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CAREER AND TECHNICAL EDUCATION IN HIGH SCHOOL:

DOES IT IMPROVE STUDENT OUTCOMES?

THOMAS B. FORDHAM INSTITUTE
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SHAUN M. DOUGHERTY

Foreword and Executive Summary by Michael J. Petrilli and Dara Zeehandelaar

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FOREWORD

Ask any group of high school teachers, and they will report that the most frequently heard question in their classrooms is, "When are we ever gonna use this?" In a traditional college prep program, the honest answer is usually, "Maybe when you get to the university." But in the real world? Depending on the class, maybe not at all.

However, in high-quality Career and Technical Education (CTE) programs, that question is moot. Students learn skills that will help them prepare for stable careers and success in a modern, global, and competitive economy. A student who wants a future in architecture doesn't question his first drafting course in high school. One interested in aerospace sees value in her introduction to engineering design class. An aspiring medical professional is enthusiastic, not indifferent, about high school anatomy.

Unfortunately for millions of American students, CTE is not a meaningful part of their high school experience. Instead, they are shuffled through large, bureaucratized schools that do not adequately prepare them for anything, be it college, career, or both.

In large part, this is because CTE has been chronically neglected by American education leaders and policymakers. Many CTE advocates suspect that it's because of the damaged "brand" of vocational education. And it's damaged for a reason, as there was a time when the "vo-tech" track was a pathway to nowhere. "Tracking," as practiced in the twentieth century, was pernicious. It sent a lot of kids—especially low-income and minority students—into low-paying, menial jobs, or worse.

Yet America is an anomaly. In most industrialized countries —nearly all of which outperform us on measures of academic achievement, such as PISA and TIMSS—students begin preparing for a career while still in high school. Around the world, CTE is not a track away from a successful adulthood, but rather a path towards it.

American students face a double-whammy: Not only do they lack access to high-quality secondary CTE, but then they are subject to a "bachelor's degree or bust" mentality. And many do bust, dropping out of college with no degree, no work skills, no work experience, and a fair amount of debt. That's a terrible way to begin adult life. We owe it to America's students to prepare them for whatever comes after high school, not just academic programs at four-year universities.

Despite its checkered past, modern CTE—often called "new vocationalism"—is a far cry from vo-tech. No longer isolated "shop" classes for students showing little future promise, CTE coursework is now strategic and sequenced. It entails skill building for careers in fields like information technology, health sciences, and advanced manufacturing. Secondary CTE is meant to be a coherent pathway, started in high school, into authentic technical education options, and credentials, at the postsecondary level.

Why don't we see more communities embracing high-quality CTE? Why are students nationwide taking fewer CTE courses today instead of more? Would it help if policymakers, educators, parents, and kids could see that CTE today isn't a dead-end track?

That's where this study comes in. We wanted to know whether the students who participated in CTE—and especially those "concentrating" by taking a sequence of three or more courses aligned to a career in a specific industry—were achieving better outcomes than their peers. Were they more likely to graduate from high school? Enroll in postsecondary education? And, perhaps most importantly, be employed and earn higher wages?

To find out, we enlisted Shaun M. Dougherty, assistant professor of educational policy and leadership at the University of Connecticut's Neag School of Education, who has previously studied high school CTE in Massachusetts and New York City. For this study, he coordinated with the Arkansas Research Center to access and analyze their truly remarkable database, which combines secondary, postsecondary, and labor market information. He designed and executed a rigorous analytic strategy that uses three different statistical approaches, giving us great confidence in his findings.

And what are they?

Arkansas students with greater exposure to CTE are more likely to graduate, enroll in a two-year college, be employed, and have higher wages. Furthermore, those students are just as likely to pursue a four-year degree as their peers. In addition, students who "concentrate" their CTE coursework are more likely to graduate high school by 21 percentage points compared to otherwise similar students—a truly staggering number. Concentration has positive links with the other outcomes as well. Moreover, the results of this study suggest that CTE provides the greatest boost to the kids who may need it most—boys, and students from low-income families.

And the good news is that CTE does not have to be super expensive and highly exclusive in order to have positive effects. The form of CTE we studied in Arkansas is CTE at its most egalitarian and scalable: most students took courses at their comprehensive high school, and some did so at regional technical centers. And it worked.

Overall, this study adds to the growing body of evidence on the impact of high school CTE. Policymakers in other states should heed Arkansas's example by increasing their investment in secondary CTE that is aligned to the demands of the local labor market. It's also high time to reauthorize the Perkins Act and increase federal investment in this area. The scars of the recession have faded, but they haven't disappeared. Connecting more young people with available opportunities by giving them the skills employers are seeking should be a national priority.

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EXECUTIVE SUMMARY

Until the late 1990s, "vocational education" in traditional trades such as carpentry, cosmetology, and auto mechanics was often the presumptive high school placement for low-performing students considered ill-suited for college. However, in the past two decades, policymakers and educators have reconsidered what is now referred to as "Career and Technical Education" (CTE). Done right, secondary CTE provides preparation and skill building for careers in fields such as information technology, health services, and advanced manufacturing, in which many positions require a postsecondary education. While some high school CTE students do enter the workforce without additional training, many secondary CTE programs feed participants into professional certification or associate degree programs at two- or four-year colleges. The goal of today's CTE is simple: to connect students with growing industries in the American economy and to give them the skills and training required for long-term success.

Unfortunately, little is known about this "new vocationalism." This study uses a rich set of data from the Arkansas Research Center (ARC) to follow three cohorts—more than 100,000 students—from eighth grade, through high school, and into college and/or the workforce. It asks:

1. Which students are taking CTE courses? Which courses—and how many of them—are they taking?
2. Does greater exposure to CTE improve education and employment outcomes (high school graduation, college enrollment, employment status, and wages)?
3. Does CTE "concentration" (taking a sequence of three or more courses in an occupationally aligned "program of study") have benefits for students? Do certain students benefit more than others?

Arkansas is a compelling case study because it recently overhauled its policies to improve career readiness and align CTE programs with the labor market. Further, beginning with the class of 2014, all high school students must take six units of "career focus" coursework to graduate, which they can fulfill with CTE. Arkansas is one of the few states that has linked K-12, postsecondary, and workforce data for long enough so that questions about the efficacy of secondary CTE can be addressed.

FINDINGS

1. MOST STUDENTS IN ARKANSAS TAKE CTE, WITH LIMITED EVIDENCE OF "TRACKING."

Students took an average of 4.9 CTE courses in high school. More specifically, 89 percent took at least one CTE class; only 30 percent took two classes or fewer; 39 percent took between three and six, and 31 percent took seven or more. Exposure to CTE coursework differs slightly by race, disability status, income, and gender. In particular, white students, students with disabilities, and female students are slightly overrepresented among students taking seven or more courses; Latino students are underrepresented. It does not appear, however, that higher-achieving students are steered away from CTE. For example, although low achievers (as defined by eighth grade math test scores) are slightly overrepresented in the seven-or-more courses category, so are middle achievers. And high achievers are not taking fewer courses than other students.

2. WHITE AND FEMALE STUDENTS ARE MORE LIKELY TO CONCENTRATE, AND SOME CONCENTRATIONS ARE MORE OR LESS POPULAR DEPENDING ON A STUDENT'S GENDER, RACE, INCOME LEVEL, AND DISABILITY STATUS.

Nearly 30 percent of all students choose to "concentrate" by earning three or more credits in a formal, coordinated program of study. The most popular concentrations are business, family and consumer sciences, and agriculture. Compared to the general student population, "concentrators" are slightly more likely to be white or female and slightly less likely to be Latino. Male students are overrepresented in concentrations related to agriculture, architecture and construction, manufacturing, STEM, and transportation and logistics. Female students are overrepresented in concentrations related to education, health sciences, and human services.

Students with disabilities are neither overrepresented nor underrepresented among concentrators as a group—but they concentrate in greater numbers in manufacturing; and transportation and logistics (and are underrepresented in finance and health sciences, among others). Likewise, students who are free or reduced-price lunch eligible are proportionally represented among all concentrators, but more frequently concentrate in government and public administration, transportation and logistics, and law and public safety. They are particularly underrepresented in education, STEM, and arts and communications.

3. THE MORE CTE COURSES STUDENTS TAKE, THE BETTER THEIR EDUCATION AND LABOR MARKET OUTCOMES.

In general, taking just one additional CTE course above the average increases a student's probability of graduating from high school by 3.2 percentage points and of enrolling in a two-year college the following year by 0.6 percentage points. It also increases a student's probability of being employed the year after graduation by 1.5 percentage points and boosts his or her expected quarterly wage that year by $28 (or roughly 3 percent). Dual enrollment—earning college credit while still in high school—magnifies the impact of an additional CTE course by doubling the probability that a student will enroll in a two-year college the year after graduation. All of these differences are statistically significant.

4. STUDENTS WHO CONCENTRATE SEE ADDITIONAL BENEFITS, ESPECIALLY WHEN IT COMES TO HIGH SCHOOL GRADUATION.

Concentrators are 21 percentage points more likely to graduate from high school than otherwise identical students (with similar demographics, eighth grade test scores, and number of CTE courses taken) who do not concentrate. In the year after high school, concentrators are 0.9 percentage points more likely to be employed (with average quarterly wages that are $45 higher), and 1.3 percentage points more likely to be enrolled in a two-year college, than similar non-concentrators.[1]

5. MALE AND LOW-INCOME STUDENTS SEE THE LARGEST BENEFITS TO CONCENTRATING.

Students of both genders are more likely to graduate from high school if they concentrate, but boys see a bigger boost. Compared to similar male non-concentrators, they are 23 percentage points more likely to graduate, while female concentrators are 19 percentage points more likely to graduate than similar females who do not concentrate. All else equal, concentrating gives male students a far greater wage benefit than it does female students ($89 more per quarter versus no significant benefit). Low-income concentrators are 25 percentage points more likely to graduate than low-income non-concentrators, while higher-income concentrators are only 17 percentage points more likely to graduate than their non-concentrator peers.

RECOMMENDATIONS

The results suggest that policymakers and education leaders nationwide should **invest more heavily (and strategically) in high school CTE.** Doing so could mean mirroring much of what is already occurring in Arkansas:

1. Examine state labor market projections to identify high-growth industries;
2. Offer CTE courses aligned to skills and industry-recognized credentials in these fields, and encourage (or require) high school students to take them;
3. Encourage (or require) students taking multiple CTE courses to concentrate, rather than enrolling haphazardly; and
4. Support and encourage dual enrollment and make credits "stackable" from high school into college, so that high school CTE courses count toward specific postsecondary credentials.

Finally, although most of its funding comes from state and local sources, throughout its history CTE has been shaped by federal policy. As such, the results should encourage federal policymakers to thoughtfully reauthorize the Perkins Act as soon as possible. High school CTE improves outcomes for students seeking to start their careers quickly, but does not hinder those hoping to go to a four-year college. While it is likely beneficial to students in myriad forms—including small, focused academies or selective whole-school programs—this study finds a positive impact of CTE at its most egalitarian: nine out of ten CTE students took those classes only at their comprehensive high school, and the remaining ten percent took CTE at a regional technical center that serves all students in a twenty-five-mile radius. It should therefore be a national priority to **increase federal support for high-quality, labor-market-aligned programs that are available and appealing to all students.**

INTRODUCTION

Until the late 1990s, "vocational education" was often the presumptive placement for low-performing students. In high school, it was used as a track for students thought to be incapable of or disinterested in attending college.[2] For students who didn't choose this path for themselves, it likely signaled that they should abandon any pretense of academic pursuits and plan to spend their adulthood in a traditional trade, such as carpentry, cosmetology, or auto mechanics.

In the past two decades, however, both the label and the expectations for career preparation have changed. Although postsecondary education is still seen as a way to promote upward mobility and workforce preparation, some now question whether a four-year degree is a prerequisite for thriving in today's economy.[3] Policymakers and educators are therefore re-imagining vocational education in secondary school as training for high-demand careers (both those that require a four-year college degree and those that do not). Such thinking is echoed by education leaders who call for "college *and* career readiness" as a measure of secondary school success.

Now more commonly referred to as "Career and Technical Education" (CTE), this "new vocationalism" is a shift from its "vo-tech" past. Modern CTE programs prepare students for careers in broad industries by developing general skills in rapidly expanding fields such as information technology, health services, biotechnology, and advanced manufacturing. These programs, many of which can feed into professional certification or associate degree programs at community or four-year colleges, have the potential to connect students with key areas of growth in the American economy, and in recent years both federal and state policies have sought to strengthen that connection. Consequently, in many places today's CTE is a much broader enterprise than the isolated auto shop or drafting classes of vocational education of a few decades ago.

Unfortunately, even basic questions about high school CTE remain under-examined, such as which students participate and what courses they take—as do more consequential queries, such as whether or how students benefit academically and professionally. Yet all of these questions must be answered if we are to understand whether CTE is actually moving away from its stigmatized legacy.

This study seeks to answer some of those questions, using a unique data set that allows us to track three cohorts of students in Arkansas from ninth grade, through high school, and into college or the labor force (or both). It asks:

1. Which students are taking CTE courses? Which courses—and how many of them—are they taking?
2. Does greater exposure to CTE improve education and employment outcomes (high school graduation, college enrollment, employment status, and wages)?
3. Does CTE "concentration" (taking a sequence of three or more courses in an occupationally aligned "program of study") have benefits for students? Do certain students benefit more than others?

This study is focused on Arkansas for several reasons. First, it is one of just five states that link education and workforce data such that questions about the efficacy of secondary CTE can be addressed. Second, it recently overhauled state policies to improve career readiness and align CTE programs with the labor market. Third, per capita income is among the lowest in the nation, and residents stand to benefit both educationally and economically from effective CTE. While no single state is truly representative of the United States as a whole, as a racially and geographically diverse state facing a number of common economic and social challenges, Arkansas can serve as a useful (and practical) test case for examining CTE.

This report is organized as follows: Section One summarizes the history of secondary CTE, and reviews the scant existing research on it. Section Two describes the present study's data and methods, and also provides context specifically for Arkansas. Section Three presents the results, and Section Four considers the implications and offers recommendations for policymakers.

SECTION ONE

BACKGROUND

FROM VOCATIONAL EDUCATION TO CTE

Although most funding comes from state and local sources, throughout its history CTE has been shaped by federal policy.[4] The Smith-Hughes Act of 1917 was the first to authorize federal funding for "vocational education," which supported training for future farmers in trade schools separate from traditional school settings. As the nation's economy evolved, a series of federal policies expanded funding for these trade schools, first for industrial education and then for other areas (mostly those related to national security, such as science and world language). However, it wasn't until the Vocational Education Act of 1963 that voc-ed was incorporated into the broader education system. Subsequent reauthorizations, starting with the Carl D. Perkins Vocational Education Act of 1984, expanded vocational education to adults, individuals with disabilities, and English language learners, and improved training specifically related to technology.

The most recent federal reauthorization (which passed in 2006) was the first to use the phrase "Career and Technical Education" in the title. Commonly referred to as "Perkins IV," the law re-conceptualized CTE by requiring that academic and technical content be linked, with the goal of readying students either to enter the labor market directly or be well prepared for additional education and training.[5] Today's CTE is more focused on developing general skills (such as problem solving, teamwork, and computer literacy) for broad, multi-faceted industries (such as health care, information technology, and hospitality services) and less focused on trade schooling to train for specific jobs (see *How Are CTE Courses Organized?*).[6]

At the secondary level, most U.S. students have access to some form of CTE. As of 2008, 94 percent of traditional comprehensive public high schools offered CTE courses, 71 percent had work-based learning or internships outside of school, and 27 percent hosted career academies (see *Where Can Students Take CTE?*).[7] However, only 4 percent of American public high schools are specialized career/technical schools,with most of these concentrated in a small subset of states. Further, recent trends toward college for all and high-stakes tests in reading and math have taken a toll on CTE course taking. Between 1990 and 2009 (the most recent year for which national data are available) the percentage of credits high school students earned from CTE decreased from 18 percent to 13 percent, while the percentage of credits in core academics increased.[8]

HOW ARE CTE COURSES ORGANIZED?

INDUSTRY CLUSTERS

An industry cluster is a broad group of careers related by skills or products. There are sixteen clusters, including Agriculture, Food, and Natural Resources; Business Management and Administration; Human Services; Manufacturing; and Science, Technology, Engineering, and Mathematics.

CAREER PATHWAYS

Within each cluster, career pathways represent smaller sub-industries. There are eighty standardized career pathways across all clusters. For example, in the Manufacturing industry cluster, Arkansas offers two pathways: production; and maintenance, installation, and repair. (There are four additional pathways in the Manufacturing cluster not currently offered in Arkansas, like quality assurance and health, safety, and environmental assurance.)

