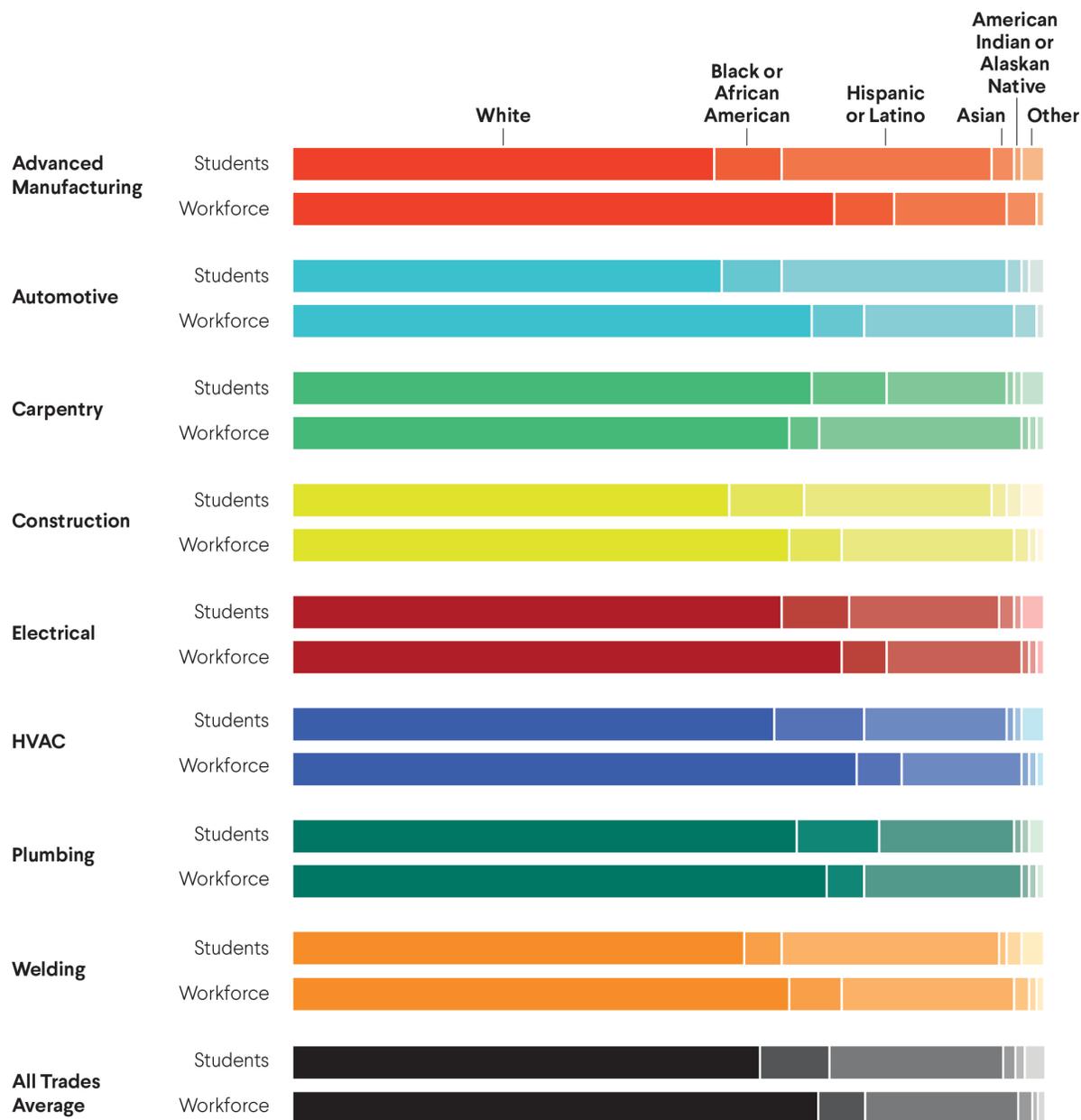
While our data do not account for local trends, our findings reinforce the need for states, regions, and school districts to be more attentive to labor market data. This is essential both to inform choices about program offerings and to inform students about trades opportunities. Alignment at the local level is important for supporting local economies and ensuring opportunity for students once they leave school. Education systems and their leaders, along with employers and workforce systems, must ensure strong alignment to current and future labor market conditions.

We recognize that on the demand side, labor markets are dynamic and vary state to state and region to region. And, on the supply side, we know that trades workers arrive at careers through multiple pathways. Yet our data underscores the reality that our current system is not aligned with labor market needs in the trades. Our data indicate the need for particular attentiveness to sectors like construction and advanced manufacturing, given that demand for labor is high but the supply of students pursuing those pathways beginning in high school is quite low. A strong labor market alignment of high school trades would help ensure that programs are offered in proportion to market needs *and* that enrollment and concentration trends match trends in labor demand.

Most Skilled Trades Students Are White and Male

Relative to the current trades workforce, the racial and ethnic makeup of trades students is slightly more diverse, though the majority of students are white. Twenty-eight states provided demographic data on high school trades education participants, which we compare to workforce demographics below.

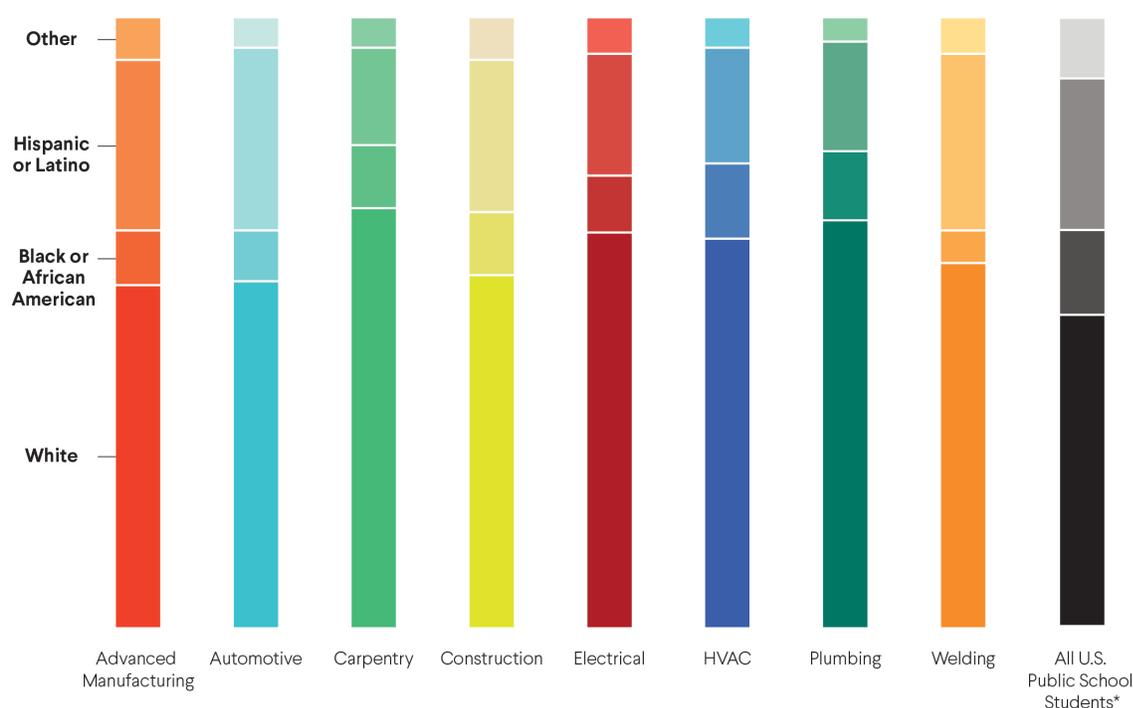
Figure 9. Race/Ethnicity of the Skilled Trade Workforce 2018 and High School Skilled Trades Students 2016-17 (n = 28 states)⁴¹



Sources: Workforce: Emsi 2019; Students: JFF research.

Relative to their proportion in the U.S. K-12 population, whites are overrepresented in all trade areas, particularly carpentry. African Americans are underrepresented in all trades areas, and Hispanic students are underrepresented in several categories except for automotive, manufacturing, and welding.⁴² Other groups, which include Asians, Pacific Islanders and Native Americans, represent an even smaller proportion of trades students, smaller than their proportion in the overall U.S. school population. Supporting students from more diverse backgrounds to complete concentrations and pursue careers in the trades could help to diversify the workforce and provide a broader range of students with the options offered by trades career pathways.

Figure 10. Race/Ethnicity of Skilled Trades Students 2016-17



Source of trades student demographic data: JFF research (n = 28 states).⁴³

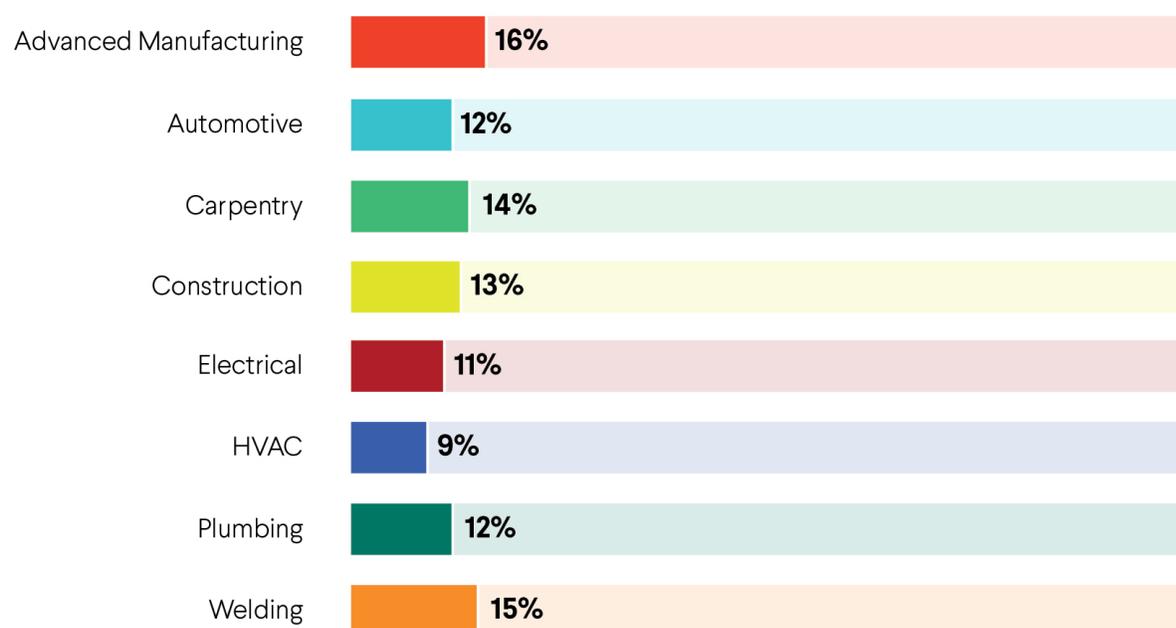
Source of U.S. public school student demographic data (all states): NCES fall 2015 distribution of public school students enrolled in pre-kindergarten through 12th grade, <https://nces.ed.gov/pubs2019/2019038.pdf>, (white—49%, black—15%, Hispanic—26%, other—10%).