PROGRAMS OF STUDY

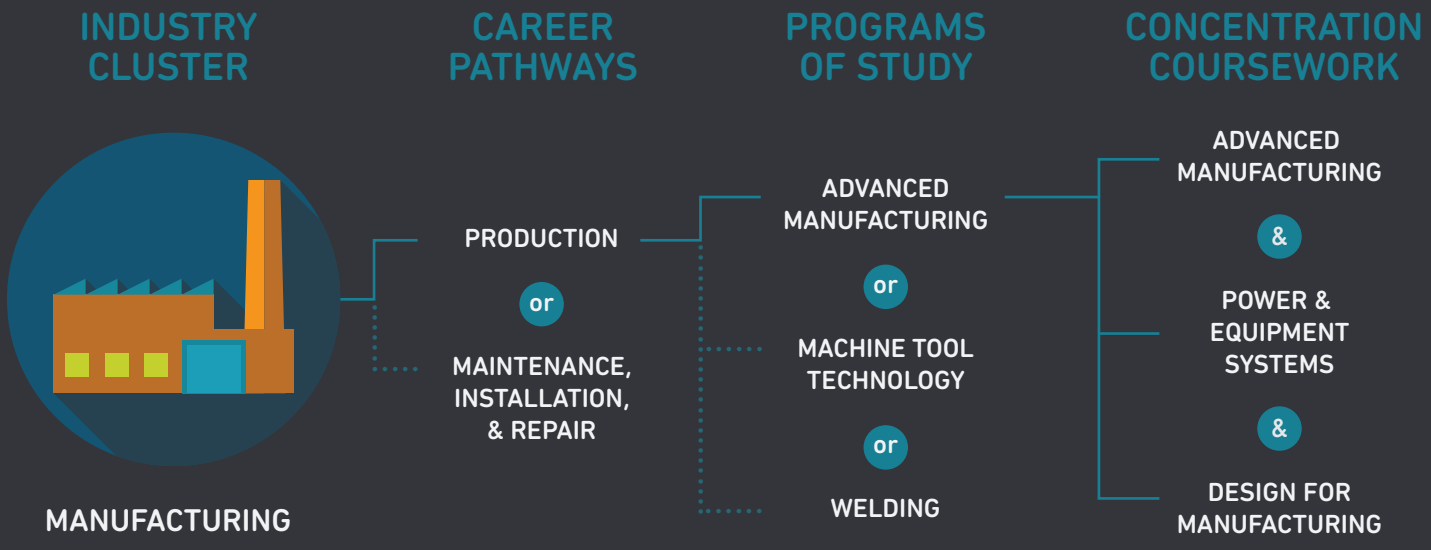
Each career pathway is comprised of one or more programs of study. These are groups of CTE courses, usually one or more core courses and several electives. Arkansas has six possible programs of study under the production career pathway, including advanced manufacturing, machine tool technology, and welding.

CONCENTRATION

Concentration means an Arkansas high school student earned three or more credits in a single program of study. For example, concentrating in the advanced manufacturing program of study requires an advanced manufacturing core course; potential electives include power and equipment systems and design for manufacturing.[9,10] Although Arkansas students must take at least six units of "career focus" coursework, they are not required to concentrate (see Section Two, *CTE in Arkansas*). Concentrators are identified by the state using course enrollment records.

Clusters and their associated career pathways are fairly standard across states; most use the National Career Clusters framework developed by the National Association of State Directors of Career Technical Education Consortium (NASDCTEc), also known as Advance CTE, or a slight modification thereof. Each state decides which programs of study to offer, what courses comprise each program, and the number of credits required for concentration.[11] (See Figure 1 for an example of how CTE courses are organized.)

FIGURE 1 | EXAMPLE OF CTE COURSE ORGANIZATION



WHERE CAN STUDENTS TAKE CTE?

Some students take CTE courses in their traditional high school, in addition to their academic classes. Others take courses through one of several alternative delivery models:

CAREER ACADEMIES
are schools-within-a-school with curricula that revolve around a group of related careers in a particular industry cluster or career pathway, such as finance or tourism. Students in academies still take core academic courses from their host school.

CAREER/TECHNICAL HIGH SCHOOLS
are self-contained schools that offer both CTE and traditional academics, with a focus on the former. Each school specializes in a particular industry and associated career pathways, and all students who attend these schools specialize in some area of CTE.

SPECIAL FOCUS SCHOOLS
offer coursework that emphasizes a content area (such as science, performing arts, or foreign language) that is not tied to a specific industry or cluster of careers.[12]

REGIONAL TECHNICAL CENTERS
are centralized locations for CTE coursework. One center serves multiple schools, and sometimes multiple districts. Students remain enrolled in their "home" high school and travel to the regional center to take specific CTE classes.

DUAL ENROLLMENT
allows students to take college courses (which can be either academic or CTE) while still enrolled in their "home" high school.

THE IMPACT OF CTE ON ACADEMIC AND LABOR MARKET OUTCOMES

Relatively little is known from existing research about who participates in CTE, and how participation impacts students. There are at least two reasons for this: First, many CTE studies are descriptive, or have methodological limitations that make it difficult to draw causal inferences from them. Second, many earlier studies were conducted in vastly different educational contexts—prior to the recent shifts in the focus and approach of CTE outlined earlier, and the rise of high-stakes accountability systems.[13] Still, it's worth reviewing what those studies reveal about the effects of CTE to contextualize this one.

In general, prior research has found that the effects of secondary CTE on career outcomes vary with the type and rigor of the program. Nevertheless, multiple studies have found that CTE has a positive association with wages and employment after high school, especially for young men.[14] For example, Hollenbeck and Huang (2014) found that secondary CTE participants earned higher wages during and after participation, and were 10 percentage points more likely to be employed than non-participants a year after exit. Similarly, consistent with prior studies, a 2004 study by the U.S. Department of Education found that high school students who graduate from career academies make 11 percent more per year than their non-career academy peers.[15,16]

Prior research also suggests that secondary CTE improves academic persistence. For example, several recent studies that rely on an instrumental variable approach find that CTE improves high school completion, and the aforementioned study of "career academies" found they reduce high school dropout rates (although that finding is not supported by a more rigorous randomized control trial, which found no effect on graduation outcomes).[17] Research on dual enrollment and early college programs also suggests that students who participate in them are more likely to graduate from high school, enroll in a four-year institution, and earn credits at the postsecondary level, and are less likely to take remedial courses.[18] However, the only experimental study to examine the impact of CTE on high school graduation found no evidence of a positive (or negative) effect.[19]

There is less evidence that CTE raises achievement. A 2004 evaluation of Perkins-funded programs concluded that "secondary vocational education itself is not likely to be a widely effective strategy for improving academic achievement or college attendance without substantial modifications to policy, curriculum, and teacher training"—weaknesses that lawmakers attempted to address in the Act's 2006 reauthorization.[20] Similarly, a 2013 study found no relationship between CTE coursework and achievement in math in high school, positive or negative, suggesting CTE is taught not to differentially change academic outcomes but rather to build applied skills for life beyond school without sacrificing academic learning.[21]

In short, evidence from the existing literature is inconclusive, mostly doesn't support causal inferences, often examines incomplete or imperfect outcomes, or is simply outdated because it studies older forms of CTE. This underpins the need for new and better studies like the one presented here.

SECTION TWO

DATA & METHODS

DATA SOURCES

This study uses a rich and unique data source made available through the Arkansas Research Center (ARC), which coordinates data for K–12, higher education, and workforce services. The ARC dataset contains student-level data on demographics; secondary school enrollment, course taking, attendance, and achievement; high school graduation; postsecondary enrollment; and employment and wages. It is supplemented with data from the National Center for Education Statistics, which adds information on school location (urban, rural, or suburban).

CTE IN ARKANSAS

Arkansas's education and workforce policy agenda is explicitly focused on career preparation and increasing training in areas of rapid and desired economic growth.[22] Its high school graduation requirements include "career focus" coursework. And, in 2015, the legislature passed and funded Act 1131, the Workforce Initiative Act, to expand the supply of workers ready for middle-skill jobs that require less than a bachelor's degree in the areas of advanced materials and manufacturing; agriculture, food and environmental science; biotechnology; bioengineering; life sciences; and information technology.[23]

What courses can (and must) students take?

Beginning with the class of 2014, Arkansas implemented "Smart Core," which requires that high school graduates complete four units each of English and math; three units each of social studies and science; half of a unit each of arts, economics, health and safety, physical education, and oral communication; and six units of career focus coursework.[24,25] Not all career focus courses are necessarily CTE courses—which classes satisfy the requirement are defined by a student's guidance counselor based on his work aspirations, and may include officially designated CTE courses such as principles of engineering or agricultural science (but also potentially additional academic courses or other electives as well). Arkansas currently offers CTE courses in sixty-two programs of study across forty-two career pathways (see Section One, *How Are CTE Courses Organized?*). Compared to other states, Arkansas' career focus requirements for graduation are fairly numerous.[26]

Where can students take CTE?

Approximately 90 percent of CTE students in Arkansas take their courses at a traditional high school. Some students receive instruction at specialized regional technical centers called Secondary Area Career Centers, or enroll in one of seven schools that host career academies.[27] Additionally, under Arkansas's dual enrollment law, secondary and postsecondary institutions have articulation agreements that allow high school students to take college courses for credit.[28]

What opportunities are available to CTE graduates?

As they complete their CTE coursework, students can earn industry-recognized credentials (e.g., "Microsoft Office Specialist" or "Adobe Certified Associate"), participate in apprenticeships that can lead to employment, and/or complete college-level credit at two-year colleges that link to postsecondary credentials and degrees. To assist students, the Arkansas Department of Career Education outlines possible certifications, postsecondary opportunities, and apprenticeships associated with each program of study. (For example, students who concentrate in advanced manufacturing might earn an industry-recognized certificate from the National Institute for Metalworking Skills, enroll in a certificate or associate's program in manufacturing technology at one of ten postsecondary institutions, or participate in the North Central Industrial Maintenance Apprenticeship program.)[29] Students can also earn a state-issued Arkansas Career Readiness Certificate, a credential recognized by employers throughout the state signifying that the holder possesses basic workplace skills. Finally, completing the Smart Core is also one of the eligibility criteria for Arkansas's college scholarship program.[30,31]

The ARC data are one of just a handful of longitudinal datasets in the United States that make it possible to follow students from the K–12 public education system into college and/or the workforce. This study follows three cohorts of students—those who started ninth grade in 2008, 2009, and 2010 (the high school classes of 2012 through 2014)—from ninth grade through the year after they should have graduated high school. Student observations include what courses they took in high school, whether they graduated, enrolled in a two- or four-year college, and/or became employed, and (if employed) their wages. Together, these cohorts include over 100,000 individual students and more than 350,000 student-year observations (Table 1).

The results presented in the following section and in the Appendices are estimated using a variety of analytic approaches. The primary approach is covariate-adjusted regression, controlling for student race/ethnicity, gender, free lunch status, dual language learner status, disability status, attendance, and discipline in ninth grade.[32] The results are robust to using instrumental variables (IV), and matching.[33] In particular, though only Cohort 3 was subject to the Smart Core graduation requirements, the fact that the requirement was long known means that there is random variation in the number and type of CTE courses being offered within schools across the years that all cohorts were in high school.

These methods place this study on a relatively short list of papers that move beyond descriptive data to suggest differences in trends or levels in outcomes. The approaches used here plausibly account for potential differences in the characteristics of students who do and do not elect to participate in CTE. Interested readers can find a more detailed discussion of these approaches in Appendix A, *Methodology*.

One caveat: The students in this study entered high school during the worst economic downturn in half a century and may have behaved differently as a result. For example, they may have been more likely to stay in school, take courses in areas with more direct application to the world of work, or view the opportunity cost of college and the challenge of paying back loans differently. It is difficult to account for these factors when analyzing the data, so readers should keep them in mind when interpreting the results.

TABLE 1 | COHORT DATA

	Cohort 1	Cohort 2	Cohort 3
One year after high school	2012-13	2013-14	2014-15
Twelfth Grade	2011-12	2012-13	2013-14
Eleventh Grade	2010-11	2011-12	2012-13
Tenth Grade	2009-10	2010-11	2011-12
Ninth Grade	2008-09	2009-10	2010-11
Number of students	36,090	35,985	32,358

Note: Cohort 3 (class of 2014) is the first graduating class that fulfilled the Smart Core requirements of six units of career focus coursework.

SECTION THREE

RESULTS

1 WHICH STUDENTS ARE TAKING CTE COURSES? WHICH COURSES – AND HOW MANY OF THEM – ARE THEY TAKING?

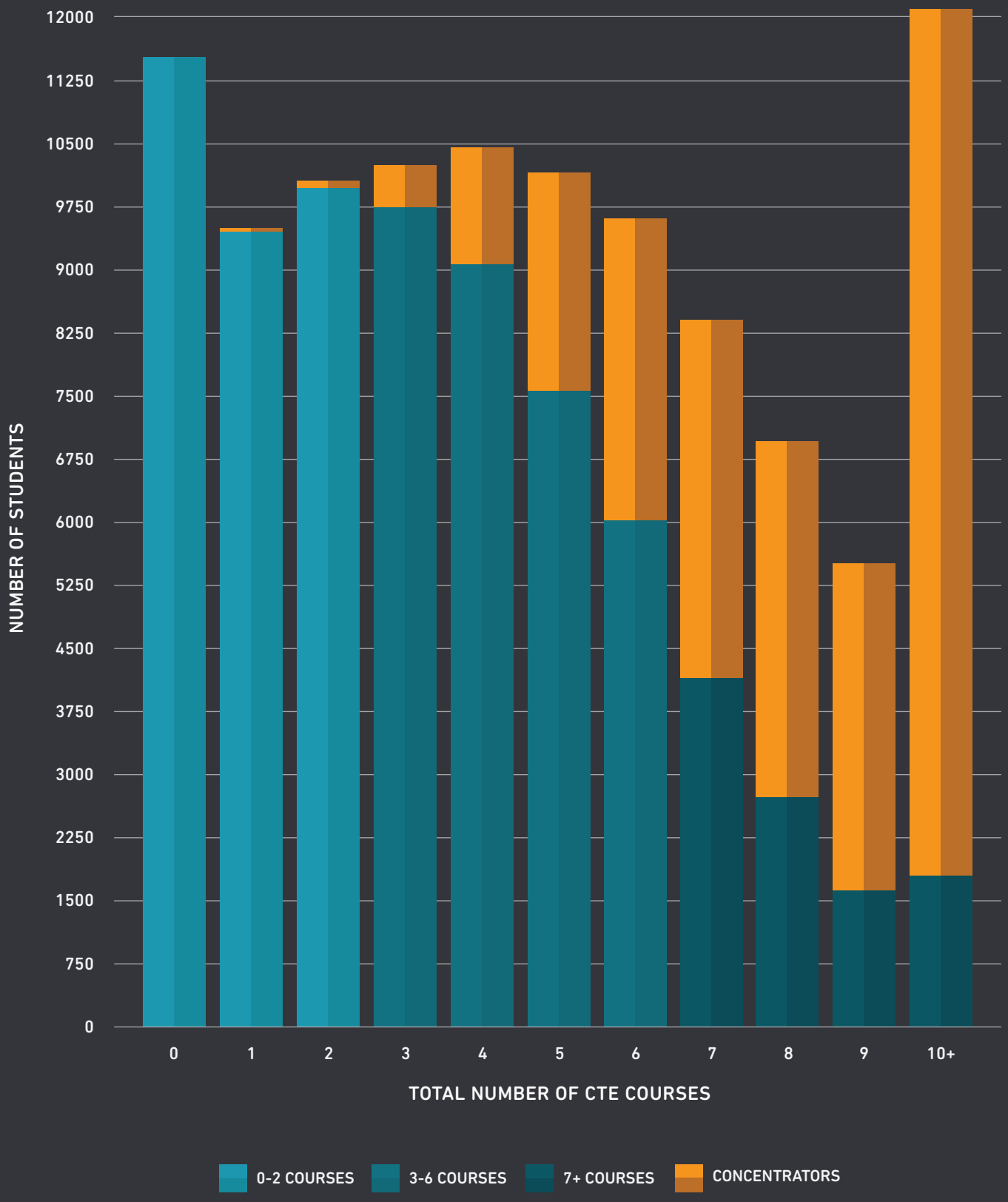
Most students participate in CTE.

Approximately 89 percent of Arkansas students took at least one CTE course in high school, and most students took several (Figure 2). Students (including those entering ninth grade before the implementation of Smart Core) took an average of 4.9 CTE courses during high school, compared with a national average of approximately 3.5.[34,35] Average exposure to CTE coursework increased between the first and last cohorts, presumably in anticipation of the Smart Core requirements. Across all cohorts, only 30 percent of students took two or fewer CTE courses; approximately 39 percent took between three and six, and the remaining 31 percent took seven or more.

Nearly 30 percent of Arkansas high school students were CTE concentrators, meaning they took three or more courses that were a part of a coordinated "program of study" (see Section One, *How Are CTE Courses Organized?*). Non-concentrators took an average of 3.4 CTE courses; concentrators took an average of 8.5.

Students took CTE courses in a variety of settings. There were a number of regional technical centers throughout the state, and of the students who took CTE, 10 percent took at least one class at such a center; participation was lowest in rural areas. The remaining 90 percent of students took CTE classes only at their comprehensive high school. An extremely small number attended one of seven secondary schools that house career academies.[36] Students were also availing themselves of postsecondary options: of the students who took CTE, a growing share participated in some form of dual enrollment while in high school—11 percent over all three cohorts, with an increase from 9 percent in the first cohort to 12 percent in the most recent one.[37]

FIGURE 2 | TOTAL NUMBER OF CTE COURSES TAKEN BY HIGH SCHOOL STUDENTS



Note: Data are for all three cohorts, only one of which was subject to the Smart Core requirements.

CTE participants are largely representative of the broader student population, but exposure differs by certain student characteristics.

Almost every student in Arkansas who entered high school in 2008, 2009, or 2010 took at least one CTE course while there (Figure 2). For the most part, no one characteristic (race/ethnicity, gender, etc.) stands out as drastically over-represented or underrepresented among the entire group of CTE course takers. However, there are differences when it comes to the *number* of courses taken. This is best shown by separating students into three levels of exposure: those who took between zero and two CTE courses, between three and six, and seven or more (Figure 3).[38]

Though trends in CTE course taking mirror the general demographics of the state, there are disproportionately more white students, and fewer Latino students, who take seven or more CTE courses and who concentrate (Figure 3). For example, white students make up 67 percent of the population but 70 percent of the CTE concentrators; Latino students make up 8 percent of the population but only 6 percent of the concentrators. African American students are fairly proportionately represented across all three course-taking levels and among concentrators, though a slightly higher share elects to take three to six courses.

Exposure to CTE courses also varies slightly with income, disability status, and gender (Figure 4). Students with disabilities make up about 12 percent of the high school population, but are overrepresented (14 percent) among those taking seven or more CTE courses, suggesting there might be some directing of students with disabilities into more CTE coursework. Said another way, on average, a student with a disability takes half a class more in CTE than his or her peers without disabilities.[39] Lower-income students are also slightly overrepresented in the highest level of CTE exposure (70 percent of the high-exposure group is low-income, compared to 68 percent of all students). Despite their greater exposure, however, neither group is overrepresented among concentrators, again perhaps suggesting that CTE is not perceived the same way for these students as it is for their peers.

One surprising finding is that males are underrepresented among those taking the greatest numbers of CTE courses, and among concentrators. This is not likely explained by males substituting college preparatory coursework for CTE to fulfill "career focus" requirements, since results show that males are less likely to enroll in college just after high school than females. Instead, this finding could reflect the changing nature of how CTE coursework is gendered. That is, CTE is less dominated now than in the past by stereotypically masculine types of work (like the traditional trades) and male participation in the labor force is also lower, which could explain some of this underrepresentation.[40] (For additional summary statistics, see Appendix B, Table B-1.)

The math achievement profile of those taking more *or* less CTE coursework also differs, and sometimes runs counter to the assumption that lower-performing students are tracked into these classes more often (Figures 5-A and 5-B). For example, although low achievers are slightly overrepresented in the seven-or-more courses category, so are middle achievers. And high achievers are overrepresented not in the minimal exposure category, as would be expected with tracking, but in the three-to-six course category.[41] Finally, both middle and high math achievers are slightly overrepresented among concentrators. So the evidence does not indicate that low-achieving students are being tracked into comparatively large numbers of CTE classes, and high-achieving students away from them. Instead, it suggests that CTE is considered a desirable elective for the majority of students, and middle and high achievers are not shying away from it.[42] The variation in coursework across the literacy achievement profile is even less suggestive of tracking; in fact, if anything it is the middle-achieving students who are overrepresented at all levels of CTE exposure.

FIGURE 3 | NUMBER OF CTE COURSES AND CONCENTRATOR STATUS BY RACE/ETHNICITY

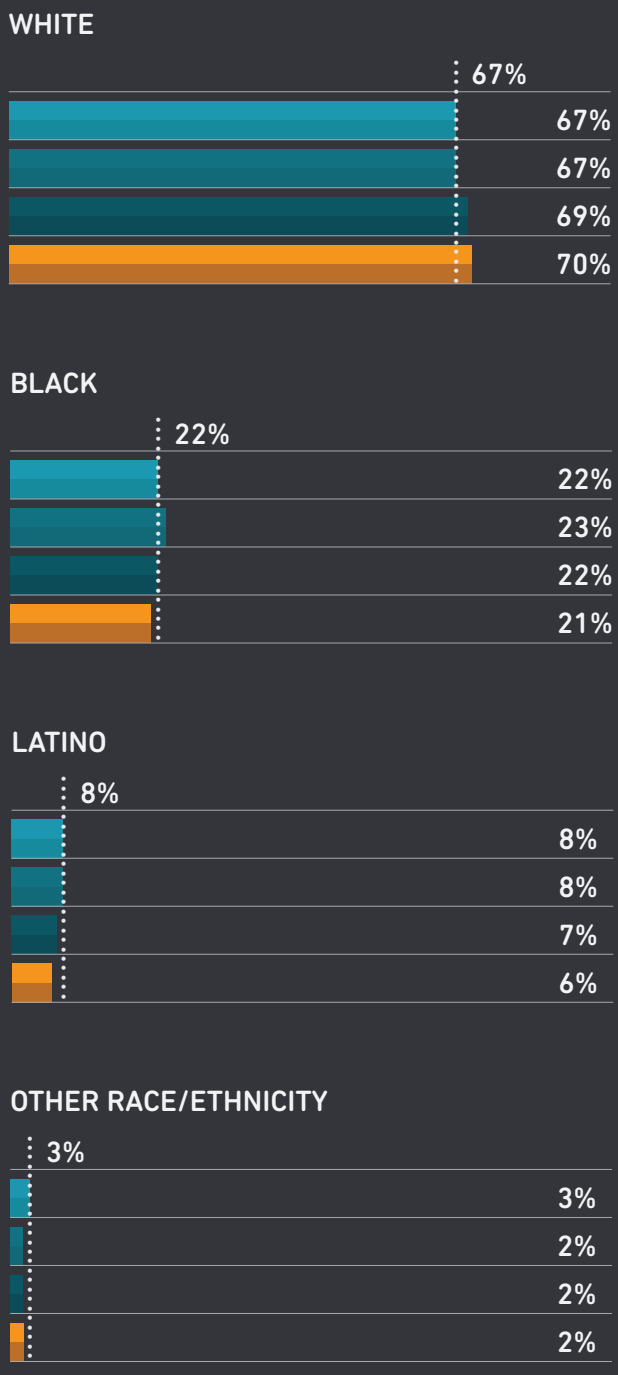
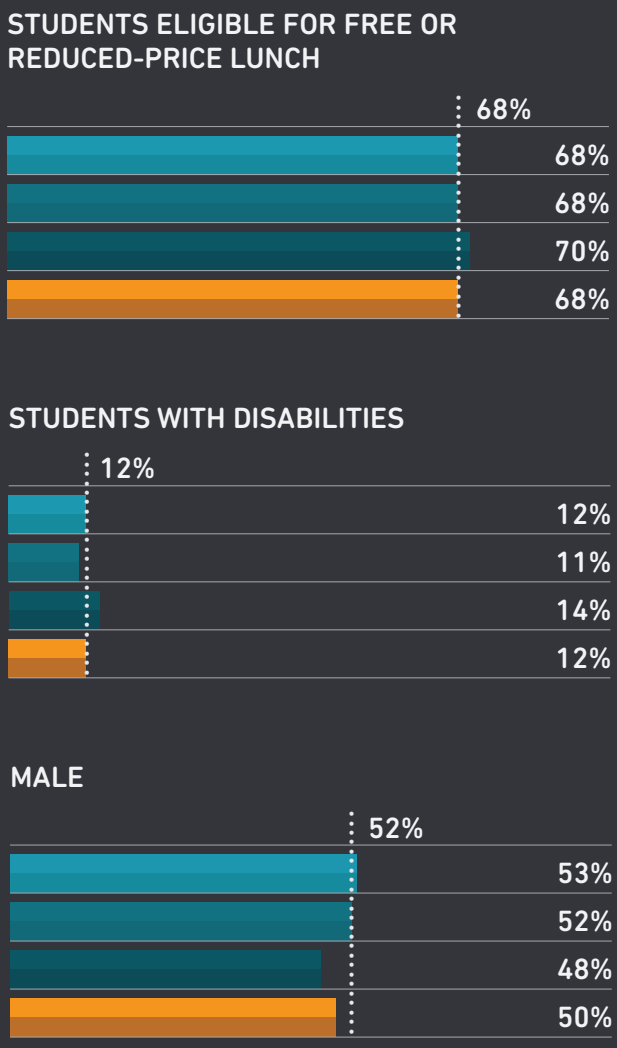


FIGURE 4 | NUMBER OF CTE COURSES AND CONCENTRATOR STATUS BY KEY DEMOGRAPHICS



ALL STUDENTS | 0-2 COURSES | 3-6 COURSES | 7+ COURSES | CONCENTRATORS

Note: Data are for all three cohorts. A student is considered free or reduced-price lunch eligible if he or she was identified as such at any point during high school, and not necessarily for the duration of high school, since identification in Arkansas is particularly dynamic.

FIGURE 5-A | NUMBER OF CTE COURSES AND CONCENTRATOR STATUS BY EIGHTH GRADE MATH TEST SCORES

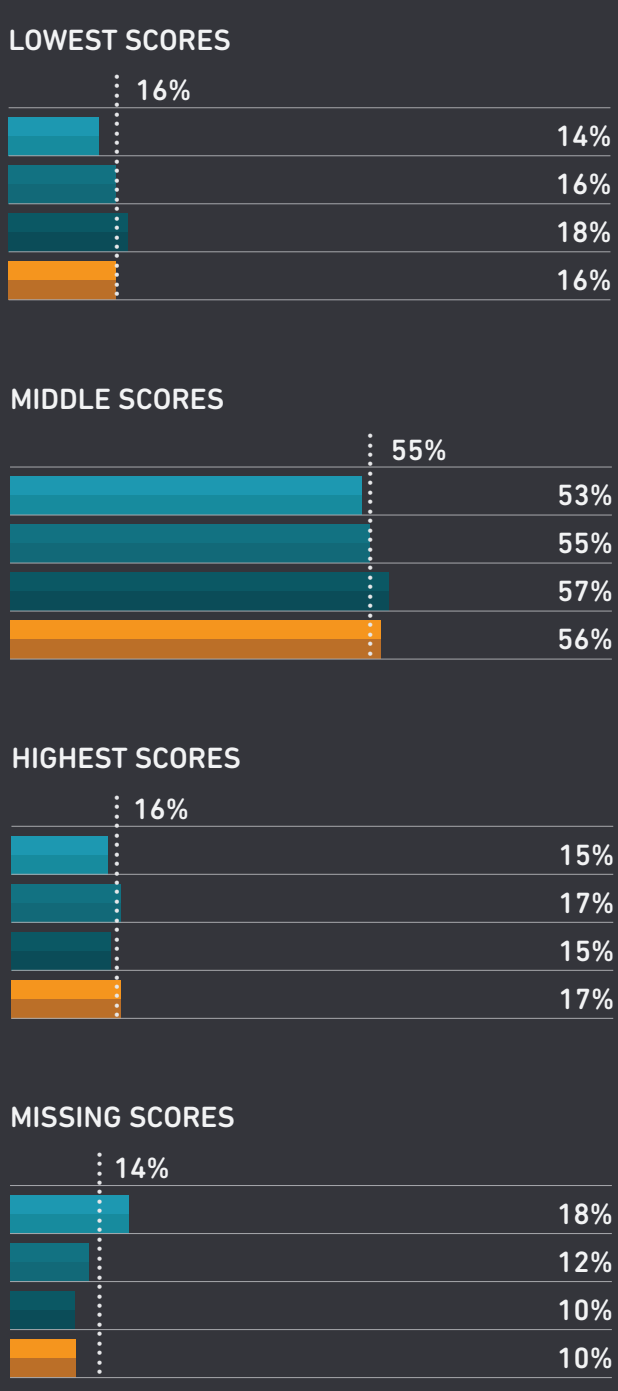
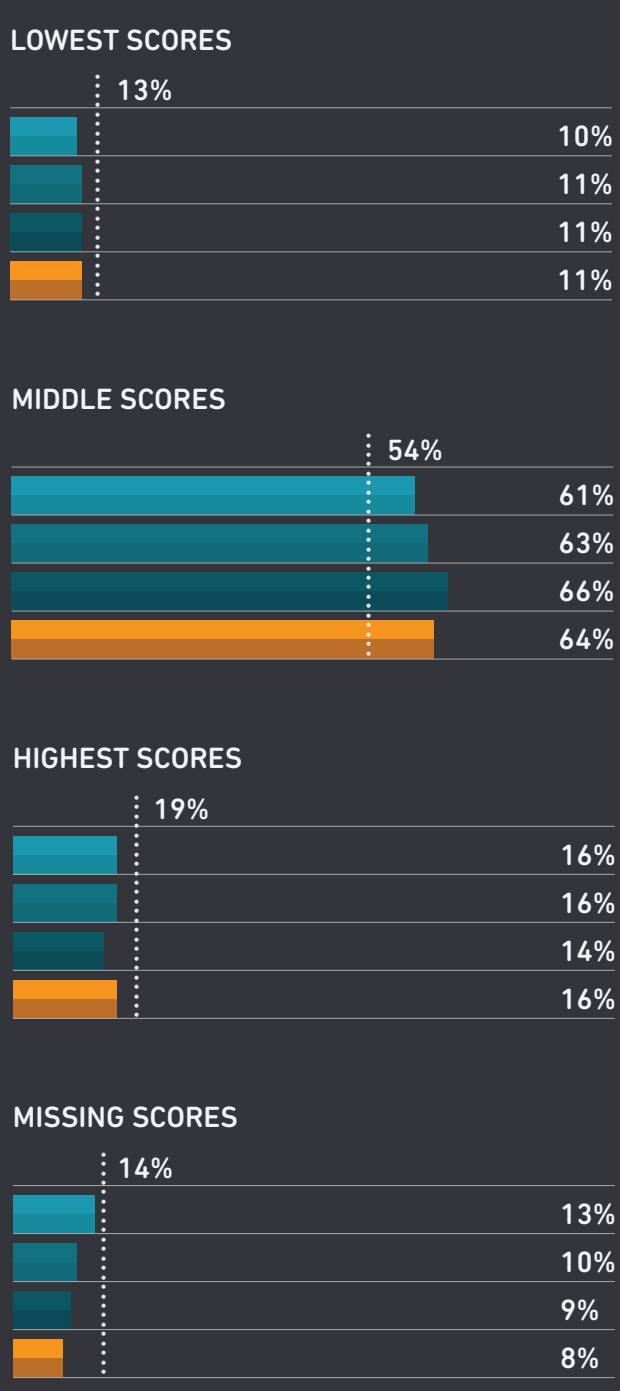


FIGURE 5-B | NUMBER OF CTE COURSES AND CONCENTRATOR STATUS BY EIGHTH GRADE LITERACY SCORES



ALL STUDENTS | 0-2 COURSES | 3-6 COURSES | 7+ COURSES | CONCENTRATORS

Note: Data are for all three cohorts. Three bins of performance on the eighth grade math and literacy state tests include: lowest (score below the 30th percentile, or more than half a standard deviation below the state mean score), middle (score between the 30th and 70th percentiles, or between half a standard deviation below and half a standard deviation above the state mean), and highest (70th percentile or higher, or more than half a standard deviation above the state mean).

Some CTE courses and clusters are more popular than others.

Of the 725,000-plus CTE courses taken by 100,000-plus students in the three cohorts, approximately 18 percent of all course taking was accounted for by just three classes: agricultural science and technology, computerized business applications, and family and consumer sciences (Figure 6). Of the students who took at least one of these three, fully one-third took no other CTE during high school. Other popular courses include: survey of agricultural systems, digital layout and design, digital imaging, computer applications, child development, food and nutrition, and parenting.