Some local efforts help students of color find pathways in the trades. In Portland, Oregon, educators and trade union groups are partnering to show the good wages, benefits, and skill development offered by construction career paths through the [Construction Careers Pathway Project](#). Focusing on students of color, the initiative offers a trades fair to provide information and introduce students to people of color working in the trades. Building on these efforts, the neighboring Beaverton School District—the third largest in the state—is working with industry to create a magnet program for construction at a local high school to help make the opportunity

available to all students, including students of color. Students completing the program will earn points to increase their rank when applying to apprenticeships, potentially leading to annual salaries of \$80,000-90,000 within five years. ⁴⁴

Skilled trades education in high schools has shown little progress in addressing gender disparities in the field, as girls make up a small proportion of students. Enrollments of girls are highest in advanced manufacturing, welding, carpentry and construction, yet all remain at 16 percent or less.

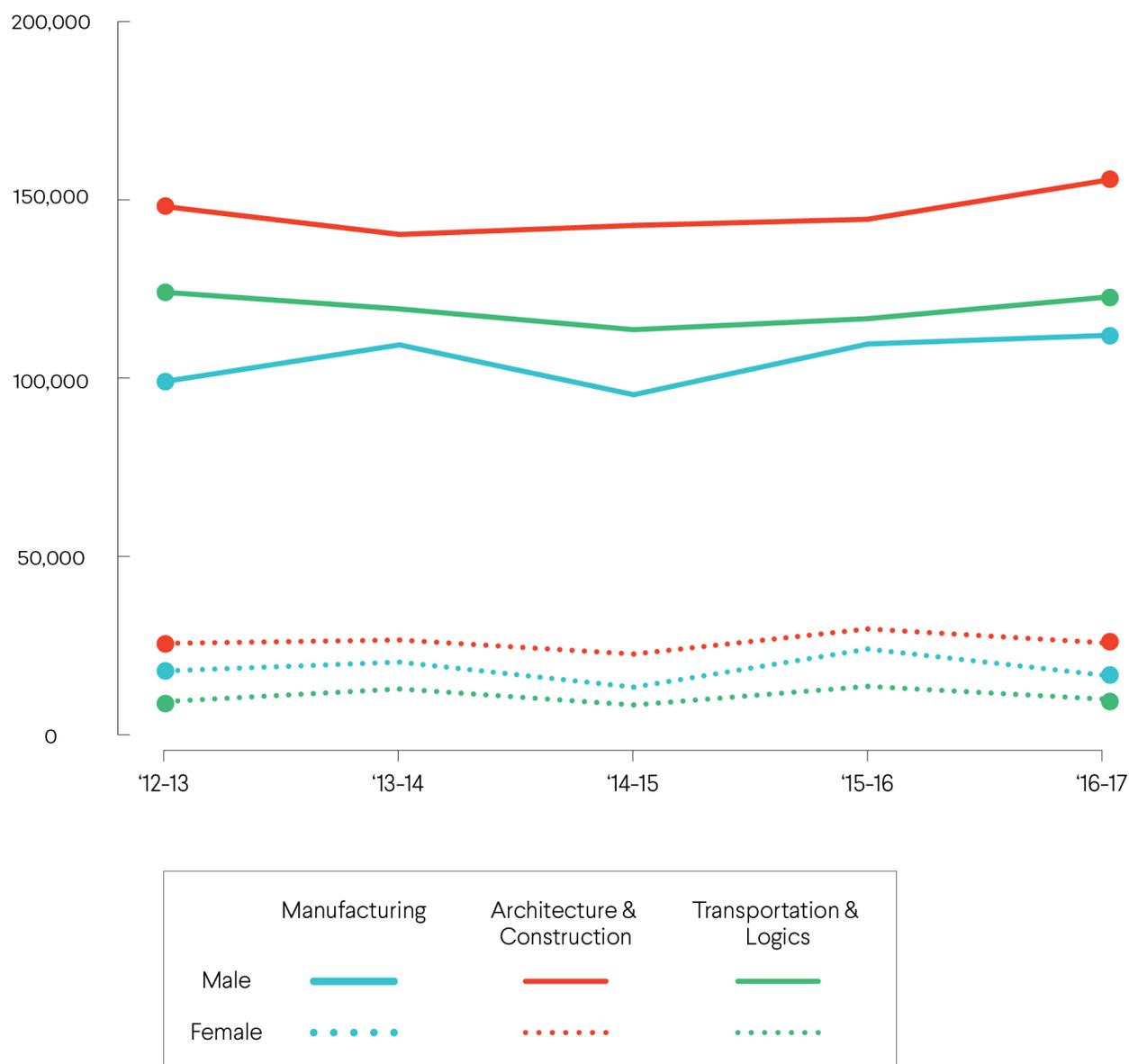
Figure 11. Girls as a Percentage of Skilled Trades Students, Based on 2016-17 Enrollments ($n = 28$ states)⁴⁵



Source: JFF research.

The low participation of girls in trades subjects we observed is consistent with U.S. Department of Education concentrator data for the most relevant career clusters, which show low participation among girls and no real change in gender distribution in the past five years.⁴⁶

Figure 11A. Gender Distribution of Students in Trades-Related Career Clusters 2017



Source: Perkins CTE Concentrator Enrollment Data 2017, <https://perkins.ed.gov/pims/DataExplorer/CTEConcentrator>.

Engaging more girls in trades education would help ensure that they have equal access to the career opportunities offered by the trades as they move into adulthood and simultaneously help address our nation’s labor shortages.

A standout among current efforts to attract girls to trades careers is Massachusetts Girls in Trades (MAGIT), whose annual conference attracts over 500 girls and 100 educators from the

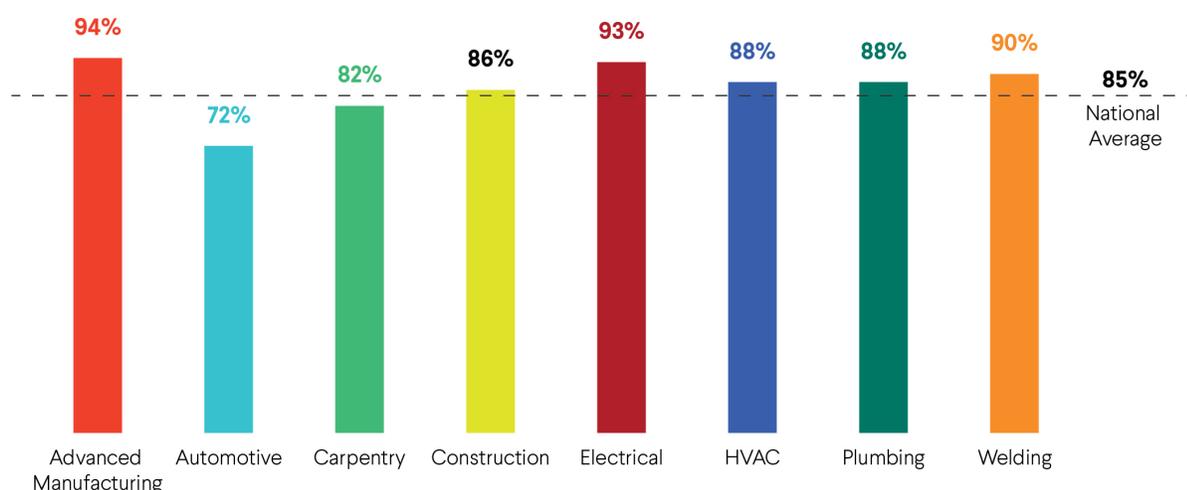
Greater Boston area and well beyond. Participants engage with representatives of apprenticeship training programs, leaders of construction firms, and working tradespeople. Interest in the event grew so much that a separate conference is now held in the western part of the state, attracting another 250 students each year. As an outgrowth of MAGIT, educators launched the Equity in the Trades Student Leadership Council, an extracurricular program for girls with 40 student leaders who develop school-based projects to help promote the trades to middle school girls. With the help of school advisors, leaders convene several times during the year, engage in leadership-building activities, and showcase their projects at MAGIT conferences.

Data Indicate Positive Outcomes for Trades Students

Very few states were able to provide postsecondary and career outcomes data, raising concerns about most states' lack of capacity to understand the value of their skilled trades programming overall or for differentiated groups of students. Several state CTE leaders acknowledged they rely on student surveys to learn about outcomes, but survey completion rates are low, so they don't have a clear picture of what CTE students do after high school.⁴⁷ The limited data that we were able to collect showed some positive trends in outcomes for trades students.

Among the 10 states that provided data, high school graduation rates among trades concentrators tend to be higher than the national average for all high school students. Although limited in scope, these data align with prior CTE research on the benefits of concentration and counter the perception that trades students are not successful students.⁴⁸

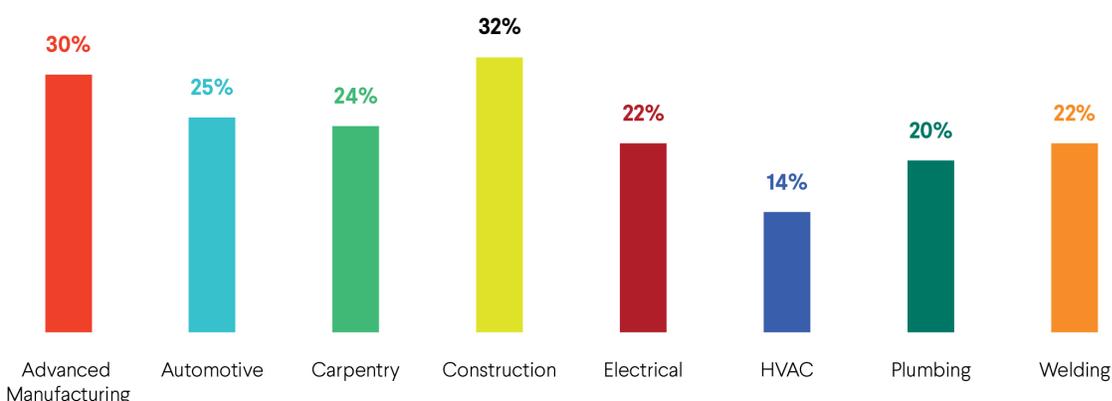
Figure 12. Four-Year Graduation Rates Among Trades Concentrators ($n = 10$ states)⁴⁹ (2011 cohort)



Sources: Trades bars JFF research; National graduation average: https://nces.ed.gov/programs/coe/indicator_coi.asp.

Contradicting the popular assumption that trades students tend not to go to college, data from 10 states suggest that many—though less than a majority—pursue a two- or four-year degree. States did not distinguish between pursuit of two- and four-year degrees, nor did they provide any data on postsecondary outcomes. Though college-going rates among high school graduates overall tend to be higher at 69 percent, and though these data do not offer a national view, they do suggest that many trades pathways include college.⁵⁰ Expanding access to clearly defined trades career pathways and dual enrollment credits could encourage more students to continue their education beyond high school graduation.

Figure 13. Percent of Concentrators Who Enrolled in Two- or Four-Year College within One Year of Graduation ($n = 10$ states) (2011 Cohort) ⁵¹



Sources: JFF research.

Other important outcomes of high school trades education, such as entry into apprenticeships, postsecondary training, and employment, are even less well-known. Although anecdotal information suggests that entry into apprenticeship is a common and valued outcome of high school skilled trades programs, few states are able to effectively track this outcome. Only 2 states reported data on apprenticeship, 7 reported on postsecondary training, and 11 reported on employment, but these data were not sufficiently complete for reporting.⁵²

The difficulty that many states face in documenting and reporting important outcomes related to trades education—and other areas of CTE—is a major concern. Our findings reinforce those of a recent survey of state CTE directors that found less than half report that their data systems provide the information required to make good decisions about CTE program quality and initiatives at secondary and postsecondary levels.⁵³ State education system leaders need to invest in data technology as part of their efforts to ensure quality and opportunity for the students they serve.