The most popular programs of study in which students *concentrated* follow similar, but not identical, patterns as those for course taking (Figure 7). Thirty-one percent of all concentrations were in the business program of study, 25 percent in family and consumer sciences, and 18 percent in agriculture. Falling well behind were medical professions (4 percent), junior reserve officer training corps (JROTC) (3 percent),and health sciences (3 percent).

As shown earlier in Figures 3–5, students who concentrate differ from the general student population but only slightly. The differences become much more pronounced when the industry cluster in which students concentrate is considered. Male students gravitate toward programs of study in five industries: Agriculture, Food, and Natural Resources; Architecture and Construction; Manufacturing; Science, Technology, Engineering, and Mathematics (STEM); and Transportation, Distribution, and Logistics. Female students disproportionately concentrate in Education and Training, Health Sciences, and Human Services. Students with disabilities concentrate in greater numbers in Manufacturing; and Transportation, Distribution, and Logistics (and are underrepresented in Finance, Health Sciences, and others). Finally, low-income students are overrepresented in Government and Public Administration; Law, Public Safety, Corrections, and Security; and Transportation, Distribution, and Logistics, and particularly underrepresented in Arts, A/V Technology, and Communications; Education and Training; and STEM. (For more, including the distribution by race/ethnicity, see Appendix B, Table B-2.)

FIGURE 6 | MOST POPULAR CLASSES IN TERMS OF TOTAL NUMBER OF COURSES TAKEN

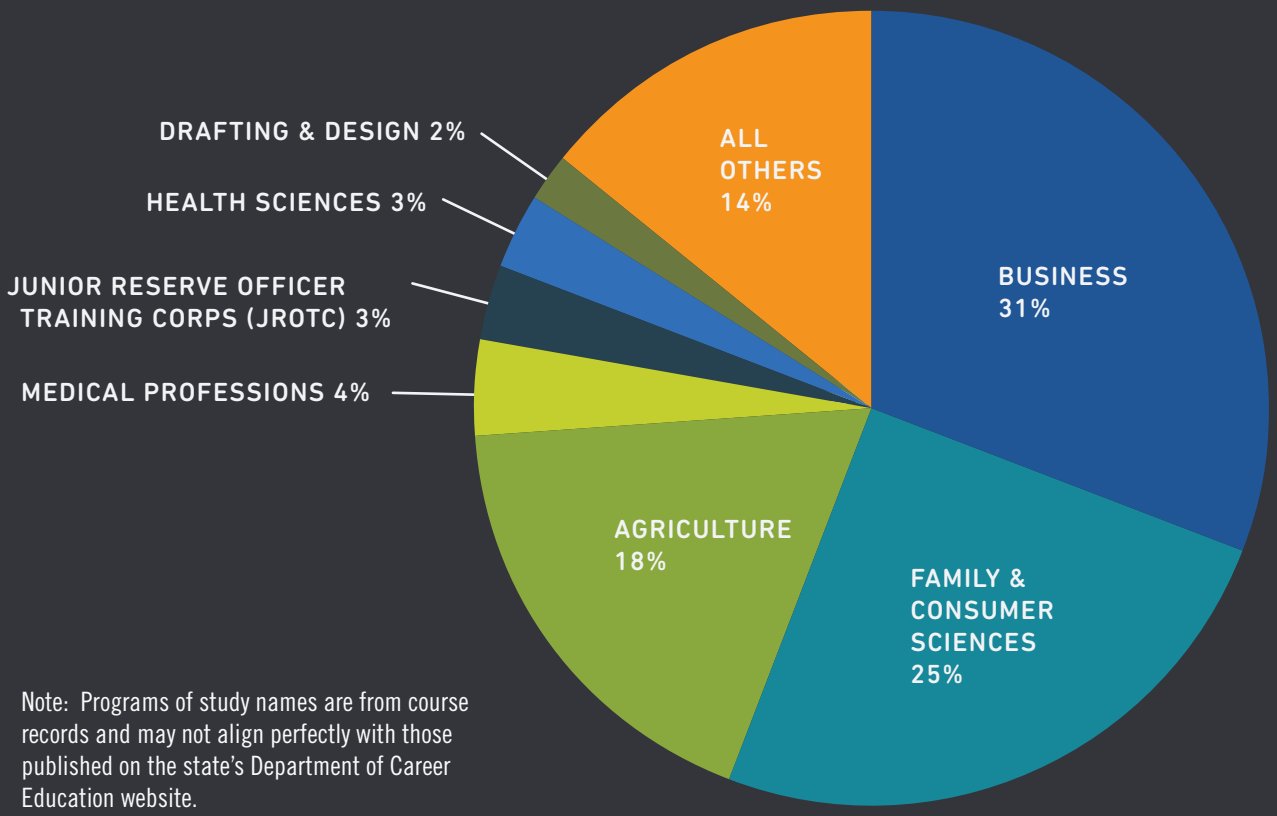
Approximately 18% percent of all course taking is accounted for by just three classes:

COMPUTERIZED BUSINESS APPLICATIONS

FAMILY AND CONSUMER SCIENCES

AGRICULTURAL SCIENCE AND TECHNOLOGY

FIGURE 7 | MOST POPULAR PROGRAMS OF STUDY FOR CONCENTRATORS



Note: Programs of study names are from course records and may not align perfectly with those published on the state's Department of Career Education website.

A NOTE ON REGIONAL DIFFERENCES

Many of the findings in this section hold no matter where in Arkansas a student lives, and trends in CTE participation generally mirror regional demographics.[43] For example, in city schools 37 percent of students are black, and a similar percentage fall into the low-, middle-, and high-course-taking buckets in urban schools. Similarly, Hispanic students in city schools are less likely to concentrate or take the highest number of CTE courses, similar to what is observed across the entire state.

However, regional differences are apparent in the types of courses students take. Some are consistent with conventional wisdom. For instance, courses in the agriculture cluster are more popular in rural and suburban areas than they are in cities. Similarly, health sciences courses are more popular in cities where population and health center densities are also high. Other trends are not so intuitive. For example, students in rural and suburban areas take information technology courses at higher rates than students in city schools. It's perhaps not surprising that courses in the STEM cluster are more popular in city schools than elsewhere, but so are courses in the Arts, A/V Technology, and Communications cluster.[44] Finally, suburban and rural students take more CTE courses across the board than their urban peers, and are more likely to concentrate. (See Appendix B, Table B-3.)

2 DOES GREATER EXPOSURE TO CTE IMPROVE EDUCATION AND EMPLOYMENT OUTCOMES?

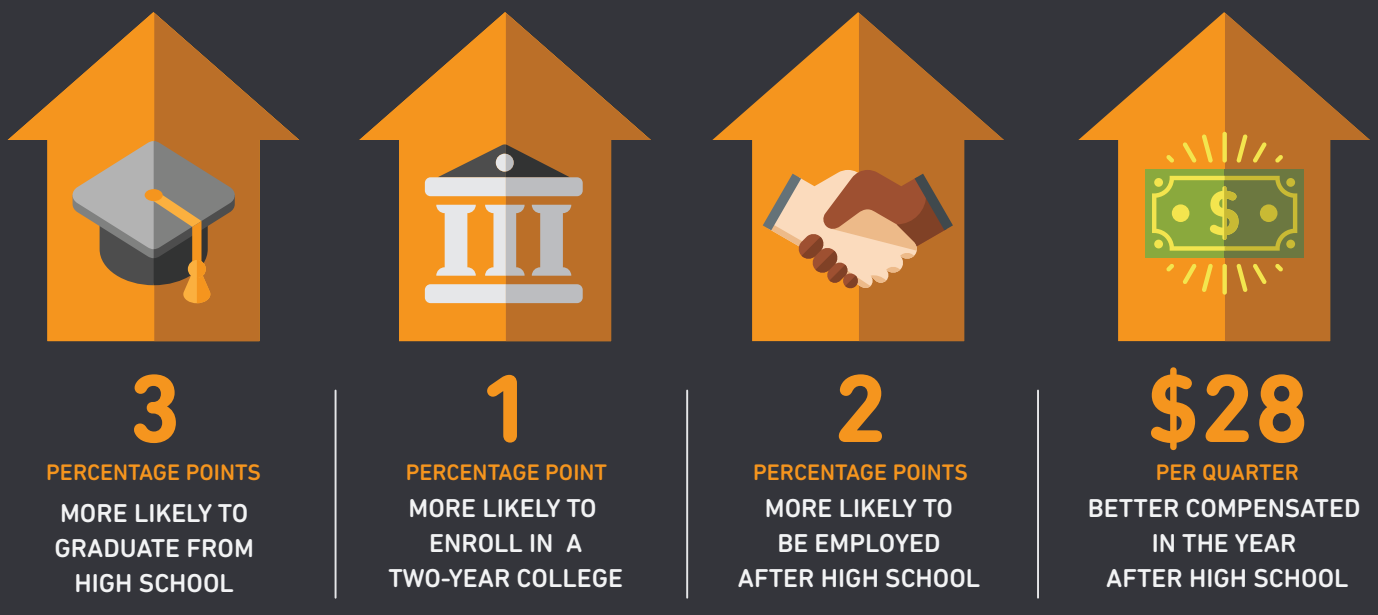
The more CTE courses students take, the better their education and labor market outcomes.

Greater exposure to CTE is associated with better outcomes for students. The average student takes 4.9 CTE courses during his or her high school career. In general, just one additional CTE course above the average increases a student's probability of graduating from high school by 3.2 percentage points and of enrolling in a two-year college the year after high school by 0.6 percentage points (Figure 8). Taking only one additional CTE course also increases a student's probability of being employed the year after high school by 1.5 percentage points and boosts his or her expected quarterly wage by $28 (3 percent higher than without the additional class).[45] (See Appendix B, Table B-4.)

Although an additional course is an easy way to think about differences in CTE participation, in fact exposure to CTE happens in less continuous terms. Recall that about 30 percent of high school students take between zero and two courses, nearly 40 percent take between three and six, and the remaining roughly 30 percent of students take seven or more (see Section Three, Figure 2). The largest benefits to an additional course accrue to those students in the latter two categories, with more modest benefits for those with only minimal exposure. For instance, students who take seven or more courses see boosts to the probability of graduating from high school by about 10 percentage points (total), compared to each additional course above the mean providing a boost of about 3 percentage points.[46]

Although the impact of additional CTE coursework varies slightly with particular student characteristics such as gender and income (Appendix B, Tables B-5, B-6, and B-7), the comparative magnitude of concentrating is even greater.

FIGURE 8 | BENEFITS OF CTE COURSEWORK



A NOTE ON EMPLOYMENT AND COLLEGE GOING

It is fairly common for Arkansas students to be simultaneously employed and enrolled in college. Of the students in this study, nearly three-quarters who enroll in college immediately after high school are also in the workforce, mirroring the national trend. [47]

Specifically, in the year immediately after high school graduation...

- 14 percent of Arkansas students were both employed and in college;
- 5 percent were in college, but not employed;
- 42 percent were employed, but not in college; and
- 36 percent were neither in college nor employed.

(For full summary statistics, see Appendix B, Table B-1.)

3 DOES CTE CONCENTRATION HAVE BENEFITS FOR STUDENTS? DO CERTAIN STUDENTS BENEFIT MORE THAN OTHERS?

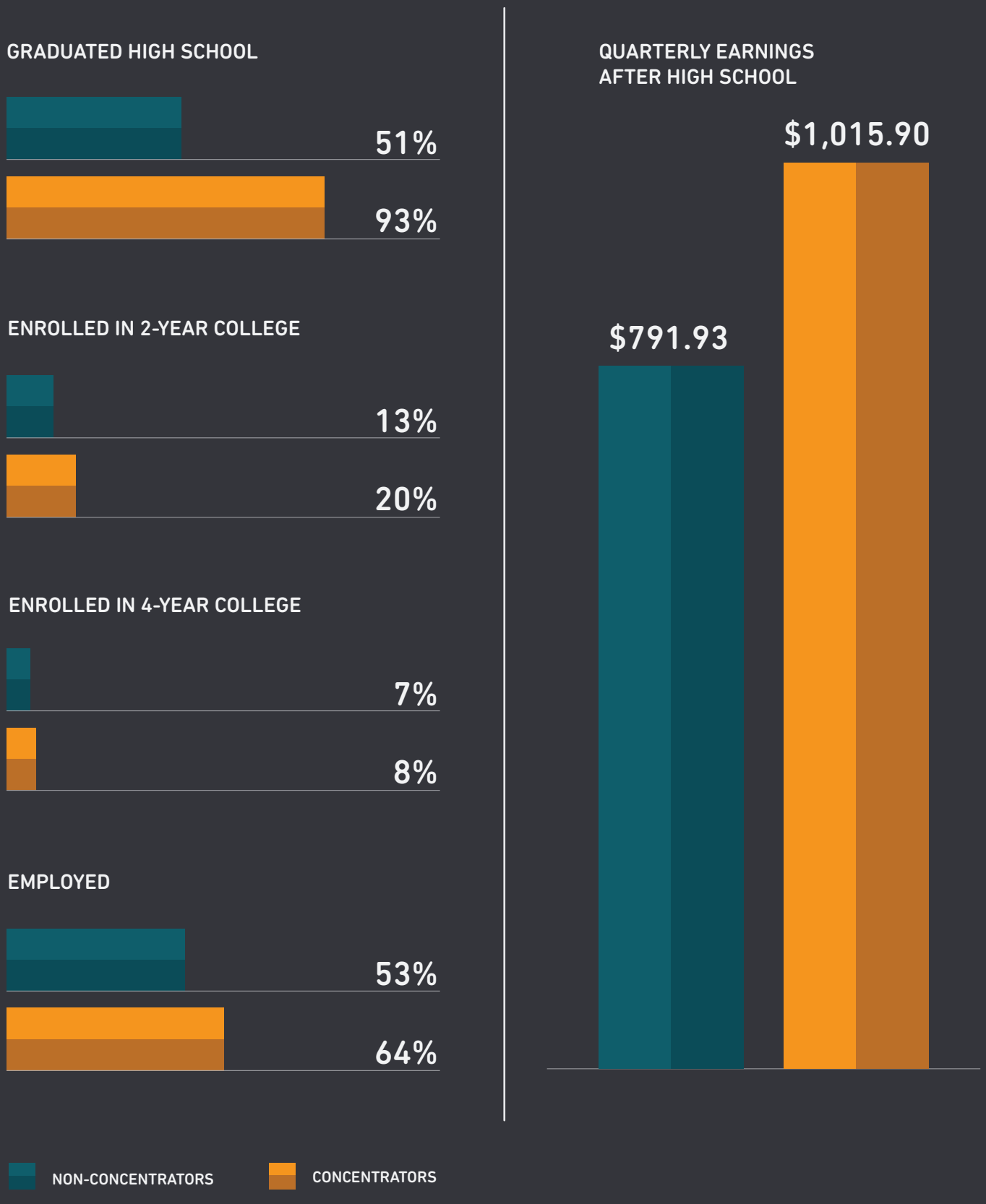
Although Arkansas' new graduation requirements specify that students must take six credits with a career focus, they do not require that the classes be related to one another (or even officially "CTE"). Students have the option of concentrating in a program of study by taking a sequence of three or more specific, related CTE classes (see Section One, *How Are CTE Courses Organized?*). In fact, nearly 30 percent of all Arkansas students are concentrators. As shown earlier in Figures 3–5, compared to the general student population, concentrators are slightly more likely to be white or female and slightly less likely to be Latino. Concentrators also have better attendance in the ninth grade and slightly higher eighth-grade literacy test scores (see Appendix B, Table B-1).

Concentrators differ from non-concentrators in outcomes, at least descriptively (Figure 9). The four-year high school graduation rate among concentrators is 93 percent, compared to 51 percent for non-concentrators. And 28 percent of concentrators enrolled in college (20 percent in a two-year school and 8 percent in a four-year school), compared to 20 percent of non-concentrators (13 percent and 7 percent in two- and four-year schools, respectively). The two-year college-going rate is especially high for students who concentrated in programs of study in Health Sciences; Law, Public Safety, Corrections, and Security; Manufacturing; and Transportation, Distribution, and Logistics clusters. The four-year rate is high for concentrators in Education and Training; Health Sciences; Information Technology; and STEM, among others. Finally, a greater percentage of concentrators are employed right after high school, and their wages are higher as well (see Appendix B, Table B-1).

Not surprisingly, the dual enrollment rate was quite high among all concentrators; these students were simultaneously enrolled in high school and college at rates well above the state average. Dual enrollment was particularly popular among students who concentrated in clusters with high two-year college enrollment rates (especially Health Sciences; Law, Public Safety, Corrections, and Security; Manufacturing; and Transportation, Distribution, and Logistics).[48]

But these differences in outcomes are simply descriptive. Concentrators take more CTE classes than non-concentrators (an average of 8.5 for concentrators compared to 3.4 for non-concentrators), and the previous section demonstrated that additional coursework has benefits. Are there advantages to concentration beyond those associated with additional coursework? Separately, does dual enrollment give CTE students a boost? The answer to both is yes.

FIGURE 9 | COMPARING OUTCOMES FOR CONCENTRATORS AND NON-CONCENTRATORS



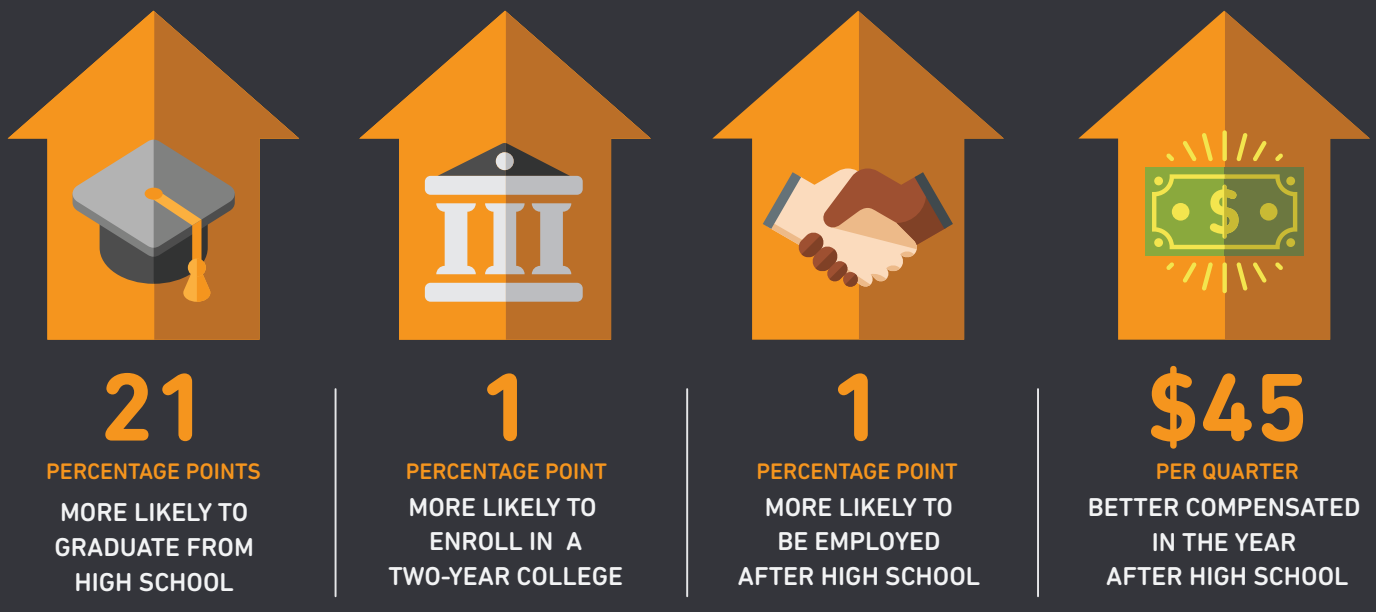
Concentrators see additional benefits beyond those associated with greater coursework, especially when it comes to high school graduation.

The previous results show that more CTE coursework improves education and labor market outcomes for students. But the benefit of concentrating is even greater in comparison. When compared to non-concentrators with similar demographics, prior test scores, and number of CTE courses taken, concentrators are 21 percentage points more likely to graduate from high school.[49] In the year after high school, they are 0.9 percentage points more likely to be employed (with average quarterly wages $45 higher), and 1.3 percentage points more likely to be enrolled in a two-year college (Figure 10).[50]

The effects of concentrating in CTE differ by gender, low-income status, and whether a student is in a "priority cluster," meaning one of the three prioritized by Arkansas state policy (Health Sciences, Information Technology, and STEM). (For more information see Section Two, *CTE in Arkansas.*) Consistent with previous research, all else equal, a male student sees a larger wage benefit to concentrating than a female student: after high school, a male concentrator earns $89 more quarterly compared to an otherwise identical male non-concentrator; however, a female concentrator sees no significant difference relative to a female non-concentrator. Compared to otherwise similar non-concentrators, male concentrators also see a greater boost to their likelihood of graduating high school than female concentrators do (23 percentage points compared to 19).[51]

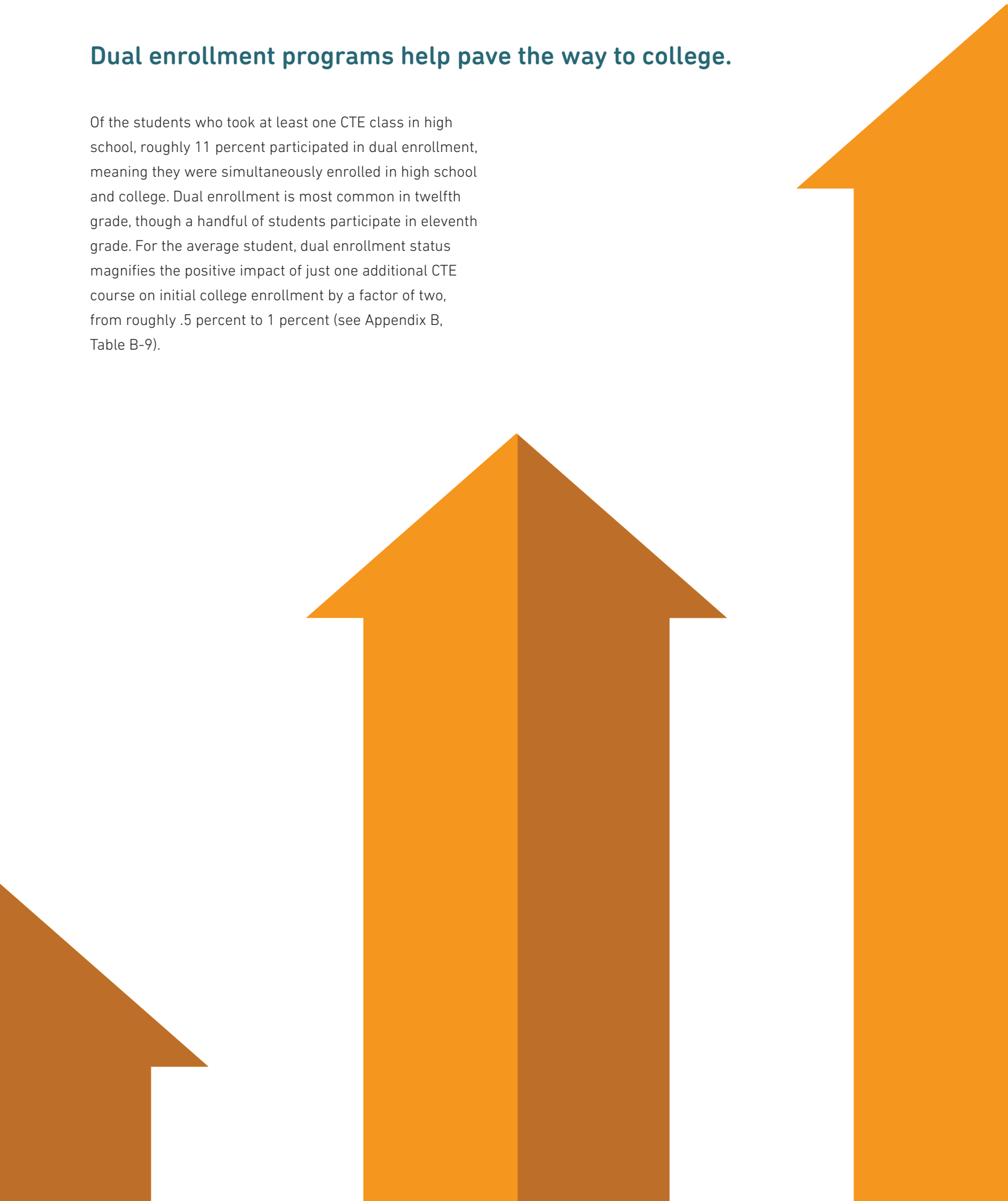
In addition, lower-income students see larger benefits to graduation from concentrating than their peers. Specifically, lower-income concentrators are 25 percentage points more likely to graduate than similar lower-income non-concentrators, while higher-income concentrators are only 17 percentage points more likely to graduate than their higher-income peers. Further, students who concentrate in a priority cluster are more likely to graduate than otherwise identical students who concentrate in other clusters (21 percentage points more likely versus 18) and receive a greater wage benefit ($47 versus no significant difference). (See Appendix B, Tables B-5, B-6, and B-8.)

FIGURE 10 | BENEFITS OF CONCENTRATION



Dual enrollment programs help pave the way to college.

Of the students who took at least one CTE class in high school, roughly 11 percent participated in dual enrollment, meaning they were simultaneously enrolled in high school and college. Dual enrollment is most common in twelfth grade, though a handful of students participate in eleventh grade. For the average student, dual enrollment status magnifies the positive impact of just one additional CTE course on initial college enrollment by a factor of two, from roughly .5 percent to 1 percent (see Appendix B, Table B-9).



SECTION FOUR

POLICY RECOMMENDATIONS

American education leaders face a tough challenge. The economic recovery is progressing, yet the match between school and work is imperfect. Students are supposed to be "college and career ready," but there is no clear definition of what that actually means—and if "career focus" coursework is not aligned with local labor markets, it may be a waste of time. Thus, the need for greater clarity is pressing.

Because of its high poverty rate, heterogeneous demographic and geographic profile, and diverse economic base, Arkansas is both a compelling case study on its own and a potentially useful model for other states. It also reveals lessons useful for federal policymakers, especially as they consider reauthorization of the Perkins Act.

WHAT ARE THE IMPLICATIONS FOR ARKANSAS?

FIRST, STAY THE COURSE.

The results presented here show clear benefits to increased exposure to CTE coursework and contradict the notion that CTE is a separate track for low-achieving, disadvantaged, minority, and/or non-college-bound students. Though students don't necessarily have to fulfill Arkansas's career focus requirement by taking CTE classes, early implementation of Smart Core shows that students are, in fact, doing precisely that. Together, these findings suggest maintaining Smart Core, and promoting the idea that CTE is for students of all backgrounds and ability levels.

SECOND, MAKE KNOWN THE BENEFITS OF CONCENTRATING.

The findings suggest that there are benefits to concentrating, especially for male, low-income, and "priority cluster" students. Granted, concentrators may be different from other students who take similarly high numbers of CTE courses in ways that are related to their success and not necessarily about the decision to concentrate. But for students who have already started a concentration, there are potential advantages from a signaling standpoint (and possibly actually technical skill) that could be realized by counseling students to actually finish their program of study. This is especially true for students in clusters without a clear postsecondary pathway, and those who do not see themselves as college-bound or who aren't interested in enrolling in college right away.

THIRD, EXPAND DUAL ENROLLMENT.

Dual enrollment magnifies the benefits of exposure to CTE. Even if students are self-selecting, and are already interested in clusters with a path to college (like education and health professions) dual enrollment can smooth the transition and reduce the financial and information cost of enrolling. Dual enrollment also encourages students to set career goals in high school, since early on they must consider whether their desired career pathways can be achieved through high school, or whether they need a two-year degree or certificate, or a four-year college program—and whether any of the requisite postsecondary coursework can be completed in high school.

FOR OTHER STATES?

Although the positive results of this study matter most for Arkansas, they also suggest that other states should **INVEST MORE HEAVILY IN SECONDARY CTE.**

The findings presented here demonstrate that CTE improves outcomes for students who focus their studies on a specific career. And the fact that CTE coursework in high school is not related to enrollment in a four-year college, either positively or negatively, should reassure leaders wary of promoting secondary CTE for fear that doing so comes at the expense of an advanced degree.

Consequently, as they have in Arkansas, state education and labor departments could take the following steps:

- Examine state labor market projections to identify high-growth industries, and support schools to offer coursework and programs of study that match them.
- Encourage (or require) secondary CTE coursework so students can earn industry-recognized credentials for in-demand careers while still in high school.
- Encourage (or require) students taking multiple CTE courses to choose a concentration, rather than taking courses in an ad-hoc manner.[52]
- Harmonize dual enrollment efforts by making credits "stackable" from high school into college, so that students can begin postsecondary credentials early and easily transfer credits as they progress.

FOR THE FEDERAL GOVERNMENT?

The recent approval of the Every Student Succeeds Act may be good news for the less divisive Perkins Act, which has been overdue for reauthorization since 2013.

REAUTHORIZING PERKINS, WITH THOUGHTFUL MODIFICATIONS, IS IMPERATIVE.

The 2006 reauthorization called for an increased focus on STEM education, yet in Arkansas it's one of the least-popular concentrations (only the hospitality and tourism, and education and training, industries had fewer concentrators). Further, STEM concentrators are disproportionately male, white, and urban. So despite Perkins' encouragement, concentrating in STEM is not appealing, not useful, or not possible due to limited course offerings and high academic barriers to entry. Subsequent iterations of Perkins' block grants should not only create stronger incentives to grow and sustain high-quality STEM programs, but also ensure that they are available to students everywhere.

In addition, recent markups of the reauthorization include language that favors career academy models. Yet evidence from Arkansas suggests that exclusively focusing on these models may be overzealous: Most students take CTE at their comprehensive high school, and these students see positive results. Those crafting the Perkins reauthorization should be less prescriptive: allow states flexibility in the delivery method, and let them consider cost and context as well. At the same time, any new legislation should incentivize states to use research-based strategies when determining where and how to offer CTE (and to evaluate their decisions after the fact).

As the results presented here show, high school CTE improves outcomes for students seeking to start their careers quickly, but is no hindrance to those who want additional academic training. Granted, even the best CTE policy requires thoughtful implementation, since there is still risk that low-performing students will be "tracked" into courses that don't leave them well prepared for college. But states can mitigate this risk by offering courses and programs of study that appeal to students of varying interests and abilities, and counseling all students into them. In light of the central findings therefore, the strongest and most general recommendation is this:

MAKE HIGH-QUALITY, LABOR-MARKET-ALIGNED CTE AVAILABLE TO ALL STUDENTS, AND ENCOURAGE (AND ENABLE) THEM TO PARTICIPATE.

APPENDIX A

METHODOLOGY

In this analysis, I define CTE participation in a number of ways in order to distinguish among effects that could be related to taking any CTE coursework in high school, relative to those that are related to increased exposure to CTE, or choosing to concentrate in a certain technical area. Specifically, I define CTE exposure as the number of CTE courses a student takes while in high school, the number of years in which they take at least one CTE course, as well as a binary measure of whether a student concentrated in a program of study as part of their overall CTE course taking.

Three analytic approaches were used to understand the CTE landscape and generate estimates for the effects of CTE on student educational attainment, college enrollment, employment, and wages. In the first approach I generated summary statistics on the prior performance, demographic characteristics, CTE participation measures, and educational and labor market outcomes of students. In order to make inferences about how student characteristics or CTE participation may relate to later outcomes, I fit a series of regression models that allowed me to understand the relationship between measures of CTE participation and student outcomes while accounting for a host of observable characteristics of the students themselves. These models capitalize on a rich set of demographic and educational covariates that are available in the dataset. For the first two of the three graduation cohorts these covariates include middle school measures of achievement that necessarily predate student exposure to CTE in high school. These data is not available for the third cohort, but results are not sensitive to the exclusion of this cohort. Specifically, I fit the following statistical model using OLS:

$$Y_{igr} = \alpha_0 + \alpha_1 CTE_{igr} + \mathbf{X'_i}\boldsymbol{\gamma} + \pi_g + \tau_r + \varepsilon_{igrc} \quad (1)$$

In this model, Y_{igr} is the generic outcome *Y* for a student *i* in cohort *g* from residentially assigned school *r*. In this model, the parameters π_g and τ_r represent fixed effects for cohort and residentially assigned school, respectively, and I include a generic indicator for exposure to CTE, which differs across specifications. The parameter of focal research interest is α_1, which represents the population relationship between CTE participation on the given outcome on average in the population. The vector X'_i contains a host of student-level covariates that may influence student selection into CTE coursework or concentration status. These covariates include binary indicators for race/ethnicity and gender, as well as indicators for disability status, free or reduced-price lunch eligibility, whether a student is an English language learner, whether a student was ever suspended, his or her attendance rate, whether he or she was employed while in high school, and the share of coursework taken at a regional technical center. For the first two of the three cohorts I also include measures of math and literacy tests scores from middle school to control for motivation and prior demonstrated ability. All of my estimates use heteroscedasticity-robust standard errors clustered at the high school level to account for a correlation of errors related to attending the same high school. Results are robust to using only the two cohorts for which I have middle school measures, or using all three cohorts and conditioning only on ninth grade measures. The results presented in this analysis focus on students in all three cohorts who could be observed at least one year after anticipated on-time high school graduation. Models that estimate the effects of completing a CTE concentration also include student-level controls for the total number of CTE courses taken in high school.