One state, Tennessee, stood out for offering a more complete view of trades education outcomes.⁵⁴ Trades students graduate from high school at rates of 94 percent or more. In most cases, a third or more of trades students went on to two- or four-year college, and

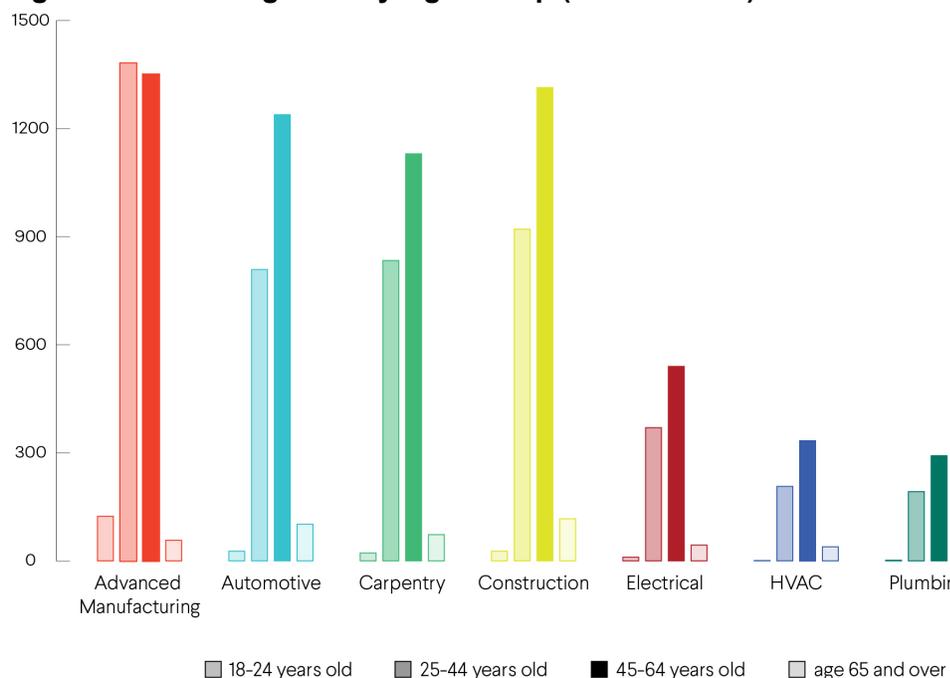
a little less than half went on to full-time employment. Several factors in Tennessee may contribute to these strong outcomes. The state’s landmark program providing two tuition-free years of postsecondary education, Tennessee Promise, can be used to attend community colleges or technical colleges that work closely with high schools to create early postsecondary opportunities like dual credit and dual enrollment opportunities, and align programs of study in the trades and other career clusters. Another state program, Tennessee Pathways, directly supports Tennessee’s “Drive-to-55” commitment to increasing postsecondary credential or degree attainment to 55 percent for adults across the state.⁵⁵ Although no research has specifically tied these efforts to trades outcomes, the state has developed a context that is supportive of trades pathways.

Trades Teachers are an Aging Workforce, Largely White and Male

An additional element of understanding the current trades education landscape is the teaching workforce. We asked states to provide information on teacher characteristics and distribution across trades. No states provided complete demographic data for teachers, and many states were unable to report any information about teachers, because the data reside in human resource or other systems to which they do not have access.

The trades teacher data we obtained show an aging workforce, older than the median age of 41 among all public high school teachers.⁵⁶ With teacher shortages already an issue in public education overall, an aging workforce raises concerns about finding replacements for retiring trades teachers.

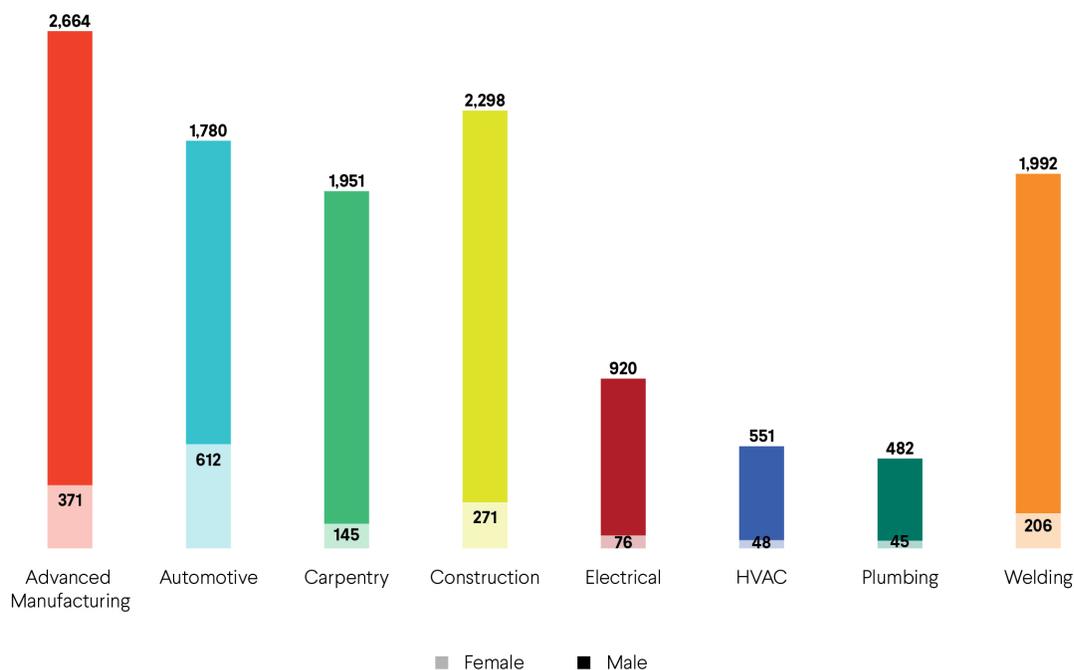
Figure 14. Teaching Staff by Age Group (n = 11 states)⁵⁷



Source: JFF research.

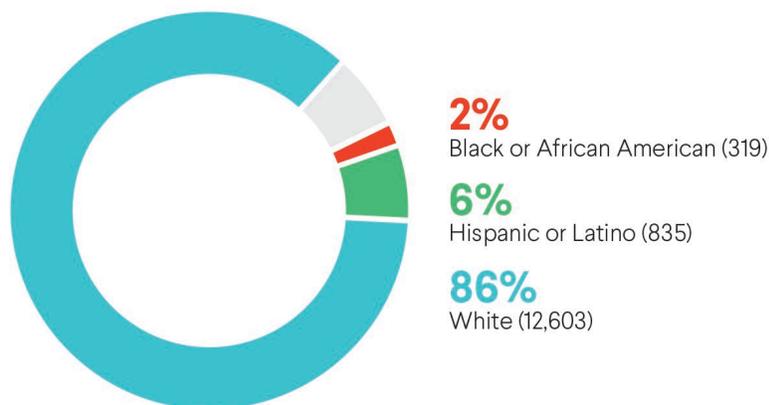
Both state directors and our data described the trades teaching workforce as largely white and male. This may be reflective of the current trades workforce, as many teachers come from industry, and is similar to the U.S. public school teachers corps overall, who are predominantly white (82 percent).⁵⁸ Going forward, diversifying the teaching workforce might be a way to attract more diverse students to the trades by hiring and retaining teacher role models from similarly diverse backgrounds.

Figure 15. Gender of Skilled-Trades Teaching Workforce (n = 13 states)⁵⁹



Numbers above the bars represent male teachers. Source: JFF research.

Figure 16. Race/Ethnicity of Skilled Trades Teaching Workforce (n = 13 states)⁶⁰



The remaining (gray) section represents “Other” (1%) and “Not reported” (5%). Source: JFF research.

Insights and Knowledge Gaps

To summarize, here are the highlights of our analysis of the high school skilled trades education data shared by states:

- The high school graduation rates of skilled trades students are strong, and there is some indication that notable numbers of these students go on to college.
- Significant numbers of trades students are concentrating in a program of study in a skilled trade, but more students need to have the opportunity to complete a concentration—especially in construction and advanced manufacturing—to ensure that they can benefit from deeper study of trades subjects and the significant resulting career opportunities.
- Trades students are mostly white and male. Girls’ participation remains low. African Americans don’t participate in proportion to their share of the population, and Hispanic students are underrepresented in multiple trade areas.
- Skilled trades teachers reflect a similar demographic consisting of predominantly white males. They are an aging workforce overall.

While these data give us important insights, many aspects of secondary trades education remain unclear, among them:

- The actual number of students who participate in skilled trades education across all states, including the 18 that provided neither enrollment nor concentrator data for our study. Our estimate of 6 percent of high school students (based on data from 32 states), while incomplete, suggests that many more students could potentially have access and be guided to coursework in the skilled trades.
- The accurate level of student participation in any particular trades area such as welding or electrical, and an accurate depiction of the degree to which some trade areas might be maintaining or losing students over successive years more than others.
- A clear picture of outcomes for skilled trades students beyond high school graduation—especially enrollment in or completion of postsecondary education or training (including apprenticeship) or employment.
- More information on the trades teaching workforce, including their longevity as compared to all high school teachers.
- A more granular description of the availability of trades courses and the structure of programs of study in the trades.

This report should be seen as a starting point in a larger conversation about the state of U.S. high school skilled trades education. As state data systems evolve in coming years, future research can help to paint a more precise picture of skilled trades education to help guide policymakers to more effective decision making and resource allocation.

Part 3. Skilled trades education today: Not your parents' voc ed

Change and Improvement

Educators and policymakers alike have come to recognize that to achieve success in the 21st century, students need preparation for both college *and* career, a notable mindset change. Public and private investments—including the 2018 reauthorization of the Carl D. Perkins Career and Technical Education Act (Perkins), the primary federal law that governs and funds CTE—are geared to help states to strengthen the ability of school systems to offer quality programs.⁶¹ Indeed, despite the negative perception of the trades cited by many of our interviewees, we're also witnessing a moment of vibrant change and improvement within the field, moving well beyond a past in which CTE was seen as a dead-end route that can't lead to college, one that unfairly tracks students and reinforces inequities.⁶²

Perkins Reauthorization Provides Flexibility

Although the Perkins reauthorization did not guarantee increased CTE funding—and, notably, it has remained largely flat for a decade—it did include updates that support trades education. Officially called the “Strengthening Career and Technical Education for the 21st Century Act,” the new law, which went into effect July 1, 2019, promotes more flexible use of funds and better alignment of programs with labor market needs. Key provisions include:

- Greater flexibility in how to direct reserve fund resources, which can encourage innovation.
- A requirement for comprehensive local needs assessments to guide applications for funding, which must address alignment with labor market needs. If assessments surface a high demand for skilled tradespeople, this should drive the evaluation of existing trades programs and the potential creation of additional programs.
- A requirement to spend state leadership funding on teacher recruitment, preparation, or retention, which could benefit the trades by addressing staff shortages (though the law does not require funding to be directed to the trades specifically).
- Increased focus on earlier exposure to career pathways, by allowing funding to be used to introduce the trades to middle school students, so they'll be exposed to trades earlier and able to pursue them throughout their high school careers should they choose.
- Support for dual enrollment and a strong emphasis on work-based learning, a key element of trades education. The law offers a formal definition of work-based learning and makes it one of three CTE program quality measures, while also allowing use of state and local funds to support it.⁶³

New Models and Policies to Strengthen CTE, Including the Trades

As our interviews with CTE directors and other experts revealed, several states are making broad changes in improving and modernizing the skilled trades learning experience.⁶⁴

Educators are working to ensure the attainment of industry-based credentials, changing graduation requirements to value CTE programs, expanding access to work-based learning and pre-apprenticeships, and building pathways to support transitions from high school to college and careers. Examples include:

- **West Virginia’s Simulated Workplace** helps to improve young people’s career readiness, addressing employability skills such as work ethic, team building, problem solving and critical thinking, while creating more opportunities for work experience.⁶⁵ Based on a pilot with 17 schools, the effort is being implemented statewide. The program turns CTE classrooms, including the trades, into a simulated business, where students are job candidates, then employees who serve roles assigned within a company (such as foreman or safety supervisor), pass a safety training, write company manuals and participate in other workplace protocols. Employers help design and assess the programs and students often work on projects directly with employer clients.⁶⁶
- **Louisiana’s Jump Start** aligns education and economic development strategies to help address worker shortages in high-demand industry sectors, including advanced manufacturing and construction. The program provides academic and workforce preparation, requiring students to attain an industry-created and -valued credential in order to graduate high school. Students also take career-readiness courses where they master employability skills, participate in internships at a workplace or virtually, and complete coursework aligned to future postsecondary education. Under Jump Start, the state also created “accountability parity,” whereby schools receive the same accountability credit for students prepared for high-demand career paths as for those achieving high academic honors.

Other states pursuing reforms to promote industry-based credentials include Oklahoma, Tennessee, Ohio, Illinois, Wisconsin, and Georgia. Ten state departments of education (Alabama, Arkansas, California, Kentucky, Louisiana, Nebraska, Nevada, North Carolina, Utah, and West Virginia) are sponsoring secondary schools to adopt the National Center for Construction Education and Research curriculum. Another 23 states have voluntarily adopted the curriculum, sponsored by trade associations or contractors. The National Center for Construction Education and Research (NCCER) will issue credentials to over 550,000 individuals this year.⁶⁷ **Florida’s** Career and Professional Education Act Acceleration Industry Certifications provide standard codes and descriptions for all industry-based certifications and allocates tiered funding for high school students that graduate with a high-value, industry-based credential.

States are altering graduation requirements in ways that elevate and validate CTE, including the skilled trades. In addition to earning industry-based credentials, students in some states may use a passing score on a technical skills assessment to help meet graduation requirements. Some states, such as **South Dakota**, recognize CTE-based courses like technical math as equivalent to more traditional required classes, like geometry. **New York State's** new multiple pathways to graduation program includes a CTE pathway, which allows students who complete an approved CTE program and pass related technical assessments to receive the same Regents Diploma traditionally awarded to students who pass academic assessments in areas of math, English, science, and social studies.⁶⁸

Ensuring Success Beyond High School

- ▶ **The proliferation of new models suggests a recognition among educators that increasing access to trades opportunities beyond high school requires connections to pathways that align with postsecondary education and training.**

This trend reflects renewed action based on the recognition of the value of work experience to promote learning and prepare young people for jobs and careers. This thinking is reflected in models such as Pathways to Prosperity, a national network that develops, implements, and scales regional and statewide college and career pathways that prominently feature work-based learning through partnerships of K–12 and postsecondary education leaders, policymakers, and employers.⁶⁹ Linked Learning, a statewide initiative in California, is a similar approach, organized around industry-sector themes. It integrates CTE, including the trades, with college-ready academics, work-based learning, and comprehensive student support services.⁷⁰

States are making efforts to build pathways at varied levels of scale. **Tennessee Pathways** creates alignment between K-12 education, postsecondary education, and employers. The initiative was launched in 2012, when the state recognized a mismatch between educational preparation and industry needs, particularly in the skilled trades. In **Kentucky**, Toyota partnered with the state's Community & Technical College System to develop the Advanced Manufacturing Technician career pathway program, which leads from the middle grades and high school to associate's, bachelor's, and graduate degrees. Students learn in a hybrid classroom / shop floor setting about manufacturing processes, lean and green manufacturing, supply chain logistics, quality assurance, health and safety standards, and maintenance installation and repair.⁷¹ On a smaller scale, **Idaho** has created a bridge-to-college program for welding that provides funding for high schools partnering with two technical colleges. Students take an eight-week welding course, which acts as a bridge and allows them to enter college with only one year to go toward a two-year degree.

- ▶ **States are strengthening systems to offer pre-apprenticeship programs that facilitate students' entry into apprenticeship after graduation.**

Interest in CTE has grown along with interest in developing apprenticeship systems to address labor market gaps. We see this trend reflected in policy such as California Governor Newsom's Cradle to Career strategy, which includes a goal of increasing apprenticeships to 500,000 by 2029.⁷² Four states, in particular, have been bellwethers in the apprenticeship space—Wisconsin, Georgia, North Carolina and Kentucky. Their example highlights the demand for high-quality, cross-sector partnerships that address the needs of both high school students and employers.

Wisconsin has the longest statewide history with youth apprenticeship in the United States, dating back to the early 1990s. The state funds 33 regional consortia to help address employer demand in concert with a youth apprenticeship coordinator. The model offers a one- or two-year high school apprenticeship; students participate in at least 450 hours of employer-paid on-the-job training, with two semesters of related classroom instruction. **Kentucky's Tech Ready Apprentices for Careers** is an employer-led program that uses the state's existing CTE infrastructure to create a pipeline for students that begins in high school and culminates in an industry-recognized credential, paid co-op work experience (that is, work combined with classroom-based education), and in many cases, advanced standing within a full Registered Apprenticeship. The TRACK program began with manufacturing in 2013 and has since expanded to both health care and construction, including carpentry, electrical, and welding.

- ▶ **At a time when educators are seeking to prepare students for both college and careers, trades education offers a model of how to achieve these dual goals.**

High-quality trades education has long offered experiences like project-based learning, through which students develop teamwork, problem-solving skills, a sense of responsibility, and a strong work ethic—many of the exact skills that employers across all sectors, not just trades, say they desire in job candidates. These qualities are developed both in the classroom and through organizations like [SkillsUSA](#), which supports local, state, and national competitions where students showcase their technical, leadership, and entrepreneurial skills.

Trades education develops both academic and technical skills, whether taught in tandem or through fully integrated models, and can help students apply skills in their communities. Skilled trades education draws on and is enhanced by strong relationships with employers that shape what goes on in the classroom, provide work-based learning opportunities, and support student transitions beyond high school. Ultimately, effective trades education positions students to make positive choices among options of work, college, or models like apprenticeships that blend earning and learning.

In our research, we learned of exemplary programs that build technical skills through hands-on and virtual learning, and develop employability, or “soft” skills. We heard how strong programs provide students practical experience that they can use in workplaces and in projects to benefit their own communities. We heard how students’ learning hours in high school can earn them college credit and position them to sit for national certification exams or enter apprenticeships with advanced standing (*see Appendix D for examples of promising programs*).

Programs such as these reflect what is possible when education and industry collaborate to ensure that skilled trades programs have the resources—including staff—needed to provide relevant, up-to-date trades education. They also reflect the critical role that employers play in ensuring program quality and offering students access to work-based learning, and they offer a glimpse of the opportunities that technology and digital learning can bring to transform educational experiences.

Part 4. The state of the field: Challenges and promising practices

While this is an auspicious time for CTE overall, our conversations with CTE state directors and other leaders in the field made clear that secondary skilled trades education faces a number of daunting challenges, which some states are addressing through promising practices.

The Trades Suffer from Negative Perceptions that Limit Participation

The most common challenge facing skilled trades education—cited by nearly every state CTE leader we interviewed—is the widespread perception among students, parents, and even educators and school counselors that trades are a dead-end route. Trades education is often stigmatized as “just shop,” a repository for low-performing students not expected to continue their education. This bias prevents many students and their families from understanding and pursuing opportunities the trades offer.

These stubborn perceptions have many sources, including a history of tracking in vocational education; the competing attraction of other CTE fields, such as STEM, IT, or health care; and students’ lack of exposure from a young age to the range of opportunities to build well-paying careers in the trades.

A persistent theme among state directors interviewed for this study was frustration with what they described as an overemphasis in our culture on “college for all”—the idea that a four-year college degree is the sole route to success. Such attitudes overlook the value of pursuing work and/or college credentials that require less than four years of postsecondary education, which is true of many skilled trades.

Promising Practices

A number of states, districts, and organizations have undertaken efforts to address these negative perceptions and promote the trades as a viable—and valuable—option for young people. On a website filled with dynamic photos and videos of carpenters, welders, and sheet metal workers, [Go Build Tennessee](#) describes trades careers, links to job openings, and provides a searchable list of over 100 training programs. **Nebraska** uses virtual industry tours to help students, parents, counselors, and teachers understand career opportunities in the trades, as part of a framework for career exploration and preparation. The Nebraska Department of Education created a “[Reality Check](#)” video to demonstrate that many skilled occupations in high demand require less than a four-year degree.

NCCER operates the [Discover More](#) campaign to highlight opportunities in construction as part of its national [Build Your Future](#) initiative, which aims to boost recruitment and shift negative perceptions about construction careers. As part of a recruitment initiative, the [Heating, Air-conditioning & Refrigeration Distributors International](#) created a short film, “Hot Commodity,” that follows the careers of several young people in jobs that do not require four-year degrees. A number of school districts around the country have instituted “signing days” to recognize and celebrate students who sign letters of intent to enter apprenticeships or employment after graduation.⁷³

Several states are also increasing efforts to target middle school students to inform them of trades opportunities. **Vermont’s** legislature passed a \$20 million bill to support exposure of middle school students to technical fields, including skilled trades. **North Carolina’s** education department is developing 15-hour curriculum modules that include construction and automotive services. **Oklahoma** has begun implementing summer institutes to expose middle schoolers to potential career paths, including skilled trades.

States Face Significant Trades Teacher Shortages into the Future

State CTE directors’ second-most commonly cited challenge for trades education is a shortage of teachers. An Advance CTE state survey found that manufacturing was the most commonly noted subject area facing a CTE teacher shortage (81 percent), higher than IT, health sciences, or STEM.⁷⁴

CTE leaders identified several issues limiting the availability of skilled teachers for trades education, starting with salary. While many states are facing teacher shortages more broadly, trades teachers are required to have work experience in their field, but teacher salaries can’t compete with industry compensation. Worse, even when new trades teachers bring years of industry experience, too often they must begin at the very bottom of the salary ladder.

In addition to salary differentials, those who are interested in becoming trades teachers find that teacher preparation programs in the field are limited, and teacher certification processes pose barriers to people working full time. The challenge of finding trades teachers will only deepen as the trades teaching workforce is aging, thus creating many more openings to fill.

Promising Practices

Some states have undertaken efforts to address CTE teacher shortages, and have taken steps to make skilled-trades teaching positions more attractive. **Kansas** offers multiple routes to teaching, including a restricted technical certification that allows trades professionals to go into schools to teach a specific skill. The state also has a transition-to-teaching program that allows individuals with a technical degree (e.g., electrical engineering) three years to take required

courses in pedagogy after they begin teaching. **New Jersey** provides teachers with access to industry externships and a CTE teacher “bridge” program to help academic teachers co-teach and gain endorsement (an add-on to their certification) in CTE. The state also offers stipends to offset the costs of certification for those who agree to co-teach 100 hours in CTE.⁷⁵ **Virginia** legislators adjusted CTE licensing requirements in recent years to make it easier for people to start teaching.