OLS estimates of the effects of CTE are likely biased if they don't account for important unobserved attributes of students who elect different levels of CTE (estimated as α_1 in equation (1)). The models account for much of this in the use of prior test scores as a proxy for ability and motivation. However, I also employed an instrumental variables (IV) approach, which capitalized on the fact that schools and districts had to ramp up their "career focus" course offerings so that the class of 2014 could satisfy the Smart Core requirements for graduation (six or more courses with a career focus, which includes CTE). I use within-school and across-year variation in the number of different CTE courses offered as an instrument for CTE course taking, and then use the exogenous portion of the variation in course taking to estimate the effects of taking an additional course on student outcomes. This approach applies only to the analysis that looks at the effects of additional course taking and cannot be extended to the analysis of the effects of being a concentrator since I do not have a suitable instrument for becoming a concentrator. Using course offerings as an instrumental variable provides a first-stage F statistic of greater than fifty, and thus satisfies conventionally accepted definitions of a strong instrument.

Finally, in a third approach I created two matched groupings of students, one that participated in CTE, and the other that did not. These matches were based on characteristics such as gender, race/ethnicity, free lunch eligibility, disability and English language learner status, as well as measures of standardized test performance and attendance in the eighth grade. The assumption that I made in creating these matched groups of students is that pre-high school measures of performance, engagement, and educational need should account for most of whether students participate in CTE in high school, and net of these characteristics, all remaining differences in their outcomes should be attributable to their differences in CTE participation. Matching results for the outcomes associated with being a CTE concentrator are presented in Appendix B, Table B-10. Some estimates are smaller, but most are comparable and remain statistically significant. The most notable difference is that the wage effects of concentration are smaller and less precisely estimated.

In the matching analysis I follow the analytic strategy of Iacus, King, and Porro, and use coarsened exact matching (CEM) to produce plausibly causal estimates of the effect on outcomes of participating in a CTE program in Arkansas during high school.[53] Choosing this non-parametric matching method favors variables suspected to estimate choices to select into CTE participation in a way that does not force a functional form on the selection process, in order to predict membership in treatment or control groups. Using sensible substantive judgments, I create "coarsened" categories within these covariates and stratify participants. The intersection of these strata creates cells within which treated and control units are similar in their values of the multiple covariates, and I therefore assume they are also homogenous in the risk of selection (the assumption of "unconfoundedness"). I assume that the remaining variation in the outcomes is plausibly exogenous and I can identify and estimate the causal effect of CTE participation on students' outcomes using CEM by re-fitting my model (1), but incorporating weights generated by the CEM algorithm to weight treatment and control units appropriately within each of the matched strata.[54,55]

By combining descriptive statistics, OLS with fixed effects for location and cohort, instrumental variables, and matching, I generated a set of evidence that can inform the answers to the research questions, with the potential that these multiple approaches can provide confirmatory evidence that, regardless of approach, the findings point in the same direction. This work makes an important contribution to the policy conversation insofar as it is among a relatively short list of papers that move beyond simple use of descriptive data to suggest differences in trends or levels in outcomes. Specifically, the approaches used here plausibly account for potential differences in the characteristics of students who do and do not elect to participate in CTE. The biggest threat to the sorts of conclusions that we'd like to draw regarding the impact of CTE is from the possibility that students who participate in CTE are somehow fundamentally different from those who do not participate. The ability to control for factors as far back as middle school, and the use of quasi-experimental methods, improve my confidence in the strength of these findings.

APPENDIX B

SUPPLEMENTAL ANALYSES & RESULTS

TABLE B-1 | SUMMARY STATISTICS

	All Students	Any CTE Class	Low Exposure	Moderate Exposure	High Exposure	Concentrator
(A) CONTROLS						
Male	0.515	0.511	0.53	0.52	0.482	0.497
White	0.673	0.675	0.667	0.666	0.694	0.704
Black	0.223	0.224	0.215	0.232	0.22	0.213
Latino	0.077	0.075	0.084	0.076	0.066	0.062
Asian	0.014	0.013	0.017	0.012	0.01	0.009
Low Income	0.683	0.683	0.678	0.677	0.702	0.675
Students with Disabilities	0.119	0.116	0.115	0.112	0.137	0.123
English Language Learner	0.041	0.039	0.047	0.04	0.033	0.03
Standardized Math Score, Grade 8	0.016	0.015	0.037	0.019	-0.025	0.015
Standardized Literacy Score, Grade 8	0.016	0.018	0.028	0.019	-0.007	0.022
Total Days Absent, Grade 9	9.962	9.735	12.186	9.058	8.215	7.496
(B) CTE EXPOSURE						
Years in CTE Courses	2.724	3.062	0.86	3.732	4	3.917
Total CTE Courses Taken	4.935	5.546	1.435	5.324	9.97	8.459
Concentrator	0.297	0.334	0.012	0.311	0.739	1
(C) OUTCOMES						
Graduated High School, 4 Years	0.632	0.689	0.38	0.732	0.868	0.925
Graduated High School, Ever	0.65	0.708	0.396	0.751	0.887	0.937
Initially Enroll, Any College	0.216	0.23	0.169	0.237	0.255	0.272
Initially Enroll, 2-Year College	0.149	0.16	0.105	0.165	0.194	0.2
Initially Enroll, 4-Year College	0.073	0.077	0.07	0.078	0.068	0.081
Initially Employed	0.565	0.596	0.464	0.619	0.637	0.639
Initial Average Quarterly Wage	858.65	905.2	682.42	926.72	1027.02	1015.9
Initial Quarters Worked	1.5	1.59	1.2	1.65	1.74	1.73
Literacy Z-Score, Grade 11	0	-0.01	0.28	-0.02	-0.16	-0.1
Missing Literacy Score	0.33	0.27	0.58	0.23	0.11	0.12
Employed, Grade 11	0.33	0.36	0.22	0.38	0.42	0.39
Average Quarterly Wage, Grade 11	393.72	430.7	252.56	459.69	508.45	461.62
N (students)	104,433	92,930	30,974	40,544	32,915	29,981

Notes: Mean values of key variables are shown for all students in the ninth grade cohorts who entered in the fall semesters of 2008 through 2010. "Any CTE class" means a student took at least one CTE class while in high school; "low exposure" means a student took two or fewer classes, "moderate exposure" between three and six, and "high exposure" seven or more. "Concentrators" take three or more classes in a particular course of study; they are identified by the state using course enrollment records. Statistics that range between zero and one are proportions/percentages. N (student-year observations) = 330,259.

TABLE B-2 | SUMMARY STATISTICS FOR CONCENTRATORS BY INDUSTRY CLUSTER

	Agriculture, Food, and Natural Resources	Architecture and Construction	Arts, A/V Technology, and Communications	Business Management and Administration	Education and Training	Finance	Government and Public Administration	Health Sciences
Male	0.739	0.863	0.474	0.487	0.143	0.493	0.571	0.228
White	0.857	0.645	0.709	0.638	0.712	0.7	0.544	0.628
Black	0.081	0.239	0.171	0.255	0.126	0.218	0.384	0.238
Latino	0.04	0.083	0.09	0.076	0.119	0.051	0.032	0.094
Low Income	0.653	0.636	0.556	0.659	0.558	0.595	0.799	0.675
Students with Disabilities	0.186	0.18	0.111	0.114	0.085	0.045	0.185	0.062
English Language Learners	0.023	0.044	0.05	0.046	0.061	0.027	0.016	0.058
Years in CTE Courses	3.913	3.959	3.849	3.913	3.88	3.835	3.891	3.982
Total CTE Courses Taken	9.037	7.968	6.883	8.318	7.914	7.836	6.764	9.439
Dual Enrollment Status	0.103	0.107	0.158	0.134	0.167	0.205	0.086	0.259
Graduated High School	0.94	0.931	0.944	0.946	0.958	0.96	0.913	0.95
Initially Enroll, 2-Year College	0.154	0.107	0.246	0.179	0.198	0.235	0.117	0.378
Initially Enroll, 4-Year College	0.064	0.093	0.101	0.087	0.116	0.129	0.041	0.114
Initial Average Quarterly Wage	1128.575	1192.029	864.05	949.837	917.896	907.483	894.796	936.314
Literacy Z-Score, Grade 11	-0.229	-0.265	0.206	0.003	0.247	0.243	-0.263	0.108
N (students)	5458	532	724	2458	302	882	705	2094
	Hospitality and Tourism	Human Services	Information Technology	Law, Public Safety, Corrections, and Security	Manufacturing	Marketing	Science, Technology, Engineering, and Mathematics	Transportation, Distribution, and Logistics
Male	0.381	0.3	0.479	0.562	0.895	0.45	0.829	0.948
White	0.562	0.648	0.712	0.643	0.751	0.6	0.686	0.717
Black	0.326	0.261	0.201	0.256	0.172	0.286	0.153	0.186
Latino	0.084	0.061	0.056	0.072	0.058	0.086	0.119	0.086
Low Income	0.72	0.724	0.644	0.738	0.672	0.622	0.581	0.731
Students with Disabilities	0.169	0.166	0.101	0.128	0.248	0.096	0.106	0.288
English Language Learners	0.041	0.036	0.027	0.03	0.033	0.052	0.076	0.048
Years in CTE Courses	3.916	3.923	3.92	3.904	3.927	3.83	3.9	3.942
Total CTE Courses Taken	8.722	8.59	8.466	7.964	8.114	6.984	7.56	7.849
Dual Enrollment Status	0.13	0.127	0.156	0.271	0.355	0.127	0.256	0.285
Graduated High School	0.943	0.912	0.921	0.917	0.912	0.9	0.932	0.92
Initially Enroll, 2-Year College	0.203	0.164	0.208	0.369	0.416	0.138	0.286	0.415
Initially Enroll, 4-Year College	0.083	0.069	0.11	0.047	0.099	0.057	0.124	0.07
Initial Average Quarterly Wage	953.913	938.11	895.988	1115.525	1348.744	1249.213	853.438	1480.28
Literacy Z-Score, Grade 11	-0.251	-0.189	0.067	-0.166	-0.55	0.06	0.106	-0.591
N (students)	541	7691	4641	418	899	1431	585	620

Notes: Mean values of key variables are shown for all students in the ninth grade cohorts who entered in the fall semesters of 2008 through 2010 and who indicated a CTE concentration in or before their final year in high school.

TABLE B-3 | SUMMARY STATISTICS BY REGION

PANEL A	City	Suburb	Rural
Male	0.45	0.499	0.49
White	0.415	0.839	0.7
Black	0.368	0.116	0.227
Latino	0.182	0.028	0.052
Asian	0.022	0.007	0.009
Low Income	0.688	0.667	0.636
Students with Disabilities	0.102	0.116	0.115
English Language Learners	0.114	0.008	0.02
Standardized Math Score, Grade 8	-0.005	0.022	0.07
Years in CTE Courses	3.2	3.4	3.3
Total CTE Courses Taken	6.3	7.2	7.2
Concentrator	0.695	0.872	0.823
Graduated High School, 4 Years	0.976	0.969	0.975
Initially Enroll, 2-Year College	0.119	0.224	0.233
Initially Enroll, 4-Year College	0.084	0.11	0.087
Initially Employed	0.664	0.641	0.645
Initial Average Quarterly Wage	1013.3	1032.7	1026.7
Employed, Grade 11	0.439	0.373	0.411
PANEL B - INDUSTRY CLUSTERS	**City**	**Suburb**	**Rural**
Agriculture, Food, and Natural Resources	0.06	0.296	0.187
Architecture and Construction	0.056	0.017	0.036
Arts, A/V Technology, and Communications	0.078	0.008	0.029
Business Management and Administration	0.03	0.019	0.022
Education and Training	0.022	0.006	0.011
Finance	0.027	0.012	0.023
Government and Public Administration	0.047	0.021	0.051
Health Sciences	0.149	0.047	0.108
Hospitality and Tourism	0.021	0.008	0.012
Human Services	0.188	0.256	0.207
Information Technology	0.122	0.236	0.191
Law, Public Safety, Corrections, and Security	0.027	0.01	0.014
Manufacturing	0.027	0.021	0.031
Marketing	0.066	0.007	0.026
Science, Technology, Engineering, and Mathematics	0.042	0.007	0.013
Transportation, Distribution, and Logistics	0.03	0.02	0.031

Notes: Mean values of key variables are shown for all students in the ninth grade cohorts who entered in the fall semesters of 2008 through 2010.

TABLE B-4 | OLS ESTIMATES OF THE EFFECT OF EXPOSURE TO CAREER AND TECHNICAL EDUCATION

	Graduated High School, 4 Years	Graduated High School, Ever	Initially Enroll, Any Postsecondary	Initially Enroll, 2-Year College	Initially Enroll, 4-Year College	Initially Employed	Initial Average Quarterly Wage
(A) Total CTE courses	0.051*** (0.001)	0.051*** (0.001)	0.007*** (0.001)	0.007*** (0.000)	-0.000 (0.000)	0.016*** (0.001)	31.974*** (1.526)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433
(B) Total CTE courses, controlling for concentrator status	0.032*** (0.001)	0.033*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	-0.000 (0.000)	0.015*** (0.001)	27.918*** (1.860)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433
(C) Concentrator	0.210*** (0.004)	0.203*** (0.004)	0.013*** (0.004)	0.013*** (0.004)	0.001 (0.003)	0.009* (0.005)	45.205*** (11.922)
N	330,259	330,259	330,259	330,259	330,259	330,259	330,259
(D) Concentrator, controlling for dual enrollment status	0.210*** (0.004)	0.203*** (0.004)	0.012*** (0.004)	0.013*** (0.004)	0.001 (0.003)	0.009* (0.005)	45.152*** (11.922)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433
(E) Concentrator, with cluster fixed effects	0.228*** (0.004)	0.221*** (0.004)	0.017*** (0.004)	0.016*** (0.004)	0.002 (0.003)	0.018*** (0.005)	57.591*** (12.074)
μ	0.70	0.71	0.24	0.17	0.08	0.60	906.39
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433

Notes: Heteroscedasticity robust standard errors clustered by school are in parentheses (* p<.10 ** p<.05 *** p<.01). The coefficients were generated using OLS, and specifications include fixed effects for graduation cohort and residentially assigned high school. All estimates also control for student characteristics including race, gender, income, disability, and language-learner status, as well as measures of suspensions, attendance, and middle school test scores. N (student-year observations) = 330,259.

(A) Estimates are of the effects of taking additional CTE courses in high school, where the comparison group is students who took fewer courses.

(B) Estimates are of the effects of taking additional CTE courses in high school, where the comparison group is students who took fewer courses, controlling for whether a student was a concentrator or not.

(C) Estimates are of the effects of concentrating, compared to an otherwise identical student who took the same number of courses but did not concentrate.

(D) Estimates are of the effects of concentrating, compared to an otherwise identical student who took the same number of courses but did not concentrate, controlling for dual enrolment status.

(E) Model includes fixed effects for industry cluster and has non-concentrators as the reference category, conditional on taking the same number of CTE courses.

TABLE B-5 | HETEROGENEITY OF THE EFFECTS OF PARTICIPATING IN CAREER AND TECHNICAL EDUCATION BY GENDER

	Graduated High School, 4 Years	Graduated High School, Ever	Initially Enroll, Any Postsecondary	Initially Enroll, 2-Year College	Initially Enroll, 4-Year College	Initially Employed	Initial Average Quarterly Wage
(A) Total CTE Courses - Female	0.030*** (0.001)	0.030*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	0.000 (0.001)	0.014*** (0.001)	22.651*** (1.965)
(A) Total CTE Courses - Male	0.03*** (0.001)	0.04*** (0.001)	0.00 (0.001)	0.01*** (0.001)	-0.00 (0.000)	0.01*** (0.001)	32.40*** (2.651)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433
(B) Concentrator - Female	0.193*** (0.005)	0.181*** (0.005)	0.021*** (0.006)	0.017*** (0.005)	0.006 (0.004)	0.008 (0.007)	0.328 (13.718)
(B) Concentrator - Male	0.23*** (0.005)	0.22*** (0.005)	0.00 (0.005)	0.01** (0.005)	-0.00 (0.003)	0.01*** (0.006)	89.30*** (16.352)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433

Notes: Heteroscedasticity robust standard errors clustered by school are in parentheses (* p<.10 ** p<.05 *** p<.01). The coefficients were generated using OLS, and specifications include fixed effects for graduation cohort and residentially assigned high school. All estimates also control for student characteristics including race, gender, income, disability, and language-learner status, as well as measures of suspensions, attendance, and middle school test scores.