Programs Face Funding Shortfalls that Impede Quality

Trades programs are expensive to run. They require machinery, maintenance, and safety equipment, as well as consumable items like welding rods and wood, that contribute to high costs. Perkins funds can be used for capital equipment, but not consumables. Some states have established funding mechanisms and budget line items to help cover these expenses. But in others, leaders noted that low or fluctuating funding impedes their ability to offer high-quality programming. Many programs can’t operate at full capacity; those that can’t meet standards must close. Cuts to state CTE funding were noted in our interviews with Arkansas, Oklahoma, and Alaska.⁷⁶

Promising Practices

States are using multiple approaches to help meet the costs of trades and other CTE programs. A few states, like California and New Jersey, increased funding in 2018 to expand and improve CTE programs.⁷⁷ **Oregon** recently passed ballot Measure 98, which established a \$170 million High School Success Fund, increasing investments and accountability in CTE and other efforts to improve graduation rates across the state.

Some state efforts have clear, direct ties to trades programs. **Louisiana** sets a strong example with the state-funded Career Development Fund, a unique mechanism that provides permanent, unlimited CTE funding for students enrolled in courses aligned with high-demand pathways like skilled trades. **Michigan’s** Fiscal Year 2018 budget included a \$10 million appropriation for CTE equipment upgrades. In **New Jersey**, voters approved a \$500,000 bond to expand secondary and postsecondary CTE programs specifically in auto technology, manufacturing, welding, construction, and green energy. In 2019, **Massachusetts** awarded \$12 million in Skills Capital Grants to 45 high schools, colleges, and educational institutions to acquire the newest technologies to educate students and expand career education opportunities.⁷⁸

Many Students Can’t Access Trades Learning Opportunities

Access issues manifest in multiple ways in trades education. Underresourced school districts (and even those with reasonable resources) cannot offer a full range of well-equipped trades programs. Employers may not be willing to host student placements because of liability

restrictions and regulations about youth in the workplace. Students must often manage their own transportation to get to job sites, which can restrict their ability to participate. Rural and remote district programs can be especially limited based on population and the availability of teachers for different subjects. Accessing work-based learning experiences, a longstanding hallmark of quality trades education, can be a challenge, especially in rural communities.

Promising Practices

States and communities have developed solutions to address some of these issues. For example, in **Alaska**, which reports robust demand for trades workers and significant numbers of available jobs, geography limits access. Across an area roughly the size of New England, the Bristol Bay CTE Consortium brings together four school districts in partnership with regional economic development centers to pool students and combine resources to provide a deeper level of training. In **South Dakota**, rural schools have pooled funds to purchase a rotation of semi-trailers that serve as shared mobile classrooms, giving students easy access to hands-on tools for learning in construction and transportation.

Where resources permit, technology can help bridge gaps for rural students, as well. In **West Virginia**, video technology enables employers to connect with students when conducting reviews of simulated workplaces. **Louisiana's** Virtual Workplace Experience course helps counter the limitations of student access to employers by providing virtual opportunities to engage with employers for career exploration in a wide range of occupations, including the trades. In **North Dakota**, students use virtual welding programs to help build skills. Some schools offer hybrid programs where students can complete coursework online to reduce travel requirements for instructors. To help encourage employers to take on students for work-based learning, **Georgia** passed legislation to help defray the cost of worker's compensation insurance by providing tax credits to employers who hire students under 18.

Programs Do Not Consistently Align with Workforce Needs

Despite the availability of up-to-date labor market information and formal structures required by Perkins, such as advisory groups to involve industry, in too many cases programs are not fully aligned with labor market needs. Numerous states operate under local control, meaning that local school districts determine which programs to offer. States vary in the degree to which they can influence offerings. Some have a list of priority subjects, informed by labor market information, to which all programs must adhere to access state funding. In others, all decisions regarding courses offered are left to the local level.

Many state leaders we interviewed reported that some programs close even when needed, due to teacher shortages and/or lack of funding, while others stay open for the wrong reasons, (e.g., the teachers doesn't want to retire yet, or students enjoy a class even though it isn't linked to a clear

career pathway). The lack of alignment between programs and the labor market means that resources are not effectively deployed, students are not well prepared to enter the job market after graduation, and employers lack the workforce they require to remain competitive.

Promising Practices

Nebraska has been tackling the issue of program alignment directly, through reVision, a strategic approach for schools to analyze their current CTE system and make adjustments to more effectively prepare students for college and careers. Stakeholders—including the state’s departments of education, labor, and economic development, as well as CTE staff, school counselors, and administrators—come together to review current programs, analyze data, and identify areas for improvement. By July 2018, 100 districts had completed the process with 22 additional districts awarded grants for completion in the 2018-19 academic year.⁷⁹ **Louisiana’s** Jump Start program requires all CTE pathways to culminate in credentials aligned with industry sectors that the Workforce Investment Council forecasts will drive the state’s economic growth. By statute, WIC evaluates industry-based credentials for: a) their alignment with high-demand industry sectors; and b) their “employability value” (i.e., how likely it is that students who earn these credentials will be able to attain entry-level employment in high-demand industry sectors). The highest-value Jump Start pathways—where student enrollment results in additional budget funds and school performance score (or SPS) points—are those where students earn credentials aligned with WIC-certified, high-demand industry sectors.

States Vary in Their Ability to Ensure Quality Programming

Definitions of quality in the trades and other CTE programs typically note elements such as relevant curricula, skilled teachers, hands-on learning in safe and modern facilities, work-based learning experiences, industry-recognized credentials, and strong employer partnerships.⁸⁰ To help ensure quality, many states have a regular program review process that occurs every three to five years, but many still lack clarity and accountability around standards. States are further challenged by the varied choices made due to the prevalence of local control in education. Limits on states’ ability to ensure quality can lead to both wasted resources and wasted time for students, who are denied effective learning experiences.

Promising Practices

Three-quarters of states have defined standards and benchmarks to promote program quality, though adherence to those standards may vary, depending on the dynamics of local control.⁸¹ The recent development of ACTE’s [Elements of a High-quality CTE Program of Study](#) may help to guide states looking to update or establish clearer standards with broad guidelines for excellence.

In interviews we conducted, several state leaders described efforts, a few of them long-standing, to maintain quality of trades and other CTE programs. **New York** instituted a program approval process in 2001. Programs are required to include development of employability skills and document technical skills with an industry-based technical assessment that contributes to a technical endorsement on a diploma. Students are required to participate in some type of work-based learning, facilitated by certified work-based learning coordinators, and programs must include postsecondary articulation, such as college credit or eligibility to join a union. **North Carolina** uses passing scores on assessments and credentials earned to assess program quality. For concentrators, the state examines results for particular demographic groups, such as girls and English learners, and creates action plans to address problem areas in programs of study. In **Louisiana**, Jump Start students must earn industry-based credentials to graduate from high school. Consequently, schools and districts must use the instructional resources and curricula, instructional quality standards, and certification exams required by each industry-certifying organization. Student completion, and hence graduation, can only be documented by submitting the student's successful attainment of each pathway's required credential(s), along with confirmation that the student has completed a state-approved career-readiness course.

State CTE Offices Lack the Staff and Data Needed to Evaluate Programs

Conversations with state CTE directors revealed staffing challenges and weaknesses in state data systems. They reported longstanding staff vacancies in state CTE offices and, in many cases, limited staff capacity for extracting and analyzing data beyond mandatory compliance reporting. Our effort to obtain basic data about trades education revealed that few states analyzed these data separately from other CTE programs. Significantly, the majority were not analyzing whether the output of their systems address labor market needs in the trades, either.

States struggle particularly around tracking student outcomes. State leaders reported that the lack of strong longitudinal data systems connected to workforce or other data systems means that programs must rely on student surveys to learn about what happens after graduation. Response rates on such surveys are low and subjective, leaving education departments with incomplete and potentially inaccurate understanding of the results of trades education programs.

Promising Practices

The Data Quality Campaign and the Statewide Longitudinal Data Systems Grant Program have been supporting innovation and progress in building robust state data systems. At present, 37 states and the District of Columbia have a Statewide Longitudinal Data System to connect data between education systems. About 16 states have systems that also bring together early childhood education, K-12 education, and postsecondary and workforce data, which helps to

provide a longer view of education outcomes.⁸² While the focus of these systems is broader than CTE or the skilled trades in particular, developing a robust data system supports both the goal of improving student employment outcomes and ensuring greater youth access to CTE programs, particularly in communities and for demographic groups that have traditionally been underserved. However, the investment and interest in data systems is often caught up in leadership transitions and political wrangling. Creating the systems is not enough; states need clear plans for sustainability.⁸³

California recently invested \$10 million toward planning for an integrated data system with the California Cradle to Career Data Systems Working Group. This effort aims to help ensure that K-12, higher education, and workforce systems are connected to allow tracking of student outcomes after high school graduation for CTE and all programs.⁸⁴

Focusing particularly on CTE data, **Maryland** has developed a data site that provides a dashboard of performance against clear targets. The purpose of the site is to provide CTE information to all education stakeholders, support school improvement efforts, and enable accountability at the state, school, and district levels for reporting educational progress.”⁸⁵ Results can be shown by gender, race/ethnicity, and for special populations, such as students with special needs. The site shows not just current data, but also indicates visually where the district CTE outcomes are compared to the target outcomes, and the change in outcomes over the past three years.

Part 5. Recommendations: A call for increased understanding and action

Ensuring widespread access to quality high school skilled trades education should be a concern for our nation, states, and communities—for both individual and family success, as well as the need to meet industry demand. States and regions need to understand their own labor market trajectories and build alliances to align supply and demand across education and industry to expand and ensure quality trades education. They also need to consider their own populations and determine who might have insufficient access to the opportunities offered by the trades.

Achieving expanded access to quality secondary skilled trades education must not be viewed as the sole responsibility of educators; it requires attention and leadership from industry, unions, government, workforce development, and philanthropy, as well as education leaders at secondary and postsecondary levels. Parents and nonprofit organizations have important voices in expanding and improving skilled trades education in our nation’s high schools. Based on our research, we offer recommendations to those we view as critical stakeholders in these efforts.

For State Education Leaders

State educational leaders can establish the standards and infrastructure needed to promote quality practice and ensure successful outcomes for students. Our research findings suggest that they should:

- Understand deeply and systemically the labor market needs and career opportunities associated with the skilled trades in their state, both statewide and by region, and ensure this information is communicated across school districts and integrated into planning and implementation.
- Join with employers and workforce development policymakers and providers to source data, focus direction, build relationships and foster systems coherence.
- Take advantage of opportunities in Perkins for more flexibility in funding to address teacher recruitment, support innovation, and develop trades exploration for middle schoolers.
- Support the development of expanded partnerships between secondary and postsecondary systems to provide new equipment for trades programs, support dual enrollment programs, and develop transparent pathways for students to move seamlessly from secondary to postsecondary levels of trades education.
- Align systems around clear standards for high-quality CTE. States can draw on resources like the ACTE Quality CTE Program of Study Framework,⁸⁶ and standards from

organizations such as the American Welding Society, Automotive Service Excellence, NCCER, or SkillsUSA, as guides for assessing and improving current program quality. State leaders should engage district teachers and administrators to consider what these elements mean and how they can be operationalized in their program contexts.

- Focus on building, continuously investing in, and utilizing robust data systems that span education agencies and systems to track student outcomes after graduation.

For State Labor and Workforce Development Leaders

Trades education offers a solution to supporting local economies and providing opportunities to individuals and families. Labor and workforce development leaders should make ensuring quality and access in trades education a priority. They can play a critical role in gathering and sharing information with families, schools, and state policymakers to inform decision making. Specifically, they should:

- Work with relevant state entities to gather data in three critical areas:
 - Employment and job openings created by impending retirements, with data broken down regionally to support effective decision making at the local level;
 - The required skills and credentials, wages, and career opportunities associated with trades openings; and
 - The infrastructure needs to help contextualize labor needs and communicate the urgency in filling trades positions.
- Validate these data and enhance them with regional and local nuance by sharing broadly to school districts, workforce boards, industry, and other relevant stakeholders.
- Ensure that labor market and other information pertaining to the trades is current, transparent, and available to multiple audiences, including educators, families, and students, to guide decisions about programming and educational options.
- Support the development of new apprenticeships or expansion of existing ones that help grow the workforce. Work with secondary education systems to connect those apprenticeships to youth apprenticeships or pre-apprenticeships.
- Take advantage of structures like workforce boards and other networks to convene groups that bring secondary and higher education, industry, union, and workforce perspectives to the table to strategize for increasing trades education participation and improving the effectiveness of the education system in meeting the needs of our economy.

For Industry and Union Leaders

The need for trades workers is a business problem that requires industry leadership, vision, and resources to find solutions. We recommend that business and union leaders:

- Get deeply involved in providing skilled trades education at the secondary level by offering financial assistance and materials to support programming or participating through direct involvement at the program level (e.g., mentoring, curriculum advisement, and supplies).
- Offer work-based learning and mentoring opportunities in and beyond high school, including expanding access to high-quality apprenticeships for students to enter after graduation.
- Develop clear career ladders within industry and share these with educators and workforce entities.
- Reach out to educational leaders at state and district levels to understand the challenges of offering secondary trades education programming.
- Provide support for campaigns with strong track records aimed at elevating the trades and encouraging participation in trades education. Fund and support campaigns with demonstrable positive outcomes for students.
- Support the trades teaching workforce through externships, co-teaching, and supporting employees to spend time in classrooms as co-teachers and presenters.
- Advocate for state and federal investments to support trades education.

For Elected Officials

Government officials can play a significant role in maintaining or elevating skilled trades education as a critical economic and legislative agenda item. Their actions—from funding to regulatory interventions—can determine whether high-quality skilled trades education programs blossom or wither on the vine. Governors, in particular, have a unique leadership opportunity when it comes to support for skilled trades education and alignment with workforce needs.

Based on our research, we recommend that government officials:

- Work to increase funding to ensure widespread access for high school students to high-quality, well-equipped trades education.
- Set clear goals connecting trades education to public infrastructure spending.

- Invest in the data systems required to inform sound policy plans, decisions, and accountability.
- Take advantage of channels of influence and opportunities to communicate both the labor market need for trades workers and the importance of making trades careers available to a broader segment of students.
- Take steps to analyze and understand the state of educational resources available to support trades education and provide opportunities for representatives from education and industry to communicate needs, opportunities, and constraints to policymakers and legislators.
- Go beyond rhetoric and platitudes to demonstrable investment in quality high school trades education.

For CTE Researchers

The field of CTE has a limited research base overall, and it is particularly limited for the trades as a specific subset of CTE. Research for this report suggests that researchers should:

- Include the skilled trades, in addition to areas like STEM and health care, as a segment to analyze when disaggregating secondary CTE data.
- Undertake longitudinal studies to better understand the education and workforce outcomes of secondary skilled trades students.
- With so much local control of education in states across the country, develop studies to examine trends at the district level to gain insight into areas such as program selection, funding models, and instructional practice to refine our collective understanding of both challenges and effective practice models.

Conclusion

This report offers a portrait in time of skilled trades education in U.S. public high schools—the first step in honoring the talents of and opportunities for young people interested in the trades. We do not intend it to be the last word on trades education, but rather a conversation starter.

In exploring the landscape of skilled trades education, we found a field energized by committed educators and interested students, a field ripe with possibility to both address critical labor needs and provide family-supporting career opportunities for young people. But what we also found are systems that are not sufficiently prioritizing the trades to ensure a pipeline of future workers and allow a broad range of students to have access to trades careers.

We found gaps in multiple places. We found misalignment between labor market needs and programs offered. We found information lacking, precluding students and families from fully understanding their choices and opportunities in trades education and careers. We found data systems that don't support educators, students, families, employers, workforce, or other stakeholders in fully understanding who is participating and how programs are performing to prepare students for trades careers—data systems that don't support informed decision-making about programs, people, and resources. We found a field that remains underfunded in ways that impede access and undermine quality, and one that suffers from a shortage of skilled, experienced teachers.

At the same time, we found many promising strategies and actions. We found states taking steps to improve quality, to develop new ways of communicating the opportunities in trades, and easing the path for skilled trades educators to transition into classrooms. We found programs preparing students for employment during and after high school *and* readying them for—even accelerating their entry into—two- or four-year college programs. We found efforts to use technology to reach students across geographic boundaries and prepare students for modern workplaces. And we found what can happen when employers meaningfully partner with education programs to ensure that young people can work with experienced, skilled craftspeople; use up-to-date equipment; and gain real-world exposure and experience in workplace settings.

The challenge is significant: to move from a field with patches of excellence to one in which students in all 50 states have full access to well-funded and well-equipped programs, taught by skilled educators, in partnership with employers who know their industry and can offer opportunity. It's not that we don't know what to do. What is required is multisector leadership and partnership making a sustained investment in and commitment to this vital sector.

Skilled trades workers will remain in high demand for the foreseeable future, and our education system must be well poised to meet those needs. Too many young people are leaving high school without direction, young people who might find purpose and fulfillment in trades programs and careers. It will be up to leaders in industry, government, and education to bridge these needs and ensure that students, families, and economies can more fully benefit from the promise and potential of skilled trades education.

Appendices

Appendix A: Methodology

In seeking to understand the landscape of public high school skilled trades education, we used a survey (online and Word versions), which we sent to state CTE directors and/or data staff from state departments of education. We requested data on programs, students, and teachers in the following areas: automotive, carpentry, construction, electrical, heating/AC, plumbing, welding, and advanced manufacturing. Specifically, we asked for enrollments, concentrators, and demographics (gender, race/ethnicity) for students enrolled in the 2016-17 school year. For the cohort of students who were freshmen in 2011, and for each trade area, we also asked for enrollments, concentrators and numbers of students (enrolled and concentrators) achieving the following outcomes:

- High school graduation in four years
- Obtained an industry credential by high school graduation
- Enrolled in postsecondary technical training within one year of graduation
- Enrolled in two- or four-year college within one year of graduation
- Enrolled in apprenticeships within one year of graduation
- Employed full-time following graduation

In addition, we requested numbers and demographics (gender, age, race/ethnicity) of teachers in each of the trades areas noted above.

The map below shows the states that responded to our request for data. As noted earlier, not all states were able to provide data in all areas. Some states that provided no data indeed do collect CTE-related information, but for various reasons (including staff shortages or digital technology failures) did not share.

State	Figure 3 Enrollment v. HS	Figure 4 Enrollment by trade area	Figure 5 Percentage concentrators	Figure 6 Trades education programs	Figure 7 Enrollments to annual job openings	Figure 8 Annual Openings & concentrators	Figure 9 Race/ethnicity of workforce/ students	Figure 10 Race/ ethnicity of enrollments	Figure 11 Girls as % of enrollments	Figure 12 Graduation rates	Figure 13 College enrollments	Figure 14 Teacher age	Figure 15 Teacher gender	Figure 16 Teacher race/ ethnicity	Appendix C Enrollments v. HS population
NE	X	X		X	X		X	X	X			X	X	X	
NV				X											
NH															
NJ	X	X	X	X	X	X	X	X	X	X	X				X
NM	X	X		X	X										X
NY	X	X		X	X										X
NC	X	X		X	X		X	X	X						X
ND															
OH	X	X		X	X		X	X	X						X
OK	X	X		X	X		X	X	X			X	X	X	X
OR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PA															
RI				X											
SC	X	X		X	X	X	X	X	X						X
SD	X	X		X	X		X	X	X						X
TN	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TX	X	X		X	X		X	X	X			X	X	X	X
UT	X	X			X	X	X	X	X	X	X		X	X	X
VT															
VA															
WA															
W. DC															
WV	X	X		X	X		X	X	X				X	X	X
WI															
WY	X	X		X	X		X	X	X			X	X	X	X
n=	32	32	8	36	32	13	28	28	28	10	10	11	13	13	31

Labor market analysis

Annual Openings data was sourced from Emsi (2018 and 2019). These annual openings represent an annual average projection of openings (a combination of new jobs and replacement jobs) between 2018 and 2028. In other words, if a particular occupation is projected to have 100 total openings between 2018 and 2028, the annual openings figure would be 10. For each state of the 32 selected states, which correspond to the states that provided enrollment data, these annual openings data were pulled at the occupation level, then categorized and totaled under each trade area.

Qualitative analysis

The qualitative information in this report was gathered through interviews with CTE state directors or other relevant leaders in all 50 states and the District of Columbia, in addition to experts identified by Harbor Freight Tools for Schools and interviewees during our research process. Interviews explored recent trends in trades education, including student demand, teaching workforce, funding, quality efforts, policy, performance standards, industry demand, and exemplary practice. Interviews were analyzed to identify trends and significant examples.

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Appendix B: Supplemental Labor Market Information

Projected U.S. Job Openings in the Skilled Trades 2018-2028 ($n = 50$ states)

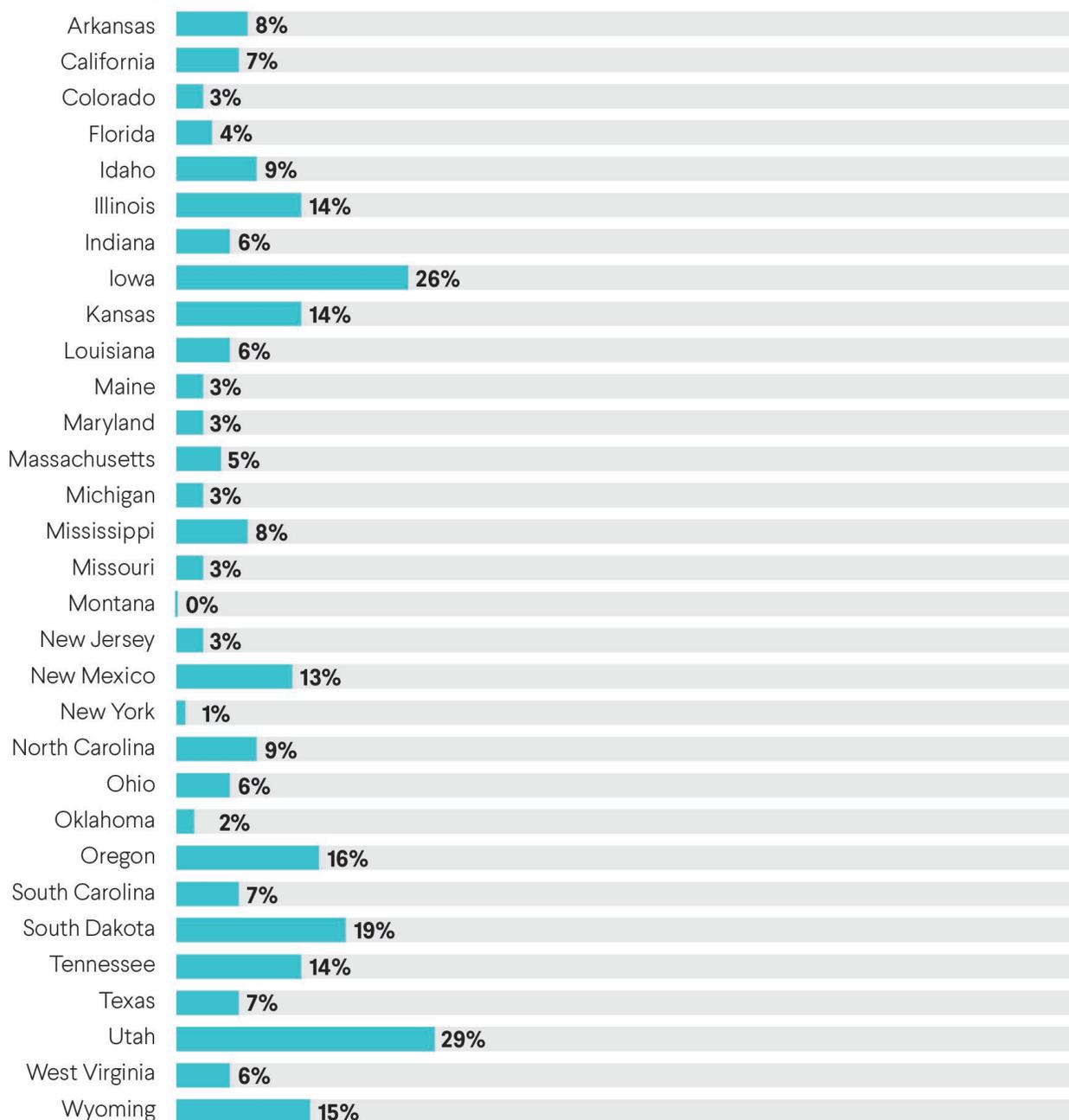
Trade Area	2018 Jobs	2028 Jobs	Percent Change	Average Annual Change (New Jobs)	Average Annual Openings
Construction	4,747,313	5,206,126	10%	45,363	529,023
Manufacturing	2,750,078	2,788,044	1%	3,796	294,067
Automotive	1,130,069	1,214,608	7%	8,453	117,615
Carpentry	1,075,208	1,135,973	6%	6,076	109,422
Electrical	725,324	800,380	10%	7,505	92,524
Plumbing	499,590	580,155	16%	8,056	64,476
Welding	457,857	488,083	7%	3,023	54,364
HVAC	357,021	410,152	15%	5,313	42,316
TOTAL	11,742,460	12,623,521	8%	87,585	1,303,807