(A) Estimates are of the effects of taking additional CTE courses in high school, where the comparison group is students of the same gender who took fewer courses.

(B) Estimates are of the effects of concentrating, compared to otherwise identical students of the same gender who took the same number of courses but did not concentrate.

TABLE B-6 | HETEROGENEITY OF THE EFFECTS OF PARTICIPATING IN CAREER AND TECHNICAL EDUCATION BY FREE OR REDUCED-PRICE LUNCH ELIGIBILITY

	Graduated High School, 4 Years	Graduated High School, Ever	Initially Enroll, Any Postsecondary	Initially Enroll, 2-Year College	Initially Enroll, 4-Year College	Initially Employed	Initial Average Quarterly Wage
(A) Total CTE Courses - Not FRPL-Eligible	0.029*** (0.001)	0.030*** (0.001)	0.006*** (0.001)	0.006*** (0.001)	-0.001 (0.000)	0.015*** (0.001)	30.685*** (2.125)
(A) Total CTE Courses - FRPL-Eligible	0.03*** (0.001)	0.04*** (0.001)	0.00 (0.001)	0.00 (0.001)	-0.00 (0.000)	0.01*** (0.001)	25.16*** (1.935)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433
(B) Concentrator - Not FRPL-Eligible	0.172*** (0.004)	0.164*** (0.004)	0.015*** (0.005)	0.017*** (0.005)	0.000 (0.004)	0.011* (0.006)	53.315*** (13.686)
(B) Concentrator - FRPL-Eligible	0.25*** (0.005)	0.24*** (0.005)	0.01*** (0.005)	0.01*** (0.004)	0.00 (0.003)	0.01*** (0.006)	39.30** (13.782)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433

Notes: Heteroscedasticity robust standard errors clustered by school are in parentheses (* p<.10 ** p<.05 *** p<.01). The coefficients were generated using OLS, and specifications include fixed effects for graduation cohort and residentially assigned high school. All estimates also control for student characteristics including race, gender, income, disability, and language-learner status, as well as measures of suspensions, attendance, and middle school test scores. N (student-year observations) = 330,259.

(A) Estimates are of the effects of taking additional CTE courses in high school, where the comparison group is students in the similar income group who took fewer courses.

(B) Estimates are of the effects of concentrating, compared to otherwise identical students in the similar income group who took the same number of courses but did not concentrate.

TABLE B-7 | HETEROGENEITY OF THE EFFECTS OF PARTICIPATING IN CAREER AND TECHNICAL EDUCATION BY URBANICITY

	Graduated High School, 4 Years	Graduated High School, Ever	Initially Enroll, Any Postsecondary	Initially Enroll, 2-Year College	Initially Enroll, 4-Year College	Initially Employed	Initial Average Quarterly Wage
(A) Total CTE Courses - Suburbs	0.032*** (0.001)	0.033*** (0.001)	0.008*** (0.001)	-0.002** (0.001)	0.000 (0.000)	0.015*** (0.001)	29.729*** (2.406)
N (student-year observations)	150,385	150,385	150,385	150,385	150,385	150,385	150,385
(B) Concentrator - Suburbs	0.203*** (0.008)	0.195*** (0.008)	0.020*** (0.007)	0.002 (0.004)	-0.000 (0.000)	0.012* (0.007)	39.309** (16.762)
N (student-year observations)	150,385	150,385	150,385	150,385	150,385	150,385	150,385
Mean	0.663	0.682	0.177	0.075	0.001	0.581	885.263
(A) Total CTE Courses - City	0.035*** (0.003)	0.037*** (0.003)	0.004*** (0.002)	-0.000 (0.002)	-0.000 (0.000)	0.019*** (0.002)	31.786*** (3.176)
N (student-year observations)	77,907	77,907	77,907	77,907	77,907	77,907	77,907
(B) Concentrator - City	0.163*** (0.017)	0.156*** (0.016)	0.018** (0.009)	-0.019*** (0.006)	-0.000 (0.000)	0.006 (0.010)	65.063*** (22.082)
N (student-year observations)	77,907	77,907	77,907	77,907	77,907	77,907	77,907
Mean	0.641	0.665	0.084	0.058	0.000	0.588	830.086
(A) Total CTE Courses - Rural	0.030*** (0.001)	0.030*** (0.001)	0.003** (0.001)	0.002* (0.001)	0.000 (0.000)	0.012*** (0.001)	23.268*** (3.215)
N (student-year observations)	101,967	101,967	101,967	101,967	101,967	101,967	101,967
(B) Concentrator - Rural	0.247*** (0.011)	0.241*** (0.010)	-0.001 (0.007)	0.010 (0.006)	-0.001* (0.000)	0.012 (0.008)	46.311** (18.527)
N (student-year observations)	101,967	101,967	101,967	101,967	101,967	101,967	101,967
Mean	0.692	0.708	0.177	0.090	0.001	0.584	912.484

Notes: Heteroscedasticity robust standard errors clustered by school are in parentheses (* p<.10 ** p<.05 *** p<.01). The coefficients were generated using OLS, and specifications include fixed effects for graduation cohort and residentially assigned high school. All estimates also control for student characteristics including race, gender, income, disability, and language-learner status, as well as measures of suspensions, attendance, and middle school test scores.

(A) Estimates are of the effects of taking additional CTE courses in high school, where the comparison group is students enrolled in schools with the same urbanicity who took fewer courses.

(B) Estimates are of the effects of concentrating, compared to otherwise identical students enrolled in schools with the same urbanicity who took the same number of courses but did not concentrate.

TABLE B-8 | HETEROGENEITY OF THE EFFECTS OF PARTICIPATING IN CAREER AND TECHNICAL EDUCATION CONCENTRATION IN "PRIORITY" CLUSTERS (STEM, INFORMATION TECHNOLOGY, AND HEALTH SCIENCES)

	Graduated High School, 4 Years	Graduated High School, Ever	Initially Enroll, Any Postsecondary	Initially Enroll, 2-Year College	Initially Enroll, 4-Year College	Initially Employed	Initial Average Quarterly Wage
(A) Total CTE Courses - Non-priority concentrators	0.032*** (0.002)	0.032*** (0.001)	0.011*** (0.002)	0.011*** (0.002)	0.000 (0.001)	0.018*** (0.002)	24.766*** (4.181)
(A) Total CTE Courses - Priority concentrators	0.03*** (0.001)	0.03*** (0.001)	0.01*** (0.001)	0.01*** (0.001)	-0.00 (0.000)	0.01*** (0.001)	27.67*** (1.879)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433
(B) Concentrator - Non-priority concentrators	0.184*** (0.011)	0.170*** (0.011)	0.075*** (0.019)	0.067*** (0.017)	0.008 (0.011)	0.017 (0.020)	-19.565 (41.064)
(B) Concentrator - Priority concentrators	0.21*** (0.004)	0.20*** (0.004)	0.01*** (0.004)	0.01*** (0.004)	0.00 (0.003)	0.01*** (0.005)	47.71*** (12.009)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433

Notes: Priority clusters are one of the three industries prioritized by Arkansas state policy (Health Sciences, Information Technology, and STEM). Heteroscedasticity robust standard errors clustered by school are in parentheses (* p<.10 ** p<.05 *** p<.01). The coefficients were generated using OLS, and specifications include fixed effects for graduation cohort and residentially assigned high school. All estimates also control for student characteristics including race, gender, income, disability, and language-learner status, as well as measures of suspensions, attendance, and middle school test scores.

(A) Estimates are of the effects of taking additional CTE courses in high school, where the comparison group is students with the same type of concentration (priority or non-priority) who took fewer courses.

(B) Estimates are of the effects of concentrating in either a priority or non-priority, compared to otherwise identical students who took the same number of courses but did not concentrate.

TABLE B-9 | HETEROGENEITY OF THE EFFECTS OF PARTICIPATING IN CAREER AND TECHNICAL EDUCATION BY DUAL ENROLLMENT STATUS

	Graduated High School, 4 Years	Graduated High School, Ever	Initially Enroll, Any Postsecondary	Initially Enroll, 2-Year College	Initially Enroll, 4-Year College	Initially Employed	Initial Average Quarterly Wage
(A) Total CTE Courses - No Dual Enrollment	0.051*** (0.001)	0.052*** (0.001)	0.006*** (0.001)	0.007*** (0.000)	-0.000 (0.000)	0.016*** (0.001)	31.638*** (1.551)
(A) Total CTE Courses - Dual Enrollment	0.03*** (0.001)	0.03*** (0.001)	0.01*** (0.002)	0.01*** (0.002)	-0.01*** (0.001)	0.01*** (0.002)	35.68*** (4.293)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433
(A) Concentrator - No Dual Enrollment	0.214*** (0.004)	0.207*** (0.004)	0.011** (0.004)	0.011*** (0.004)	0.002 (0.003)	0.010** (0.005)	46.400*** (11.978)
(A) Concentrator - Dual Enrollment	0.07*** (0.008)	0.06*** (0.008)	0.06*** (0.011)	0.09*** (0.011)	-0.03** (0.009)	0.00 (0.012)	33.07 (30.177)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433

Notes: Heteroscedasticity robust standard errors clustered by school are in parentheses (* p<.10 ** p<.05 *** p<.01). The coefficients were generated using OLS, and specifications include fixed effects for graduation cohort and residentially assigned high school. All estimates also control for student characteristics including race, gender, income, disability, and language-learner status, as well as measures of suspensions, attendance, and middle school test scores. N (student-year observations) = 330,259.

(A) Estimates are of the effects of taking additional CTE courses in high school, where the comparison group is students with similar dual enrollment status who took fewer courses.

(B) Estimates are of the effects of concentrating, compared to otherwise identical students with similar dual enrollment status who took the same number of courses but did not concentrate.

TABLE B-10 | MATCHING ESTIMATES OF THE EFFECT OF BEING A CONCENTRATOR IN CAREER AND TECHNICAL EDUCATION

	Graduated High School, 4 Years	Graduated High School, Ever	Initially Enroll, Any Postsecondary	Initially Enroll, 2-Year College	Initially Enroll, 4-Year College	Initially Employed	Initial Average Quarterly Wage
Concentrators	0.207*** (0.005)	0.199*** (0.004)	0.022*** (0.004)	0.018*** (0.004)	0.005** (0.003)	-0.003 (0.005)	20.618 (12.841)
N	64,716	64,716	64,716	64,716	64,716	64,716	64,716

Notes: Heteroscedasticity robust standard errors clustered by school are in parentheses (* p<.10 ** p<.05 *** p<.01). Estimates are of the effects of being a concentrator where the comparison group are matched students who were never CTE concentrators but who may have taken CTE coursework. The coefficients shown were generated using coarsened exact matching, where treated and control students were matched on ninth grade characteristics and middle school math and literacy test scores, including absences and suspension in eighth grade and the total number of courses taken in CTE. Specifications include fixed effects for graduation cohort and high school.

TABLE B-11 | OLS ESTIMATES OF THE EFFECTS OF PARTICIPATING IN CAREER AND TECHNICAL EDUCATION

	Graduated High School, 4 Years	Graduated High School, Ever	Initially Enroll, Any Postsecondary	Initially Enroll, 2-Year College	Initially Enroll, 4-Year College	Initially Employed	Initial Average Quarterly Wage
(A) Effect of taking any CTE class (versus none)	0.190*** (0.006)	0.197*** (0.006)	0.053*** (0.005)	0.035*** (0.004)	0.020*** (0.004)	0.105*** (0.007)	102.084*** (15.278)
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433
(B) Effect of taking CTE in an additional year of high school	0.022*** (0.001)	0.023*** (0.001)	0.004*** (0.001)	0.003*** (0.001)	0.001 (0.001)	0.017*** (0.001)	22.078*** (2.912)
μ	0.70	0.71	0.24	0.17	0.08	0.60	906.39
N	104,433	104,433	104,433	104,433	104,433	104,433	104,433

Notes: Heteroscedasticity robust standard errors clustered by school are in parentheses (* p<.10 ** p<.05 *** p<.01). The coefficients were generated using OLS, and specifications include fixed effects for graduation cohort and residentially assigned high school. All estimates also control for student characteristics including race, gender, income, disability, and language-learner status, as well as measures of suspensions, attendance, and middle school test scores. N (student-year observations) = 330,259.

(A) Estimates are of the effects of taking any CTE course in high school, where the comparison group is students who did not take any.

(B) Estimates are of the effects of taking CTE in an additional year of high school, where the comparison group is students who took CTE courses in fewer.

ADDITIONAL ANALYSES REFERENCED IN THE TEXT BUT NOT PRESENTED ARE AVAILABLE UPON REQUEST.

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1 The impact of concentrating is potentially an overestimate because differences in outcomes (especially those in college-going and wages) could be driven by differences in the chosen area of concentration (say, agriculture as compared to STEM), which as noted also differs by student characteristics. Further, robustness checks cannot adequately account for endogenous choices (such as intrinsic qualities of a student who self-selects into concentrating as opposed to taking a large number of uncoordinated classes), which are potentially intertwined with the effects of concentrating. The reader should be aware of these caveats, which are carefully considered when making the recommendations that follow.

2 A. Gamoran and R. Mare, "Secondary School Tracking and Educational Inequality: Composition, Reinforcement, or Neutrality?" *American Journal of Sociology* 94 (1989), 1146–1183.

3 See, for instance, W. Symonds, R. Schwartz, and R. Ferguson, "Pathways to Prosperity: Meeting the Challenge of Preparing Young Americans for the 21st Century" (Cambridge, MA: Pathways to Prosperity Project, Harvard Graduate School of Education, February 2011), http://www.gse.harvard.edu/sites/default/files//documents/Pathways_to_Prosperity_Feb2011-1.pdf.

4 States do receive some federal monies, which they then allocate to districts so they can purchase equipment and materials, build labs, hire and train staff, offer career counseling and guidance, and provide supplemental services for special populations. Additionally, some states have made their own investments in CTE, which have allowed them to experiment with a variety of new delivery models, including Career Academies, ConnectEd, and other specialized schools with a CTE focus.

5 National Skills Coalition, "Carl D. Perkins Career and Technical Education Act: Recommendations for Reauthorization" (Washington, D.C.: National Skills Coalition, October 2015), http://www.nationalskillscoalition.org/resources/publications/file/NSC-PerkinsActpolicypaper_web.pdf.

6 See W. Norton Grubb, "The New Vocationalism: What It Is, What It Could Be," *The Phi Delta Kappan* 77, no. 8 (April 1996), 535–536, 538–546, and T. Lewis and S. Cheng, "Tracking, Expectations, and the Transformation of Vocational Education," *American Journal of Education* 113, no. 1 (November 2006), 67–99.

7 Unfortunately, these figures are the most recent available from "Career/ Technical Education (CTE) Statistic: Table H1. Percentage of public high schools that are regular, career/ technical, and other special focus, and various characteristics of each school type: 2008" (Washington, D.C.: National Center for Education Statistics), accessed May 16, 2013, http://nces.ed.gov/surveys/ctes/tables/h01.asp.

8 NCES, "Career/ Technical Education (CTE) Statistic: Table H125. Average number of credits and percentage of total credits that public high school graduates earned during high school, by curricular area: 1990, 2000, 2005, and 2009" (Washington, D.C.: National Center for Education Statistics), accessed May 16, 2013, http://nces.ed.gov/surveys/ctes/tables/h125.asp. Though more recent national data are unavailable, trends within states suggest the decline in exposure has likely continued. For example, between 2000 and 2015, Oregon halved its CTE offerings. See L. Frazier, "After Years of Decline, Oregon Rebuilds School-to-Career Programs," *Oregonian*, April 23, 2015, http://www.oregonlive.com/education/index.ssf/2015/04/after_years_of_decline_oregon.html. Similarly, the proportion of California students who took a career and technical education course declined by 12 percent between 2011–12 and 2012–13. See S. Frey, "New Report Fuels Fears of Decline of Regional Occupational Programs," *EdSource*, January 26, 2014, http://edsource.org/2014/new-report-fuels-fears-of-decline-of-regional-occupational-programs/56617.

9 Arkansas Department of Career Education, "Sample Plan of Study," http://ace.arkansas.gov/cte/careerClusters/Documents/Sample%20Advanced%20Manufacturing%20Program.pdf.