Source: Emsi 2019.

Appendix C: Supplemental Trades Student Information

Enrollment in Skilled Trades 2016-17 as a Proportion of High School Population, Fall 2016

(n = 31 states)



Enrollment data source: JFF research.

High school population source: https://nces.ed.gov/programs/digest/d18/tables/dt18_203.30.asp.

Notes: Montana provided small numbers of enrollments and thus, their figures rounded to 0 percent.

Enrollments may comprise some duplication of students; these figure represent the best approximation of students enrolled in trades education available for our research.

Appendix D: Examples of Promising Programs

Among the strong programs surfaced in our national scan of trades programs, three stood out in demonstrating the promise of modern skilled trades education:

Anderson I & II Career and Technology Center's Automotive Technology

Program in Williamstown, South Carolina, emphasizes soft skills as it builds technical skills through hands-on and virtual learning with well-equipped and up-to-date facilities. The program maintains strong employer relationships that provide student access to work-based learning and a community of practice. Students can earn industry certifications as well as college credit.

Norwich Technical High School's Construction Trades Program, Electrical Shop

in Norwich, Connecticut, schedules students for two weeks of academic classes followed by two uninterrupted weeks of technical training in their shop, enabling them to engage in large scale, off-site construction projects in the community. Homeowners apply to have a project completed at their home and pay the school for the work, generating revenue for the shop. The shop integrates digital resources to simulate electrical systems that students will encounter in the field. Graduates are positioned to apply their 1,500 hours of supervised work experience toward a state electrical license, and are prepared to enter electrician apprenticeships.

Western Maricopa Education Center is a public-school district of 47 high schools in the Phoenix metropolitan area. The center has developed strong employer relationships in several industry sectors. One example is Delta Airlines, which supports the Aviation Maintenance Technician program by supplying training tools, materials, and professional development for center staff. The program offers 1,925 instructional hours that comprise the same curriculum and technical assessments used by adult college or trade-school students. Program completers fulfill the federal requirements for FAA certification exams, which can lead to Airframe and/or Powerplant Mechanic certificates.

Endnotes

¹ *Solving the Talent Shortage: Build, Buy, Borrow, Bridge* (Milwaukee, MI: Manpower Group, June 2018), [https://go.manpowergroup.com/hubfs/TalentShortage%202018%20\(Global\)%20Assets/PDFs/MG_TalentShortage2018_lo%206_25_18_FINAL.pdf?hsLang=en](https://go.manpowergroup.com/hubfs/TalentShortage%202018%20(Global)%20Assets/PDFs/MG_TalentShortage2018_lo%206_25_18_FINAL.pdf?hsLang=en); “Getting the Word Out About Trade Careers,” *Community College Daily*, accessed June 4, 2019, <http://www.ccdaily.com/2019/06/getting-word-trade-careers/>.

² “Career Clusters,” Association for Career and Technical Education, December 12, 2019, <https://www.acteonline.org/career-clusters-2/>.

³ One state reported a staff structure with eight positions, of which four had been vacant for months due to budget constraints. Another state reported the retirement of a director and months without a replacement. One state’s leaders felt the data were too incomplete to present a fair picture of trades education in their system and so declined to share it. Another state experienced a shutdown of their data system for over a month, creating an extreme backlog of required reporting and precluding extraction of data for our research purposes.

⁴ Based on Fall 2016 enrollment. *Digest of Education Statistics* (Washington, DC: National Center for Education Statistics, 2018), https://nces.ed.gov/programs/digest/d18/tables/dt18_203.30.asp. The 32 states that provided enrollment data represent 76% of public high school students.

⁵ “Talent Shortage Survey,” Manpower Group Solutions, accessed June 8, 2019, <https://insights.manpowergroupsolutions.com/2018-talent-shortage-survey/>; “Closing the Skills Gap: What Workers Want,” Manpower Group, accessed June 8, 2019, <https://workforce-resources.manpowergroup.com/closing-the-skills-gap-know-what-workers-want/closing-the-skills-gap-know-what-workers-want>.

⁶ Manpower Group Solutions, “Talent Shortage Survey.”

⁷ “Failure to Act Report,” 2017 Infrastructure Report Card, accessed July 12, 2019, <https://www.infrastructurereportcard.org/the-impact/failure-to-act-report/>.

⁸ Unless a different source is provided, data related to the labor market comes from Emsi, a Strada company, which curates data from government sources, including the U.S. Census Bureau and the Bureau

of Labor Statistics. The data are updated quarterly. Data provided are based on the first quarter release from 2019.

⁹ Emsi data 2019.1.

¹⁰ Emsi data 2019.1.

¹¹ Emsi data 2019.1.

¹² Emsi data 2019.1.

¹³ Emsi data 2019.1.

¹⁴ “Trends in Student Aid Highlights,” College Board, accessed October 30, 2019, <https://trends.collegeboard.org/student-aid/figures-tables/cumulative-debt-bachelor-degree-recipients-four-year-institutions-over-time>.

¹⁵ “National Occupational Employment and Wage Estimates,” U.S. Bureau of Labor Statistics, accessed March 7, 2020, https://www.bls.gov/oes/current/oes_nat.htm#47-0000.

¹⁶ U.S. Bureau of Labor Statistics, “National Occupational Employment and Wage Estimates.”

¹⁷ “Construction Manager Overview,” U.S. News, accessed September 10, 2019, <https://money.usnews.com/careers/best-jobs/construction-manager>.

¹⁸ “New Research Shows College Graduation Rates for Dual Enrollment Students Vary Widely by State—and by Income,” Community College Research Center, September 27, 2017, <https://ccrc.tc.columbia.edu/press-releases/new-research-graduation-rates-dual-enrollment.html>.

¹⁹ “Apprenticeships Data and Statistics,” U.S. Department of Labor, accessed March 7, 2020, https://www.doleta.gov/OA/data_statistics.cfm.

²⁰ “About Local 6,” Heat and Frost Allied Workers Local 6 Boston, accessed December 5, 2019, <https://insulators6.org/about-us/>.

²¹ “New York City UA Local 1 Plumbers Complete Their SUNY Empire Degrees,” SUNY Empire State College, January 03, 2018, <https://www.esc.edu/news/around-college/2018/new-york-city-ua-local-1-plumbers-complete-their-suny-empire-degrees.php>.

²² “Advanced placement at work: a 21st Century apprenticeship model for the US,” Managing the Future of Work, Harvard Business School, last modified July 17, 2019, podcast transcript, <https://www.hbs.edu/managing-the-future-of-work/podcast/Pages/podcast-details.aspx?episode=10555181>.

²³ Debbie Reed et al., *An Effectiveness Assessment and Cost-Benefit Analysis of Registered Apprenticeship in 10 States: Final Report* (Oakland, CA: Mathematica Policy Research, 2012), https://wdr.doleta.gov/research/FullText_Documents/ETAOP_2012_10.pdf.

²⁴ Wage data source: Emsi data 2018.

²⁵ Wage data source: Emsi data 2018.

²⁶ “Table 203.30: Public school enrollment in grades 9 through 12,” Digest of Education Statistics, National Center for Education Statistics, accessed March 8, 2020, https://nces.ed.gov/programs/digest/d18/tables/dt18_203.30.asp; Enrollments do not provide a precise count of students as some students may enroll in more than one trades course across multiple programs. Although they do not tell us exactly how many students are participating in trades education, enrollment figures do offer an indicator of interest in trades classes among students, and enrollments remain the best approximation we have for the number of students enrolled.

²⁷ “Perkins Data Explorer CTE Participant Enrollment,” Perkins Web Portal, accessed September 9, 2019, <https://perkins.ed.gov/pims/DataExplorer/CTEParticipant>.

²⁸ It should be noted that not all skilled trades programs participate in Perkins due to the small amount of funding available and often burdensome reporting requirements. Thus the Perkins figure here underrepresents all trades education operating in the United States.

²⁹ These gaps may be due to states not offering programs in some trades areas and/or states’ difficulty in determining enrollment in some specific trades areas.

³⁰ There is significant variation in how concentration is defined, ranging from completion of one course to three or more courses in a subject or a course sequence. Because Perkins funding requires that states

report concentration at the level of the career cluster, many states define concentrations at the career cluster level and were not able to report concentration data at the level of a specific trade area. In most cases, concentration is defined by the number of courses a student has already completed.

³¹ Here, we focused on states that provided concentrations for the cohort of students that entered as freshmen in 2011, to understand what proportion of students enrolled in trades at some point in high school end up concentrating.

³² Florida, Indiana, Maryland, Mississippi, Missouri, New Jersey, Oregon, and Tennessee.

³³ “Tennessee Pathways,” TN Department of Education, accessed May 26, 2019, <https://www.tn.gov/education/pathwaystn.html>.

³⁴ Steve Playl, Jr., senior director, College and Career Experiences, Tennessee Department of Education, personal communication with author, February 3, 2020.

³⁵ Samuel J. Kamin, “Career and Technical Education Issue Brief: Current Trends and Results,” University of Connecticut, May 29, 2018, <https://education.uconn.edu/2018/05/29/career-and-technical-education-issue-brief-current-trends-and-results/#>.

³⁶ Daniel Kreisman and Kevin Stange, “Depth Over Breadth,” *Education Next* 19, no. 4 (Fall 2019), <https://www.educationnext.org/depth-over-breadth-value-vocational-education-u-s-high-schools/>.

³⁷ Arizona, Arkansas, California, Connecticut, Delaware, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, West Virginia, and Wyoming.

³⁸ Arizona, Arkansas, California, Connecticut, Delaware, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, West Virginia, and Wyoming.

³⁹ Arkansas, California, Colorado, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Montana, Nebraska, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wyoming.

⁴⁰ Florida, Indiana, Kansas, Kentucky, Maryland, Massachusetts, Mississippi, Missouri, New Jersey, Oregon, South Carolina, Tennessee, and Utah.

⁴¹ Arkansas, California, Colorado, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Jersey, North Carolina, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wyoming.

⁴² *Statistics and Trends in the Education of Racial and Ethnic Groups* (Washington, DC: National Center for Education Statistics, 2019), https://nces.ed.gov/programs/raceindicators/indicator_rbb.asp.

⁴³ Arkansas, California, Colorado, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Jersey, North Carolina, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wyoming.

⁴⁴ Cristle Jose, “Organizations, school districts strategize, reach out to youth to advance equity in construction pathways,” *Metro News*, April 8, 2019, <https://www.oregonmetro.gov/news/organizations-school-districts-strategize-reach-out-youth-advance-equity-construction-career>.

⁴⁵ Arkansas, California, Colorado, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Jersey, North Carolina, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Texas, Utah, West Virginia, and Wyoming.

⁴⁶ The most relevant career clusters in Perkins data are Architecture and Construction, Manufacturing, and Transportation and Logistics. We are excluding Agriculture since it includes many non-trades subjects.

⁴⁷ This situation was corroborated in: *The State of Career Technical Education: Improving Data Quality and Effectiveness* (Silver Spring, MD: Advance CTE, 2019), <https://careertech.org/resource/state-cte-improving-data-quality-effectiveness>.

⁴⁸ Shaun M Dougherty, *Career and Technical Education in High School: Does it Improve Student Outcomes?* (Washington, DC: Thomas B. Fordham Institute, 2016), <https://eric.ed.gov/?id=ED570132>.

⁴⁹ Florida, Indiana, Kansas, Maryland, Massachusetts, Missouri, New Jersey, Oregon, Tennessee, and Utah.

⁵⁰ “College Enrollment and Work Activity of Recent High School and College Graduates Summary,” Economic News Release, U.S. Bureau of Labor Statistics, last modified April 26, 2019, <https://www.bls.gov/news.release/hsgec.nro.htm>.

⁵¹ Florida, Indiana, Kansas, Maryland, Massachusetts, Missouri, New Jersey, Oregon, Tennessee, and Utah.

⁵² States reported as follows: Apprenticeships: Indiana and Michigan. Postsecondary training: Florida, Indiana, Massachusetts, Michigan, Missouri, Oklahoma, and Tennessee. Employment: Arkansas, Florida, Indiana, Kentucky, Massachusetts, Michigan, Missouri, New Jersey, Oklahoma, Tennessee, and Utah.

⁵³ Advance CTE, *The State of Career Technical Education*.

⁵⁴ Tennessee was not able to provide data on entry into apprenticeships.

⁵⁵ “The state has a goal of getting 55 percent of its population to have a college degree or certificate by the year 2025,” Drive to 55 Alliance, accessed January 9, 2020, <http://driveto55.org>.

⁵⁶ “Schooling and Staffing Survey (SASS),” National Center for Education Statistics, accessed March 8, 2020, https://nces.ed.gov/surveys/sass/tables/sass1112_2013314_t1s_002.asp.

⁵⁷ Florida, Illinois, Indiana, Kansas, Missouri, Nebraska, Oklahoma, Oregon, Tennessee, Texas, and Wyoming.

⁵⁸ Smaller proportions are Black (7%) and Hispanic (8%): NCES, “Schooling and Staffing Survey (SASS).”

⁵⁹ Florida, Illinois, Indiana, Kansas, Missouri, Nebraska, Oklahoma, Oregon, Tennessee, Texas, Utah, West Virginia, and Wyoming.

⁶⁰ Florida, Illinois, Indiana, Kansas, Missouri, Nebraska, Oklahoma, Oregon, Tennessee, Texas, Utah, West Virginia, and Wyoming. The remaining 6% in the graph represents “Other” (1%) and “Not reported” (5%).

⁶¹ The federal Carl D. Perkins Act of 2006 provided a program framework, funding, and accountability for CTE for many years. The legislation’s recent reauthorization, as the Strengthening Career and Technical Education for the 21st Century Act of 2018, is encouraging states to rethink, reorganize, and improve all of their CTE programming, including the skilled trades. The final Perkins allocation for Fiscal Year 2020 was 1,282,598 (an increase in 20 million from FY19). On average, 64 percent of funds are spent at the secondary level; *Perkins IV: Title I—Basic State Grants* (Washington, DC: U.S. Department of Education, n.d.), <https://www2.ed.gov/about/offices/list/ovae/pi/cte/factsh/title1-factsheet-32510.pdf>.

⁶² See, for example, David Boesel et al., *Participation in and Quality of Vocational Education, National Assessment of Vocational Education, Vol. II* (Washington, DC: US Department of Education, Office of Educational Research and Improvement, 1994), 25; and Jeannie Oakes et al., *Educational Matchmaking: Academic and Vocational Tracking in Comprehensive High Schools* (Santa Monica, CA: RAND, 1992).

⁶³ The other two measures are attainment of a postsecondary credential and of postsecondary credit.

⁶⁴ Information in this section is based on interviews with state CTE directors and other key informants unless otherwise indicated.

⁶⁵ *West Virginia’s Simulated Workplace (SW) Initiative: Q and A with Kathy D’Antoni, Chief Career and Technical Education Officer* (Arlington, VA: CAN, 2016), https://www.cna.org/CNA_files/PDF/D'Antoni-Interview-Quick-Update.pdf.

⁶⁶ “Simulated Workplace Protocols,” Sway.office.com, accessed August 31, 2019, <https://sway.office.com/uLZUqX9Cvjx6Qano?ref=Link>.

⁶⁷ Dan Belcher, director of workforce development, NCCER, personal communication with author, December 18, 2019.

⁶⁸ “Pathways Policy,” CTE Technical Assistance Center of NY, accessed October 25, 2019, <http://nyctecenter.org/pathways-policy>.

⁶⁹ “Pathways to Prosperity Network,” JFF, accessed October 25, 2019, <https://www.jff.org/what-we-do/impact-stories/pathways-to-prosperity-network/>.

⁷⁰ “About the Linked Learning Approach,” Linked Learning, accessed October 25, 2019, <https://www.linkedlearning.org/about/>.

⁷¹ “Work-Based Learning: How States and Schools Can Engage Employers to Invest in Workplace Learning,” Southern Regional Education Board, accessed November 5, 2019, <https://www.sreb.org/work-based-learning>.

⁷² Gavin Newsom, “Here’s How we Grow California’s Economy for Everyone,” *Medium*, February 8, 2018, <https://medium.com/@GavinNewsom/heres-how-we-grow-california-s-economy-for-everyone-b1b06c7b49c9>.

⁷³ Mary Jo Dilonardo, “Signing Day Recognizes High School Seniors Starting Jobs, Not College,” *MNN*, January 15, 2019, <https://www.mnn.com/money/green-workplace/stories/signing-day-recognizes-high-school-seniors-starting-jobs-not-college>.

⁷⁴ *CTE Teacher Faculty Shortages* (Silver Spring, MD: Career Technical Education, 2018), [https://cte.careertech.org/sites/default/files/Teacher Shortage Fact Sheet 2018.pdf](https://cte.careertech.org/sites/default/files/Teacher%20Shortage%20Fact%20Sheet%202018.pdf).

⁷⁵ Sophie Quinton, “States want more career and technical training, but struggle to find teachers,” *PBS News Hour*, April 9, 2017, <https://www.pbs.org/newshour/education/states-want-career-technical-training-struggle-find-teachers>.

⁷⁶ Arkansas amended the Arkansas Medical Marijuana Amendment of 2016 and redirected marijuana sales tax revenues from vocational and technical training to a different fund. Oklahoma’s FY18 budget made a significant CTE cut of 5.9 percent, or \$6.7 million from general revenue. Alaska’s FY19 budget decreased allocations for the Alaska Vocational Technical Center by \$171,900.

⁷⁷ ACTE and Advance CTE report that: “California directed \$150 million to make permanent the Career Technical Education Incentive Grant program, which supports new or expanded high-quality K-12 CTE programs, while voters in New Jersey approved a ballot initiative for \$500 million in state bonds to expand secondary and postsecondary CTE programs, among other activities”; *State Policies Impacting CTE: 2018 Year in Review* (Silver Spring, MD: Career Technical Education, 2019), [https://www.acteonline.org/wp-content/uploads/2019/01/2018 State CTE Policy Review.pdf](https://www.acteonline.org/wp-content/uploads/2019/01/2018_State_CTE_Policy_Review.pdf).

⁷⁸ “Baker-Polito Administration Awards \$12 Million in Skills Capital Grants,” Mass.gov, August 29, 2019, <https://www.mass.gov/news/baker-polito-administration-awards-12-million-in-skills-capital-grants>.

⁷⁹ *reVISION: Establishing a clear vision for Nebraska career education* (Lincoln, NE: Nebraska Department of Education, 2018), <https://www.education.ne.gov/wp-content/uploads/2018/07/what-is-reVISION-2018.pdf>.

⁸⁰ See, for example: *Harbor Freight Tools for Schools Platinum Standard* (Calabasas, CA: Harbor Freight Tools), <https://harborfreighttoolsforschools.org/wp-content/uploads/HFTfS-PlatinumStandard-9.12.pdf>; Catherine Imperatore and Alisha Hyslop, *Defining High-Quality CTE: Quality CTE Program of Study Framework, Version 4.0 (Beta)* (Alexandria, VA: ACTE, 2017), <https://www.acteonline.org/wp-content/uploads/2018/02/ACTE-HighQualityCTEFramework-Draft4.0-Beta.pdf>; or New York: “Implementation Guide,” Program Approval Process, NYSED.gov, last updated March 10, 2011, <http://www.p12.nysed.gov/cte/ctepolicy/guide.html>.

⁸¹ A recent study found 38 states had publicly available quality standards and guidelines. See: Xue Xing, Sara Shaw, and Howard R.D. Gordon, “Quality Indicators Guiding Secondary Career and Technical Education Programs of Study,” *Journal of Research in Technical Careers* 1, no. 2 (December 2017): 47-60, <https://digitalscholarship.unlv.edu/cgi/viewcontent.cgi?article=1012&context=jrtc>.

⁸² *50-State Comparison: Statewide Longitudinal Data Systems* (Denver, CO: Education Commission of the States, 2020), <https://www.ecs.org/state-longitudinal-data-systems/>.

⁸³ Jessica Leigh Brown, “4 best practices for implementing state longitudinal data systems,” *Education Dive*, May 2, 2019, <https://www.educationdive.com/news/4-best-practices-for-implementing-state-longitudinal-data-systems/552355/>.

⁸⁴ Jacob Jackson and Hans Johnson, “Integrating California’s Education Data,” *Public Policy Institute of California*, August 29, 2019, https://www.ppic.org/blog/integrating-californias-education-data/?utm_source=ppic&utm_medium=email&utm_campaign=blog_subscriber.

⁸⁵ “Charts and tables of CTE student performance,” CTE Trends Analysis Dashboards, Maryland CTE Data, mdctedata.org, accessed March 8, 2020, <https://www.mdctedata.org>.

⁸⁶ “High-Quality CTE Tools,” Association for Career & Technical Education, accessed March 8, 2020, <https://www.acteonline.org/professional-development/high-quality-cte-tools/>.