10 More specifically, in Arkansas, the state Department of Career Education sets guidelines for each program of study, including required and potential elective courses and their respective course descriptions. Districts then decide which programs of study to offer and which specific electives will be available to students, and the state reviews and approves the programs. See Arkansas Department of Career Education, "Career and Technical Education Program Operational Guides," April 2015, http://ace.arkansas.gov/cte/informationForms/Documents/2015%20Updates/Program%20operational%20guides_Updated%20April%202015.pdf.

11 Although "concentrating" generally means a student focuses in a single program of study, the required number of courses in that program of study is determined by each state and varies nationally. See C. Dortch, "Carl D. Perkins Career and Technical Education Act of 2006: Implementation Issues" (Washington, D.C.: Congressional Research Service, December 14, 2012), https://www.fas.org/sgp/crs/misc/R42858.pdf.

12 NCES, "Secondary/High School Level Glossary" (Washington, D.C.: National Center for Education Statistics), accessed May 29, 2013, http://nces.ed.gov/surveys/ctes/tables/glossary_secondary.asp.

13 The No Child Left Behind Act of 2001 (NCLB) created a strong incentive for schools to focus on reading and math at the expense of other subjects, which may have contributed to the decline in CTE enrollment (especially among demographic subgroups among which CTE enrollment was particularly high).

14 J. Kemple and C. Willner, "Career Academies: Long-Term Impacts on Labor Market Outcomes, Educational Attainment, and Transitions to Adulthood," (New York, NY: MDRC, June 2008), http://www.mdrc.org/publication/career-academies-long-term-impacts-work-education-and-transitions-adulthood; D. Stern, C. Dayton, and M. Raby, "Career Academies: A Proven Strategy to Prepare High School Students for College and Careers" (Berkeley, CA: Career Academy Support Network, 2010), http://casn.berkeley.edu/resources.php?r=158.

15 U.S. Department of Education, "Expanding Successful Career and Technical Education Through Career Academies," http://www2.ed.gov/about/offices/list/ovae/pi/cte/transforming-career-technical-education-expanding.pdf; J. Kemple and C. Willner, "Career Academies: Long-Term Impacts on Work, Education, and Transitions to Adulthood"; M. Silverberg et al., "National Assessment of Vocational Education - Final Report to Congress Executive Summary" (Washington, D.C.: U.S. Department of Education, Office of the Under Secretary of Policy and Program Study Service, 2004), accessed May 17, 2013, http://www2.ed.gov/rschstat/eval/sectech/nave/naveexesum.pdf; K. Hollenbeck and W. Huang, 2014, "Net Impact and Benefit-Cost Estimates of the Workforce Development System in Washington State," Upjohn Institute Technical Report No. 13-029 (Kalamazoo, MI: W. E. Upjohn Institute for Employment Research, 2014), http://research.upjohn.org/up_technicalreports/29/; J. Bishop and F. Mane, "The Impacts of Career-Technical Education on High School Labor Market Success," *Economics of Education Review* 23, 381–402.

16 Several studies have also examined how CTE benefits students when taken at the community college level. For example, Hollenbeck and Huang find clear wage and employment benefits; see K. Hollenbeck and W. Huang, "Net Impact and Benefit-Cost Estimates of the Workforce Development System in Washington State"; K. Hollenbeck and W. Huang, "Workforce Program Performance Indicators for the Commonwealth of Virginia," Upjohn Institute Technical Report No. 08-024 (Kalamazoo, MI: W. E. Upjohn Institute for Employment Research, 2007), http://research.upjohn.org/cgi/viewcontent.cgi?article=1027&context=up_technicalreports. Recent studies also find clear wage benefits to postsecondary CTE, but no differences in the rate of degree completion, or in the specific returns of their programs; A. Stevens, M. Kurlaender, and M. Grosz, "Career Technical Education and Labor Market Outcomes: Evidence from California Community Colleges," NBER Working Paper No. 21137 (Cambridge, MA: National Bureau of Economic Research, April 2015), http://www.nber.org/papers/w21137; D. Xu and M. Trimble, "What About Certificates? Evidence on the Labor Market Returns to Non-Degree Community College Awards in Two States" (New York, NY: Community College Research Center, Columbia University Teachers College, November 2014), http://ccrc.tc.columbia.edu/media/k2/attachments/what-about-certificates-returns-to-non-degree-awards.pdf.

17 M. Castellano, et al., "Rigorous Tests of Student Outcomes in CTE Programs of Study: Year 3 Report" (Louisville, KY: National Research Center for Career and Technical Education, June 2011), http://www.nrccte.org/sites/default/files/publication-files/rigorous_tests_year_3_final_report.pdf; S. Dougherty, "The Effect of Career and Technical Education on Human Capital Accumulation: Causal Evidence from Massachusetts" (Washington, D.C.: Society for Research on Educational Effectiveness Spring Conference, March 2015), http://chasp.lbj.utexas.edu/author/ch26626/files/2015/04/EffectofCareerandTechnicalEducation.pdf.

18 M. Karp et al., "The Postsecondary Achievement of Participants in Dual Enrollment: An Analysis of Student Outcomes in Two States" (St. Paul, MN: National Research Center for Career and Technical Education, University of Minnesota, October 2007), http://67.205.94.182/media/k2/attachments/dual-enrollment-student-outcomes.pdf; K. Hughes, et al., "Broadening the Benefits of Dual Enrollment: Reaching Underachieving and Underrepresented Students with Career-Focused Programs" (New York, NY: Community College Research Center, Columbia University Teachers College, July 2012), http://67.205.94.182/media/k2/attachments/broadening-benefits-dual-enrollment-rp.pdf; D. Allen and M. Dadgar, "Does Dual Enrollment Increase Students' Success in College? Evidence from a Quasi-Experimental Analysis of Dual Enrollment in New York City" *New Directions for Higher Education* 158 (2012), 11–19; A. Berger et al., "Early College, Early Success: Early College High School Initiative Impact Study" (Washington, D.C: American Institutes for Research, September 2013), http://www.mtsac.edu/president/board-reports/ECHS_Impact_Study_Sep2013.pdf.

19 J. Kemple and C. Willner, "Career Academies: Long-Term Impacts on Labor Market Outcomes, Educational Attainment, and Transitions to Adulthood."

20 M. Silverberg et al., "National Assessment of Vocational Education."

21 R. Bozick and B. Dalton, "Balancing Career and Technical Education with Academic Coursework: The Consequences for Mathematics Achievement in High School," *Educational Evaluation and Policy Analysis* 35, no. 1 (June 2013), 123–138.

22 Association for Career and Technical Education, "State Profiles," March 2015, https://www.acteonline.org/stateprofiles/.

23 The bill expands the supply of qualified workers for these positions by creating opportunities for job training and career planning. Resources for providers of training programs are contingent upon participants receiving course credit that can be applied to a certificate of proficiency, technical certificate, Associate of Applied Science degree, or a Bachelor of Applied Science degree.

24 Although there is no supporting documentation, it is possible that students with special needs could be exempt from the Smart Core requirements. Families can also request waivers from the Smart Core requirements: http://www.arkansased.gov/public/userfiles/Learning_Services/Curriculum%20and%20Instruction/Smartcore%20Core/smartcore_waiver_2015_05062015.pdf.

25 As explained in the technical appendix, the ramp-up in course offerings for Smart Core provides plausible exogenous variation from which to verify some of the estimates of the impacts of CTE course taking.

26 Association for Career and Technical Education, "State Profiles," March 2015, https://www.acteonline.org/stateprofiles/.

27 Arkansas Department of Career Education, "Arkansas Career Academies," http://ace.arkansas.gov/cte/specialPrograms/careerAcademies/Pages/careerAcademyInitiatives.aspx.

28 At the postsecondary level, CTE is delivered through the community colleges as well as three technical institutes, which offer programs with certificates that can be completed in as little as six to twelve weeks or one to two years. See L. Golden, "A Lifetime of Learning: Arkansas Colleges and Universities: Continuing Education Opportunities Abound in Arkansas," Arkansas.com, http://www.arkansas.com/relocate/education/; Arkansas Department of Career Education, "Technical Institutes," http://ace.arkansas.gov/cte/Pages/technicalInstitutes.aspx.

29 Arkansas Department of Career Education, "Sample Plan of Study," http://ace.arkansas.gov/cte/careerClusters/Documents/Sample%20Advanced%20Manufacturing%20Program.pdf.

30 Arkansas Department of Education, "Rules Governing Standards for Accreditation of Arkansas Public Schools and School Districts," October 2014, http://www.arkansased.gov/public/userfiles/rules/Current/EMERGENCY_RULES_Showing_markups.pdf; Arkansas Department of Higher Education, "Academic Challenge Scholarships," http://scholarships.adhe.edu/scholarships-and-programs/high-school/.

31 Despite being formally introduced as a requirement for the class of 2014, there was apparently some confusion, and schools began pushing students to meet these requirements beginning with the class of 2013. Both classes are included in this study.

32 Data are also available for eighth grade for Cohorts 2 and 3, but not Cohort 1 due to a change in Arkansas record keeping. However, the results are not sensitive to using all three cohorts with only high school-level covariates, or just the last two cohorts and including eighth grade measures as well.

33 Natural variation in the labor market for CTE teachers (across fields) created quasi-random variation in the year-to-year within school CTE course offerings. I capitalize on this randomness in the offering of programs as a way to isolate random variation in CTE course taking, and then estimate the effects of that course taking on student outcomes. Robustness of results applies to estimates where total CTE courses taken is used as the measure of CTE exposure. IV results cannot be replicated for the decision to concentrate in a particular industrial cluster.

34 Counting only students who took at least one CTE course, the average is 5.5 courses. Even students in the most recent graduating class, who faced the Smart Core requirement of six "career focus" classes, may not have taken six CTE courses. As noted earlier, other courses, besides those officially designated as "CTE" in the state database, can be considered "career focus." For example, AP courses, world language, and other electives could satisfy the career focus requirement, but are not classified as CTE. The determination of which courses (CTE or otherwise) meet the career focus requirement is made at the school level, by a student's guidance counselor. See Arkansas School Boards Association, "Smart Core Curriculum and Graduation Requirements: Class of 2018 and Thereafter," 2014, http://www.vbsd.us/policies/pdfs/4.45.1--Smart%20Core%20Curriculum%20and%20Grad%20Requirements-Class%20of%202018%20and%20Thereafter.pdf.

35 D. Kriesman and K. Stange, "Vocational and Career Tech Education in American High Schools: Curriculum Choice and Labor Market Outcomes," March 2015, http://chasp.lbj.utexas.edu/author/ch26626/files/2015/04/VocationalandCareerTechEducation.pdf; NCES, "Career/ Technical Education (CTE) Statistic: Table H125. Average number of credits and percentage of total credits that public high school graduates earned during high school, by curricular area: 1990, 2000, 2005, and 2009" (Washington, D.C.: National Center for Education Statistics), accessed May 16, 2013, http://nces.ed.gov/surveys/ctes/tables/h125.asp.

36 Arkansas Department of Career Education, "Career Academy Schools," http://ace.arkansas.gov/cte/specialPrograms/careerAcademies/Pages/careerAcademySchools.aspx.

37 Dual enrollment statistics represent CTE students who are simultaneously enrolled in high school and college; course records do not indicate what courses, CTE or otherwise, these students took.

38 For ease of presentation, these divisions were chosen based on patterns observed in the data. Roughly 30 percent of students take between zero and two CTE courses, 40 percent take between three and six, and 30 percent take seven or more.

39 Higher representation of students with disabilities may imply old-fashioned negative tracking, as shown in the past, but other recent work using data from Massachusetts suggests that CTE may be used to the benefit of students with disabilities. See T. Hehir, S. Dougherty, and T. Grindal, "Students with Disabilities in Massachusetts Career and Technical Education Programs" (Malden, MA: Massachusetts Department of Elementary and Secondary Education), http://www.doe.mass.edu/sped/hehir/2013-07cte.pdf.

40 An additional variation not presented here is age. Juniors and seniors take more CTE courses than freshmen and sophomores, which is an expected variation since the latter have fewer opportunities for electives. Male students also have a lower graduation rate. So it is also possible that male students are taking fewer CTE courses simply because they are not completing their senior or even junior year of high school.

41 Further, 14 percent of students in the sample are missing test scores, and these students are disproportionately taking only a few CTE classes. So while the low- and average-achieving students appear to be underrepresented in the two-or-fewer courses category, that might not actually be the case; instead, those students could have missing test scores.

42 As previously noted, some courses are not officially labeled "CTE" but are nonetheless "career focus." High-performing students are likely taking career focus Advanced Placement courses, which may explain why students with more than six high school CTE courses have lower middle school test scores.

43 City schools enroll higher percentages of minority and English language learner students compared to their suburban and rural counterparts. Notably, in other states, cities often have higher proportions of students who are free or reduced-price lunch eligible, but this is not true in Arkansas, where two-thirds of all students are eligible regardless of where their school is located.

44 Observed differences may be due to student preference, or because schools in certain areas are more or less likely to offer certain courses and students are simply taking what is available to them.

45 There is no significant difference, positive or negative, on enrollment in a four-year college. All OLS results presented in this section control for concentrator status, so the benefits of additional exposure are averaged across concentrators and non-concentrators (see Appendix B, Table B-4). It is possible that the relationship between CTE and improved college-going and employment outcomes is conflated with the relationship between graduation and these outcomes (since a student who graduates high school also has more time to take CTE). However, the results here are supported by the IV analyses where possible, which are less susceptible to this possibility because students are unlikely to drop out prior to tenth grade—meaning they would have two years to have their behavior (and post-high school outcomes) impacted by changes in CTE offerings. For the benefit of concentration, see Section Three, *Results*.

46 The continuous measure is preferable for analysis purposes, as it is a both discrete and an actionable unit. It is also preferable because the results of the analysis using the continuous measure can be verified with an instrumental variable approach; results of the two analyses are similar. Finally, an additional analysis explores the impact of the impact of taking any CTE course versus none; taking at least one CTE course had a positive impact on all the outcome measures. However, because the majority of Arkansas students take at least one class, the results of such an analysis are not particularly illuminating. For full results of all analyses, see Appendix B.

47 A. Carnevale et al., "Learning While Earning: The New Normal" (Washington, D.C.: Georgetown University Center on Education and the Workforce, 2015), https://cew.georgetown.edu/wp-content/uploads/Working-Learners-Report.pdf.

48 This appears to be largely by design. The clusters with high rates of dual enrollment also have some of the clearest educational pathways into college, especially community college. Dual enrollment may smooth the transition for students in these concentrations. The potential upside of such programs is that they might increase participation in postsecondary education if they can reduce costs or information barriers for students who would not otherwise pursue college right away or at all.

49 An important caveat to all the findings in this section: the impact of concentrating is likely an overestimate because differences (especially those in college-going and wages) could be driven by differences in the chosen area of concentration. Furthermore, the instrumental variable cannot adequately account for endogenous choices to becoming a CTE concentrator, which should give the reader greater caution when interpreting these results.

50 A natural follow-up is whether concentrating magnifies the impact of additional coursework; it does not. For a concentrator, taking one additional course above the (already high) average is not related to any significant change in outcomes, whereas there are benefits of additional coursework for non-concentrators. This is likely because concentrators on average take about 8.5 CTE courses; they have "maxed out" the benefits of high exposure. Non-concentrators take only about 3.4 courses on average, so an additional course does have benefits for them. These benefits, however, are significantly smaller than the boosts concentrators see compared to high-exposure but non-concentrating peers. See Appendix B.

51 Differences in wages could also be driven by differences in the chosen area of concentration. Similarly, gender selection into different concentrations is the likely explanation for concentration having a greater impact on the likelihood of postsecondary enrollment for female students as compared to male. See Appendix B, Table B-5.

52 Granted, this recommendation only works if (1) course offerings allow students to complete a concentration, and (2) the career pathways available to students are aligned with the labor market needs.

53 S. Iacus, G. King, and G. Porro, "Causal Inference Without Balance Checking: Coarsened Exact Matching" *Political Analysis*, August 2011, http://gking.harvard.edu/files/political_analysis-2011-iacus-pan_mpr013.pdf.

54 G. Imbens and J. Wooldridge, "Recent Developments in the Econometrics of Program Evaluation," *Journal of Economic Literature* 47, no. 1 (2009), 5–86, https://dash.harvard.edu/bitstream/handle/1/3043416/imbens_recent.pdf?sequence=2.

55 To test the sensitivity of my estimates generated by CEM, I employ several other matching estimators to confirm that the magnitude and significance of my results are not driven by my choice of matching estimator.